Position Papers from

The Third National Injury Control Conference

"Setting the National Agenda for Injury Control in the 1990s"

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
Public Health Service
Centers for Disease Control

US Department of Transportation
National Highway Traffic Safety Administration

CDC
CENTERS FOR DISEASE CONTROL

Position Papers
from

The Third National Injury Control Conference

"Setting The National Agenda for Injury Control in the 1990s"

April 22-25, 1991
Denver, Colorado

Department of Health and Human Services
Public Health Service
Centers for Disease Control
National Center for Environmental Health and Injury Control
Division of Injury Control
in conjunction with
National Institute for Occupational Safety and Health
and
National Highway Traffic Safety Administration

PREFACE

This is the report of the seven injury control panels convened by the Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control (CDC), to assess where the field of injury control should be headed during the 1990s. The production of this report reflects the growing awareness of the public health impact of injuries and of the promise that this fledgling field offers for enhancing the health and well-being of the public.

Injury control has experienced modest growth in resources and substantial impact since the creation of the injury control program at CDC, subsequent to the 1985 National Academy of Sciences (NAS) report, *Injury in America**. In the NAS report, the authors noted that the breadth of injury control, defined as including prevention, acute care, and rehabilitation, requires coordination across many disciplines and jurisdictions. They also noted the need for coordinated leadership by CDC at the federal level. In a later report, the Academy reviewed the status of the CDC program and called for the development of an explicit national plan as part of this coordinated leadership.

The production of this report with input by staff from 14 federal agencies and by hundreds of experts from a wide range of specialties attests to CDC's commitment to coordinating and catalyzing the injury control field.

The position papers in this report represent the work of the contributing authors listed at the beginning of each paper who served on the seven panels during the past year and a half. While the recommendations reflect the best collection of the panelists' thoughts, they do not always represent unanimity. These opinions have been refined by an extensive written review process, as well as by discussion of their contents at the Third National Injury Control Conference, April 1991, in Denver. We, as chairpersons of the seven panels, trust that the ideas contained herein will be helpful to CDC in developing its national plan for injury control. We also expect that these position papers will go a long way toward achieving the coordination of injury control efforts at various levels of government. Our experience at the Third National Injury Control Conference in Denver has convinced us that the field of injury control shares not only common goals but a strategic plan for achieving these goals.

Susan P. Baker, M.P.H.

Theodore M. Cole, M.D.

Felton J. Earls, M.D.

A. Brent Eastman, M.D.

Thomas A. Gennarelli, M.D.

John D. Graham, Ph.D.

Frank R. Lewis, M.D.

Leon S. Robertson, Ph.D.

C. William Schwab, M.D.

*Committee on Trauma Research, Commission on Life Sciences, National Research Council, and the Institute of Medicine. Injury in America: a continuing public health problem. Washington (DC) National Academy Press, 1985.

These position papers were solicited by the Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control (CDC), Public Health Service, U.S. Department of Health and Human Services, Atlanta, Georgia, for the Third National Injury Control Conference, held April 22-25, 1991, in Denver, Colorado. The views expressed are those of the contributors and do not necessarily represent the policy of CDC or any other federal agency. Furthermore, although all contributors agreed on the overall content of the papers, they did not agree on every recommendation. Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

April 1992

Acknowledgement
Appreciation is extended to
Martha Ann Highsmith and Deloris Coleman
for their invaluable assistance, and also to
Melissa Wilkes Chamberland
for her technical assistance.

Table of Contents

Prevention of Violence and Injuries Due to Violence

Home and Leisure Injury Prevention

Occupational Injury Prevention

Trauma Care Systems

Acute Care Treatment

Rehabilitation of Persons with Injuries

FOREWORD

The concern and interest of the American public, policy makers, and public health professionals have increasingly focused on the problem of injury, including the high number of deaths and disabilities and the enormous costs, both human and financial, to our country. As part of this increased focus, the Committee on Trauma Research and the Institute of Medicine, in the *Injury in America* report, and, subsequently, the Secretary's Advisory Committee for Injury Prevention and Control called for a national plan to control injuries. As the first step in developing such a plan, the National Center for Environmental Health and Injury Control (NCEHIC) and the National Institute for Occupational Safety and Health (NIOSH) of the Centers for Disease Control (CDC) have spent more than a year facilitating the development of the position papers in this book. The plan will help shape the future of injury control research, programs, and policies for this decade.

The objectives of the seven position papers are to (a) define the field of injury control, (b) assess the current status of injury control research and programs, (c) help CDC, other federal agencies, and nongovernmental organizations clearly define directions and priorities in a coordinated way, (d) identify what interventions should be evaluated and disseminated, (e) plan for the development of injury control program capacity in state and local health departments and other agencies, and (f) identify organizations and opportunities for carrying out various research and programmatic recommendations.

In their leadership role, NCEHIC and NIOSH sought input from experts from many sectors — federal, state, and local government; academic institutions; industry and labor; and a wide range of national organizations. At the beginning of this process, we asked some 150 experts to assist us. It was particularly encouraging that representatives of many agencies from seven federal departments participated. These agencies are as follows: **(Department of Defense)** Department of the Air Force; **(Department of Education)** National Institute on Disability and Rehabilitation Research; **(Department of Health and Human Services)** Maternal and Child Health Bureau, Alcohol Drug Abuse and Mental Health Administration, including the National Institute of Mental Health and the National Institute on Alcohol Abuse and Alcoholism, and the National Institutes of Health, including the National Institute on Aging and the National Institute of Child Health and Human Development; **(Department of Justice)** National Institute of Justice; **(Department of Labor)** Bureau of Labor Statistics and the Occupational Safety and Health Administration; **(Department of Transportation)** Federal Highway Administration and the National Highway Traffic Safety Administration; **(Department of Veterans Affairs)** Veterans Affairs Medical Center; and the Consumer Product Safety Commission.

Additional participation came from people representing motor vehicle safety advocacy, trauma surgery, neurosurgery, orthopedic surgery, pediatrics, emergency and rehabilitation

medicine, trauma nursing, public health, biomechanics, emergency medical services (EMS) and trauma system management, survivors of injury, and national safety programs.

We asked these experts to address the objectives in their respective fields of interest by answering three key questions: (I) Where are we? (II) Where do we want to be at the end of the decade? (III) How do we get there? As a result, seven draft papers were developed for those who attended the Third National Injury Control Conference and others interested in the field of injury. These preconference position papers were devoted to motor vehicle injury prevention, violence prevention, unintentional injury prevention (later retitled home and leisure injury prevention), occupational injury prevention, trauma care systems, acute care treatment, and rehabilitation of persons with injuries. Numerous reviewers submitted written comments, and at the conference the conferees debated and discussed the papers extensively. Indeed, the conference theme, "Setting the National Agenda for Injury Control in the 1990s," was chosen to encourage conferees to devote almost the entire conference to discussing the development of a national plan.

On the basis of the written comments from almost 200 reviewers and the discussions at the conference, the seven panels of experts who produced the draft papers revised them. These revisions are the position papers in this book. Although the recommendations in these papers express the opinions of the authors, not CDC, we believe that these recommendations represent an important and substantial step forward in the identification of injury control priorities for this Nation. The CDC will consider these position papers, along with the input from reviewers, conference attendees, and other federal agencies in developing a national plan for injury control.

Each of the position papers contains topic-specific recommendations. The major topic-specific recommendations are contained in the Executive Summaries that follow this introduction. In addition, each paper has independently addressed broader crosscutting issues relating to the overall field of injury control. The consistency of these recommendations from paper to paper emphasizes their importance to all injury control professionals, regardless of their area of expertise, and warrants their restatement here. They include the following:

- Increase public awareness of injuries and injury control.
- Increase attention and support from the Office of the Assistant Secretary for Health to coordinate multiagency and multidepartment efforts.
- Increase resources for injury surveillance, research, control programs (state capacity), intervention evaluation, training, and health services.
- Allow cooperative industry/government research and development projects.
- Require E-codes for all hospital discharges as part of a national surveillance system.
- Establish a Center for Injury Control at CDC to provide national leadership.
- With CDC playing a key role, develop a national applied injury control research laboratory to study both human and engineering factors.

Injury control's unique challenge to cut across many organizational and disciplinary boundaries has required a similarly unique approach to leadership, with widespread coordination and clear communication. This approach, in turn, will require an enormous effort and substantial resources to overcome boundaries and implement a coordinated plan for injury control in the United States. We believe that in these times of economic restraint our best chance of attracting the public attention and institutional support needed to make injury control a practical reality rests upon our ability to join together and produce a clear and compelling national plan.

Finally, we acknowledge the dedication and tremendous effort of the chairpersons, panelists, reviewers, conference attendees, and CDC staff who made these papers possible. We are very grateful for their hard work and commitment.

Vernon N. Houk, M.D.
Assistant Surgeon General
Director
National Center for Environmental Health and Injury Control

J. Donald Millar, M.D.
Assistant Surgeon General
Director
National Institute for Occupational Safety and Health

Mark L. Rosenberg, M.D., M.P.P.
Director
Division of Injury Control
National Center for Environmental Health and Injury Control

Richard J. Waxweiler, Ph.D.
Special Assistant for Scientific Affairs
Division of Injury Control
National Center for Environmental Health and Injury Control

Executive Summaries

Motor Vehicle Injury Prevention
— Contributors —

John Graham, Ph.D., Chairperson, Harvard School of Public Health, Boston, MA

Patricia Waller, Ph.D.,* University of Michigan Transportation Research Institute, Ann Arbor, MI

Terence Chorba, M.D., M.P.H., M.A., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Marilena Amoni, M.S., Traffic Safety Programs/National Highway Traffic Safety Administration, Washington, DC

R. Clark Bennett, Federal Highway Administration, Washington, DC

B.J. Campbell, Ph.D., University of North Carolina, Highway Safety Research Center, Chapel Hill, NC

Kennerly Digges, Ph.D., University of Virginia, Automobile Safety Program, Charlottesville, VA

Michael Finkelstein, M.A., Federal Highway Administration, Washington, DC

Thomas Hall, Federal Highway Administration, Washington, DC

Howard Hanna, P.E., Federal Highway Administration, Washington, DC

Ralph Hitchcock, M.S., Research and Development/National Highway Traffic Safety Administration, Washington, DC

Garland Land, M.P.H., Missouri Department of Health, Jefferson City, MO

William M. Marine, M.D., M.P.H., University of Colorado School of Medicine, Denver, CO

Robert Munson, M.B.A., Ford Motor Company, Dearborn, MI

Robert Nicholson, M.A., Traffic Safety Programs/National Highway Traffic Safety Administration, Washington, DC

Brian O'Neill, Insurance Institute for Highway Safety, Arlington, VA

Jeffrey Pike, M.E., Ford Motor Company, Dearborn, MI

Judith Lee Stone, Advocates for Auto and Highway Safety, Washington, DC

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Roy Thigpen, M.Ed., Governor's Representative for Highway Safety, Jackson, MS

David Viano, Ph.D., General Motors Research Laboratories, Warren, MI

David Wallace, M.S.E.H., Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Deborah D. Landen, M.D., National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

Julie Russell, Ph.D., Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Nicole Lezin, M.P.P., Macro International, Inc., Atlanta, GA

Motor Vehicle Injury Prevention
Executive Summary

Many injuries associated with motor vehicle crashes are preventable. In 1985, motor vehicle crashes cost our Nation more than $75 billion. About 65% of this amount was the result of only 15% percent of the crashes — those that caused death or injury (1). By 1991, this sum had increased considerably because of increases in the number of crash injuries and fatalities, increases in the cost of medical treatment and vehicle repair, and a rise in general price levels.

But it is not the impact on our economy that is the force behind our desire to reduce the mortality and morbidity associated with highway crashes. Rather, it is the human tragedy that these crashes represent — the 45,000 persons killed on our roads each year; the fact that more than 60% of these victims are not yet 35 years of age; and the fact that almost every day, throughout the United States, 125 families meet at grave sites to bury a loved one killed in a motor vehicle crash. In addition, millions are injured in crashes. Especially tragic is the fact that some survivors of motor vehicle crashes are seriously disabled. Crashes are the leading cause of traumatic brain injury and spinal cord injury.

The magnitude of injury's impact on our society has made the control of crash injuries one of the goals of *Healthy People 2000*. The goal is to reduce crash fatalities from 19.1 per 100,000 people in 1987 to 17.0 per 100,000 people by the year 2000 (2). Many sectors of our society will have to cooperate to achieve this 11% reduction in crash mortality, and many of the recommendations of this panel must be implemented.

Unfortunately, even if this decreased crash fatality rate envisioned in the Year 2000 Objectives is achieved, there will be no meaningful reduction in the actual numbers of persons killed and injured in motor vehicle crashes. In terms of absolute numbers, projected increases in both population and travel will offset the efforts of the health and safety community. Motor vehicle crashes will remain the principal means by which young Americans are permanently disabled and by which they die.

If we are to reduce materially the enormous toll that crashes impose every year, "business as usual" will not be sufficient. The multidisciplinary attack on injury that was the vision of *Injury in America* (3) must be employed. Investment in the prevention of injury and in the care and rehabilitation of injured persons must increase appreciably, so that it is commensurate with the magnitude of the problem. Research must be directed toward solving this problem, which will require federal, state, and private resources. Furthermore, collaboration between former adversaries must become the rule. But resources and collaboration will not be enough. We must also convince the public that motor vehicle injuries are not "accidents" and that the application of scientific principles to the prevention of injury has a real likelihood of succeeding in reducing crash-related fatalities and injuries.

The report of this panel documents the record of success that health and safety professionals have achieved in this field. But more importantly, the report describes the steps that we must take to do more than merely maintain the status quo. The panel's recommendations are designed to be illustrative, rather than exhaustive, but their implementation can launch an era of major reductions in the crash fatality and injury rates on our roads.

The panel's recommendations to federal agencies, state and local governments, private industry, employers, labor organizations, advocacy groups, and the health care community are listed in the position paper. The panel's key recommendations are as follows:

Improve Leadership, Collaboration, and Coordination

The panel heartily supports the recommendations of the Transportation Research Board (TRB) Special Report 229, Safety Research for a Changing Highway Environment (4), with respect to the advancement of research in Department of Transportation programs. The recommendations are listed in the position paper. In addition, the recommendations on organizational structure that the Committee on Trauma Research made in the National Research Council's document, *Injury in America* (3), should be fully implemented. These include the establishment of a National Center for Injury Control within the Centers for Disease Control (CDC). This center should facilitate coordination of federal injury control efforts. Motor vehicle injuries constitute the single largest category of injuries and thus should be a key focus of the center's research and programs. The center should collaborate with established lead traffic safety agencies at both the federal level (for example, the National Highway Traffic Safety Administration and the Federal Highway Administration within the Department of Transportation) and at the state and local levels (such as the state highway safety agencies). In particular, CDC should link the public health and traffic safety communities at the federal, state, and local levels and emphasize the importance of motor vehicle injuries within the broader field of injury control.

Enhance Public Recognition and Support

Public awareness of the preventability of motor vehicle injuries must increase because it will contribute to individual prevention efforts, public support for laws and enforcement efforts, and demands for legislative action in funding research and programs.

Implement Proven Interventions

Many technologies and behaviors are known to prevent or mitigate motor vehicle injuries, but they have not been widely used or adopted. The following **legislative** and **law enforcement** interventions must be fully implemented:

- Adopt and enforce primary enforcement safety belt use laws and ordinances and extend them to cover all seating positions in all motorized vehicles, where feasible.

- Adopt and enforce administrative license suspension for drivers with a blood alcohol concentration $\geq$0.08% and >0.00% for youths under the age of 21.
- Adopt and enforce laws and ordinances requiring all motorcyclists and bicyclists to wear helmets.
- Enforce existing speed limits, oppose further increases in speed limits, and encourage legislation to ban the use of radar detectors.
- Strictly enforce minimum drinking age laws as they apply both to sellers and purchasers.
- Strengthen and enforce existing laws and ordinances requiring child safety seat use and extend them to cover all passenger seating positions in all motorized vehicles.

In addition to adopting, strengthening, and enforcing these laws, information on factors facilitating and impeding effective enforcement should be identified and disseminated.

The panel recommends that vehicles be equipped with both driver and passenger airbags and that vehicle designs protect both occupants and pedestrians. Vehicle designs that protect **occupants** include improved occupant-compartment integrity (including enhanced side-impact protection), energy-absorbing interior surfaces, and improved door design, roof crush resistance, seats, and restraint systems. Designers of protective restraint systems should give attention to the comfort and convenience of persons of all sizes and ages. Vehicle designs that protect **pedestrians** include softer hood and fender designs and lower front bumpers. In addition, comprehensive community-based pedestrian and bicycle safety programs that target defined problems and high-risk populations should be developed.

The panel recommends that roadway delineation be improved through increased use of effective reflective pavement markings and signs, and that safer, "forgiving" roadsides be provided for errant vehicles.

Despite recent progress, alcohol and other drugs continue to play a significant role in motor vehicle injuries and fatalities. Although several research and programmatic recommendations in this document specifically address impaired driving, the panel concurs with the Surgeon General's Workshop on Drunk Driving (5) that the extent of the alcohol problem must be addressed at a broader, more comprehensive level. It is unlikely that we will substantially reduce impaired driving until and unless we reduce problem drinking, drug use, and total per capita alcohol consumption and modify many commonly accepted practices related to the availability and promotion of alcoholic beverages.

Expand the Scientific Base

Continued progress in reducing motor vehicle injury cannot be achieved without technologic advances and a better understanding of human tolerance to injury. A scientific, rigorous understanding of human performance, behavior, capabilities, and motivation is also needed. The following measures are needed to expand and maintain the field's vital scientific base:

- Expand intramural and extramural research programs within the U.S. Department of Transportation and the U.S. Department of Health and Human Services; specifically, CDC should play a key role in developing an applied injury research laboratory to study both human and engineering factors.
- Enhance the training of professionals at all levels.
- Develop data systems; specifically, link traffic and medical records to improve our ability to develop and evaluate effective interventions.
- Support cooperative industry-government research and development projects with adequate protection of both the public's interests and manufacturers' proprietary concerns.
- Build the fields of engineering, biomechanics, human behavior research, and policy development in the areas related to injury prevention. Specifically, develop university-based centers of excellence in these areas.
- Enhance the knowledge and understanding of factors facilitating and impeding safe driving behaviors among various population subgroups, including youth, minorities, women, and the elderly, and use these data to develop and target prevention and intervention efforts.
- Encourage collaborative interdisciplinary research among scientists working in fields that affect motor vehicle injury control, such as engineering, biomechanics, behavioral science, public policy, medicine, public health, and rehabilitation.

References

1. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress. San Francisco, CA: Institute for Health & Aging, Univ. of California, and Injury Prevention Center, The Johns Hopkins Univ., 1989.

2. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991: DHHS Publication No. (PHS) 91-50212.

3. Committee on Trauma Research, Commission on Life Sciences, National Research Council, and the Institute of Medicine. Injury in America: a continuing public health problem. Washington DC: National Academy Press, 1985.

4. Transportation Research Board. Safety research for a changing highway environment. Washington DC: National Research Council, 1990. Special Report No. 229.

5. Public Health Service. Surgeon General's workshop on drunk driving. Washington DC: Office of the Surgeon General, 1988.

Prevention of Violence and Injuries Due to Violence — Contributors —

Felton (Tony) Earls, M.D., Chairperson, Harvard School of Public Health, Cambridge, MA

Ronald G. Slaby, Ph.D.,* Background Paper (Interpersonal Violence), Education Development Center, Newton, MA, Harvard University, Cambridge, MA.

Anthony Spirito, Ph.D.,* Background Paper (Suicide), Rhode Island Hospital, Providence, RI

Linda E. Saltzman, Ph.D., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Timothy N. Thornton, Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Alan Berman, Ph.D., Washington Psychological Center, Washington, DC

Lucy Davidson, M.D., Emory University School of Medicine, Atlanta, GA

Jeffrey Fagan, Ph.D., Rutgers University, Newark, NJ

Andy Goodman, M.D., M.P.H., New York City Department of Health, New York, NY

Darnell Hawkins, Ph.D., J.D., Black Studies Program, University of Illinois at Chicago, Chicago, IL

Jess F. Kraus, Ph.D., M.P.H., U.C.L.A. School of Public Health, Los Angeles, CA

Colin Loftin, Ph.D., University of Maryland, College Park, MD

Eve Moscicki, Sc.D., M.P.H, National Institute of Mental Health, Rockville, MD

Peter Muehrer, Ph.D., National Institute of Mental Health, Rockville, MD

Patrick O'Carroll, M.D., M.P.H., Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Howard Sudak, M.D., Case Western Reserve University, Cleveland, OH

Christy Visher, Ph.D., National Institute of Justice, Washington, DC

*Coauthor of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Cathy Spatz Widom, Ph.D., Indiana University, Bloomington, IN

Garen Wintemute, M.D., M.P.H., University of California at Davis School of Medicine, Sacramento, CA

Katie Baer, M.P.H., Macro International, Inc., Atlanta, GA

Prevention of Violence and Injuries Due to Violence Executive Summary

The health impact of self-directed and interpersonal violence in the United States is staggering, and the need for action to address this problem has never been greater. In this paper we present an agenda for reducing injuries and deaths due to interpersonal violence and suicidal behavior.

Interpersonal violence is a major public health problem in the United States: homicide is the 12th leading cause of death, accounting for 22,032 deaths in 1988, and is a leading cause of premature mortality. The U.S. homicide rate is many times higher than that of other industrialized countries. Blacks and other minorities are at particularly high risk of injury and death due to interpersonal violence. Females are at high risk of nonfatal injuries from rape, child sexual abuse, and assaults by husbands, ex-husbands, and other intimate partners. Child abuse and neglect is a major cause of morbidity among infants and young children.

Suicide is the eighth leading cause of death in the United States. About 20% of all deaths due to injury are suicides. In 1988, 30,407 persons committed suicide. Since 1950, rates of suicide among young people (15 to 24 years of age) have essentially tripled. Since 1979, after several decades of declining rates of suicide among the elderly, rates have been increasing in this age group.

In developing this agenda for violence prevention, we focused on factors that are clearly linked with the risk of injury and death from violence and that are apparently amenable to preventive efforts or public health action in the near future. We sought to develop a largely cross-cutting set of high-priority recommendations that had relevance to *Healthy People 2000* for the prevention of both self-directed and interpersonal violence (1). We structured our recommendations around a single major area of emphasis and four special areas of emphasis. The major area of emphasis is the need for a coordinated approach and coherent framework for planning and implementing a comprehensive violence prevention effort. The four special areas of emphasis are (a) injuries from firearm violence (b) alcohol and other drug use, (c) early childhood experiences that affect the risk of future violent behavior or victimization, and (d) treatable mental disorders associated with an increased risk of suicide.

Our recommendations for a broader, comprehensive infrastructure for violence prevention addressed the need to target resources for prevention toward high-risk groups, to improve surveillance, to empower communities to develop their own violence prevention programs, to broaden training for violence prevention, and to rigorously evaluate promising prevention programs. Key recommendations include (a) developing culturally appropriate violence prevention and intervention programs for communities with high rates of violent injury in

order to address the specific needs, characteristics, and circumstances of these communities; (b) improving recognition, referral, and treatment of people at high risk for violence or violent injury (e.g., battered wives, suicidal persons, and victims of child abuse or neglect); (c) setting up a system whereby E-codes (codes to identify the external causes of injury — e.g., attempted suicide or child abuse) would be included with the usual nature-of-injury data in all hospital-discharge data; (d) developing and disseminating guidelines for preventing violent injuries at the community level; (e) developing new financial and other resources for the development and long-term support of community-based violence prevention programs; and (f) establishing fellowship training programs in violence prevention, with special efforts to recruit minorities and women.

The panel believes the strategies most likely to produce immediate reductions in mortality from violence are those related to reducing firearm violence. We developed several recommendations in this regard, all designed to minimize ready access to handguns and other firearms. We suggest strategies for minimizing ready access to guns, including educational and behavioral change, technological and environmental efforts, enhanced enforcement of existing laws, and new legislative and regulatory efforts. We also call for increased research in this area to more precisely delineate the risks and benefits of ready access to handguns and other firearms.

Regarding alcohol and other drug (AOD) use, we make several recommendations, which (if implemented) should decrease chronic use of AODs by persons at high risk of violent behavior by ensuring that such persons are properly identified and given adequate treatment for their drug use problems. We also make recommendations regarding efforts to decrease initiation of AOD use, especially among people already at high risk of interpersonal or self-directed violence. Finally, to reduce the risk of violence associated with drug trafficking and addiction, we call for research to explore alternatives to the current laws regulating illicit substances such as cocaine and heroin.

Some portion of our violence prevention efforts should be designed (a) to reduce the prevalence of childhood experiences (such as child abuse and neglect, witnessing violence in the home, and viewing media violence) that are associated with long-term risks of perpetrating violence or becoming a victim; and (b) to intervene with children who are so exposed in order to mitigate the consequences of this exposure. Key recommendations in this regard include nurse home visitation programs (or other home-visitor programs) for high-risk infants; educational interventions for children in nonviolent interpersonal problem- solving skills, social skills, and appropriate norms of nonviolent behavior; timely crisis intervention for families under stress and at risk for violence; and development of media programs for children that foster nonviolent behavior.

We call for expanded efforts to identify and treat people suffering from treatable mental disorders associated with suicide. Specifically, we endorse the National Institute for Mental Health Depression/Awareness, Recognition, and Treatment Program, which seeks to educate the general public and potential gatekeepers on how to recognize and refer persons

with depression. We also call for expanded training for and coordination among professionals who are potential gatekeepers to treatment services. Finally, we recommend increasing public health and insurance funding for outpatient treatment of persons with mental disorders.

We recognize that, in developing a broad, largely cross-cutting agenda for intentional injury prevention, issues and opportunities for prevention that are specific to particular types of violence have necessarily been missed or underemphasized. We hope that those interested in preventing certain types of violence or violent injuries will modify and expand upon these recommendations as appropriate.

References

1. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991:DHHS Publication No. (PHS) 91-50212.

Home and Leisure Injury Prevention — Contributors —

Leon Robertson, Ph.D., Chairperson, Nanlee Research, Branford, CT

Lorann Stallones, Ph.D.,* Colorado State University, Fort Collins, CO

Christine M. Branche-Dorsey, Ph.D., M.S.P.H., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Nancy Nowak, R.N., M.P.H., Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Susan Baker, M.P.H., The Johns Hopkins University, Baltimore, MD

Thomas R. Bender, M.D., M.P.H., National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

Mary Dufour, M.D., M.P.H., National Institute on Alcohol Abuse and Alcoholism, Rockville, MD

John Lumpkin, M.D., M.P.H., Illinois Department of Public Health, Springfield, IL

Elizabeth McLoughlin, Sc.D., San Francisco General Hospital, San Francisco, CA

Sylvia Micik, M.D., North County Health Services, San Marcos, CA

Marcia Ory, Ph.D., M.P.H., National Institute on Aging, Bethesda, MD

Thomas W. Planek, Ph.D., National Safety Council, Chicago, IL

Fred Rivara, M.D. M.P.H., Harborview Injury Prevention and Research Center, Seattle, WA

George W. Rutherford, Jr., M.S., Consumer Product Safety Commission, Bethesda, MD

Peter C. Scheidt, M.D., M.P.H., National Institute for Child Health and Human Development, Rockville, MD

Mark Widome, M.D., M.P.H., Pennsylvania State University College of Medicine, Hershey, PA

Nicole Lezin, M.P.P., Macro International, Inc., Atlanta, GA

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Home and Leisure Injury Prevention
Part 1: Selected Injuries
Executive Summary

Much attention has been focused on injuries related to motor vehicle crashes, yet each year tens of thousands of lives are lost or irrevocably shattered as a result of unintentional injuries in other circumstances. In 1986, 48,410 Americans died from unintentional injuries not related to motor vehicles; these deaths accounted for 32% of all injury-related deaths. In 1985, the lifetime human capital costs in lost earnings and medical care (excluding consideration for pain and suffering) totalled about $21 billion for fall-related injuries, $2.1 billion for drownings or near-drownings, $8.5 billion for poisonings (including intentional poisonings), $2.8 billion for fire- and burn-related injuries (not including property damage), and $14.4 billion for firearm injuries (intentional and unintentional) (1). We can reduce the incidence and severity of these and other injuries by applying the traditional tools of public health: **surveillance** to identify patterns and circumstances; **research** to understand causes and to develop and evaluate interventions; and **implementation** of programs that prevent injuries or mitigate their impact.

The types of injuries addressed in this paper — those resulting from falls, drownings, poisonings, fires, burns, and firearms — are examples of the many unintentional injuries that are not related to motor vehicles. As members of the Home and Leisure Injury Prevention Panel, we chose to emphasize these injuries because of their prominence in *Healthy People 2000*, and because of their magnitude in terms of morbidity and fatalities, or because they can be prevented by effective interventions that are already available (2). These types of injuries affect different populations and vary in their causes and circumstances. As a result, the research and programs that address these types of injuries must encompass an array of academic disciplines, government and private organizations, and segments of society. No single intervention, agency, or approach can dramatically reduce the toll of unintentional injuries. We need a broad-based set of interventions that build on both research and examples of successful interventions.

Programs that have succeeded in reducing definable injuries share common elements: adequate surveillance to define the circumstances of the injury, recognition of an action that would probably reduce incidence or severity, and action by persons in positions to initiate it. This approach has reduced many types of injuries. Examples include the modification of aspirin dosages and packaging to reduce the incidence of aspirin poisonings among children, regulations requiring that children's sleepwear be made flame-retardant, and the installation of window guards in high-rise apartment buildings to prevent falls.

Recommendations for each topic addressed in this paper — falls, drownings, poisonings, fire- and burn-related injuries, and firearm injuries — are listed here and at the end of the appropriate chapter. The panel's priority recommendations are in bold print. The designated agency for implementation for each priority recommendation is listed in parentheses: federal government (FG) or state and local government (SLG).

Falls

Falls are the leading cause of all nonfatal injuries and are the second leading cause of death from unintentional injuries after motor vehicles. Efforts waged by a variety of organizations can curb the number and severity of these preventable injuries.

- **Require helmet use during recreational activities with significant head injury rates such as bicycling, horseback riding, surfing, and snow skiing. (SLG)**
- **Encourage research on optimal living designs, ensure that public and private building designs and codes take injury surveillance results into account, and enforce building code regulations that reduce major contributors to fall injury and its severity. (SLG)**

Federal Government

- Support epidemiologic surveillance of fall injuries to identify circumstances and specific locations of falls.
- Support analytic studies of major contributors to fall injuries, including biomedical, behavioral, and environmental risk factors for injuries and the interaction of these risk factors with age.
- Fund local injury prevention workers to interpret and act on results of surveillance and analytic studies.
- Develop and disseminate prevention programs.
- Ban baby walkers, which apparently cannot be made safer.
- Develop standards for changing-tables, high chairs, and playground equipment.
- Increase support of clinical trials to test strategies for injury reduction and rehabilitation in later life.

State and Local Governments

- Conduct surveillance of the circumstances and specific locations of fall injuries.
- Develop, revise, or enforce standards for residential facilities for the elderly on the basis of the best evidence of optimal designs for stairs, rails, and grips.

Private Organizations

- Health care providers and professional associations should encourage increased clinical counseling regarding fall risk from specific heights, cessation of the use of baby walkers, and the use of barriers for stairs.
- Insurance companies should provide financial incentives, such as lower premiums, to encourage compliance with safety standards.
- Health maintenance organizations (HMOs) and pharmacies should increase vigilance of prescribed drugs and polydrug use that is likely to impair vision, gait, coordination and judgment. In addition, HMOs and pharmacies should consider putting warning labels on drugs that may increase the incidence of falls and injuries among the elderly.
- Businesses should not serve alcohol to intoxicated persons.

Academic and Research Institutions

- Conduct analytic studies (including risk factors for falls) listed under "Federal Government."
- Conduct clinical trials to test strategies for fall injury prevention and rehabilitation in later life.
- Develop and evaluate innovative interventions, such as barriers, warnings, alarms, hip pads, and residential facility standards and staffing.

Drownings

In 1986, drownings were the third most common cause of death by unintentional injuries in the United States. Agencies are in a position to establish regulations where strategies to prevent drowning are understood. More research is needed on high-risk populations and the places and circumstances implicated in drownings.

- **Require complete four-sided isolation pool fencing at least 5 feet high with self-closing latches for all swimming pools. (SLG)**

- **Advance research on the circumstances and locations of drownings and near-drownings that result in hospitalization, with special attention to minority populations, to drownings associated with water other than that in pools, and to potential means of prevention. (FG)**

Federal Government

- Advance analytic studies of combinations of boat and motor characteristics in drownings and near-drownings and studies of alcohol involvement in drownings.
- Develop, evaluate, and disseminate drowning intervention programs.

State and Local Governments

- Conduct surveillance of circumstances and specific locations of drownings and near-drownings.
- Promote cardiopulmonary resuscitation (CPR) training for all pool owners and teenagers and adults among populations with high drowning rates.
- Promote licensure and standard training for all boat operators.
- Enact and strictly enforce state laws that prohibit boat operation while intoxicated.
- Enforce requirements for having personal flotation devices for all persons on boats.

Private Organizations

- The pool industry should sell safety equipment as part of the pool purchase and develop new and more effective prevention technology, such as energy-absorbing pool bottoms to reduce diving injuries (e.g., head and spinal cord injuries).
- The insurance industry should review actuarial data and write homeowner insurance policies to reflect the presence of pools and spas, the presence of children under age 5 where a pool or spa is present, and the presence of protective barriers to a pool or spa.
- The American Red Cross and other organizations should promote isolation pool fencing, poolside phones, and CPR training for all pool owners and for teenagers and adults among populations with high drowning rates.

Academic and Research Institutions

- Conduct studies mentioned under "Federal Government."

Poisonings

We have seen a decline in fatal poisonings among young children over the last 2 decades. This has been attributed to the function of poison control centers, which have been found to be cost-effective but are now in jeopardy because of loss of funding.

- **Support continued funding for poison control centers, including funding from insurance and Medicare/Medicaid payments. (SLG)**
- **Review standards for drug packaging and tighten standards for child-resistant containers that are frequently involved in child poisonings while considering needs of the elderly. (FG)**

Federal Government

- Support surveillance of the circumstances and locations of severe and fatal poisonings.
- Support analytic research on the distribution of and access to both legal and illegal drugs.

State and Local Governments

- Provide an 800 telephone number for information on poisons for people who do not have access to a local poison control center.

Private Organizations

- Conduct campaigns to increase the availability of ipecac syrup in all households.
- Cooperate with scientists in the evaluation of campaigns against drug use.
- Discourage advertisers from linking alcohol use to sports activities and from sponsoring television programs that glamorize drug use.

Academic and Research Institutions

- Conduct analytic studies on the extent to which persons at risk for poisoning can be identified.
- Evaluate the effectiveness of poison prevention and drug use treatment programs.

Fire- and Burn-Related Injuries

Despite the widespread adoption of smoke detectors, fires and their concomitant burn injuries remain a formidable cause of death. In 1986, they resulted in nearly 5,000 deaths. Groups at higher risk for fire- and burn-related deaths include the very young, the elderly, and minority populations. Coordinated efforts can affect community standards and individual practices so that unnecessary deaths and severe disabilities are prevented.

- **Require cigarettes sold in the United States to have a low potential for igniting upholstered furniture. (FG)**

- **Develop, implement, and enforce codes to address burns in residences, including requirements for smoke detectors, sprinklers in new housing, and antiscald devices in hot water systems. (SLG)**

Federal Government

- Support surveillance of the circumstances and specific locations associated with burns that result in fatalities or hospitalizations.

- Support analytic studies of kitchen scalds, gasoline burns, clothing ignition, and burns among the elderly, coupled with research by engineers and product designers to remedy correctable hazards.

- Fund the development and evaluation of community-based prevention programs in high-risk urban and minority communities.

- Conduct in-depth investigations of clothing ignition burns among children to determine if the flammable fabrics standard for children's sleepwear is being undermined by the labeling of sleepwear as daywear.

- Apply the flammable fabrics standard to loose-fitting housecoats and bathrobes now commonly involved in burns associated with cooking and smoking.

- Regulate disposable cigarette lighters to make them child-resistant.

State and Local Governments

- Conduct surveillance of the circumstances and locations of fatal and hospitalized fire- and burn-related injuries.

- Collaborate with the Centers for Disease Control and the U.S. Consumer Product Safety Commission in conducting in-depth investigations of clothing ignitions, kitchen scalds, and burns involving gasoline.

- Require antiscald devices in new showers and tubs.
- Develop or enforce maximum hot water temperature regulations for residential institutions.

Private Organizations

- Safety organizations should form a coalition among themselves and with local fire departments to promote a campaign in the media to change batteries in smoke detectors when clocks are changed in the fall.
- Utility companies should check hot water temperatures when meters are read and recommend settings at 120° or less, if necessary.
- The American Association of Retired Persons should push for flame retardant clothing for the elderly.
- Insurance companies should support the installation of sprinklers in multifamily homes through reductions in insurance premiums.

Academic and Research Institutions

- Conduct analytic studies listed under "Federal Government."
- Evaluate fire department, community, and school-based fire- and burn-related injury prevention education.
- Study the characteristics of appliances and utensils that may affect the incidence and severity of burns.

Firearm Injuries

Many of the Violence Panel's recommendations apply to unintentional as well as intentional firearm injuries. (For the full text of the Violence Panel's recommendations, see its position paper.) We fully endorse all of the Violence Panel's recommendations. In particular, we endorse the panel's suggestions on the need to (a) minimize ready access to handguns and other firearms through a variety of strategies focused on three broad areas: educational or behavioral change interventions, technological or environmental interventions, and enhanced and new legislative or regulatory efforts; and (b) continue rigorous scientific research to delineate with greater precision the risks and benefits of ready access to fireams. In addition, we make the following recommendations on firearm injury prevention:

- **Recognize firearms as a public health problem and esablish the regulatory authority for promulgating safety standards for firearms, addressing the problems of trigger locks, muzzle velocity, and visible indication as to whether the gun is loaded. (FG)**

- **Develop and disseminate prevention programs, including strategies to store guns in facilities outside of homes. (FG)**

Federal Government

- Establish the regulatory authority for promulgating safety standards for all ammunition, applying the international laws (Geneva Convention) and current military ammunition safety standards.
- Support surveillance of firearm injuries, including a history of the involved firearm, its make and model, characteristics of the weapon and ammunition, circumstances of the injury, storage of the weapon, and means of access.
- Support analytic studies of characteristics of firearms and ammunition that are thought to increase the incidence and severity of injury.
- Evaluate the effects of firearm safety training on injuries.

State and Local Governments

- Collaborate with CDC in increased surveillance.
- Enact legislation requiring waiting periods and background checks for firearm purchases and building codes for firearm storage.
- Enforce extant regulations.

Academic and Research Institutions

- Conduct analytic studies of characteristics of firearms and ammunition involved in injury.
- Conduct evaluation of the effectiveness of firearm education and gun control laws and regulations.
- Conduct research on the psychological, social, and economic effects of firearm injuries on the injured, the shooters, the families of both, and communities.

Alcohol As a Contributing Factor

In addition to its specific recommendations regarding the types of injuries addressed in this paper, the panel notes that alcohol is implicated as a contributing factor in many of these types of injuries. Since policies that restrict the inappropriate consumption of alcohol affect home and leisure injuries as well as motor vehicle injuries, the panel reiterates and endorses the following recommendations of the Surgeon General's Workshop on Drunk Driving:

- **Equalize federal excise tax rates by ethanol (pure alcohol) content for all beverages by raising rates for beer and wine to that of distilled spirits. Adjust the resulting equalized excise tax rate to reflect the change in the Consumer Price Index since 1970, and in the future, annually adjust the resulting excise tax rate to reflect changes in the price index for the previous year. (FG)**

- **Strengthen enforcement of underage drinking laws with penalties for purchasers, sellers, and servers. (SLG)**

References

1. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress. San Francisco CA: Institute for Health & Aging, Univ. of California, and Injury Prevention Center,The Johns Hopkins Univ., 1989.

2. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991:DHHS Publication No. (PHS) 91-50212.

Home and Leisure Injury Prevention
Part 2: An Infrastructure for Injury Control
Executive Summary

Injury is the leading cause of death and disability among this country's children and young adults, killing more Americans between the ages of 1 and 34 years than all diseases combined. Injuries rob Americans of more years of working life than all forms of cancer and heart disease and cost this Nation between $150 and $200 billion annually (1). Yet injury research receives only 2 cents out of every federal dollar devoted to research on health problems. And despite the fact that millions of Americans experience firsthand the loss of a loved one or witness the irrevocable changes that disabilities cause in the health and livelihood of those who are injured, people too often continue to perceive injuries as random encounters with fate. The tragic consequences of injuries are compounded by the fact that they are, in many cases, preventable.

During the next decade, implementation of the recommendations in this position paper will reduce the unacceptable and largely preventable toll that injuries take on our society. To achieve significant and lasting progress, however, we need an **infrastructure for injury control** that will coordinate efforts, avoid unnecessary duplication, ensure and sustain the continuity of resources, train a cadre of injury control researchers and practitioners, and develop and maintain standardized surveillance systems to identify problems, target interventions, and evaluate progress in preventing injuries and reducing their severity.

Organizational Structure and Coordination

A variety of public and private organizations are involved in injury control. These include federal agencies, state and local health departments, advocacy groups, employers, and universities. The need for a national lead agency for injury control that will provide leadership, guidance, and funding to these organizations is clear and has been defined in several reports to Congress, including *Injury in America* (2). Moreover, the agency's funding must be adequate to meet the magnitude of the injury problem.

Priority Recommendations

Our priority recommendations are as follows:

- The federal government should establish a federal Center for Injury Control to serve as the national lead agency for injury control.
- The federal government should appropriate adequate funding for the Center to carry out a national injury control initiative, totaling $100-200 million per year.

- The CDC should establish a national strategic plan to direct the activities of the new center so that national injury control priorities can be set consistent with the Year 2000 Objectives. The plan should include the establishment of state and local capacity to carry out injury control programs as well as injury control research.

- State legislatures should revise public health laws to include state and local health departments' surveillance and program implementation directed towards preventing injuries as a major cause of years of potential life lost and morbidity.

Training and Research

Injury control encompasses many disciplines, including health care, epidemiology, engineering, ergonomics, architecture, public policy, law, and health communications. In these fields, however, graduate curricula rarely incorporate injury control principles. Lack of faculty expertise, funding, and training materials has thwarted scientific training in injury control and its incorporation into the many academic areas to which it is relevant. These barriers must be addressed, and training in injury control must be incorporated into allied health fields.

Once a cadre of injury control researchers and professionals is created through training, it must be sustained through consistent funding for research and for the development and evaluation of intervention and prevention strategies. Without sustained funding, the needed scientific base for injury control will erode.

Our priority recommendations for advancing injury control training and research are as follows:

- To increase the pool of injury control professionals, CDC should develop and implement a strategic plan for national training based on the national injury control strategy and on sound education technology. The plan should call for identifying target audiences and learning objectives, developing model curricula, integrating injury control training into ongoing professional education, and evaluating the success of these efforts.

- The federal government should expand funding of the CDC extramural research program to support approved but unfunded injury prevention research centers and research projects.

Surveillance

Surveillance has been defined as "the ongoing and systematic collection, analysis, and interpretation of health data in the process of describing and monitoring a health event." In the case of injury control, surveillance data are potentially useful to a wider audience, including product manufacturers, builders, farmers, industries, small businesses, insurance companies, regulatory agencies, state and local governments, hospitals, advocacy groups, and researchers.

Various injury control surveillance systems have been developed in response to the differing needs of those using the information. One approach is to gather data on severe injuries — to whom, how, and where they occur — and to match appropriate prevention strategies to the circumstances leading to particular types of injuries. Another approach is to gather minimal data, such as data on external causes of injury (E-codes), in mortality and hospital data sets and then to use these data to identify high-frequency causes that need to be studied further.

To achieve surveillance objectives and understand the relative effectiveness of various approaches, we offer the following priority recommendations:

- External-cause-of-injury codes should be routinely obtained for hospitalized patients whenever an injury is the principal diagnosis or is directly related to the principal diagnosis. E-codes should be required for reimbursement by federal and private health insurance systems, and they should include two separate fields — one for cause of injury and another for place of occurrence, when appropriate.
- Congress should fund CDC (perhaps through its National Center for Health Statistics) to contract with states to collect data on fatal nonmotor-vehicle injuries. This effort would be equivalent to the Fatal Accident Reporting System used for on-road motor vehicles.
- The CDC should assess the cost-effectiveness of alternative surveillance systems. This could be done by comparing different approaches used by health departments and other agencies.

References

1. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress. San Francisco, CA: Institute for Health & Aging, Univ. of California, and Injury Prevention Center, The Johns Hopkins Univ., 1989.

2. Committee on Trauma Research, Commission on Life Sciences, National Research Council, and the Institute of Medicine. Injury in America: a continuing public health problem. Washington DC: National Academy Press, 1985.

Occupational Injury Prevention
— Contributors—

Susan P. Baker, M.P.H., Chairperson, The Johns Hopkins University, Baltimore, MD

Carol Conroy, Ph.D., M.P.H.,* California Public Health Foundation, Berkeley, CA

Janet J. Johnston, Ph.D., Division of Safety Research, National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

Thomas R. Bender, M.D., M.P.H., Division of Safety Research, National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

Gwendolyn Cattledge, M.S.E.H., Ph.D., Executive Secretary, Division of Safety Research, National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

George S.T. Chu, Dr.P.H., California OSHA, San Francisco, CA

David DeJoy, Ph.D., University of Georgia, Athens, GA

Richard Duffy, M.S., International Association of Firefighters, AFL-CIO-CLC, Washington, DC

William M. Eisenberg, Bureau of Labor Statistics, Department of Labor, Washington, DC

Donald Elisburg, J.D., Center to Protect Workers' Rights, Washington, DC

James C. Fell, National Highway Traffic Safety Administration, Washington, DC

Lawrence J. Fine, M.D., Division of Surveillance, Hazard Evaluations and Field Services, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, OH

Susan Goodwin Gerberich, Ph.D., University of Minnesota, Minneapolis, MN

Joseph A. Kinney, National Safe Workplace Institute, Chicago, IL

Jess F. Kraus, Ph.D., M.P.H., U.C.L.A., Los Angeles, CA

William Marine, M.D., M.P.H., University of Colorado, Denver, CO

Vernon McDougall, International Brotherhood of Teamsters, Washington, DC

Earl Pollack, Sc.D., George Washington University, Rockville, MD

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Gordon R. Reeve, Ph.D., M.P.H., Ford Motor Company, Dearborn, MI

Richard H. Roettger, M.D., United States Air Force Medical Center, Lackland AFB, TX

Carol W. Runyan, Ph.D., M.P.H., University of North Carolina, Chapel Hill, NC

Thomas Seymour, Occupational Safety and Health Administration, Department of Labor, Washington, DC

Gordon S. Smith, M.B., Ch.B., M.P.H., The Johns Hopkins University, Baltimore, MD

Emily Spieler, J.D., West Virginia University College of Law, Morgantown, WV

Lorann Stallones, M.P.H., Ph.D., Colorado State University, Fort Collins, CO

Janice Travnick, Kemper Insurance, Long Grove, IL

James L. Weeks, Sc.D., Laborers' Health & Safety Fund of North America, Washington, DC

Craig Zwerling, M.D., Ph.D., M.P.H., University of Iowa, Iowa City, IA

Mary Ann Fenley, Macro International, Inc., Atlanta, GA

Occupational Injury Prevention
Executive Summary

Acute injury that occurs in association with work is a tragedy of enormous proportions. Every year in the United States —

- Between 7,000 and 11,000 workers die because of job-related injuries. Most of these workers are in the prime of their lives.
- 88,000 workers are hospitalized.
- Almost 2 million injuries result in disability.
- 75 million days of work are lost.
- About 250,000 potential productive years of life are lost because of premature death.

The overall cost of work-related injuries incurred in 1989 has been estimated by the National Safety Council at greater than $48 billion. This figure is less than the true cost because not all workers are included and intentional injuries are not counted. Even these statistics cannot convey the personal hardships that workers and their families undergo as a result of occupational injury and the tremendous cost to our society that these injuries impose.

Most occupational incidents that result in injury to the worker are avoidable and could be prevented if known strategies were implemented widely. Strategies to reduce the number of injuries must be aggressive, directed, and supported by all who have a responsibility or interest in protecting workers, including workers themselves. Interdisciplinary action is crucial; government, industry, labor, universities, workers, and the public must focus attention on this problem and coordinate their efforts to solve it.

Costs often play a significant role in decisions affecting occupational safety, both in public policy and at the individual company level. The costs of injury prevention are often given greater weight than the money that would be saved through reduced medical costs and increased productivity. In "selling" the prevention of occupational injuries, we need to stress the economic benefits as well as the human benefits.

There is currently no standard definition of a work-related injury. Although some countries count injuries sustained by bystanders resulting from actions of others at work or injuries sustained by workers commuting to or from work, in the United States such injuries are not included in any definition of occupational injury. In the United States, a work-related injury is one that is attributable to work activities, which are defined as those duties or tasks that produce a product or result or are done in exchange for money, goods, services, profit, or advantage.

Lack of commitment to injury prevention could well be at the heart of the occupational injury problem in the United States. At present, there is no multidisciplinary, multiorganizational approach to preventing occupational injury. Funds for research and training programs are scarce, and the lack of well-trained people in injury epidemiology and safety engineering is a real problem. When employers and employees are united in their commitment to workplace safety, the number of work-related injuries decreases. We must convince organizations of the benefits of this commitment.

The Year 2000 Health Objectives developed by the Public Health Service of the U.S. Department of Health and Human Services call for (a) reducing the number of deaths resulting from work-related injury; (b) reducing the incidence of injuries that result in medical treatment, time lost from work, or restricted work activity; and (c) implementing plans for state-based identification and prevention programs, increased worksite programs, consultation and assistance to small business, and increased awareness and attention by health care providers. However, the Year 2000 Objectives reflect the limitations of the data upon which they are based (e.g., the data on injuries to members of some high-risk occupational groups, such as the self-employed and most farm workers, are excluded). Improvements in surveillance will affect the reported numbers and rates of injuries and will, therefore, make it difficult to evaluate true change. Success of these objectives should take into account improvements in baseline data.

Efforts to reach the Year 2000 Objectives must be augmented with complementary strategies and incorporated into a national plan to prevent work-related injuries. This plan must include comprehensive and coordinated action steps in education, research, surveillance, and prevention. The catalyst for the success of national prevention strategies will be public consensus that injuries in the workplace are unacceptable. This change in awareness and attitude can be accomplished by developing a grass-roots initiative to broaden public appreciation and understanding, by educating the nation's youth from grammar school through college and postgraduate levels about the prevention of occupational injury, and by training researchers and practitioners in disciplines that have a positive impact on injury control. Above all, workers must be informed about risks and prevention measures and given the power and knowledge to report specific hazards and aid in their mitigation.

Surveillance of occupational injuries should be enhanced to improve the timeliness, accuracy, and completeness of reporting at all levels, from the plant or company level through the national level, at which trends are monitored and research priorities established.

Research must be conducted to describe the extent of the occupational injury problem in the United States, improve and standardize occupational injury surveillance systems, and develop and test hypotheses aimed at identifying risk factors through the study of specific injury problems in special populations. The most compelling problem areas warrant examination of workplace components to identify the circumstances under which injuries occur, potential causal mechanisms, opportunities for intervention, and prevention

strategies. Research efforts should emphasize "passive" or automatic protection in which hazards are designed out in preference to "active" prevention measures requiring frequent action on the part of the worker. Evaluation research should be used to test the effectiveness of preventive strategies under variable workplace conditions.

Although surveillance and research provide future directions for occupational injury control, these activities cannot override the importance of doing something now. Known prevention strategies can and must be implemented at all U.S. worksites. Compliance with standards should be strictly enforced. The mandates of the Occupational Safety and Health Administration (OSHA) should be broadened to include workers not now covered. Information about model programs should be developed into a broad communications system that provides a framework for sharing information and providing assistance, particularly for companies or organizations with few resources.

Responsibilities within these broad categories can be identified for all the major participants in preventing occupational injury.

Recommendations:

Congress should —

- Extend Department of Labor responsibility and authority to cover all public sector and agricultural workers.
- Expand worker empowerment and involvement under the Occupational Safety and Health (OSH) Act.
- Make injury prevention a factor in awarding contracts, loans, and grants.
- Set an example by protecting all federal employees.
- Expand criminal prosecution for willful acts that endanger workers' lives.
- Increase resources for occupational injury prevention programs and research.

The National Institute for Occupational Safety and Health (NIOSH) should —

- Design a model injury surveillance system, including sample forms for recording injuries.
- Evaluate the effectiveness of intervention strategies.
- Work with the Bureau of Labor Statistics and the Bureau of Census to improve worker population estimates, including those of minority, self-employed, migrant, and other neglected workers.

- Study injuries in high-risk or poorly understood worker populations (e.g., agricultural workers, the self-employed, adolescents, migrants, public sector employees, and employees in small companies).
- Develop the laboratory capacity to develop worker protection systems.
- Communicate to employers and workers information on hazards and hazard reduction strategies.
- Work to improve fatality reporting and to establish data on work-related injuries requiring hospitalization.
- Assist states in developing occupational injury control programs.

OSHA and the Mine Safety and Health Administration (MSHA) with NIOSH should —

- Evaluate the effectiveness of standards.
- Determine which inspection strategies work best in what circumstances.
- Promulgate new and improved standards.
- Develop the capacity to acquire and use injury data to set rulemaking priorities.
- Significantly expand enforcement capability through the states.

The Bureau of Labor Statistics should —

- Continue to develop its Census of Fatal Occupational Injuries program and establish its revised Occupational Safety and Health Survey.

The National Center for Health Statistics (NCHS) should —

- Expand efforts to encourage and develop guidelines for work-related injuries to be reported on death certificates and for occupation and industry coding.

The Department of Agriculture should —

- Coordinate with NIOSH in its outreach effort to improve safety and health in agriculture and rural small businesses.

Unions and employees should —

- Identify and report potential hazards.
- Work with employers to establish injury surveillance systems.
- Include safety demands in collective bargaining.
- Ensure that employers implement and evaluate injury prevention programs for workers.

- Participate with government agencies in developing injury prevention programs for workers.
- Use workers' rights fully to promote safe workplaces.
- Comply with established procedures for occupational safety.

Employers should —

- Implement injury prevention programs for workers, with an emphasis on engineering controls and other passive countermeasures.
- Apply effective, state-of-the-art injury prevention measures.
- Encourage workers to identify and report hazards.
- Make safety and health a "bottom line" component of all company activities.
- Communicate information on injury experience and injury control programs in annual reports and other external communications.
- Incorporate safe workplace design and practices in procurement, contracts, and acquisitions.
- Build training programs around job hazard analyses.
- Identify, record, and report all injuries resulting in death, hospitalization, other medical attention, or lost time from usual job, separately, and use this information for injury prevention strategies.
- Incorporate injury surveillance and prevention in business organization or practice.
- Determine safety consequences of new technologies.
- Implement rehabilitation programs that help injured workers regain full-life function and that comply with the Americans with Disabilities Act.
- Share their prevention experience with other employers, especially employers in small companies with limited resources.

State agencies should —

- Designate a lead agency to coordinate occupational injury prevention and control activities involving all relevant state agencies, including health, labor, workers' compensation, transportation, emergency medical service, vital statistics, law enforcement, and agriculture.
- Coordinate occupational injury control activities with other injury control activities at the state and local level.

- Investigate deaths due to on-site work injuries (especially those not investigated by OSHA, MSHA, or the National Transportation Safety Board) through appropriate designated state agencies, including the health department.
- Encourage local prosecuting attorneys and law enforcement officials to investigate serious work-related injuries and deaths and pursue criminal prosecution of employers where appropriate.
- Include worker injury prevention considerations in requirements for state and local permits and licenses.
- Encourage the collaboration of workers' compensation programs and insurance companies to develop injury surveillance data.
- Require that injuries at work be reported on death certificates.
- Develop injury prevention programs for public workers in conjunction with cities and counties.
- Adopt requirements for including an injury-at-work code on hospital discharge data.

Insurance companies should —

- Provide policy holders with information on economic incentives for developing injury control programs.
- Provide technical assistance in injury prevention to client employers.
- Cooperate with other organizations in developing injury surveillance data.
- Require, as appropriate, injury prevention programs for workers.

Academic and research centers should —

- Conduct research on occupational hazards, injury occurrence, and injury prevention.
- Develop and evaluate injury prevention and control strategies in collaboration with federal and state agencies and representatives of the private sector, including employers, workers, and advocacy groups.
- Work with NIOSH, NCHS, the Bureau of Labor Statistics, and other relevant agencies to develop model forms and surveillance systems.
- Help to develop a standard definition of work injury.
- Work with management and labor to develop surveillance systems for specific companies.

- Stimulate the incorporation of injury prevention principles in all curricula and related educational materials for professionals in business, architecture, engineering, public health, nursing, medicine, and agriculture.
- Develop injury prevention curricula for elementary and high school students.
- Develop and evaluate rehabilitation programs.

Advocacy groups should —

- Promote legislation, regulations, and initiatives that protect workers.
- Educate the public regarding occupational injury.
- Advocate injury control as a high priority.

The news and entertainment media should —

- Improve reporting of the circumstances, costs, and preventability of occupational injury.
- Run public service announcements on injury hazards and controls.
- Reduce the portrayal of unsafe practices and portray behaviors that enhance injury prevention.

Private foundations should —

- Give priority to funding research and evaluation regarding occupational injury.
- Increase communication with governmental agencies regarding occupational injury prevention.

Professional societies should —

- Provide their members with continuing education in injury prevention.

Occupational injury is a public health crisis that demands immediate attention. Although it is important that improved surveillance establishes an accurate count of injuries and deaths and that research and timely reporting result in new prevention strategies, it is absolutely essential that prevention strategies available now be used to protect workers today. The recommendations proposed in this position paper provide the plan to help us achieve these goals.

Trauma Care Systems
— Contributors —

A. Brent Eastman, M.D.,* Cochairperson, Scripps Memorial Hospital, La Jolla, CA

C. William Schwab, M.D.,* Cochairperson, Hospital of the University of Pennsylvania, Philadelphia, PA

Joseph L. Annest, Ph.D., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Charles Aprahamian, M.D., Medical College of Wisconsin, Milwaukee, WI

Mary Beachley, R.N., Society of Trauma Nurses, Frederick, MD

Bruce Browner, M.D., University of Texas Medical School, Houston, TX

Paul Burlack, Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Howard Champion, M.D., Washington Hospital Center, Washington, DC

Gail Cooper, Emergency Medical Services, San Diego, CA

David Heppel, M.D., Maternal and Child Health Bureau, Rockville, MD

Lenworth Jacobs, M.D., Hartford Hospital, Hartford, CT

Ellen J. MacKenzie, Ph.D., Johns Hopkins Health Services Research and Development Center, Baltimore, MD

Ronald Maier, M.D., Harborview Medical Center, University of Washington, Seattle, WA

Ricardo Martinez, M.D., Stanford University Medical Center, Stanford, CA

Kimball Maull, M.D., University of Tennessee Medical Center, Knoxville, TN

Thom Mayer, M.D., Fairfax Hospital, Falls Church, VA

Susan McHenry, Division of Emergency Medical Services, Virginia Department of Health, Richmond, VA

Stuart Reynolds, M.D., Havre, MT

Richard Roettger, M.D., Wilford Hall, USAF Medical Center, Lackland AFB, TX

*Coauthor of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Sue Ryan, National Highway Traffic Safety Administration, Washington, DC

Steven Shackford, M.D., College of Medicine, University of Vermont, Burlington, VT

Joseph Tepas, M.D., University of Florida, Jacksonville, FL

Harold Wilkinson, M.D., University of Massachusetts Medical Center, Worcester, MA

Nancy Burton, M.P.H., Macro International, Inc., Atlanta, GA

Trauma Care Systems
Executive Summary

The impact of trauma, or injury, on American society is profound. Trauma is the leading cause of years of potential life lost and the fourth leading cause of death in the United States; it causes more than 150,000 deaths annually. Each year, 57 million Americans are injured (1 in 4) seriously enough to require medical treatment. Nonfatal injuries account for 1 in 6 hospital days and for 1 in 10 hospital discharges (1). Trauma and its adverse outcomes occur disproportionately among young and elderly persons, who have special trauma care needs. Overall, among children and adolescents aged 1 to 19 years, trauma causes more deaths than all diseases combined (2).

Trauma, including intentional and unintentional injuries, takes a large toll on our society in terms of death, morbidity, and disability and creates huge problems in lost productivity and medical care costs. In 1985, the overall cost of trauma was estimated at $158 billion (1). That same year, trauma cost the federal government $21.7 billion. This figure includes $8.9 billion in direct medical payments and $12.8 billion in disability and death payments (1).

Trauma care systems can play a significant role in reducing mortality, morbidity, and disability due to injuries. The optimal trauma care system is designed to care for **all** injured patients and provides a continuum of services, including prevention programs, prehospital care, acute care, and rehabilitation. In this document, this type of system is referred to as an inclusive trauma care system. A small subset of patients are major trauma patients with life-threatening injuries. Optimal care for these patients will require the resources of highly specialized institutions called **trauma centers.**

The evidence that current trauma care systems which treat the most severely injured patients improve patient outcome is clear and indisputable (3-10). Since nonfatal, traumatic injury has a major impact on the young, effective trauma care systems can play a key role in returning these people quickly to their roles as functioning members of society. However, to address the needs of **all** injured patients, we must develop inclusive trauma care systems that involve all acute care facilities. Only then will we have a truly comprehensive and cost-effective system. More importantly, the constant surveillance of injuries by trauma systems would allow identification of high-risk groups and injury problems. In turn, the information gathered would help in the design and implementation of effective changes in the environment to prevent injuries and ultimately lower the cost of injuries within a region (11). Recommendations in this paper were made because of the key role of trauma care systems in mitigating injuries and because of their support for the Year 2000 Objectives in *Healthy People 2000* (12).

Major Challenges for Trauma Systems

Public Education: Establishing trauma care as a major public health priority and educating the public about the benefits of an inclusive trauma care system are essential. An informed public will demand optimal care and effective injury prevention efforts, including training for health professionals in trauma care and research, education, and prevention programs. Support from the public, business, government, and a strong coalition of health professionals can provide the necessary impetus and funds to establish a national trauma care system.

Financing Trauma Care: Current financing for trauma care is grossly inadequate. Recently, the proportion of uncompensated or undercompensated care has been so large that many metropolitan hospitals with trauma centers have closed their doors to severely injured persons. Treating large numbers of uninsured, severely injured patients, especially those associated with violent crime and drug abuse, has had a negative economic impact on hospitals and trauma care and has resulted in a shortage of professionals, such as prehospital care providers, trauma physicians, nurses, and technicians. Constantly increasing medical costs, combined with the decreased proportion of third-party reimbursement and decreased federal subsidies, continues to financially overburden hospitals that maintain trauma centers. Without significant changes in this financial situation, development of trauma systems will cease, and more trauma centers will close (13-16).

Rural Trauma Care: Several challenges face rural trauma care. Limited access to care and prolonged response and transport times are detrimental to the outcome of the trauma patient. In addition, many health care providers in rural communities lack the experience necessary to provide optimal care because of their infrequent exposure to major trauma patients. Continuous training for rural health care providers is essential. Rural health care institutions depend on an inclusive and integrated trauma care system for support, referrals, and training. Without coordination and cooperation between rural care systems and urban hospitals in the same region, the rural trauma patient remains at higher risk for long-term disability and mortality (17-20).

System Evaluation: To be effective, efficient, and proficient, trauma care systems require continuous monitoring and evaluation. In addition, the current competitive environment in health care delivery mandates routine evaluation of resources, facilities, and patient outcomes to illustrate cost-effectiveness. A national uniform data set is essential for conducting this evaluation. This data set should be appropriate for use by all acute care institutions. It will be vital for demonstrating improved patient outcome, assessing quality of care, and directing resource allocation.

Key Recommendations

- Establish trauma care as a **national public health priority.**
- Develop, implement, and evaluate an **inclusive trauma care system** in the United States.
- Develop, implement, and evaluate a **national uniform data set** for trauma care. National standards for case criteria and collecting, analyzing, and reporting trauma care data should be appropriate for use by all acute care institutions.
- Increase the availability of funding for **research** on injury control.
- Identify, implement, and evaluate **cost-effective** measures for trauma care systems.
- Conduct a comprehensive evaluation of **reimbursement** problems and provide financial support for trauma care systems.

References

1. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress. San Francisco, CA: Institute for Health & Aging, Univ. of California, and Injury Prevention Center, The Johns Hopkins Univ., 1989.

2. Committee on Trauma Research, Commission on Life Sciences, National Research Council, and the Institute of Medicine. Injury in America: a continuing public health problem. Washington DC: National Academy Press, 1985.

3. Ornato JP, Craren EJ, Nelson NM, Kimball KF. Impact of improved emergency medical services and emergency trauma care on the reduction in mortality from trauma. J Trauma 1985;25(7):575-9.

4. Shackford SR, Hollingsworth-Fridlund P, Cooper GF, Eastman AB. The effect of regionalization upon quality of trauma care as assessed by concurrent audit before and after institution of a trauma system: a preliminary report. J Trauma 1986;26(9):812.

5. Alexander RH, Pons PT, Krischer J, Hunt P. The effect of advanced life support and sophisticated hospital systems on motor vehicle mortality. J Trauma 1986;24(6):486.

6. Jacobs LM, Sinclair A, Beiser A, D'Agostino RB. Prehospital advanced life support: benefits in trauma. J Trauma 1984;24(1):8.

7. Cales RH. Trauma mortality in Orange County: the effect of implementation of a regional trauma system. Ann Emerg Med 1984;13(1):15.

8. West JG, Cales RH, Cazzaniga AB. Impact of regionalization. Arch Surg 1983;118:740.

9. West JG, Trunkey DD, Lim RL. Systems of trauma care: a study of two counties. Arch Surg 1979;114:460.

10. National Highway Traffic Safety Administration. Emergency medical services program and its relationship to highway safety. Washington DC: U.S. Government Printing Office 1985:832. U.S Dept. of Transportation technical report; Publication No. DOT HS 806.

11. Martinez R. Injury control: a primer for physicians. Ann Emerg Med 1990;19:72-7.

12. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991:DHHS Publication No. (PHS) 91-50212.

13. Schwab CW, Young G, Civil I, Ross SE, Talucci R, Rosenberg L, et al. DRG reimbursement for trauma: the demise of the trauma center (the use of ISS grouping as an early predictor of total hospital cost). J Trauma 1988;28(7):933-46.

14. Allen M. Miami trauma care network founders over unpaid bills and grumbling doctors. Wall Street Journal 1987 Feb 25 Sect 1:31(col.4).

15. Dailey JJ, Teter H, Provenzano G. Trauma center closures: a national assessment poster presentation. Third Annual Injury Control Conference. Denver CO: April 1991.

16. General Accounting Office. Trauma care lifesaving system threatened by unreimbursed costs and other factors. Gaithersburg MD: U.S. Government Printing Office, May 1991. HRD-91-57.

17. Baker SP, Whitfield RA, O'Neill B. Geographic variations in mortality from motor vehicle crashes. N Engl J Med 1987;316:1384-7.

18. Baker SP, Whitfield RA, O'Neill B. County mapping of injury mortality. J Trauma 1988;28:741-5.

19. Baker SP, O'Neill B, Karpf RS. The injury fact book. Lexington MA: DC Heath and Company, 1984.

20. National Safety Council. Accident facts. Chicago IL: National Safety Council, 1987.

Acute Care Treatment
— Contributors—

Frank R. Lewis, M.D.,* Cochairperson, San Francisco General Hospital, San Francisco, CA

Thomas A. Gennarelli, M.D., Cochairperson, Hospital of the University of Pennsylvania, Philadelphia, PA

Daniel A. Pollock, M.D., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Denise Johnson, Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Robert H. Demling, M.D., Harvard Medical School, Boston, MA

Frank Ehrlich, M.D., The Graduate Hospital, Philadelphia, PA

Martin R. Eichelberger, M.D., Children's National Medical Center, Washington, DC

Arthur W. Fleming, M.D., King-Drew Medical Center, Los Angeles, CA

John H. Ferguson, M.D., National Institutes of Health, Bethesda, MD

Kenneth W. Kizer, M.D., M.P.H., California Department of Health Services, Sacramento, CA (Present address: School of Medicine, University of California, Davis, CA)

Raj K. Narayan, M.D., Baylor College of Medicine, Houston, TX

Grace Rozycki, M.D., The Washington Hospital Center, Washington, DC

G. Thomas Shires, M.D., Cornell University Medical Center, New York, NY

Peter G. Trafton, M.D., Rhode Island Hospital, Providence, RI

Donald D. Trunkey, M.D., Oregon Health Sciences University, Portland, OR

John Weigelt, M.D., University of Texas Health Science Center, Dallas, TX

Nancy Burton, M.P.H., Macro International, Inc., Atlanta, GA

Acknowledgment: The panel thanks Robert Morris, M.D., and C. Douglas Witherspoon, M.D., University of Alabama at Birmingham, Louis D. Pizzarello, M.D., Southampton Hospital, Southampton, NY, and James P. Ganley, M.D., Dr.P.H., Louisiana State University Medical Center, Shreveport, LA, for their contributions to the section on ocular trauma. The panel thanks Ricardo Martinez, M.D., Stanford University Hospital, Stanford, CA, for his contributions to the section on prehospital care and emergency department care.

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Acute Care Treatment
Executive Summary

The Issue

Traumatic injury is epidemic in the United States, and it is the largest killer of people from 1 through 44 years of age, which includes those in their most productive years. It continues to be a significant threat among older people and is among the four leading causes of death. Traumatic injury takes an economic toll greater than heart disease and cancer combined; even when it does not result in death, it is the cause of an extraordinary amount of disability, the human cost of which is impossible to quantify.

Trauma, which has been called the number one public health problem in the United States today (1), particularly affects people in industrialized societies, where heavy tolls are taken by occupational and household injuries and even heavier tolls by motor vehicle trauma. The United States, however, has an additional cause of trauma — interpersonal violence — which causes a toll of death and disability not seen in other industrialized countries.

Every year, 150,000 people in the United States die from trauma, and more than 2 million people are hospitalized as a result of injuries (2). The yearly economic losses, including direct medical costs, disability costs, and lost wages and taxes, amount to over $100 billion.

Despite this appalling toll in human and economic costs, we have done little as a Nation to address this problem. Since 1967, it has been highlighted periodically in national white papers, but the public and legislative response can best be characterized as apathetic. Annual federal research expenditures related to trauma care are approximately 5% of those for cancer, heart disease, or AIDS. The legislative response in mandating the development of trauma systems and trauma centers has occurred entirely at the state level and has been quite variable, with fewer than five states having any kind of complete system in place.

The treatment phase of acute care begins before the patient reaches the hospital and extends through the hospital phase, including treatment in the emergency department, operating room, intensive care unit, and hospital ward. Rehabilitation should begin while the patient is in the hospital phase of treatment.

Although the medical care of traumatized patients is generally well defined, improved care is needed in many areas if we are to reduce the toll of death and disability. In the broadest sense, the goal of the treatment phase is to minimize the effects of the injury. In this chapter, we identify and discuss those areas of acute care treatment that we believe need further study and improvement.

The Challenges

The principal goal of treatment is to give patients the care that will lead to their maximal functional recovery. Starting in the prehospital environment and continuing through all phases of hospital care, the aim of those providing acute care treatment is to minimize the effects of injury. In many situations, however, the correct treatment method is not apparent, since many standard care procedures have not been objectively studied, particularly those in the prehospital environment.

Early mortality among traumatized patients is due principally to head and high spinal cord injury (50%), blood loss (30-40%), and airway and pulmonary compromise (5-15%) (3). With all of these causes, the time between injury and treatment becomes a critical variable that must be factored into the decision process. Severe airway and pulmonary compromise generally must be relieved within minutes if the patient is to survive: major bleeding must be addressed from within minutes to as much as 1 to 2 hours; and for the most effective results, persons with head injuries should be treated within 2 to 3 hours. Timeliness is far more important in trauma treatment than in most other areas of medical care. Thus a major challenge of treatment is not only to determine and carry out the optimal treatment but to do so within an appropriate time frame. To better understand what "an appropriate time frame" is, we need to investigate the relationship between the time from trauma to treatment and the patient's outcome; we also need to study the effectiveness of particular treatments conducted under particular time constraints.

In the hospital, the major challenge to health care providers is to rapidly determine the nature and extent of a patient's injuries and to quickly provide the proper treatment, again with an awareness of the crucial role time plays in determining the outcome. We need to improve diagnostic modalities in several areas, particularly in those related to perfusion and oxygenation at the tissue level.

Among those patients whose bleeding has been controlled and who survive the acute phase of injury, the major cause of death during the first few days is irreversible cerebral damage or uncontrollable cerebral swelling. We urgently need research into methods of reducing secondary cerebral injury and of controlling brain swelling. Methods now in use have changed little over three decades and are inadequate in a substantial number of cases.

Deaths among trauma patients who survive the first few days are most often due to infection and organ failure, with the lung being the most commonly affected organ. The body's response to traumatic tissue damage and major blood loss appears to result in an activation of multiple processes (collectively known as the inflammatory response) that are themselves destructive to body tissues in various ways. As the result of advances in molecular biology, our knowledge of these processes has expanded dramatically in the last few years, and our understanding of the inflammatory processes is similarly increasing. The nature of the inflammatory response, however, needs to be investigated further; our goal should be to

develop agents that can attenuate the inflammatory response or modify it in beneficial ways while not causing further damage.

Finally, the overall impact of trauma care systems needs much greater study and validation if we are to build broader support among third-party payers, nontrauma system providers, and other interested parties. The lack of development of trauma systems is partly because no large-scale studies of the cost-effectiveness of trauma care have been conducted. Such studies are needed if we are to clearly demonstrate the value of trauma care, to define the potential benefits from widespread implementation of trauma care systems, and to support the Year 2000 Objectives in *Healthy People 2000* (4).

In the detailed material to follow this executive summary, we will examine the broad areas touched on above and make specific recommendations.

Key Recommendations:

To improve the treatment of trauma patients, we recommend that the following research goals receive priority:

- Evaluate (with a multidisciplinary group of professionals from fields such as marketing, public relations, and psychology) why the public does not provide greater support for efforts to reduce the toll of injuries, despite their significance as a cause of morbidity and mortality in all age groups.
- Develop improved methods to score injury severity and to evaluate and predict clinical outcomes in the general trauma population as well as among specific populations in the areas of pediatrics, neurotrauma, burns, and orthopedics.
- Develop population-based studies of trauma outcomes and of the cost-effectiveness of trauma system care versus traditional health care.
- Define the optimal treatments to be given before patients reach the hospital, the relationship between the time it takes them to reach the hospital and their outcome, and the optimal resuscitative fluid to use on patients before they reach the hospital.
- Formulate objective trauma treatment guidelines for use in the emergency department phase of care, including guidelines for improved diagnosis of abdominal injuries.
- Develop techniques for real-time monitoring of tissue perfusion and oxygenation.
- Support basic scientific investigations of the inflammatory process, including the immunologic, metabolic, hormonal, and cytokine responses to traumatic injury.

- Develop better methods for assessing perfusion and metabolism in all tissues and for evaluating agents used to modulate the inflammatory and growth processes that can lead to tissue damage after injury.
- Develop and conduct clinical trials of pharmacologic agents used to treat acute sequelae of traumatic injury, particularly those that reduce edema of the brain and spinal cord, attenuate the inflammatory response, and enhance healing.
- Evaluate new treatment modalities of nutritional support, including the early institution of nutritional support, the use of nutritional regimens with enhanced concentrations of specific nutrients, and the use of enteral alimentation to enhance immunologic responsiveness.
- Develop and test new orthopedic therapies to enhance healing, reduce immobility and disability periods, and improve functional outcomes.
- Develop interventions that address the psychosocial impact of traumatic injury on patients and their families.

References

1. Committee on Trauma Research, Commission on Life Sciences, National Research Council, and the Institute of Medicine. Injury in America: a continuing public health problem. Washington DC: National Academy Press, 1985.

2. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress. San Francisco, CA: Institute for Health & Aging, Univ. of California, and Injury Prevention Center, The Johns Hopkins Univ., 1989.

3. Baker CC, Oppenheimer L, Stephens B, Lewis FR, Trunkey DD. Epidemiology of trauma deaths. Am J Surg 1980; 140:144-50.

4. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991:DHHS Publication No. (PHS) 91-50212.

Rehabilitation of Persons with Injuries
— Contributors—

Theodore M. Cole, M.D., Chairperson, Department of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, MI

Frederick M. Maynard, M.D.,* Department of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, MI

Philip L. Graitcer, D.M.D., M.P.H., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

David F. Apple, Jr., M.D., Shepherd Spinal Center, Atlanta, GA

Kathleen H. Acree, M.D., California Department of Health Services, Sacramento, CA

James R. Boen, Ph.D., University of Minnesota School of Public Health, Minneapolis, MN

Catherine F. Bontke, M.D., Baylor College of Medicine, Houston, TX

John F. DiTunno, Jr. M.D., Thomas Jefferson University Hospital, Philadelphia, PA

Douglas A. Fenderson, Ph.D., Department of Family Practice and Community Health, University of Minnesota School of Public Health, Minneapolis, MN

Lawrence J. Fine, M.D., National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, OH

Philip R. Fine, Ph.D., University of Alabama, Birmingham, AL

Marcus J. Fuhrer, Ph.D., Baylor College of Medicine, Houston, TX

Dorothea D. Glass, M.D., Rehabilitation Medicine, Department of Veterans Affairs Medical Center, Miami, FL

William Graves, Ed.D., National Institute of Disability and Rehabilitation Research, Washington, DC

Phala A. Helm, M.D., University of Texas Southwestern Medical Center, Dallas, TX

Kenneth M. Jaffe, M.D., University of Washington School of Medicine, Seattle, WA

Allen Jette, P.T., Ph.D., New England Research Institute, Watertown, MA

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Ellen J. MacKenzie, Ph.D., Health Services Research and Development Center, The Johns Hopkins University, Baltimore, MD

Jay Moskowitz, Ph.D., National Institutes of Health, Bethesda, MD

Jacqueline Perry, M.D., Rancho Los Amigos Medical Center, Downey, CA

Roberta B. Trieschmann, Ph.D., Scottsdale, AZ

Kent Waldrep, Kent Waldrep National Paralysis Foundation, Dallas, TX

T. Franklin Williams, M.D., National Institute on Aging, National Institutes of Health, Bethesda, MD

Katie Baer, M.P.H., Macro International, Inc., Atlanta, GA

Rehabilitation of Persons with Injuries
Executive Summary

Improvements in emergency medical systems, trauma centers, injury prevention, and medical and surgical management have resulted in increased survival rates for people with serious injuries. Mere survival, however, is not enough; children and adults with injuries need rehabilitation and educational services to help them regain biologic, psychologic, and social functions. These services must be comprehensive, longitudinal, and coordinated. Rehabilitation must be seen as part of a continuum of care provided to people with injuries by an interdisciplinary team and by the injured person's family from the early acute stage to the end of the person's life, if necessary.

In terms of human suffering and costs, injuries exact a huge toll, especially injuries in the following six major categories for which a person requires intensive rehabilitation services.

Spinal Cord Injury. Estimates of people with spinal cord injury (SCI) in the United States range from 177,000 to 200,000, and 10,000 to 20,000 more people receive an SCI each year. Most people with SCIs are permanently impaired, and most have major disabilities. In the United States, the cost of SCI is estimated at $6.2 billion annually.

Traumatic Brain Injury. No surveillance data with exact numbers of traumatic brain injuries exist. An estimated 70,000 people annually incur moderate-to-severe head injuries and require long-term rehabilitation services to help cope with cognitive, behavioral, and emotional deficits. Children and young adults are disproportionately affected by traumatic brain injuries and often require lifelong rehabilitation services.

Burns. About half of all people who receive burn injuries require medical care. Each year, between 70,000 and 100,000 hospital admissions are for burns; about a third of these admissions are to facilities with specialized burn units. Data are limited on long-term sequelae to burn injuries, rehabilitation outcomes, and the costs of rehabilitation care for burns.

Limb Injuries. About half of all hospital trauma admissions are due to injuries to the upper and lower limbs, resulting in a total of $5.4 billion in hospital charges.

Back Injuries. Of the estimated 5.2 million Americans with low back pain, about half are chronically disabled. Low back pain is the most common cause of work disability in adults younger than 45 years of age. The cost of compensable low back pain has been estimated at $11 billion.

Polytrauma and Other Injuries. Polytrauma (injuries to more than one body system) occurs frequently. For example, about half of all people injured in motor vehicle crashes have multiple injuries, including head, spinal, facial, or extremity injuries. Each year, an estimated 2.4 million Americans suffer from an eye injury, and nearly 1 million Americans now have permanent visual loss as a result of ocular trauma.

Rehabilitation can improve functional outcomes by maintaining function of body systems and reducing residual disabilities. Unfortunately, rehabilitation services are not available to all who need them. The capacity of the health care system to provide rehabilitative services is not uniform throughout the country; services are sometimes fragmented and poorly distributed. Moreover, the cost of rehabilitation is a barrier for people who lack medical insurance or third-party payers for medical expenses.

Although great progress has been made in the development and delivery of rehabilitation services, many improvements are still needed. Two recent developments are encouraging. First, the passage of the Americans with Disabilities Act reflects a recognition of the rights of persons with disabilities to have access to employment and to an independent, noninstitutional lifestyle. This legislation will have a major impact on our Nation when it becomes law in 1992. Similarly, the recently published Institute of Medicine study, *Disability in America*, will have an impact on policymakers and researchers by providing them with a framework for prevention strategies (1).

This position paper has been developed to serve as a national agenda for rehabilitation services, research, and policy for this decade while supporting the Year 2000 Objectives in *Healthy People 2000* (2). Vital to this agenda is the belief that all injured children and adults and their families should receive the benefits of rehabilitation that are currently available and that research, both basic and applied, should receive adequate funding. **Our goal is to establish, by the year 2000, a cost-effective system of rehabilitative care that will permit an injured person to achieve optimal health, personal autonomy, and an independent, noninstitutional lifestyle. A cost-effective system of rehabilitative care will help achieve an important objective of *Healthy People 2000*, namely the reduction of secondary disabilities as a result of head and spinal cord injuries.**

We acknowledge that this is an ambitious goal and that it requires substantial financial commitment, new systems of health care delivery, and new research and evaluation. The achievement of this goal depends on cooperation and collaboration among researchers, clinicians, consumers, families, communities, and public and private agencies. We believe that obtaining the finances and the cooperation needed to attain this goal is possible.

Six major areas need special attention.

Basic Science Research

The National Institutes of Health (NIH) convened a group of experts in rehabilitation medicine, behavioral and social sciences, allied health, nursing, and related fields to help determine what research is needed to build a strong foundation for rehabilitation services. This task force recommended a solid program of basic science research and outcome research. In addition, NIH recently established the National Center for Medical Rehabilitation Research to address the need for basic rehabilitation research. **We strongly endorse the recommendations of the NIH task force report and the establishment of the National Center for Medical Rehabilitation Research. We recommend establishing a cohesive program of research that would include projects ranging from basic science to ways injured persons can function in the community.**

Injury and Rehabilitation Surveillance

The field of rehabilitation is hampered by lack of data on etiology, risk factors, treatment, and outcomes related to rehabilitating persons with injuries. Evaluating preventive strategies and clinical care approaches is important; however, without objective measurement tools, measuring evaluation outcomes is difficult. **We recommend developing a clinical care data base that would include epidemiologic information on etiology, risk factors, treatment, outcome, and cost on all persons with injuries.**

Information Dissemination and Technology Transfer

Information from researchers must reach clinical and public health programs and the general public, and information about gaps in care, the relative effectiveness of various clinical care strategies, and emerging problems must reach researchers. **We recommend that high priority be given to funding proposals for information dissemination and technology transfer among researchers, clinicians, all health-care providers, injured persons and their families, and community members.**

Increased Capacity for Delivering Rehabilitation Services

Comprehensive rehabilitation services are not uniformly available throughout the country. Successful clinical service systems, such as the Model Spinal Cord Injury Care Systems, provide integrated care by using existing clinical and prevention knowledge. Such innovative systems, however, are not available in all regions of the country, and not everyone who needs such services can afford them. **We propose that systems of care be developed for all people with injuries that produce significant limitations in function and that the effectiveness of these systems be evaluated.**

Research on Clinical and Health Services

Many types of interventions and other factors influence the medical outcomes and quality of life of a person with disabilities. **Health systems research, incorporating a variety of innovative and traditional approaches, is needed to address issues such as access to and payment for services, cost-benefit analysis of rehabilitation services, reemployment training and back-to-work incentives, and combinations of traditional and nontraditional rehabilitation services and therapeutic methods.**

Training

The field of rehabilitation faces shortages of trained medical, allied health, and nonmedical care givers. Various professional and nonprofessional groups need many levels of training. Formal methods must be developed to train, support, and certify personal care attendants who are critically important in helping people with disabling injuries achieve independence. **We strongly believe that more trained personnel are needed in all areas of rehabilitation, including research, clinical care, and personnel services, to ensure the development of model systems of rehabilitative care.**

References

1. Pope AM, Taylor AR, eds. Disability in America. Washington DC: National Academy Press, 1991.

2. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991:DHHS Publication No. (PHS) 91-50212.

Motor Vehicle Injury Prevention

Motor Vehicle Injury Prevention
— Contributors—

John Graham, Ph.D., Chairperson, Harvard School of Public Health, Boston, MA

Patricia Waller, Ph.D.,* University of Michigan Transportation Research Institute, Ann Arbor, MI

Terence Chorba, M.D., M.P.H., M.A., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Marilena Amoni, M.S., Traffic Safety Programs, National Highway Traffic Safety Administration, Washington, DC

R. Clark Bennett, Federal Highway Administration, Washington, DC

B.J. Campbell, Ph.D., University of North Carolina, Highway Safety Research Center, Chapel Hill, NC

Kennerly Digges, Ph.D., University of Virginia, Automobile Safety Program, Charlottesville, VA

Michael Finkelstein, M.A., Federal Highway Administration, Washington, DC

Thomas Hall, Federal Highway Administration, Washington, DC

Howard Hanna, P.E., Federal Highway Administration, Washington, DC

Ralph Hitchcock, M.S., Research and Development, National Highway Traffic Safety Administration, Washington, DC

Garland Land, M.P.H., Missouri Department of Health, Jefferson City, MO

William M. Marine, M.D., M.P.H., University of Colorado School of Medicine, Denver, CO

Robert Munson, M.B.A., Ford Motor Company, Dearborn, MI

Robert Nicholson, M.A., Traffic Safety Programs, National Highway Traffic Safety Administration, Washington, DC

Brian O'Neill, Insurance Institute for Highway Safety, Arlington, VA

Jeffrey Pike, M.E., Ford Motor Company, Dearborn, MI

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Judith Lee Stone, Advocates for Auto and Highway Safety, Washington, DC

Roy Thigpen, M.Ed., Governor's Representative for Highway Safety, Jackson, MS

David Viano, Ph.D., General Motors Research Laboratories, Warren, MI

David Wallace, M.S.E.H., Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Deborah D. Landen, M.D., National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

Julie Russell, Ph.D., Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Nicole Lezin, M.P.P., Macro International, Inc., Atlanta, GA

Where We Are

Dimensions of the Problem

With about 500 million cars and commercial vehicles in use worldwide, more than half a million people die each year in motor vehicle crashes. In the United States alone, motor vehicle crashes have killed 2.8 million people since 1900 — more than twice the number of Americans killed in all U.S. wars since 1775. Motor vehicle crashes are the leading cause of death among U.S. citizens for all age groups from 1 through 34 years of age (1); the third most significant cause of years of potential life lost, after heart disease and cancer (2); and the leading cause of work-related deaths. At current rates, approximately 1 of every 70 babies born will eventually die in a motor vehicle crash.

The risk of premature death is only one dimension of this public health hazard. In the United States each year, crashes are responsible for more than 500,000 hospitalizations and 4.8 million nonhospitalized injuries (2). Motor vehicle crashes are the major cause of serious head and spinal cord injuries leading to permanent disabilities; they account for one-third to one-half of all serious head injuries, and an estimated 30% to 60% of all spinal cord injuries (2). At current rates, approximately 3 of every 100 babies born will eventually suffer a disabling injury in a motor vehicle crash.

The economic impact of crash-related injuries is often overlooked. The estimated economic cost to the Nation from motor vehicle crashes in 1985 exceeded $75 billion. The injury-related costs were $48 billion, of which $12 billion were for direct medical and rehabilitation costs, $19 billion for indirect productivity costs associated with morbidity, and $17 billion for indirect productivity costs associated with mortality (2).

In view of these burdens, the benefits to be derived from reducing crash-related injuries are great indeed. They include reductions in costs of emergency department visits, hospitalization, rehabilitation, home care, public assistance, productivity losses, and pain and suffering among injured persons and their loved ones. In these times of fiscal constraint, with an urgency to address the appropriate allocation of dollars, it is prudent for society to think of the unseen as well as the seen victim. In the words of Dr. Harvey Fineberg, Dean of the Harvard University School of Public Health, who spoke at the 1988 Joseph W. Mountin Lecture at the Centers for Disease Control (CDC):

> Many people will remember the names and faces of those babies who are presented on television or in newspapers as needing a liver transplant. But how many people ever think about the baby in the automobile accident who died and whose liver becomes the liver that is available for the transplant? Can we discern if the life of the baby in the automobile is any less precious than that of the baby who is in need of the transplant? (3)

Motor vehicles are integral to our lifestyles, and the number of vehicle-miles traveled yearly per person continues to grow. From 1965 to 1990, motor vehicle mileage for the U.S. population increased more than 133%, from under 900 **billion** to over 2.1 **trillion** miles per year (Figure 1). Vehicle miles of travel are expected to continue to increase throughout the 1990s. In 1989, there were 24,300 fewer deaths than there would have been if the 1980 rate had continued undiminished (National Highway Traffic Safety Administration (NHTSA) press release, November 1990).

Efforts to predict the magnitude of the highway safety problem more than 10 years into the future have been notoriously unsuccessful. In the past, many analysts forecast increases in the annual highway death toll from the 40,000 to 50,000 range to the 60,000 to 80,000 range. Such projections have usually assumed steady annual increases in vehicle-miles of travel and a constant death rate per mile of travel. In fact, the death rate (per 100 million vehicle-miles traveled (VMT)) has declined from 15.6 in 1930 to 5.1 in 1960, and to 2.1 in 1990 (Figure 1).

Factors that may depress the mileage death rate in the 1990s include

- A decrease in the relative size of the teenage driving population.
- Increased population density and urbanization.
- Further reductions in alcohol consumption and alcohol-involved crashes.
- Further increases in occupant restraint use.
- Vehicle safety improvements, including airbags and side impact protection.
- Decreasing use of motorcycles and increasing use of motorcycle helmets.
- Roadway improvements.

Factors that may inflate the mileage death rate include

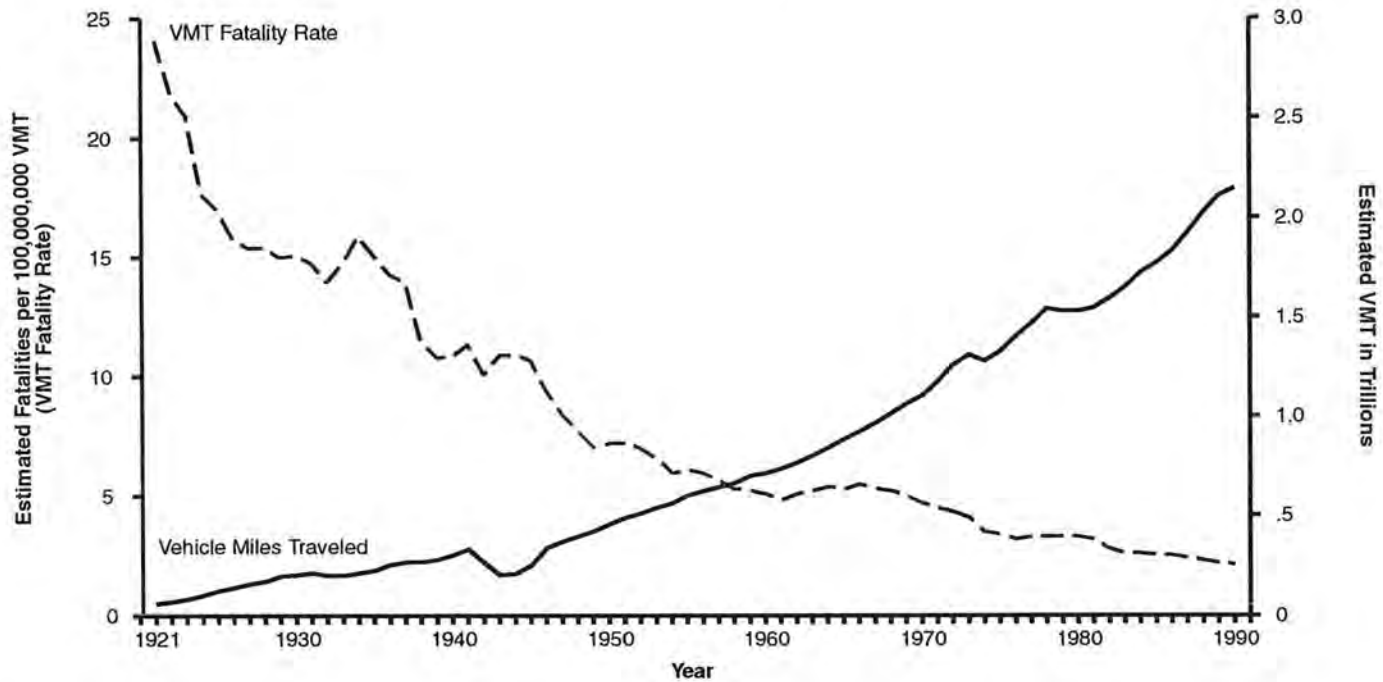
- An increase in the number of elderly drivers, passengers, and pedestrians.
- Continued increases in vehicle speeds, including speeds on rural interstate highways following the implementation of 65 mph speed limits (4).
- More vehicle downsizing and sales of small cars in response to gas prices and pressures for improved fuel economy.
- Continued increases in large truck and trailer weights.

Unless major new intervention programs are implemented, the annual U.S. death toll from motor vehicle crashes probably will remain in the 40,000 to 50,000 range over the next few years.

This paper is entitled "Motor Vehicle Injury Prevention," but it is not intended to be exclusionary or limiting, and where applicable, the concepts discussed should be applied to the prevention of injury associated with all common road vehicles, including nonmotorized

Figure 1

Vehicles Miles Traveled (VMT) and Traffic Fatality Rates, United States, 1921-1990



Sources: 1921-1974 National Center for Health Statistics, Centers for Disease Control, and State Accident Summaries

1975-1990 National Center for Statistics and Analysis, National Highway Traffic Safety Administration

vehicles, such as bicycles. In this paper, the terms highway safety, motor vehicle injury prevention, road safety, roadway safety, and traffic safety are, in general, used interchangeably.

Cost-Effective Prevention Opportunities

Motor vehicle injury prevention is a sound investment of scarce public health and highway safety dollars. Health economists have compared the estimated costs per life (and life year) saved by numerous public health programs. Such studies have consistently concluded that traffic safety programs are more cost effective than almost all other kinds of public health interventions. For example, Graham and Vaupel (5) found that the median cost per life year saved for selected National Highway Traffic Safety Administration (NHTSA) programs was over 100 times less than for selected occupational and environmental health programs. Similar findings have been reported by Schwing (6), Bailey (7), and Morrall (8).

The cost-effectiveness of regulatory actions also varies tremendously, reflecting the poor allocation of society's resources for reducing risk. An example of this variation appears in the Federal Budget for Fiscal Year (FY) 1992: on the average, spending $2 million regulating cancer risks posed by wood preserving chemicals prevents one cancer case every 2.9 million years, whereas the same amount spent on highway safety saves at least one life in just a few years (9). The evidence suggests that our limited public health resources could lower costs and save more lives if they were reallocated to favor more traffic safety investments.

If traffic safety programs reduce the number or severity of injuries, they can produce economic savings. Motor vehicle injuries account for 9% of all nonhospitalized injuries, but they account for 22% of all injury-associated hospitalizations, 32% of all injury-associated fatalities, 31% (or $48.7 billion) of the total lifetime costs of injuries in the United States (2), and more than 25% of all uncompensated hospitalization charges. Expressed in 1985 dollars, the average lifetime cost per person injured by a motor vehicle exceeds $9,000 (2), and the average cost per fatal injury exceeds $350,000 (2). These cost estimates include only medical costs and losses in economic productivity. When dollar values are added for pain and suffering and other quality-of-life factors, the costs are frequently 10 times greater than these estimates (10). The U.S. Department of Transportation (DOT) currently uses $1.5 million for the dollar value per life when conducting cost-benefit analyses; this value includes some consideration for pain and suffering.

The results of cost-benefit analyses of motorcycle helmets, child safety seats, and airbags suggest that the economic savings in terms of medical and rehabilitation costs far exceed the cost of these protective devices. For many highway safety programs, the economic savings have been estimated to exceed program costs (see Table 1) (11-20).

No Single Magic Solution

As with many diseases that affect large numbers in the population, no single magic bullet — technological or behavioral — will eliminate the problem of motor vehicle injury. Over the past 4 decades, numerous interventions in motor vehicle and highway safety have contributed incrementally to reductions in the likelihood of injury in the United States. These countermeasures have included public awareness, education, and incentive programs; legal proscriptions; innovative vehicle and equipment designs; improved roadways, enhanced emergency medical services (EMS) systems; new acute care technologies at trauma centers; and modernized rehabilitation programs. A multifaceted approach has been necessary because of the complexity and array of significant traffic problems that contribute to morbidity and mortality on our roads.

In September 1990, as part of a "management-by-objectives" planning process, Secretary of Health and Human Services, Louis Sullivan introduced 298 health objectives for the Nation (21). A complete list of objectives relating to motor vehicle injury control appears in Appendix A. The wide range of issues reflected in the following summary of the relevant objectives illustrates that no single strategy will solve the problem of motor vehicle injuries:

- Reduce the rate of motor-vehicle crash deaths per VMT.
- Reduce serious nonfatal head injuries.
- Reduce nonfatal spinal-cord injuries.
- Reduce secondary disabilities associated with injuries of the head and spinal cord.
- Increase use of active and passive restraints.
- Increase helmet use by motorcyclists.
- Extend laws on safety-belt and motorcycle-helmet use to all states for all ages.
- Reduce deaths caused by alcohol-related motor vehicle crashes.
- Reduce per capita alcohol consumption.
- Extend administrative license suspension and revocation laws (or other effective programs) to all states.
- Enact and enforce laws that reduce access to alcoholic beverages by minors.
- Restrict alcoholic beverage promotions that are focused principally on young audiences.
- Extend blood alcohol concentration (BAC) tolerance levels of .00% for drivers under the age of 21 to all states.

All of the recommendations in this paper that address the Year 2000 Objectives are so noted in the text. The panel's recommendations, however, extend beyond the focused Year 2000 Objectives listed in Appendix A.

Table 1

Highway Safety Improvements With The Highest Benefit-Cost Ratios

1974-1989

Rank	Construction Classification	Percent Reduction in Injury Rates After Improvements			
		Fatal Injury	Nonfatal Injury	Fatal and Nonfatal Injury	Benefit-Cost Ratio
1	Illumination	47	22	22	9.5
2	New Median Barrier	66	6	9	4.8
3	Upgrade Bridge Rail	75	32	36	4.1
4	Upgrade Guardrail	40	8	10	4.1
5	Traffic Signs	28	8	8	3.6
6	Remove Obstacles	50	23	24	3.6
7	New Traffic Signals	52	20	21	3.5
8	Upgrade Median Barrier	45	27	27	3.3
9	Impact Attenuators	33	35	35	2.7
10	Improve Minor Structure	35	20	21	2.5

Source: (20)

Notes: 1. Revised project cost indices were used to convert the original construction cost of each project to 1987 dollars. The indices are used to counter the effect of inflation when comparing the benefit-cost ratio of safety projects implemented in different years. The indices are based on information provided in a Federal Highway Administration (FHWA) publication entitled "Price Trends for Federal-Aid Highway Construction," Second Quarter 1989.

2. Costs (in 1986 dollars) of $1,500,000 per fatality and $11,000 per injury were used in calculating the benefit-cost ratio of highway safety improvement projects. These costs are based on the findings of a 1986 FHWA research contract entitled "Alternative Approaches to Accident Cost Concepts."

Factors that Transcend Motor Vehicle Injury

The solutions to the problem of motor vehicle injury do not lie solely in the realm of either traffic safety or public health. Many behaviors and risk factors are associated with both traffic safety trends and larger, societal issues. Illustrative behaviors and risk factors include impaired driving, risk taking, age, and literacy.

Impaired Driving

The traffic safety community has long recognized the association of alcohol and other drugs with serious motor vehicle crashes, and during the last decade, public awareness has risen considerably. Citizen advocacy groups demanded greater attention to the morbidity and mortality attributable to impaired driving. Enforcement and sanctions are necessary to combat impaired driving, but a more comprehensive approach must be taken if significant progress is to be made in preventing impaired driving.

In 1988, the Surgeon General's Workshop on Drunk Driving was convened as the first major national public health effort to take a comprehensive approach to alcohol-impaired driving (22). The workshop's origins in the public health community and its attention to the effects of alcohol on motor vehicle safety constituted an important and growing link among the alcohol, health, and transportation communities.

The workshop addressed enforcement and judicial procedures, but it also examined the pricing and availability of alcohol, the advertising and marketing of alcohol, and transportation and alcohol service policies. Changes in each of these areas have the potential to reduce alcohol consumption and minimize its deadly and costly effects on individuals and society. This comprehensive approach to impaired driving has triggered some opposition. However, it is unlikely that we will substantially reduce impaired driving until and unless we (a) reduce problem drinking, drug use, and total per capita alcohol consumption, and (b) modify many commonly accepted current practices such as granting licenses to drinking establishments that can be reached only by private transportation and allowing the alcoholic beverage industry to sponsor events targeted at audiences who are below the minimum drinking age.

Specific recommendations regarding alcohol are addressed in the section titled "Program Successes," and in "How We Get There," page 129, under "Corporate America."

Driver Attitudes and Risk Denial

The risk of involvement in a fatal crash is often expressed in terms of fatalities per VMT. Today, the motor vehicle crash fatality rate is less than 2.1 per 100 million VMT. As Figure 1 shows, this rate represents a dramatic decrease in rates from earlier years and reflects improvements in many aspects of traffic safety. The decline in the fatality rate, however, obscures the tremendous variation in **relative** risk. For example, an 18-year-old male is over nine times more likely to be involved in a fatal crash than a 40-year-old male. Drivers whose

BAC levels are $\geq$ .10% are more than 12 times as likely to be involved in a fatal crash as a sober driver (23). The use of safety belts, the vehicle's weight and speed, and even the type of road on which a driver is traveling, all combine to affect a driver's relative risk. Some aspects of relative risk have been minimized through improvements in the safety features of roads and vehicles. However, driver behavior and actions also play an important and often decisive role in either increasing or decreasing relative risk.

Many motor vehicle crashes can be classified into one of two groups: crashes that are the result of aggressive, reckless driving, and crashes that are the result of lapses in judgment by otherwise attentive, responsible drivers (24). Vehicle and roadway design can potentially help good drivers avoid crashes, but a reckless driver can overcome built-in safety features by driving irresponsibly.

Aggressiveness is a behavior issue related to the individual driver, individual motivation, and peer pressures. Drivers who routinely take irresponsible risks with their vehicles must be reached in order to reduce traffic casualties. This may require early education and training of children before they get driving privileges (25), and careful review of television and film portrayals of heroes who unrealistically avoid the consequences of reckless driving and speeding. Aggressive driving is a critical factor in injuries among adolescents and has been associated with other risk-taking behaviors (26). These issues warrant further study, as do various behavior-based interventions (27).

Age

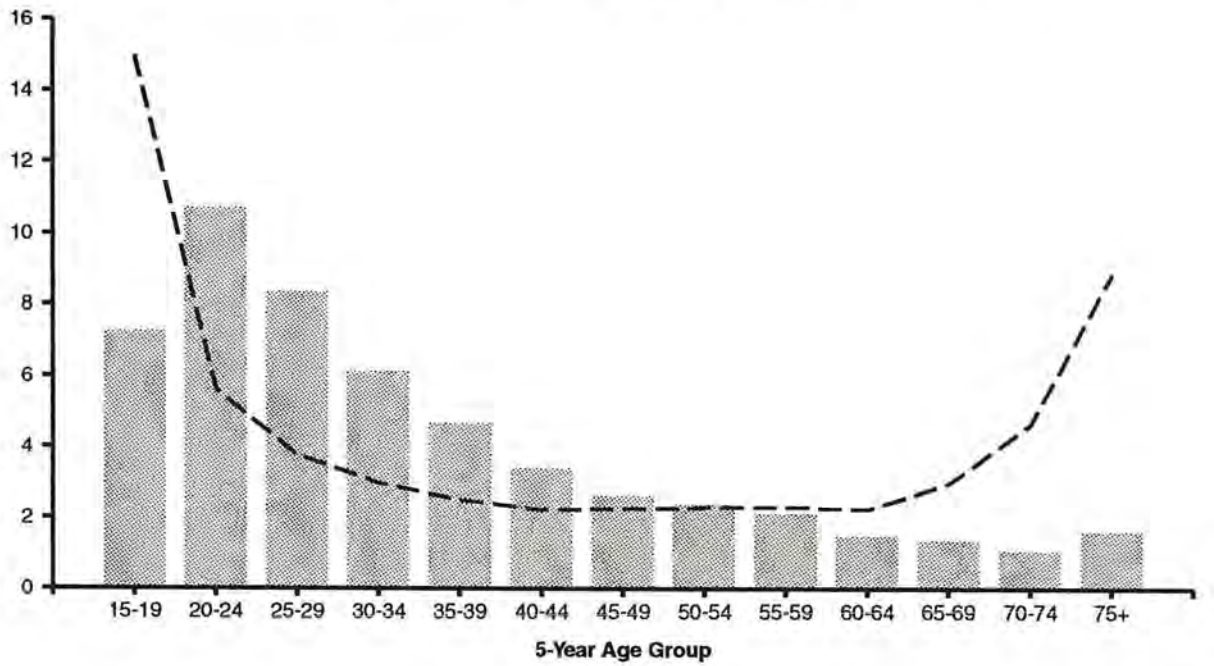
Age is one of the most powerful risk factors for motor vehicle injury, in part because it relates to alcohol consumption, aggressive behavior, and driver capabilities (26). Raising the minimum age of licensure has been proposed as one solution to the higher crash risk of young drivers. This would not reduce any crash risk due to inexperience in driving, but would reduce appreciably the risk due to immaturity and to exposure.

Although age per se should not be used as a criterion for denying a license at the other end of the age continuum, the risk of crash per mile driven increases after age 65, and markedly so after age 75 (Figure 2). Increased age is also associated with higher probability of serious or fatal injury in a crash of given severity (28, 29). However, continued mobility may be a factor in maintaining the health and psychological well-being of the elderly (30), and mobility needs should be balanced with safety concerns.

The changing demographics of our population herald increases in the older driving population and decreases in the younger driving population. Changing demographics will require broad societal attention to developing appropriate alternative transportation systems for older people no longer able to drive and to urban planning that enables older people to meet their needs with reduced exposure to traffic.

Figure 2

Driver Involvement in Fatal Crashes and Fatal Involvement Rates by Age, United States, 1983



Source: Transportation Research Board (28), based on data from the 1983-1984 Nationwide Personal Transportation Study, Federal Highway Administration/ National Highway Traffic Safety Administration/Urban Mass Transportation Administration, and data from the Fatal Accident Reporting System, National HighwayTraffic Safety Administration

Literacy

A causal relationship between literacy and driving performance has not been proven, but the two appear to be related. Literacy is clearly related to socioeconomic status. In one state, applicants taking the oral version of the knowledge test to obtain a driver's license had more crashes and in older vehicles, when other relevant factors were considered (31). Addressing such a fundamental problem might augment highway safety efforts to reduce injuries.

Research Successes

Successes in motor vehicle injury prevention have not come easily, but when they have, they have usually been based on advances in scientific knowledge of the causes of injury and the methods of injury reduction. These advances in driver, vehicle, and highway safety have been achieved by years of scientific research, development, testing, and evaluation.

Between 1966 and 1982, improvements in motor vehicle safety resulted in the saving of at least 90,000 lives and the prevention of hundreds of thousands of injuries (32-34). Each year selected vehicle safety programs save more than 4,000 lives and prevent more than 150,000 injuries (11-19). These numbers are expected to increase substantially as airbags, safety belts, and side impact improvements come into more widespread use.

State safety belt use laws save an estimated 3,600 lives each year (35, 36). An estimated 1,100 lives each year have also been saved (37) as states have passed and enforced "Age 21" minimum drinking age laws (38) and have taken other similar measures based on research to prevent alcohol impaired driving (39, 40). Roadway safety research has been another contributor to saving lives and preventing injuries (Table 1). These various safety features are based on research conducted or supported by various government agencies, automotive manufacturers, and automotive suppliers (41).

Despite the effectiveness of traffic safety programs, federal safety research funds have not been sufficient for studying vehicle crashworthiness, crash avoidance, highway safety, and driver behavior; hence there has been a reduction in the number of scientists and engineers with expertise in traffic safety working in the field. Several universities and research organizations that once were productive contributors to the advances in motor vehicle safety no longer engage in safety research. Private sector research on safety has also struggled. As a result, insufficient funds have kept new researchers from entering the field.

A comparison of federal research investments indicates that motor vehicle injury research is a relatively neglected field. In FY87, the NHTSA research budget was $39.8 million, and the total federal expenditure for injury-related research was $160 million. By comparison,

the FY87 budget obligation for the National Cancer Institute was $1.4 billion, and $930 million for the National Heart, Lung, and Blood Institute (42).

The NHTSA FY90 research and development (R&D) budget for motor vehicle safety of $32.4 million amounted to about $619 per death. Compared with the annual costs to society that are associated with motor vehicle injuries, this reflects about six cents invested per $100 in economic costs to society, or about $17 per life year lost because of motor vehicle fatalities. When the Federal Highway Administration (FHWA) R&D budget for safety of about $6 million and CDC funds of about $2 million earmarked for motor vehicle injury prevention research are included, the total amounts to about $41 million (42). This amounts to $21 per life year lost to motor vehicle injuries in contrast to federal R&D spending of $86 per life year lost to cardiovascular diseases and $195 per life year lost to cancer. Per life year lost, the federal R&D expenditures for motor vehicle injury represent less than one-ninth of those for cardiovascular disease and cancer.

With better funded research programs and trained researchers, the Nation can continue the scientifically based motor vehicle safety progress reflected in current effective interventions, such as vehicle occupant protection, safety legislation, public education, and law enforcement. These interventions are already saving many thousands of lives each year, and they prevent many more thousands of serious injuries.

Program Successes

Motor vehicle injury prevention is a promising and exciting field because significant program successes have already been proven. These successes are encouraging, but more work needs to be done in each of the critical areas described below.

Occupant Protection

It is estimated that among front seat passenger-vehicle occupants over 4 years of age, safety belts saved more than 4,800 lives in 1990, almost 3,000 of which were related to belt use laws (43). In 1988, surveys indicated that belt use in states with belt laws averaged about 50%, but varied widely from state to state, from 68% in Hawaii to only 27% in Tennessee (44). Belt use is generally lower in states without belt laws, but those states also show substantial variance in belt use (45, 46). It is estimated that if only 70% of all vehicle occupants had been protected by safety belts in 1990, another 3,750 lives could have been saved (43). As safety belt use becomes a common practice and supplementary airbags become more widely available, many more lives will be saved (Appendix A, Objective 9.12).

When combined with public education, enforcement, and incentives, belt use laws can significantly increase belt use rates and reduce injuries (47, 48). An analysis of Fatal Accident Reporting System (FARS) data from 1975 through 1986 revealed that among

occupants of cars in 24 jurisdictions with safety belt use laws, total crash fatalities were 6.6% lower than the number forecast from previous trends (49). In several of these jurisdictions, downward shifts in the number of fatalities were linked to the month of the law's onset (49). By August 1991, 42 states, the District of Columbia, and Puerto Rico had enacted safety belt use laws. Safety belt use laws that allow for primary enforcement empower law enforcement officers to stop drivers for a belt use violation alone, whereas secondary enforcement laws require that a vehicle must first be stopped for some other traffic violation before citing the driver for a belt use violation. Whereas laws that allow for primary enforcement have no additional costs, states in which primary enforcement laws have been implemented have higher safety belt use rates than states with secondary enforcement or no laws (50, 51).

Further reductions in injury may result from implementation of the proposed Occupational Safety and Health Administration (OSHA) rule that would require employers to ensure use of safety belts and airbags among their employees when driving on-the-job (52). Such a rule could also have a spillover effect, increasing the use of safety belts off-the-job.

Child safety seats and adult belts on children have been credited with saving more than 1,300 infants' and toddlers' lives between 1982 and 1990 (36). However, 460 more lives could have been saved in 1990 if **all** children under 5 years of age had been restrained in child safety seats on every trip. Programs that enhance motivation to use child safety seats (53, 54), extend access to child safety seats, and educate parents regarding the need for and proper use of safety seats are needed (55). Although the cost of child seats can be prohibitive for some families, the effectiveness of child seat loaner programs should be evaluated, and liability issues that hinder such programs should be resolved.

Vehicle seat and safety belt designs that better accommodate child safety seats are also needed (Appendix A, Objective 9.12). Child safety seats should be designed to decrease the high frequency of misuse and failure.

In addition to encouraging safety belt and child safety seat use, laws and enforcement are needed to prevent the dangerous practice of passengers (particularly children) riding unrestrained in the cargo areas of pickup trucks.

Motorcycle Safety

From 1979 through 1990, more than 51,000 motorcyclists died from motorcycle-related injuries; more than half of these deaths involved head injury (56). It is estimated that motorcycle helmets have saved more than 5,000 lives since 1984 (57). However, death is the outcome for only 1% of motorcyclists injured severely enough to receive medical care (58). Deaths represent but a small fraction of the head injury problem presented by motorcycle crashes.

In states where motorcycle helmet use laws are in place, helmet use in observational studies exceeds 99%. In states without helmet use laws, use is about 44% among all motorcyclists (59) and considerably lower among those fatally injured in motorcycle crashes (Table 2). As with safety belt use, helmets are less frequently used by those fatally injured in crashes (24). Studies indicate a relatively high use of public funds in medical and rehabilitation costs by those injured in motorcycle crashes (60, 61).

TABLE 2
Fatalities Involving Nonuse of Motorcycle Helmets and Safety Belts and Estimate of Lives Saved Per Year with Helmet and Safety Belt Use United States, 1987

	1990 Fatalities Without Use		Annual Estimated Lives Saved		
	In States With Use Laws	In States Without Use Laws	In States With Use Laws	If 70% Use Nationwide	If 100% Use Nationwide
Helmets	380	1,269	450	777	1,110
Belts	19,515	2,989	4,302	8,592	15,275
Total			4,752	9,369	16,385

Source: (57, 59)

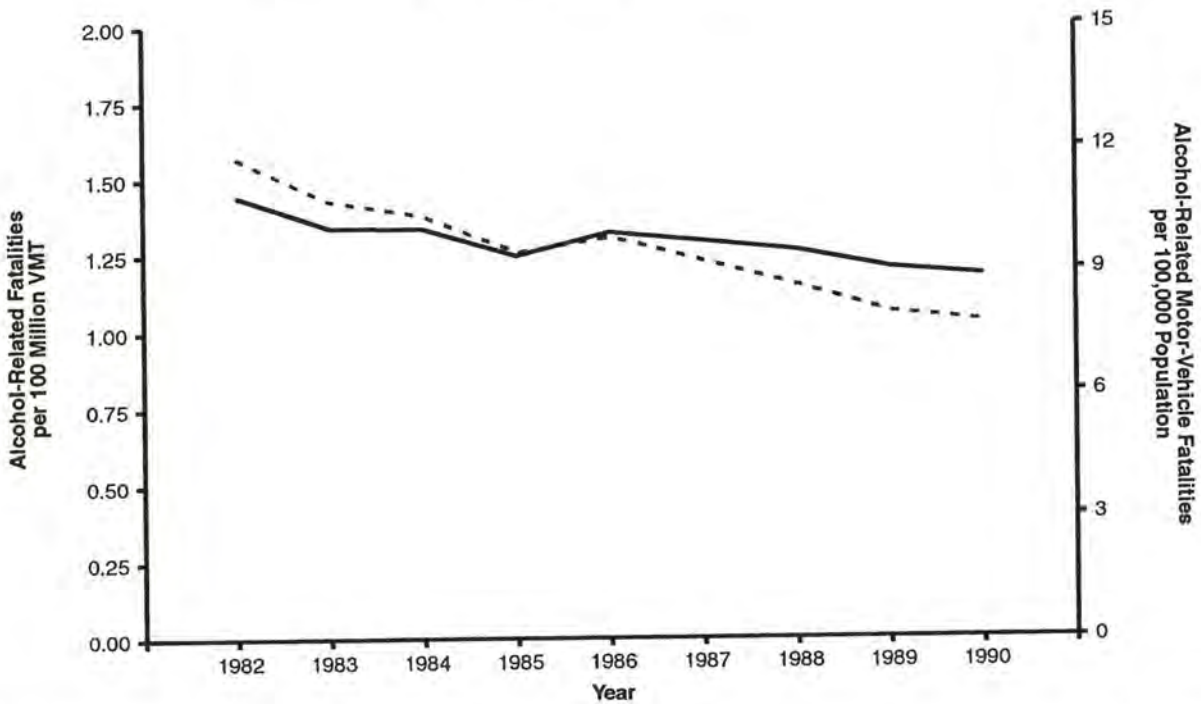
As of mid-1991, only 24 states and the District of Columbia had helmet use laws that pertained to riders of all ages. Much can be gained if all states adopt and enforce all-rider helmet use laws (Appendix A, Objective 9.14). In addition, all states should enact and enforce laws that require all motorcycle operators to obtain a motorcycle operator license. In 1989, 41% of motorcycle fatalities occurred among unlicensed or improperly licensed operators (61).

Impaired Driving

Despite recent progress, alcohol and drug use continue to be major highway safety problems (Figure 3 and Appendix A, Objective 4.1). An estimated 47% of traffic fatalities in 1987 would have been prevented if alcohol-related deaths could have been completely eliminated; this means between 20,000 and 24,000 fewer deaths annually (62). In 57% of all fatal crashes in 1982, either a driver or a pedestrian had a detectable BAC. This figure was 50% in 1990; over 22,000 persons were killed in alcohol-related crashes in 1990. In addition, the results of several studies have shown drugs in the bloodstream of 10% to 22% of injured drivers, often in combination with alcohol (63). The extent to which these substances contribute to the circumstances of such crashes warrants further study.

Figure 3

Alcohol-Related Motor Vehicle Fatality Rates by Vehicle Miles Traveled (VMT) and by Population, United States, 1982-1990



Source: Fatal Accident Reporting System, National Highway Traffic Safety Administration

The enforcement of minimum drinking age laws is one way of reducing young drivers' access to alcohol. As the Year 2000 Health Objectives for the Nation (21) and the Surgeon General's Workshop report (22) also note, an important element of enforcing these laws is to cite those who sell or serve alcohol to minors, in addition to citing minors who illegally purchase alcohol (Appendix A, Objective 4.16). Other approaches to restricting minors' access to alcohol include restricting or controlling the availability of alcohol in settings where young people constitute the majority of the audience and restricting alcohol beverage companies' sponsorship of collegiate, athletic, and motor sports events.

Alcohol consumption among both minors and adults can also be affected by raising taxes on alcoholic beverages (64, 65). The Pricing and Availability Panel of the Surgeon General's Workshop calculated that a weighted alcohol price increase of 33.6% may yield 19% to 25% reductions in motor vehicle fatalities, or between 8,400 and 11,000 fatalities annually (22, 66). Even if only a fraction of this level is attained, increasing taxes may be appropriate.

Minimum drinking age laws saved over 1,100 lives in 1988 (39), and appear to have had sustained effects in several states (67, 68). A study of high school seniors and young adults found that higher minimum drinking ages were associated with lower levels of alcohol use across a number of demographic variables (69). Significantly lower levels of alcohol use persisted as high school youth moved into their early twenties, suggesting that these laws can lead to lasting changes in consumption patterns among both the target under-21 group and in the over-21 age group as the target population ages.

Administratively imposed license revocation (ALR) laws for drivers with BACs above the legal level of intoxication (administrative per se laws) are another example of laws effective in reducing impaired driving (Appendix A, Objective 4.15). The contribution of alcohol to impaired vision, perception, judgment, and reaction time warrants a reduction in the legal BAC limit to .08% for adults 21 years of age and older and to .00% (zero tolerance) for persons under the age of 21 (70). (By convention, .02% is the level applied to indicate .00% BAC, in order to allow for instrument error.) If impaired drivers perceive that the likelihood of being cited for impaired driving (at lower BAC levels) is relatively high, they might be more cautious about drinking and driving. However, reducing BAC limits to .04%, as recommended in the Year 2000 Health Objectives for the Nation, would place a burden on the enforcement of laws concerned with drinking and driving ("driving under the influence" (DUI)), enforcement that is already insufficient. The panel recognizes this trade-off, but notes that stricter BAC limits are needed. There is also a need for vigorous enforcement of DUI laws at any BAC level, including citation of persons who often are not cited for DUI because they are transported for emergency medical treatment.

Although all states have DUI laws, there is considerable room for improvement. More than half the states do not have an open container law, and many states lack administrative license penalties, mandatory BAC tests for drivers killed or injured in crashes, anti-plea bargaining statutes, and preliminary breath tests. In addition, access to alcohol treatment and to rehabilitation programs is limited both in terms of absolute numbers of program positions

available and in terms of prohibitive monetary costs to those seeking treatment. Some progress has been made in understanding the value and effectiveness of these countermeasures, but additional policy research and analysis are needed to develop the most cost-effective approach.

Motor Vehicle Safety Standards

Motor vehicle safety standards that have led to vehicle improvements such as enhanced side impact protection, improved steering assemblies, and high penetration-resistant windshields have saved an estimated 5,160 lives each year from 1975 to 1985 (71), as shown in Table 3. Implementing other specific known vehicle improvements for passenger cars (Table 4a) and light trucks (Table 4b) would save an estimated 1,300 lives and prevent approximately 10,000 injuries annually. To evaluate and implement these improvements further, we need more sophisticated test procedures, improved measuring devices, and more research in biomechanics.

Table 3

Annual Number of Lives Saved and Injuries Prevented by Vehicle Safety Improvements

Improvement	Number of Lives Saved	Number of Injuries Prevented
Instrument Panel Padding	550	8,000
Head Restraints	Unknown	64,000
Steering Assemblies	1,300	24,000
Windshields	Unknown	47,000
Door Retention	400	Unknown
Side Protection	480	9,400
Brake Improvements	320	27,000
Occupant Protection (light trucks and vans)	2,000	Unknown
Total	5,160	155,100

Source: (71)

Table 4a

Annual Benefits from Selected Vehicle Safety Improvements to Passenger Cars

Program	Target Population		Potential Reductions	
	Fatalities	AIS 2-5* Injuries	Fatalities	AIS 2-5* Injuries
Improve occupant restraints and vehicle structures to meet current occupant protection standards in full frontal crashes up to 40 mph	1,170	1,980	230	400
Improve occupant restraints and vehicle structures to meet current occupant protection standards in offset frontal crashes up to 30 mph	1,640	26,400	330	5,280
Improve vehicle hoods to reduce the risk of pedestrian head injuries	320	1,790	27	30
Upgrade existing standards to improve head to upper interior impact protection	4,000	22,000	400	2,200
Total	7,130	52,170	987	7,910

Source: (35)

*The Abbreviated Injury Scale (AIS) is a commonly used system for assessing injury severity. For any of six designated body regions, an AIS score of 1 denotes minor injury, 2 moderate injury, 3 serious injury, 4 severe injury, and 5 critical injury. The system is used to code single injuries and is the foundation for methods to assess multiply injured patients with more precise definitions of what these levels of injury constitute for each body region (72).

Table 4b

Annual Benefits from Selected Vehicle Safety Improvements to Light Trucks

Program	Target Population		Potential Reductions	
	Fatalities	AIS 2-5* Injuries	Fatalities	AIS 2-5* Injuries
Improve occupant restraints and vehicle structures to meet current occupant protection standards in full frontal crashes up to 40 mph	370	270	70	50
Improve occupant restraints and vehicle structures to meet current occupant protection standards in offset frontal crashes up to 30 mph	740	3,600	150	720
Improve vehicle hoods to reduce the risk of pedestrian head injuries	35	230	3	1
Upgrade existing standards to improve head to upper interior impact protection	600	4,600	60	460
Develop dynamic side impact test requirements for light trucks	215	5,800	50	1,300
Total	1,960	14,500	333	2,531

Source: (35)

*The Abbreviated Injury Scale (AIS) is a commonly used system for assessing injury severity. For any of six designated body regions, an AIS score of 1 denotes minor injury, 2 moderate injury, 3 serious injury, 4 severe injury, and 5 critical injury. The system is used to code single injuries and is the foundation for methods to assess multiply injured patients with more precise definitions of what these levels of injury constitute for each body region (72).

There are numerous other examples of estimated savings attributable to motor vehicle safety devices and laws:

- Voluntary safety belt use saved 4,580 lives in 1989 and 19,360 lives from 1984 through 1989 (43).
- Safety belt use laws saved 3,660 lives in 1989 and 14,190 lives from 1984 through 1989 (43).
- Child safety seats saved 240 lives in 1989 and 1,140 lives from 1984 through 1989 (43, 73).
- Motorcycle helmets saved 530 lives in 1989 and 4,120 lives from 1984 through 1989 (43).
- Motorcycle helmet use laws saved 290 lives in 1989 and 2,180 lives from 1984 through 1989 (43).
- Minimum drinking age laws saved 1,090 lives in 1989 and 5,560 lives from 1984 through 1989 (43).

Roadway Safety Improvements

Enhancing the physical highway environment can have a significant, positive impact on highway safety. This is illustrated by the lower fatality rates on the Interstate Highway System; this system separates opposing traffic, limits access, eliminates crossing traffic, and is designed to meet higher safety standards than do other roads. Interstate highways have a crash fatality rate that is about half the national average. Sections of interstate highways constructed after 1967, when the concept of providing clear roadsides for all interstates was adopted, have generally had two-thirds the crash fatality rate of older sections of interstates. The system of highways with the lowest design standards, local and collector roads, continues to report a crash fatality rate about 25% higher than the national average for all roads (74).

Highway safety improvements have proven particularly effective at specific "high accident locations." Federal Aid Highway Safety Improvement projects implemented by the states since 1974 have saved over 55,000 lives (over 3,400 lives per year) and have prevented more than 1 million serious injuries (10). Examples of these types of improvements include traffic signs, better illumination, guardrail upgrades, obstacle removal, and crash cushions. On average, these improvement projects have returned over four dollars in safety benefits for every dollar expended on project costs (see Table 1, page 82, benefit-cost ratios.)

A new concept that holds great promise involves a comprehensive interdisciplinary approach to reducing crashes in "high accident corridors." In the corridor strategy, physical improvements to the highway are combined with enforcement, public awareness, and EMS programs. The combined effect of the different approaches appears to yield a far greater payoff in crash reduction than would be expected had the programs been undertaken separately (71). Interdisciplinary efforts may be an innovative and productive future safety strategy. Evaluation research is the key to determining which combination of interdisciplinary efforts would be most beneficial.

Research Directions

Crash Avoidance Research

Crash avoidance research addresses improvements in vehicle safety by reducing the frequency of crashes, crash severity, or both. A variety of factors contribute to crashes. "Driver error" is one contributing factor to most crashes (75). The sources of driver error are varied, covering fatigue, impaired driving, innate sensory or motor deficiencies (in some cases age-related), poor judgment or inexperience, speeding or other traffic law violations, inattention, and information detection or processing deficiencies. These human factors are frequently exacerbated by weather, road conditions, vehicle maintenance, and other factors.

To address the full range of issues, growth in crash avoidance research should be accompanied by growth in applications-oriented human factors research. A scientific framework should be established that allows researchers to understand the role of the driver in crashes. While not meant to be exhaustive, the following areas are representative of those areas that should be pursued:

Driver-Machine Interaction

Research is required to assess the impact of vehicle design parameters on operator performance. This can include research to evaluate the response of drivers to a variety of vehicle modifications, including warning systems, lights, information displays, controls, handling characteristics, and various performance feedback systems. Development and wide use of the center-mounted brake light are an example of a driver-machine human factors approach.

Intelligent Vehicle Highway Systems Research

Intelligent Vehicle Highway Systems (IVHS) is an emerging field that systematically applies advanced technology to the driver-vehicle-roadway system. IVHS crash avoidance systems build on advances in electronics, computers, and communications and artificial intelligence technologies. These technologies can alert drivers to impending dangers or lapses in attention and judgment. By assisting drivers with the driving task, IVHS systems can compensate for some of the errors and risk denial that lead to crashes.

The IVHS initiative seeks to improve safety, driver convenience, and system capacity, and to reduce congestion, emissions, and fuel consumption. Since over 60% of nonrecurring delays on freeways are the result of crashes or disabled vehicles, improvements in crash avoidance capabilities will lead to improvements in both safety and traffic flow. With IVHS,

step-function increases in road capacity and safety — rather than incremental percentage improvements — are possible. Instead of merely managing worsening conditions, IVHS has the potential for solving transportation problems.

The research ranges from the development and evaluation of advanced technology systems to policy research, such as analyses of the public's willingness to accept these technologies, and their social and legal ramifications. The ultimate success of IVHS depends on matches between the technology and the capabilities and limitations of drivers who will use it. Unless attention is paid to the driver-vehicle interface, expectations may not be achieved, and safety benefits could be undermined because drivers are confused or overloaded by the information that is intended to help them.

Highway Design Research

There is compelling evidence that improved highway design contributes to the reduction in frequency and severity of crashes. The Nation's highway network includes almost 4 million miles of roads. Research to optimize this system's design features, ranging from signs and pavement markings to highway geometry, should have a major payoff in safety. The Federal Highway Administration (FHWA) currently recommends further human factors research on sign reading, overhead illumination, and traffic control devices. Additional recommended topics and research strategies include —

- Evaluating vehicle design options relative to different user populations (e.g., by age and gender) and impairments (e.g., known medical conditions).
- Evaluating roadway guidance and warning systems relative to drivers' responses (e.g., signing, delineation, work zones, railroad crossings).
- Evaluating different methods of making motorcyclists and pedestrians (including workers in highway work zones) more visible to drivers.
- Developing research capabilities within the U.S. Department of Transportation (DOT) — in terms of both staff and equipment — to conduct research on driver-vehicle-roadway interaction.

Heavy Vehicle Safety Research

Improvements in truck design and performance are needed to ensure safe environments for both trucks and smaller vehicles. Heavy vehicle safety research is currently focused on the following areas:

- Developing advanced technology truck braking systems.
- Identifying ways to improve heavy truck stability.
- Identifying practical means of designing truck front- and rear-end structures to reduce the effects of truck impacts on smaller vehicles.
- Developing test procedures and ways to enhance truck occupants' crash protection.

Suggested areas of additional research include the following:

- Evaluating the use of special lanes on highways to isolate heavy vehicles from lighter passenger vehicles.
- Assessing the effectiveness of lowering urban speed limits for heavy vehicles.

Additional research is warranted on other issues affecting driver performance such as fatigue, sleep disorders, inattention, impaired driving, the use of special lanes on highways to isolate heavy vehicles from passenger vehicles, and the effectiveness of lowering urban speed limits for heavy vehicles.

Crash Injury and Survival Research

Crashworthiness Research

Crashworthiness research is focused on the major crash modes affecting occupants of passenger cars, trucks, and vans: frontal, side impact, rollover, and rear impact crashes. Research strategies for reducing the effects of these types of crashes include —

- Increasing occupant protection by improving door designs (hinges, latches, locks, and glazing) to prevent the occupant from being ejected through openings during a crash.
- Making the roofs of vehicles more crush-resistant.
- Making interior surfaces (including steering wheels and instrument panels) more energy absorbent, thereby reducing head injuries to occupants.
- Improving seats and restraint systems to provide better occupant containment and protection against injuries from interior impacts in crashes.
- Improving vehicle structures to preserve the integrity of the occupant compartment and prevent harmful intrusion.

Crashworthiness research also addresses protection for the approximately 7,500 pedestrians and pedalcyclists killed in motor vehicle crashes each year. For example, vehicle designs that incorporate softer hood and fender designs have demonstrated potential for reducing the severity of head injuries among pedestrians struck by motor vehicles (76). Test procedures and vehicle designs that reduce leg and thorax injuries — such as lower front bumpers — are other current research projects that seek to protect pedestrians in crashes.

Biomechanics Research

Fundamental to the practice of medicine and public health is the study of disease and injury causation. Crash injury is caused by application of mechanical forces to the body, and the amount of energy delivered and the area of contact are important determinants of the outcome. Biomechanics uses engineering principles to explore the physical and physiologic responses to mechanical forces (77). Fruits of biomechanical research include safety belts, airbags, antilacerative windshields, head restraints, child safety seats, padded dashboards, stronger side-door structures, and collapsible steering columns (77). Biomechanics research

contributes to the development of products designed to be safe **before** the public uses them, thus preventing injuries.

Impact severity can be reduced by energy-absorbing structures and padding material that limit deformations of the body to levels insufficient to cause injury. It is difficult to define the appropriate interface, recognizing the range in impact severities, tolerances of people likely to be exposed to impact risks, and the range in possible outcomes. Optimizing product designs is the critical issue requiring a scientific approach; this approach must be based on the goal of overall societal benefit and must emphasize safety for occupants of all ages and tolerances in a wide range of crashes (78, 79).

One research goal is to develop a test tool, such as an anthropomorphic testing device ("dummy"), or a test method, such as a crash test, in which products can be evaluated for safety performance. These tests determine the built-in safety of the product in a crash or impact. Crash tests provide only the most basic information on system performance, and the anthropomorphic test devices are only crude representations of people, yet biomechanicists and engineers rely on these procedures and devices to improve product safety.

The consequences of inadequate biomechanics research are enormous. If test devices to measure crash injury protection are unavailable, introduction of safety features can be delayed unnecessarily. The use of flawed test procedures can increase the cost of motor vehicles without providing commensurate safety benefits. Recommended areas of research on the biomechanics of injury control include the following:

- Developing centers of excellence in which research, education, and training are pursued in the basic biomechanics of injury and medical sciences.
- Optimizing the design of safety systems for the protection of the full population (recognizing a 4:1 range in impact tolerance from young men to older women).
- Establishing a method for assessing the societal benefit of products, considering differences in exposure severity, injury responses, risks, and tolerances.
- Improving the understanding of the biomechanics of brain and spinal cord injury.
- Developing the core needs for an improved science of injury biomechanics.
- Developing more realistic injury models in order to improve treatment protocols and develop innovative rehabilitation procedures.
- Improving the realism and accuracy of the evaluation of human safety with anthropomorphic testing devices and impact tests, emphasizing crash situations that cause serious injury and disability, and using a range of anthropomorphic testing devices, including newborns, children, small women, and other adults.
- Developing improved safety equipment, including motorcycle and bicycle helmets and protective clothing.
- Devising and implementing evaluations of crash safety restraints and energy-absorbing interiors.

- Identifying opportunities for improving pedestrian and cyclist protection through vehicle design.

Behavioral Research

Technological advances have helped reduce the severity of motor vehicle crashes. Yet technology alone cannot prevent or reduce the severity of crashes resulting from lack of knowledge and skills, poor judgment, and reckless driving. More importantly, technology cannot change the attitudes and motivations that predispose drivers to increased crash risks by excess speeding, aggressive driving, and substance abuse. Understanding how these aspects of human behavior affect the driving task requires research to develop new interventions, as well as rigorous evaluation of existing programs. Currently, there is no adequately funded program devoted primarily to peer-reviewed, investigator-initiated research on the role of behaviors (both motivation and performance) in traffic safety.

Behavioral scientists can help design interventions that work by changing the behaviors or social norms of individuals and groups. As with other public health issues, more data are needed on traffic safety to understand how people behave, why people behave the way they do, what the outcomes of various behaviors are, how deleterious behaviors can be changed, and how effective efforts to modify those behaviors are. As a model for approaching public health problems, this conceptual framework has recently received considerable attention as a means for limiting the spread of infection with the human immunodeficiency virus (80).

Similarly, applications of health promotion strategies in traffic safety could be useful (81-84). As James Mason, Assistant Secretary for Health, has noted, "Persons can hardly be expected to avoid the health risks imposed by personal choices about lifestyle when they do not know or understand these risks, when they lack the knowledge or skills needed to choose a healthier lifestyle or, worst of all, when they seek guidance or support from their community and it is unavailable to them" (85).

Driver Performance

An expanded program of human factors research could improve understanding of driver performance limits and capabilities, especially with respect to attention, vision, perceptual judgments, information processing, information overload, and motor control. Such research may be useful in redesigning driver licensing and education programs, and in making vehicle modifications and improving roadway design. This line of research should investigate the role of driver capabilities and should address not only the performance of well-motivated, safety-conscious drivers but also that of young and aggressive drivers.

Impaired Driving

Alcohol- and drug-impaired driving continues to be a major highway problem. Examples of promising areas of research include the following:

- Changing attitudes toward drinking and driving (86, 87).
- Evaluating further alternative methods to increase deterrence (39).
- Changing social norms and server and host policies (87, 88).
- Assessing the effects of alcohol intoxication on injury level and survivability (89).
- Evaluating alternative approaches to repeat offenders.
- Evaluating the relative effectiveness of various penalties and laws for deterring impaired driving.
- Developing and evaluating health promotion approaches (90).
- Identifying users of programs such as Techniques for Effective Alcohol Management (TEAM), responsible alcohol service, designated drivers, their characteristics, and the effects of these programs in reducing drinking and driving (DUI).
- Investigating the failure to cite underage drinkers or arrest underage drinking-drivers.
- Determining the extent of use of false identification and how technology can be used to minimize the manufacture and sale of false identification.
- Identifying treatment and rehabilitation programs for persons arrested for DUI.
- Researching new technology that would help law enforcement officers do their jobs.

Little research has been done on the use of drugs other than alcohol. Potential research topics include the incidence of driving under the influence of both illicit and prescription drugs; the effects of different types of drugs on driver behavior; the development of cost-effective, reliable screening methods to detect drug-impairment levels among drivers; and the assessment and ranking of cost-effective ways to decrease the incidence of impaired driving.

Traffic Laws and Their Enforcement

The highway system operates under a variety of laws. Expanded research and evaluation are needed to assess the relative effectiveness of traffic laws, the efficiency of various law enforcement techniques, and ways to apply advanced technology to law enforcement. Evaluations of traditional and innovative sanctions for traffic law violations are needed to determine which are most effective. Specific research questions include the following:

- What factors aid or abet traffic law enforcement? Which laws are vigorously enforced and which are overlooked? Why?
- How do community standards, customs, rules, and practices influence the enforcement of traffic safety laws?
- Given diminishing resources, how can communities support traffic law enforcement? What are some innovative approaches that communities can use to support traffic law enforcement, even with diminishing resources?

- How can private citizens contribute to traffic law enforcement? Some communities have used citizen patrols for speed watches. What are the constraints to mobilizing local citizens (as a neighborhood watch) for traffic law enforcement?

Driver Education and Training

Considerable expense and effort have been devoted to driver education and training, with little evidence of effectiveness with respect to safety. Further research and evaluation are needed to determine the most effective timing, content, and techniques for improving the driving skills of both the general driving public and of special populations (e.g., commercial vehicle operators and elderly drivers).

Pedestrians and Bicyclists

As noted earlier, approximately 7,500 pedestrians and pedalcyclists die each year in motor vehicle crashes (37, 91). Although the types of crashes have been described, effective countermeasures (such as improved crosswalk delineation and signing) must be developed, tested, and implemented, and more widespread use of bicycle helmets needs to be encouraged. Methods for improved visual detection of pedestrians and pedalcyclists must be researched, along with the development of multifaceted programs (92).

Motorcyclists

Many avenues of research hold promise for reducing the incidence and severity of motorcycle crashes. These include research on and evaluation of operator education, licensing, and training; risk taking; conspicuity; and roadway design. Methods to increase the use of motorcycle helmets should also be topics of evaluation research.

Youth

Young drivers are disproportionately involved in traffic crashes. More than 43% of all deaths among 16- to 20-year-olds result from motor vehicle crashes (93). Young drivers are also significantly overrepresented in alcohol- and other drug-related crashes, often drive at excessive speeds, and often do not wear safety belts. Research is needed on the reasons underlying unsafe driving practices by youths, on methods of changing attitudes to induce safer driving behavior, and on methods for deterring unsafe practices. Improvements to traditional licensing practices, such as graduated licensing programs, appear promising.

Elderly

By the year 2020, 22 million people will be 75 years of age or older **and** eligible for a driver's license. Of these, 7 million will be 85 or older (28). Driver performance research topics of particular relevance to the elderly include developing tests or measures of visual performance, glare sensitivity, contrast sensitivity, and cognitive performance such as attentiveness, information processing, and problem solving (94). Many of these lines of research have implications for highway signs, illumination, timing of pedestrian signals, and

roadway design. The development of optimal licensing programs for protecting elderly drivers should be based on research and effective pilot programs that screen, identify, and monitor drivers with impairments — such as loss of visual performance and increased reaction time — that affect their driving. In addition, the feasibility of identifying impaired elderly drivers through their physicians needs to be explored.

Diversity

By the year 2000, the demographics of the U.S. population will have shifted considerably. The effects of the population's diversity on traffic safety should be assessed, and appropriate countermeasures should be developed to meet the needs of different segments of the population. Topics to be addressed include the effects of age, sex, race or ethnicity, and language barriers on all aspects of traffic safety.

Data Needs

Valid data, in accessible and understandable form, will be the foundation of any effective program to control motor vehicle injury. Standardized data are essential for identifying problems, factors associated with these problems, and emerging issues, as well as for evaluating the effectiveness of interventions and making informed judgments about where to invest limited resources.

No single data source contains all the information necessary for the study and prevention of motor-vehicle injuries. Currently the Fatal Accident Reporting System (FARS) maintained by the National Highway Traffic Safety Administration (NHTSA) collects limited data on occupant, vehicle, and crash characteristics for fatal traffic crashes. FARS has proven invaluable in supplying detailed representative data on fatal traffic crashes and has been used effectively to identify traffic safety problems, develop and implement better ways to deal with these problems, and evaluate existing and proposed motor vehicle safety standards and traffic safety programs. Besides the benefits derived by NHTSA from FARS data, researchers in other government agencies and academia also use these data extensively.

Data Linkage Needs

Unfortunately, the full impact of injuries on individuals, families, and society as a whole remains difficult to quantify. Because of improvements in safety and medical technology, many people are surviving relatively severe injuries. However, there is no data system parallel to FARS for the far more frequent nonfatal traffic crashes. Statistical samples of motor vehicle crashes maintained by NHTSA are not of sufficient size to permit statistical analysis of detailed crash injury characteristics. Linking existing data bases to build statewide motor vehicle-related injury data bases would be the most cost effective solution. Linked data could provide a relatively low-cost surveillance system for the most common and costly injuries. For example, most states have computerized files of police accident reports (PARs) available. Although these files contain information on the vehicle, the crash,

and the use of safety equipment and alcohol, they contain little information on injuries and underestimate the numbers of injuries that occur. More accurate and complete information on injuries exist in statewide injury data systems such as prehospital (EMS), hospital, injury registry data, and hospital discharge data. Only by merging the information obtainable from PARs with EMS reports and hospital discharge data could a data base of sufficient size and detail be created. Linking PARs to the other injury information available at the state level would provide valuable data about —

- The relationship between vehicle design characteristics and their propensity to cause injuries in crashes,
- Outcomes such as frequency of occurrence, severity, and disability resulting from motor-vehicle related injury,
- Effects of legislation such as legislation related to alcohol-impaired driving and to safety belt use, child-restraint use, and other interventions.

Effective data linkage would facilitate the use of existing data to support the implementation and evaluation of drinking and driving laws and laws requiring safety belt use, child restraints, or motorcycle helmets. It would allow for better estimates of public costs associated with nonuse of safety devices and use of alcohol, and it would raise consciousness among policy makers and the public about the benefits of motor-vehicle injury prevention measures. Effective data linkage would improve accessibility of extant data and help identify data needs. It would help eliminate existing organizational and jurisdictional boundaries and help build upon successful models to reduce the frequency and severity of motor vehicle-related injuries. Effective data linkage in the field of motor-vehicle crash-related injury would also serve as a model for other causes of injury. The methods developed for linking records should be adapted to many types of epidemiologic studies that use administrative and hospital records.

Progress in and Impediments to Data Linkages

As noted above, motor-vehicle injury data bases can greatly increase in usefulness when they can be linked to other data systems. Over the past decades, progress has been made in linking crash files to highway files in order to identify highway problems. Linkages to driver history files and vehicle registration files have also been facilitated, so that drivers involved in crashes may be readily studied in relation to their previous driving records. As data bases are linked, the relative usefulness of each data file is enhanced.

Linking traffic records to detailed injury data in EMS records, trauma registries, and hospital records has not proceeded so rapidly. Some of the difficulty has been associated with the need for identifying information in order to make linkages. In most states, crash records and driver history files are public, but hospital records are confidential. One suggested approach to facilitate such linkages is to include police crash report numbers on hospital emergency room and admission records. However, researchers attempting to make such linkages should adhere to appropriate confidentiality guidelines with respect to the individual records.

Surveillance

Surveillance data for motor vehicle injury are better than data for other types of injury. As noted above, police, EMS, and hospitals report a variety of data on motor vehicle crashes. However, accurate data on safety belt use and work-relatedness in crashes are lacking, and many motor vehicle injuries do not result in hospitalization or an investigation and crash report by a law enforcement officer. Injuries to young children (e.g., from hitting the dashboard or windshield in a sudden stop, from falling out of the cargo area in a pick-up truck, or from falling out of a vehicle door) often go unreported in official police files (95), as do many motor vehicle injuries brought to medical attention in emergency rooms or physicians' offices. It is for this reason that injury surveillance systems that include information on the cause of injury (e.g., through use of external-cause-of-injury codes (E-codes)) are needed to determine the magnitude of the injury problem (58, 96).

Data are also needed on the long-term use of services, the effects of injuries on families, and the impact of impairments. These data will be used to assess the need for prevention and will help health officials and others set priorities for injury reduction at all levels of severity. Existing sources of data can be tapped. However, new sources of data will be needed to measure accurately these long-term effects.

Measures of Exposure

Exposure to risk is a standard measure used in public health to determine morbidity and mortality rates. For most diseases, population-based rates are routinely used. For motor vehicle injury, it has been customary to measure changes over time using mortality rates based on vehicle miles traveled (VMT). The rationale has been that the highway transportation system has been created to facilitate mobility and that mobility is of value. As noted earlier, using VMT as the denominator, the motor vehicle death rate in the United States has steadily declined since the mid-1930s.

Other widely used measures of exposure include number of motor vehicles registered, number of licensed drivers, and measures of induced exposure. Induced exposure reflects risk of being in a crash (97). One common measure of induced exposure is the "innocent" party or parties involved in two-vehicle crashes. Because induced exposure can be determined from existing crash data, and because it provides additional information such as time of day, day of week, and roadway type, it makes it possible to estimate risk in relation to more specific crash-related variables.

Some public health professionals prefer to use population figures. With respect to crash-related fatalities, the United States has one of the best records on a VMT basis, but does not fare so well on a population basis. Population-based rates for motor vehicle injury and death are higher in the United States than in many other industrialized nations. The measure of exposure used in calculating the rate greatly affects one's perceptions. For example, on the basis of number of licensed drivers, older drivers as a group do not appear to pose any special problem. However, on the basis of VMT, their risk of crash is second

only to that of teenagers (93) (Figure 2). Such discrepancies indicate the need to know the purposes to which the measures of exposure will be put.

E-Codes

E-codes have been referred to as "the missing link in injury prevention" (96). These are part of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) that is used to code morbidity data in the United States and elsewhere. In this system, N-codes are used to describe the nature of the injury or the injury diagnosis, for example, "closed fracture of base of skull." E-codes are used to describe the external cause leading to the diagnosis of injury or poisoning. Thus, in the case of the skull fracture, the E-code would indicate whether it resulted from a fall, an assault, or a motor vehicle crash. While N-codes are important for treatment purposes, countermeasures to prevent injuries require information provided by E-codes. Hospital discharge data routinely include N-codes, primarily because this information is required for reimbursement. However, only a handful of states have mandated that E-codes also be included (98, 99).

The panel recognizes a need for E-codes in hospital discharge data and emergency room data for several purposes:

- To quantify severe injury morbidity according to cause.
- To help define the health and societal costs of vehicular injury by cause.
- To measure the magnitude of nonfatal occupational injuries by cause.
- To expand the usefulness of police accident reports and existing national data systems used to establish public health priorities.
- To identify the effectiveness of specific interventions (such as airbags or safety belts).

Driver Behavior and Characteristics Data Base

In 1987, NHTSA published its Driver Performance Data Book (100). Its intent was to provide a compendium of research data to assist researchers in setting up designs and paradigms and to aid administrators in making decisions regarding human performance research. It contains normative data on reaction time, visual performance, auditory performance, information processing, anthropometrics, and precrash behaviors. This data book should be updated with particular references to current highway safety trends and issues, such as IVHS and older and medically impaired drivers.

In addition, the data book could become a centralized source of information, for both researchers and practitioners, on safety belt use (nationally, by state, and by various demographic groups), incidence of alcohol-impaired driving, and information pertinent to motorcycle, bicycle, and pedestrian safety.

Programmatic Directions

The highway death rate per VMT reported by the DOT is now at an all-time low, as shown in Figure 1. However, much more remains to be done in applying known interventions in vehicle, roadway, and traffic safety programs more broadly.

Vehicle Safety

Crash avoidance and survival programs are complementary approaches to reducing both the incidence and severity of motor vehicle crashes. Improvements in vehicle design can yield reductions in the number of persons killed and injured in motor vehicle crashes each year. These improvements are areas of ongoing research not only in the federal government, but also in academic institutions and in the private sector. Examples of current crash avoidance research and programs include the application of safety technologies in four major areas:

- Use of antilock brakes.
- Ways to reduce the number of rollover crashes.
- IVHS — the development of electronic systems that should reduce the risk and severity of crashes.
- Human factors — driver performance and workload; vision and visibility; warning signals and warning systems; lighting and signaling; controls and displays; the aging driver; and crash causation analysis.

To reduce the effects of frontal crashes, NHTSA now requires light trucks and vans to meet the automatic crash protection standards currently required of passenger cars by Federal Motor Vehicle Safety Standard 208. These could save an estimated 2,000 lives per year if fully implemented. However, benefits due to regulatory interventions take many years to achieve because of the slow pace of fleet turnover.

To improve side impact protection, NHTSA is considering requiring that light trucks and vans meet dynamic side impact standards similar in concept to those that currently apply to passenger cars. In current studies, investigators are assessing the benefits and costs of this proposed regulatory requirement.

A variety of regulatory options are being considered to reduce both the propensity of vehicles to roll over and the severity of injuries that occur once vehicles are involved in this type of crash. Improved vehicle handling and stability can help drivers avoid a crash; in addition, several crashworthiness improvements are promising. These include —

- Door retention improvements such as stronger hinges, latches, and locks (to prevent an occupant from being ejected during a crash).
- Interior head impact protection, such as padded dashboards and safer steering wheel designs to lessen head and facial injuries.

- Improved roof crush resistance.

Roadway Safety

The following actions should be implemented by appropriate agencies with responsibility for the design, operation, and maintenance of highways to reduce the frequency of traffic crashes and their severity:

- *Improve roadway delineation through increased use of effective reflective pavement markings and signs* (Appendix A, Objective 9.20). Positive guidance through roadway delineation systems may be effective for crash avoidance, particularly in single vehicle accidents (71). Uniform and widespread application of pavement edge lines, advance warning signs for curves, and postmounted delineation facilitate the driving task, especially at night. Unfortunately, many of the devices, although easily visible during the daytime, have reduced visibility in the dark because they have lost reflectivity. Minimum performance levels for reflectivity, both at time of installation and subsequently, could alleviate this problem.
- *Provide physical separation from other vehicular traffic for nonmotor vehicle occupants.* Over 7,000 pedestrians and pedalcyclists die in traffic crashes annually. Because of the high severity of these crashes, more attention needs to be focused on crash avoidance measures. It has been argued that physical separation through the use of sidewalks, bikeways, grade separations, or even a well-marked reserved area along roadways are effective in reducing this type of crash (71).
- *Provide a "forgiving" roadside for errant vehicles on high speed roads.* Almost a third of all fatalities occur when a vehicle leaves the roadway and strikes a fixed object, rolls over, or both (71). Effective methods of reducing the incidence and severity of these types of crashes are to provide a forgiving recovery area and gentle sideslopes and to eliminate unyielding obstructions for a distance outside the edge of the roadway. Studies at the General Motors Research Laboratories indicated about 85% of run-off-road impacts occur within 30 feet of the edge of the roadway on high speed roads (101). Subsequent studies and experience on lower-speed high-volume highways (such as urban arterials) indicate a 10- to 15-foot clear distance can provide similar benefits. The practice of offsetting unyielding poles, signs, trees, and similar objects as far as possible within rights-of-way on all roads is beneficial.

Where obstacles cannot be eliminated practically, they should either be made to break away or be shielded with traffic barriers or crash cushions. Such devices should be performance tested for their ability to yield to or redirect a striking vehicle while minimizing the potential for injury to the occupant and bystander. However, attention should also be given to the compatibility of different safety systems.

- *Establish a management plan in every major metropolitan community to minimize losses due to disruptive traffic crashes.* This plan should address EMS. Losses due to injuries and congestion have been reduced through systematic planning for major incidents, often involving traffic crashes in heavily travelled urban corridors.

An effective incident management plan can reduce the risk of turning a relatively minor incident into a catastrophic occurrence; responsive EMS can minimize trauma losses.

- *Evaluate the safety of highway work zones* (including those on the interstate highway system), using surveillance of fatal and nonfatal injuries in such zones.

Traffic Safety Programs

The following actions should be implemented by appropriate agencies with responsibility for traffic safety efforts designed to reduce injuries and fatalities. For each intervention, researchers and policymakers should develop a better understanding of the factors that facilitate or impede safe driving behaviors among various population subgroups, and they should use these data to target prevention efforts.

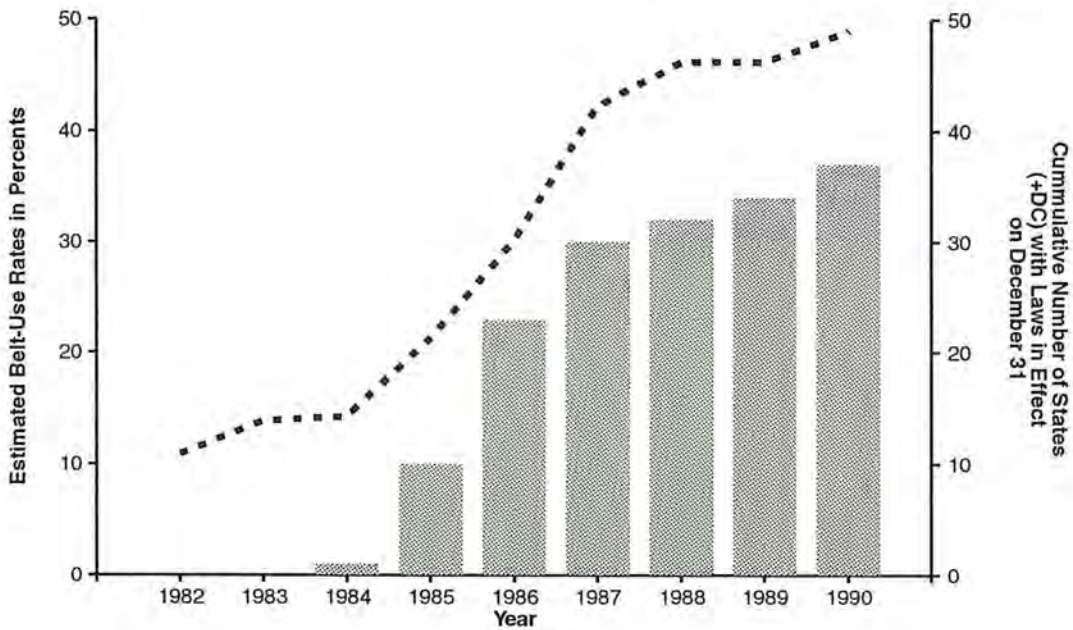
- *Provide a comprehensive program to combat impaired driving.* To be effective in reducing drunk and drugged driving, programs should incorporate prevention approaches (including programs for public information and education, schools, employers, alcohol servers, and transportation alternatives); deterrence approaches (including laws, public information and education, enforcement, prosecution, and adjudication); treatment and rehabilitation approaches; and coordinated program management with appropriate agencies. As part of this comprehensive program, alcohol and drug treatment programs should be accessible to impaired drivers, and the DUI event should be viewed as an opportunity to identify persons needing treatment, to initiate treatment and rehabilitation, and to prevent future impaired driving episodes.

Evaluations of community-based interventions such as "designated driver" programs need to be launched. Campaigns against underage and binge drinking on college campuses should also use motor vehicle-related injury as one of the outcome measures for evaluation.

- *Enhance comprehensive occupant protection programs that educate and motivate citizens to use available motor vehicle occupant protection systems, including safety belts, child safety seats, and automatic crash protection (such as airbags)* (Figure 4 and Appendix A, Objectives 9.12 and 9.13). A combination of use requirements, enforcement, public information, education, and incentives are necessary to achieve significant, lasting increases in safety belt and child safety seat usage.
- *Establish a comprehensive program to promote motorcycle safety.* To be effective in reducing the number of motorcycle crash deaths and injuries, programs and laws must address issues of the use of helmets and other protective gear (Appendix A, Objective 9.14), proper licensing, impaired riding, motorcycle conspicuity, and motorist awareness.

Figure 4

Number of States with Safety Belt-Use Laws and Estimated Safety Belt Use Rates, United States, 1982-1990



Sources: Rates: 19-City Survey, National Highway Traffic Safety Administration
Laws: Traffic Safety Programs, National Highway Traffic Safety Administration

- Emphasize dangers of excessive speed as part of a comprehensive traffic safety program. A national campaign must be conducted to educate the public about the dangers of excessive speeding and aggressive driving behavior. This campaign should be on the same scale as those aimed at curbing impaired driving and increasing the use of occupant protection devices. The campaign should include efforts to encourage legislation to ban the use of radar detectors in all vehicles.
- *Establish and implement a complete traffic records program.* A complete traffic records program is necessary for planning (problem identification), operational management or control, and the evaluation of state highway safety activities. The traffic records program should have a data base consisting of crash, driver, vehicle, roadway, citation or conviction, EMS, health care, and insurance files, and the program should provide for file linkage. (Data linkage issues are discussed in greater detail on pages 104-106.)
- *Develop comprehensive community-based traffic safety programs, including pedestrian and bicycle safety programs that target defined problems and high-risk populations, including highway workers.* Effective pedestrian and bicycle safety programs are implemented at the local level, and include education, enforcement, and engineering components (91, 102).
- *Provide for an efficient and effective police traffic services program to enforce traffic laws, prevent crashes, assist the injured, document specific details of individual crashes, supervise crash clean-up, and restore safe and orderly movement of traffic.* Traffic law enforcement plays an important role in deterring drunk and drugged driving, achieving safety belt use, encouraging compliance with speed laws, and reducing other unsafe driving actions. Experience has shown that a combination of highly visible enforcement, public information, education, and training is necessary to achieve a significant and lasting impact in reducing crashes, injuries, and fatalities.
- *Ensure that persons incurring traffic injuries receive prompt and appropriate emergency medical care.* An effective urban and rural system of emergency medical and trauma care includes comprehensive enabling legislation, regulations, and operational policies and procedures; a lead agency with resource management responsibility; recruitment of trained personnel; reliable, safe, ambulance transportation; appropriate medical facilities for seriously injured patients; an effective communications systems including universal system access numbers such as 911; trauma systems; public information and education; medical direction; and evaluation. (The Position Paper on Acute Care Trauma Systems also addresses this topic.)
- *Establish a comprehensive program to promote traffic safety in highway work zones.* To be effective in reducing the number of motor vehicle deaths occurring among highway workers in highway work zones, programs must address the issues of training all traffic control personnel (flaggers), improving the conspicuity of highway workers, evaluating state highway safety activities as they pertain to highway work zones, and improving the collection of injury data on highway workers in local, state, and national data bases.

A Strategy for Success

The Year 2000 Health Objectives for the Nation call for a decrease in the annual motor vehicle-related injury death rate from a 1987 figure of 2.4 per 100 million vehicle-miles traveled (VMT) to no more than 1.9 (Appendix A, Objective 9.3). Even if this objective is met, however, the number of lives that will be lost as a result of these injuries is still not likely to fall below 40,000 per year. Constant or slightly decreasing death rates are an improvement over previous trends, but the toll in lives and disabilities is still too high.

How can these levels of morbidity and mortality be reduced significantly? In this paper, four elements of a comprehensive strategy have been discussed. Although no single element can adequately reduce the impact of motor vehicle injuries, together these four elements constitute a strategy. The four elements are as follows:

- **Leadership, collaboration, and coordination** — in the traffic safety, injury control and public health fields, among different levels of government, and between private and public organizations.
- **Public recognition and support** — of motor vehicle injury as an unacceptable, preventable cause of morbidity and mortality, of the need for increased research funding and programs, and of tough, effective laws enforcing proven interventions.
- **Implementation of proven interventions** — such as comprehensive occupant protection and other traffic safety programs, including laws, enforcement, education, and engineering interventions; and vehicle safety devices such as airbags and antilock brakes.
- **Expansion of the scientific base** — to develop and test other effective interventions.

In this section, each of these elements is briefly summarized. In the next section, we discuss specific recommendations for elected officials, state and local governments, the U.S. Department of Transportation (DOT), the U.S. Department of Health and Human Services (DHHS), corporate America, private and public employers, the health care community, academia, and citizen advocacy groups.

Leadership, Collaboration, and Coordination

Many strategies have been at least partially successful in the prevention of motor vehicle injuries. Passage of safety-related laws, changes in societal norms, enforcement of the laws, road design, automobile design, and trauma systems all play significant and complementary roles in preventing motor vehicle injuries and deaths. While the spectrum of solutions is encouraging, it demands a multifaceted and coordinated approach in order to use resources as effectively as possible.

The list of organizations and agencies either directly or indirectly dedicated to the prevention of motor vehicle injuries is extensive. For example, consumer groups are concerned about auto safety and the high cost of car insurance; insurance companies are concerned about escalating medical costs; advocacy groups against impaired driving and head injury associations are concerned about those involved in motor vehicle crashes; government agencies, such as health, highway safety, and law enforcement, are all interested in protecting the public; auto manufacturers are concerned with the production of safe products at reasonable prices; hospitals are concerned with providing care but minimizing the financial impact of uncompensated care; labor organizations — especially those with highway maintenance and construction workers — are concerned with preventing work-related injuries; and medical care professionals are interested not only in caring for injured persons but also in preventing injuries. (An overview of federal agencies involved in motor vehicle research or regulation is provided in Table 5.)

Each group or agency has unique reasons for being concerned about motor vehicle injuries and has unique resources to offer. In combination, these organizations possess financial resources, scientific expertise, community organization skills, political influence, regulatory and enforcement authority, and data systems for program planning and evaluation. No single group or agency can tackle motor vehicle injury prevention alone. To continue the progress that has already been made in this field, there must be more coordination and collaboration among all interested parties.

Some interventions are clearly the responsibility of a particular organization or level of government. For example, developing minimum safety requirements for the design of automobiles is a federal responsibility, while enacting safety belt laws is a state responsibility. Enforcement of safety belt laws is carried out by state and local law enforcement agencies. At the local level, communities should address local traffic safety problems through the implementation of community traffic safety programs that combine education, engineering, and enforcement interventions.

The fact that organizations' interests, jurisdictions, and resources differ should not lead to conflict and competition for funds within the overall effort. Coalitions can be an effective way to influence legislators and the public, establish common goals, focus attention on underfunded areas, and help deliver effective interventions where they are needed most.

Motor vehicle injuries may be one of the few societal problems for which an array of known solutions, concerned organizations, and resources is available. When communities initiate broad, multifaceted interventions that bring together the forces of technology, the media, law enforcement, and product design, success can be achieved. Highway safety is the responsibility of a broad spectrum of government agencies and private industries (Table 6). A significant part of the answer to the prevention of motor vehicle injuries lies in coordinating these organizations and agencies and applying what is already available and known to work, while supporting and encouraging research in promising new areas.

Table 5

Federal Agencies Involved in Motor Vehicle Injury Research or Regulation

Department of Transportation (DOT) National Highway Traffic Safety Administration (NHTSA) Federal Highway Administration (FHWA)
Department of Health and Human Services (DHHS) Public Health Service (PHS) Centers for Disease Control (CDC) National Center for Environmental Health and Injury Control (NCEHIC) Division of Injury Control (DIC) National Institute for Occupational Safety and Health (NIOSH) Division of Safety Research (DSR) National Center for Health Statistics (NCHS) Health Resources and Services Administration (HRSA) National Institutes of Health (NIH) National Institute on Aging (NIA) National Institute of Child Health and Human Development (NICHD) National Institute of Neurological Disorders and Stroke (NINDS) Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) National Institute on Drug Abuse (NIDA) National Institute on Alcohol Abuse and Alcoholism (NIAAA) Indian Health Service (IHS)
Department of Commerce (DOC) *(Regulates imported cars)*
Department of Defense (DOD)
Department of Education (ED) National Institute on Disability and Rehabilitation Research (NIDRR)
Department of Labor (DOL) Occupational Safety and Health Administration (OSHA) Bureau of Labor Statistics (BLS)
Consumer Product Safety Commission (CPSC) *(Bicycles, bicycle helmets, all-terrain vehicles)*
Interstate Commerce Commission (ICC) *(Interstate trucking)*
National Transportation Safety Board (NTSB)

Table 6

Major Sponsors of Highway Safety Research

Organization	Primary Areas of Emphasis			
	Human	Vehicle	Highway	Other
Federal Government				
National Highway Traffic Safety Administration	X	X		X[a]
Federal Highway Administration	X	X	X	X[b]
Centers for Disease Control	X	X		X[c]
States			X[d]	
Private Industry				
Automobile manufacturers		Xe		
Automobile suppliers		X		
Insurance industry	X	X		X[f]
Highway industry			X	

[a] **Crash data collection, maintenance, and analysis.**

[b] **Special regulatory analysis and motor carrier information systems.**

[c] **Research on trauma and injury mechanisms.**

[d] **The majority of state sponsored safety research is highway-related but a modest amount of human- and vehicle-related safety research is also conducted.**

[e] **The majority of the research sponsored by the automobile manufacturers is vehicle-related. However, evaluations of crashes are also undertaken and some research is conducted on driver-related issues, such as alcohol-impaired driving.**

[f] **Crash analysis.**

Source: Adapted from (103) which presents a detailed discussion of the complementing organizational responsibilities of government agencies in motor-vehicle injury prevention research.

Regulations in the areas of occupant protection, motor vehicle design standards, and motor vehicle maintenance standards can have a significant impact on the incidence of injury. They should be developed on the basis of the best scientific information available and tested in a scientific manner whenever possible. This will be accomplished only if there is communication between researchers and regulators.

DOT-Sponsored Highway Safety Research

Recently, the Federal Highway Administration (FWHA) and the National Highway Traffic Safety Administration (NHTSA) jointly funded a Strategic Transportation Research Study for Highway Safety to assess the adequacy of current research programs to take the lead in improving the Nation's safety record (103). A special committee of the Transportation Research Board, which carried out the study, reviewed the scope, direction, and funding of highway safety research programs. The panel heartily supports the committee's recommendations with respect to ways that the process of conducting research could be improved to encourage innovation and quality of scholarship. These recommendations include the following:

- The rebuilding and sustaining of programs of long-term research in the mission agencies.
- Additional annual federal funding of $30 to $40 million (in 1990 dollars), growing annually at 5% to 7% in real terms over the next 5 to 10 years, to support long-term research programs and build the necessary research infrastructure (this recommended funding level would be higher but for the lack of available qualified scientists to conduct the research).
- Use of the recommended additional resources to support a program that emphasizes peer-reviewed, investigator-initiated research; multiyear funding of research programs; more flexible funding arrangements; and the education and training of new researchers.
- Enhanced funding of biomechanics research by DOT to provide the knowledge base for further advances in injury reduction.
- Support for three to five university centers specializing in human factors and other highway safety research disciplines to advance the knowledge of effective crash avoidance strategies.
- A new cooperative program for state-sponsored highway safety research to stimulate more joint state research on driver- and vehicle-related issues.

DHHS-Sponsored Injury Control Research

To address motor vehicle and other types of injuries as a public health problem, the panel recommends full implementation of the organizational structure recommendations in *Injury in America* (104). These include establishing of a National Center for Injury Control (NCIC) within the federal government. The Centers for Disease Control (CDC) is recommended as an appropriate location for such a center.

A solid scientific base formed by research would allow DHHS to develop injury control interventions; to work with epidemiologists and other public health professionals in evaluating those interventions; to serve as an interdisciplinary model and national resource in injury control for academic institutions, state and local health departments, and others; to provide standards or serve as a reference laboratory; to increase the visibility of injury control as a science; and to develop internal expertise in the area of injury to help facilitate extramural research activities and coordinate national efforts in injury control. Center activities should include research in epidemiology, biomechanics, behavior, and the clinical and rehabilitative sciences. The continuing contribution of researchers in traffic safety, which cuts across several of these disciplines, should be ensured.

The NCIC would have the following functions:

- To coordinate prevention research within and outside the federal government.
- To fund research outside the federal government.
- To fund training for researchers in various aspects of injury control.
- To develop intramural research.

To support the functions of the NCIC, the panel recommends the following:

- Allocation of sufficient resources to serve these functions.
- Allocation of positions and funding for research by DHHS for motor vehicle injury research and prevention (in collaboration with DOT), commensurate with its size and importance as a public health problem.
- Establishment of an injury control laboratory, but only after sufficient expansion of the CDC injury control program (see Recommendations to Implementers: Department of Health and Human Services, page 126.)

The proposed center should collaborate with federal agencies involved in research in motor vehicle-related injuries, as well as agencies that have regulatory functions over motor vehicle travel. (These agencies are listed in Table 5, page 115.) The NCIC should also collaborate with the Division of Safety Research at the National Institute for Occupational Safety and Health (NIOSH) to ensure coverage of issues related to work-related motor vehicle injuries.

Public Recognition and Support

Recognition of motor vehicle injuries as a public health problem can lead to increased support for research funding, for acceptance of laws and enforcement, and for existing programs and technology. In addition, consumer demands for motor vehicle safety features can continue to expedite safety innovations in vehicle design.

Efforts by advocacy organizations, law enforcement, public health, and safety officials — primarily at the state level — have produced new-found public support for public education and for enforcement of state laws requiring responsible behavior by motor vehicle

operators. Impaired driving laws and laws requiring safety belt, motorcycle helmet, and child safety seat use are examples of state legislative actions that have saved lives. When these laws are combined with sustained education and enforcement efforts, roads can be made even safer.

The lesson of these efforts is clear: strong public policy, law enforcement, and widespread, yet focused, public education are required to change public attitudes and behavior. In contrast with earlier highway safety campaigns that emphasized media campaigns alone, successes during the last decade have been based on comprehensive, multifaceted programs. Building on this foundation, education can reach more of the public and have a more lasting impact.

Implementation of Proven Interventions

The effectiveness of various vehicle and highway safety features is well documented and was discussed earlier. Programs designed to educate the public and enforce traffic safety laws can reduce the rate of motor vehicle injuries. Finally, passage and enforcement of strict impaired-driving laws can deter impaired driving and its consequences. Each of these types of interventions offers unrealized potential to save more lives, if the interventions were systematically implemented.

Expansion of the Scientific Base

Although proven interventions must be more fully implemented, new research offers the potential for further interventions, as well as technical support for specific interventions and public policies. Research in the areas of biomechanics, Intelligent Vehicle Highway Systems (IVHS), crash avoidance technologies, occupant protection technologies, driver performance, trauma care, behavior, appropriate treatment, and highway design must be funded and sustained to understand the causes of motor vehicle injuries and to design interventions that prevent them.

Recommendations to Implementers

In this section, recommendations to "implementers" are discussed, with special attention to the previous four elements: leadership, collaboration, and coordination; public recognition and support; implementation of proven interventions; and expansion of the scientific base.

Elected Officials

Motor vehicle injuries, unlike many other public health problems, offer many opportunities for near-term cost-effective interventions. By supporting comprehensive programs, legislative initiatives, and funding of basic scientific research, members of Congress and other elected officials have a rare opportunity to support programs that represent some of

the most cost-effective ways to save lives as well as future dollars. This is clearly demonstrated in the President's budget discussion on managing risk sensibly (9).

Implementation of Proven Interventions

Motor vehicle safety is a national issue and deserves national attention. Elected officials should champion motor vehicle safety because of the compelling evidence that proven interventions save lives and money and because the overwhelming cost-effectiveness of these interventions is well documented.

The combined federal commitment to motor vehicle safety research is $41 **million** a year, but the federal government spends between $12 and $15 **billion** annually in direct subsidies to people injured in motor vehicle crashes. Legislators should recognize and emphasize that far greater amounts can be saved by implementing proven, effective interventions.

Many effective interventions, such as enforcement of laws and ordinances, education, and trauma systems, can be shown to prevent injuries — especially costly head and spinal cord injuries — and to save thousands of lives (105). These types of interventions — and results — are within the legislative realm, and should be promoted by elected officials.

Expansion of the Scientific Base

Beyond drawing national attention to these issues and advocating the implementation of proven interventions, Congressional leaders and other elected officials can ensure continued success by maintaining and expanding the field's scientific base. This means that funding levels for existing intervention research and surveillance programs within DOT and DHHS should be expanded. Congressional leaders should also encourage leaders in the private sector to initiate, sustain, and expand their safety research programs.

State and Local Government

Although some measures to reduce motor vehicle injury must occur at the federal level (e.g., motor vehicle safety standards), state and local traffic safety efforts play a critical role in preventing motor vehicle injuries. State and local governments can play a significant role in promoting traffic safety by providing leadership, collaborating and coordinating with other agencies and levels of government, building public recognition and support, supporting data and research systems, and identifying local needs.

Leadership, Collaboration, and Coordination

To achieve maximum effectiveness, a state program should be closely coordinated with all appropriate state and local agencies. Ideally, a state should create a statewide mechanism for designing an overall injury control plan, with input from the local governments so as to assure the acceptability and feasibility of the proposed programs. Because injury control requires the commitment of so many different state agencies, it is difficult for any one agency

to plan and implement a comprehensive program. A mechanism that has proven successful in several states is a Governor's Task Force on Injury Control, either exclusively or partially dedicated to motor vehicle injury. Such a mechanism draws together interagency resources, skills, and knowledge and provides endorsement of the program from the highest level.

A successful Governor's Task Force must have knowledgeable technical support to ensure that programs are based on the results of sound scientific research or effective programs. However, the membership of the task force itself should include persons with influence in the political and private sector communities, such as representatives of law enforcement agencies, intergovernmental and health care provider associations, insurance companies, consumer groups, labor organizations, voluntary organizations, state and local elected officials, educational institutions, and local health departments. Injury control professionals seldom wield such influence, but they can provide those who do with the data necessary to persuade decision makers to support injury control programs.

A primary focus and one of the first missions of a Governor's Task Force should be to compile statewide data on the extent and type of motor vehicle injury experienced in that state. In addition, the estimated costs of the injury should be calculated, including both total societal costs and direct costs to the state — that is, the amount paid for by public funds. Such information should enable the task force to make informed judgments and recommendations about where to expend resources and estimate the kinds of savings that may be anticipated from implementing countermeasures.

Some effort should be devoted to cataloging current state programs in injury control. It is likely that such programs are fragmented and not coordinated with other programs sharing similar interests. The task force can be instrumental in identifying gaps in coverage and facilitating better coordination and collaboration among programs. The task force can also bring strong leadership to the implementation of programs that have proven to be effective in reducing motor vehicle injury, such as effective laws and enforcement strategies. Collaboration with the State Highway Safety Agency (SHSA), which includes the Governor's Highway Safety Program, is essential from the outset. The SHSA provides leadership, state-of-the-art technical information and assistance, data, grants to local communities, and coordination with other public safety agencies, such as law enforcement and emergency medical services (EMS).

Another agency that must be heavily involved in any statewide motor vehicle injury control program is the state health department. One important goal of any state program should be to institutionalize injury control within existing programs. Although a few state health departments have developed injury control programs, this has been largely accomplished with federal funds and institutionalization will require some state core funding for such programs. In the area of motor vehicle injuries, much can be accomplished if the SHSA and state health department join forces and increase their collaborative efforts.

Although federal monies may appropriately be used to initiate programs, ultimately state and local programs should be self sufficient. Because responsibility for the reduction of motor vehicle injury requires the involvement of so many different interests and entities, it becomes difficult to calculate how costs and benefits affect each agency's budget. It may be that if more funding were provided to highway engineering, enforcement, and education, health care costs would be reduced. However, because the specific budgets are quite independent, it is difficult to arrive at a decision based on the more global view. It is unlikely that one state agency will agree to spend more of its budget on a particular program to enable another state agency to save money. It is this kind of problem that requires high-level leadership to solve.

Public Recognition and Support

State-level task forces have played an important role in focusing attention on motor vehicle injury. Over the past 10 years, many state task forces have been established in the area of impaired driving or occupant protection. These task forces have been instrumental in initiating legislative and program action. For example, in 1989, the North Carolina Governor's Highway Safety Program initiated a statewide task force, appointed by Governor James Martin, to collect and review injury morbidity and mortality data, develop a plan for increasing public awareness on injury, and convene the first statewide symposium on injury. During this same period, the Wisconsin Highway Safety Office and Wisconsin Department of Health initiated a statewide task force, appointed by Lieutenant Governor Scott McCallum, to address childhood injury. Both task forces were successful in drawing both public and political attention to injury prevention and control and have established ongoing collaborative statewide programs.

Implementation of Proven Interventions

Within each state, the support of the Governor and the legislature is also critical to the establishment of a statewide motor vehicle injury prevention and control program that is adequately funded. Their political clout and effort will be needed to enact significant life-saving legislation and establish self-sufficient programs (106). Local government also plays a critical role in enacting local ordinances where state laws do not exist and in supporting law enforcement, EMS, and the establishment of community traffic safety programs. For example, in Lexington-Fayette County, Kentucky, driver restraint use increased from 36% before adoption and implementation of a local safety belt ordinance to 76% after enforcement began (107). Recently, the first bicycle helmet ordinance in the United States was enacted in Howard County, Maryland.

Expansion of the Scientific Base

Much of the information needed to quantify the scope of the motor vehicle injury problem and to evaluate programs is not readily available. Data concerning motor vehicle injury are far more complete than they are for other major injury types, but even here there is room for improvement. Leadership at the state level could facilitate the coordination of data

systems — for example, routine linkage of motor vehicle crash data with medical examiner files and hospital discharge data.

Leadership at the state level could also encourage the increased use of technology for purposes of data collection and linkage. For example, the use of bar coding for driver licenses and vehicle registration could facilitate the recording of this information and reduce the time required for data collection. Laptop computers could be used in the field for crash data entry, thus bypassing the time-consuming and expensive process of editing and coding crash reports as currently practiced in most states.

State-level task forces will become increasingly aware of important questions that remain unanswered. Especially in times of limited resources, reliable research, evaluation, and other data are essential for decisions regarding the allocation of resources. The task force can play a significant role in steering research resources into those areas that will most benefit the statewide programs.

Department of Transportation

By statute, the U.S. Department of Transportation (DOT) is the federal agency charged with responsibility for motor vehicle and highway safety. Under the National Motor Vehicle and Traffic Safety Act of 1966, DOT is responsible for establishing necessary motor vehicle safety standards, conducting motor vehicle safety research, and requiring manufacturers to recall defective vehicles.

Under the Highway Safety Act of 1966, DOT is required to collaborate with state and local governments to develop and implement comprehensive highway and traffic safety programs. Under the various motor carrier safety statutes enacted during the 1980s, DOT is responsible for removing unsafe drivers and vehicles from the road and establishing operating requirements for all commercial operators of motor vehicles involved in interstate commerce. DOT, which includes NHTSA and FHWA, has produced a number of policy statements that establish safety as one of the Department's highest priorities. DOT's efforts include funding programs, data systems, research and demonstrations, state-of-the-art technology transfer, state legislative advocacy, new motor vehicle safety regulations, vehicles-in-use regulations, training, and evaluation.

The Department has adequate statutory authority to continue to make important contributions to the reduction of motor vehicle crash-related morbidity and mortality. DOT has been and will continue to be an important agent for change in each of the following areas:

Leadership, Collaboration, and Coordination

DOT is uniquely positioned to work with virtually every sector of our society to promote the effective prevention and control of transportation injuries. DOT is a source of objective

data in the field and can provide evaluations of the widest variety of transportation safety interventions.

While DOT has worked closely with state and local governments and has recognized the importance of working with citizen activists in the field of safety, it also can seek more effective collaboration with the private sector, the scientific community, and the field of public health. Transportation safety has been viewed as a mobility constraint and not a societal health problem of enormous magnitude. To remedy this, DOT should consider collaborative research with the transportation industry, where appropriate, particularly with motor vehicle manufacturers and with agencies within DHHS. However, as noted in the section on corporate America, there are legal constraints that currently proscribe such collaborative research. DOT should also continue to make its databases widely available to the scientific community to encourage its involvement in transportation safety issues.

With respect to coordination, DOT should serve as a national source of objective data as well as a national clearinghouse for research in the field. Currently, there is no available means to inventory adequately the body of work in the field of transportation safety.

NHTSA has successfully participated in an ongoing Interagency Agreement with CDC since March 1986. Through this agreement, these agencies have been able to combine forces in supporting cross-cutting programs such as biomechanics, trauma research, data collection, and acute care. Continuing and fostering such agreements between DOT and DHHS agencies should be encouraged in the interest of developing procedures to jointly fund competitive grants for biomechanics research centers, to enhance and develop trauma registry database linkages with crash databases, and to work with the public health community in addressing issues of behavior modification.

Public Recognition and Support

If we are to reduce the incidence and severity of motor vehicle crashes, we must have the public's support. The Department's role in this area is best fulfilled by making information available to the entire safety community. DOT must also continue to focus attention on both the size of the injury problem and the long history of successful intervention. The message that DOT must promote is that there are effective solutions to the motor vehicle safety problem.

Implementation of Proven Interventions

In the areas of motor vehicle crash avoidance and crashworthiness, DOT's authority to issue Federal Motor Vehicle Safety Standards assures that vehicle safety performance can be required in the new car fleet as soon as countermeasures are determined to be feasible and meet the need for motor vehicle safety.

In the traffic safety areas, DOT has the authority to implement state and community grant programs that address the issues of impaired driving, occupant protection, EMS, police traffic services, motorcycle safety, and traffic records, among others. Through its Section 402 State and Community Highway Safety Grant Program, DOT helps to assure that financial support can be provided to begin implementing countermeasures at the state and local levels, once they have been determined to be effective. In addition, these grants support the development of effective local traffic safety programs that can be targeted to community needs.

NHTSA has published a priority plan for the implementation of proven interventions (108). This plan is a schedule of actions that address motor vehicle safety, impaired drivers, occupant protection, technology innovation, and other safety initiatives.

Similarly, FHWA has recently published a list of 11 complementary priority short-term countermeasures that are considered to offer a high payoff within the next 2 years. FHWA will emphasize national implementation of these countermeasures (109).

Expansion of the Scientific Base

DOT should consider establishing two parallel research programs: extramural and intramural. DOT's current mode for conducting research is a hybrid of both, with outside contractors responding to DOT's internally defined needs and approaches via Requests for Proposals (RFPs). This approach should be continued and expanded. With additional funds, an extramural grant program could be established. Such a program would nurture long-term academic interest, scientific credibility, and activity in the area as well as provide DOT with an additional source of creative inputs. DOT should also enhance its internal capabilities by hiring scientists to conduct selected studies and not only monitor them. Finally, innovative collaborations with other agencies or the private sector should be pursued as a means of expanding support for the safety research community.

In addition, NHTSA has developed a detailed research and development program plan for 1992-1996 that addresses the following topics:

- Crashworthiness research.
- Crash avoidance research.
- Highway safety research.
- Crash data collection and analysis.
- Technology transfer.
- Program delivery.
- Resource needs (110).

FHWA's 1992-96 research and technology program emphasizes the following highway safety areas:

- Highway safety information management.
- Human factors research for highway safety.
- Pedestrian and bicycle safety.
- Highway safety design practices and criteria.
- New traffic control methods and devices.
- Motor carrier safety research (109).

Attention should be given to these plans as a framework for priority research in these areas.

Department of Health and Human Services

Although Congressional mandate has given NHTSA primary responsibility for reducing the burden of traffic injury, leadership is needed at the highest levels of the Department of Health and Human Services (DHHS) to focus national attention on the extent of this injury problem. Throughout DHHS and the federal government, several agencies are charged with various aspects of injury control programs. In 1984, the Committee on Trauma Research recommended that the federal government create an organizational setting and structure to coordinate the study of injury and that this unit be placed within DHHS, initially at CDC (104). Such a single coordinated focus of activity would give visibility to injury as an "important public health issue and permit an organized program of effective action to address the problems." In addition, the Committee emphasized that "vast sums could be saved by a relatively small investment in this field." Accordingly, our panel finds historical precedent in the spirit of its recommendations to DHHS. These include the full implementations of the organizational structure recommendations in *Injury in America,* including the establishment of a Center for Injury Control as previously described. Other panel recommendations to DHHS are as follows:

Leadership, Collaboration, and Coordination

To address motor vehicle injury more comprehensively, collaboration and coordination of program research and prevention activities must be conducted within DHHS. Over the past 10 years, motor vehicle injury research and prevention activities have been conducted through the Indian Health Service, Bureau of Maternal and Child Health, National Institutes of Health, the Alcohol, Drug Abuse, and Mental Health Administration, CDC's National Institute for Occupational Safety and Health, National Center for Health Promotion and Education, National Center for Environmental Health and Injury Control, and several other organizations. The coordination of programs, strategic goals, research, and data systems within DHHS is instrumental in effective collaboration with other federal agencies and state health departments.

In accord with the recommendations of the Committee on Trauma Research in *Injury in America,* the panel recommends that DHHS coordinate the Nation's injury prevention efforts in a spirit of collaboration with DOT, the Consumer Product Safety Commission, the Department of Defense, the Department of Labor, and other federal agencies. Because of DOT's regulatory responsibilities and transportation-related focus, DHHS has been perceived as a better locus for these coordinating efforts. However, active participation of DOT and other federal agencies will help in setting the agenda and overseeing DHHS' injury control activities.

The panel recommends that state health departments be actively encouraged to collaborate in injury research and prevention projects with State Highway Safety Agencies (SHSA). As noted earlier, such an agency provides leadership in the state for highway safety programs. In addition to program action, there are a number of data sources that collect various aspects of the motor vehicle injury problem. Although there is no comprehensive national surveillance system for nonfatal crash-associated injury and disability, "police accident reports," trauma registries, and EMS "run sheets" all provide a collective view of the problem. Linkage of these systems with hospital records would —

- Provide valuable data on the impact of nonuse of safety belts and child safety seats, pedestrian and bicyclist injuries, and impaired driving.
- Provide data to decision makers regarding resource allocation or legislative action.
- Increase interest in using data that are already available for analyzing injury issues.

The panel believes that the motor vehicle aspects of the injury control program, as well as the other aspects, would benefit from a specific responsibility for injury control in the Office of the Assistant Secretary for Health. This office would help ensure an orderly growth and development of the program and would act as a leader in coordinating the various satellite activities within DHHS. This responsibility is also critical because coordination with DOT and other cabinet-level departments will be vital for a cohesive national program. Since injury is underfunded in comparison to other health and societal problems, a responsible contact within the DHHS leadership will help develop an appropriate allocation of a funded and broad-based focus for injury control.

The principal current DHHS injury control program at CDC must balance its support of motor vehicle research in the broader field of injury control (111). This will help attract talent to address all aspects of injury control while rebuilding the cadre of professionals active in the field. To assure proper balance in the CDC program, the panel recommends that the DHHS Advisory Committee on Injury Control maintain adequate representation from the transportation safety research and program field and that grant review panels dealing with transportation-related proposals have adequate representation of traffic injury control researchers and program managers. This should include traffic injury control researchers as reviewers on biomechanics and traffic injury prevention grant reviews and CDC's reliance on professionals active in traffic safety as the field grows. This approach should lead to the orderly development of a research base in motor vehicle safety.

Expansion of the Scientific Base

The federal government needs a laboratory to conduct research on the basic sciences of injury control, including traffic-related issues. This will provide not only a visible focus for broad-based studies and national attention, but also the opportunity to involve leading scientists and professionals outside the DOT and DHHS as partners in the injury control program. In addition, an injury control laboratory can help ensure the real-world effectiveness of various countermeasures. The proposed laboratory is envisioned as an essential component of a future National Center for Injury Control, and would complement DOT research as well as that of the university-based "centers of excellence" and industrial research regarding motor vehicle injury prevention. The laboratory should have close connections to CDC and NHTSA and to universities involved in engineering, human sciences, and medicine, thus enabling the field of injury control to attract professionals in biomechanics, acute care, and rehabilitation.

Although a laboratory is an important way in which federal programs can effectively develop capabilities, such a laboratory should be funded by new monies and not drain funds from CDC's extramural research program or from NHTSA's research budget. These needs speak to a requirement for growth in the overall budget of federal injury control programs. By playing a key role in developing an applied injury research laboratory, CDC's mission will be broadened. This laboratory should also collaborate with NIOSH's Division of Safety Research to facilitate research in work-related motor vehicle injury issues.

DOT does not solicit investigator-initiated studies, but rather conducts studies on areas it establishes. This has led to a fragmented development of academic expertise and little or no development of training and education for traffic safety researchers. Consequently, the panel recommends that DHHS resources be allocated for training programs for researchers and practitioners in all aspects of the motor vehicle injury field, both inside and outside government agencies. Attention should be given to the judicious allocation of funds for creating and managing sorely needed research training programs in epidemiologic, behavioral, biomechanical, clinical, and rehabilitative medical sciences related to motor vehicle injury. Adequate attention must be provided to state and local practitioners in the field who assume program responsibilities for injury control program activities.

The panel recommends that the National Committee on Vital Health Statistics consider making the following recommendation to the Secretary of DHHS: Whenever an injury is the principal diagnosis or directly related to the principal diagnosis for a hospitalized patient, an external cause of injury should be recorded in the medical record. When an external cause is recorded, applicable E-codes should be reported in the hospital discharge data set.

The panel also recommends that E-codes be required for all hospitalized patients, in all DHHS programs that deliver care, regardless of the payment source. The panel also recommends that the revised Uniform Bill (UB-82) for hospitals accommodate the collection of E-codes. The panel also strongly encourages all other jurisdictions and programs

collecting Uniform Hospital Discharge Data Set (UHDDS) data to include E-coding as a requirement for injury hospitalizations. The panel is concerned that, without strong financial incentives or sanctions, the mandate to report E-codes may not succeed nationally.

Corporate America

As part of the Nation's program to reduce motor vehicle crash injuries, the corporations of America can play a role. Some businesses, including motor vehicle manufacturers and automobile insurers, have unique opportunities to contribute to reducing injuries, because their products are directly involved with the problem. Other corporations can also play a role in reducing crash injuries.

Motor Vehicle Manufacturers

Manufacturers of motor vehicles and components sold in the United States are asked to undertake several key initiatives:

- *Develop a cooperative research program with DOT and DHHS.* Considering the range of research needed and the limited resources in both the public and private sectors, the panel believes that CDC, NHTSA, and motor vehicle manufacturers should be specifically permitted to conduct a collaborative research program that gives adequate protection to the public's interest and adequate protection to the manufacturers' proprietary concerns. Currently, without specific authorization, NHTSA and the manufacturers are precluded from developing such a program.
- *Expand safety marketing and provide consumer information.* It is recommended that manufacturers emphasize safety in their advertising and refrain from advertising unsafe practices such as speeding. For example, they should cancel advertisements that require disclaimers such as the following: "This maneuver should not be attempted by ordinary drivers." Manufacturers can also emphasize safety by encouraging auto and motorcycle dealers to provide point-of-sale education on safety features.
- *Accelerate the pace of safety-related design changes.* Manufacturers should hasten the development and introduction of design improvements that will lead to crash avoidance and reduced injuries.
- *Curtail the production of high-speed vehicles.* Many vehicles capable of speeds well in excess of 100 mph are produced every year, even though the maximum speed limit is 65 mph. The production and promotion of such cars and motorcycles should be curtailed.
- *Assist state and local authorities in promoting safety laws.* Manufacturers should continue to promote safety belt use laws and require their own employees to use belts. In communities where manufacturers have facilities, they can contribute directly to community efforts by becoming actively involved in traffic safety programs.

Car Rental Companies

Car rental companies can contribute to motor vehicle safety by purchasing fleet vehicles equipped with antilock braking systems and driver and passenger airbags, by reminding customers to use safety belts and child safety seats, and by providing child safety seats to customers free of charge.

Insurance Industry (Auto and Health)

The Nation's property and casualty insurers have a vested interest in reducing the incidence of motor vehicle crashes and crash injuries. Other segments of the insurance industry, including life and health carriers, also have a strong interest in this reduction because crashes are a leading cause of death and serious injuries.

Insurers should undertake several crash prevention and crash injury reducing initiatives, including the following:

- *Provide premium discounts.* Auto insurers should promote the use of safer cars and driving practices, such as safety belt use, by providing appropriate premium discounts for cars with safety features such as airbags and antilock brakes.
- *Supply consumer information.* Auto insurers should routinely supply policyholders with information about motor vehicle safety, including information about the actual insurance losses associated with specific car makes and models. In addition, the insurance industry should provide consumers with comprehensive information on the relative safety of new cars. To encourage safe driving behaviors, auto and health insurers should provide risk prevention information to policyholders.
- *Assist state and local authorities in promoting safety laws.* Like motor vehicle manufacturers, insurers should actively assist state and local authorities in enacting and promoting safety laws. In states and communities where insurers are located, they could participate in existing community traffic safety programs and other educational campaigns and contribute directly to enforcing local safety laws by providing equipment to improve the enforcement of such laws.

These and other initiatives can contribute to increased public awareness of traffic safety issues, as well as to an improved public understanding of the insurance industry's commitment to controlling costs.

Alcohol Beverage Industry

A high proportion of fatal motor vehicle crashes involve drivers who are impaired by alcohol. For this reason, the alcohol beverage industry has a special responsibility to contribute to motor vehicle crash injury reduction efforts. However, it is unlikely that the industry will change its successful and profitable marketing of alcohol significantly. If the alcohol beverage industry were to alter its promotion practices, the panel recommends the following

as two areas in which it could make the most significant contribution to reducing the toll of impaired driving on our society.

- *Discourage drinking and driving.* The alcohol beverage industry should not promote its products in a way that encourages the use of alcohol in connection with motor vehicle use. The industry should emphasize responsible use of alcohol, including abstinence by drivers, and the problems that result from irresponsible use. Companies that make alcoholic beverages should not sponsor motor sports activities.
- *Discourage drinking among young people.* The problem of impaired driving is acute among young people who are learning to drive at the same time that they are beginning to consume alcohol. The alcohol beverage industry should not promote its products in ways that encourage underage drinking; rather, the industry should encourage compliance with the minimum drinking age of 21. For example, the industry should reassess the common practices of sponsoring collegiate, athletic, and cultural events geared to young audiences and advertising alcoholic beverages in ways that glamorize dangerous driving or other risky behaviors.

News and Entertainment Industries

The magnitude of the motor vehicle injury problem is such that it warrants wide attention — wider, perhaps, than it now receives in the print and electronic media. Such attention should be increased in both the news and entertainment segments of television and newspapers. For example, the news and entertainment industries should do the following:

- *Encourage more — and more accurate — news coverage.* A straightforward way in which media coverage can contribute to injury reduction involves reporting when safety belts are (or are not) used in crashes, when airbag deployments are involved in crashes, what the alcohol levels of drivers were, and similar information. But news reporters are not public health experts. Therefore, highway safety and health professionals must work with reporters on a long-term and continuing basis to ensure that what they report is accurate and that it helps reduce motor vehicle injuries.
- *Encourage injury reduction themes in television programming.* The public gets a message about injury-related behavior every time an actor on film wears or does not wear a motorcycle helmet or safety belt, and every time film and television stars unrealistically survive drinking and driving or dangerous driving maneuvers in chase scenes. Programming executives should ensure that entertainment themes serve the public health purposes of reducing injuries.

All Segments of Corporate America

As employers, all of the Nation's businesses are in a position to implement work-related travel measures that affect motor vehicle injury rates. Corporations are urged to implement the motor vehicle safety measures recommended below, in the section titled "Employers, Contractors, and Labor Organizations."

Employers, Contractors, and Labor Organizations

Employers, contractors, and labor organizations are in a unique position to implement work-related travel measures that affect motor vehicle injury rates. These may include measures not yet legislated in the state or Nation, as well as reinforcement of existing legislation.

Collaboration, Leadership, and Coordination

Management and labor should be encouraged to be partners in this effort. The industries most affected by motor vehicle fatalities — transportation, communications, and public utilities — have generally been quite supportive of programs such as those outlined above. Now, however, these industries account for less than a third of the occupational motor vehicle injury problem. Therefore, it is important that efforts be generalized to other industries, especially those in which motor vehicle injury fatalities account for a significant number of occupational injury fatalities. For example, research is needed in the construction industry to assess the effect of fatalities as a result of vehicle-associated injuries occurring in highway work zones.

Labor unions and employers can also promote motor vehicle safety programs through their associations or by participating directly in state and local injury prevention and control coalitions. Likewise, employers, business associations, and labor unions employing health and safety professionals and joint labor-management education, training, and health and safety funds can be effective independent forces in the state and local legislative arena to advocate for maintaining and expanding effective injury prevention legislation and regulation. Examples include occupant protection and impaired-driving legislation. These groups can also contribute to surveillance efforts by collecting accurate data on incidence and costs of motor vehicle crashes and injuries in the workplace. Finally, employers and associations can provide employee education programs in injury prevention as part of an overall health promotion and disease prevention program. These educational efforts are important beyond the immediate work environment; employer policies and programs in the workplace may "spill-over" to off-the-job driving practices.

Implementation of Proven Interventions

Examples include the following:

- Purchasing fleet vehicles that are equipped with safety features such as antilock brakes and driver and passenger airbags.
- Prohibiting alcohol use before or during driving on the job.
- Mandating the use of safety belts (regulation recently proposed by the Occupational Safety and Health Administration (OSHA)).
- Providing transportation to and from all corporate events at which alcohol is served.

- Imposing company penalties for on-the-job traffic violations.
- Regulating maximum permissible continuous driving hours.

Health Care Community

Hospitals, physicians, nurses, and other health care providers have many opportunities to help prevent motor vehicle injuries by participating in data collection systems, training staff, and acting as a point of contact with patients. Several specific recommendations follow.

Leadership, Collaboration, and Coordination

- Physicians, trauma nurse coordinators, and other hospital personnel should join and actively participate in state and local coalitions, which will set policy and programmatic initiatives for injury prevention.
- Physicians, emergency personnel, and other hospital personnel should serve as agents to identify and refer persons with identified substance abuse problems or other conditions that put them at risk for injury.
- Hospitals should actively work with EMS personnel, state and local health departments, highway safety agencies, and other governmental and nongovernmental agencies in developing and promoting injury prevention programs.
- State medical societies and public health, nursing, and hospital associations should have a motor vehicle injury prevention committee and actively support motor vehicle safety legislation.

Public Recognition and Support

- Physicians and other health care providers should make questions and counseling about the use of safety belts, child safety seats, and helmets a routine part of patient consultations (112, 113).
- Hospitals with obstetric and pediatric units should participate in programs to promote use of safety belts and child safety seats.
- Whenever feasible, all primary health care providers should be furnished with clear, brief, authoritative handouts on proper safety belt use, child safety seat selection and use, and motorcycle and bicycle helmet selection and use, for distribution to their patients.
- Hospitals should have safety belt education and child safety seat use discharge policies for all inpatients and outpatients.

Expansion of the Scientific Base

- Physicians and emergency department personnel should provide sufficient information in medical records so that hospital personnel can record E-codes in hospital discharge data systems, and they should obtain and record a blood alcohol concentration (BAC) level for all patients treated for acute traumatic injury.

- Hospital administrators should recognize the community need for E-coded data and should provide sufficient resources to train and provide personnel to use E-codes.
- Hospitals should receive sufficient resources to provide high-quality information to state trauma, head injury, and spinal cord injury registries.
- Hospitals should provide sufficient patient identifiable information through discharge data and registries to allow linkage with other data sets. Confidentiality guarantees should be in place to restrict the use of such information to research purposes only.

Training and Educational Institutions

The panel recommends that resources be allocated for training programs for researchers and practitioners in all aspects of motor vehicle injury, both inside and outside of government agencies. Attention should be given to the judicious allocation of funds for creating and managing sorely needed research and training programs in the epidemiologic, behavioral, biomechanical, clinical, and rehabilitative medical sciences related to motor vehicle injury. Attention should also be given to state and local practitioners in the field who assume program responsibilities for the delivery of injury control program activities.

Recent efforts are drawing more attention to the health aspects of injury, but the health establishment itself remains remarkably indifferent. A major target in overcoming such indifference is the preparatory training and continuing education of health professionals. In the past, the treatment of injury has received attention but the prevention of injury has been virtually neglected. From 1965 to 1975 DHHS funded only one training program for public health professionals in injury prevention, and there is no systematic federal funding of such programs today.

In the absence of DHHS training, NHTSA developed a motor vehicle injury prevention course for highway safety and health professionals. Medical and nursing specialties in injury control, such as emergency medicine, have been stepchildren in the medical arena and are only beginning to gain academic credibility. The panel recommends that training in all aspects of motor vehicle injury be included in the curricula of all health professionals and that their knowledge in this area be evaluated in professional board examinations.

Leadership, Collaboration, and Coordination

Training health professionals in motor vehicle injury prevention can be facilitated through collaboration with state and local agencies. Some health care delivery training programs work closely with state and local agencies involved in injury prevention, but they are the exception, in part because so few training programs address injury control at all. Fewer institutions formally address motor vehicle injury control in their training programs. However, collaboration with state and local programs provides mutual benefits. The programs benefit from having access to the latest information and the energy and enthusiasm of students and faculty, while the students and faculty learn more about the real world

constraints in implementing programs and conducting research or evaluation. In addition, such collaboration builds bridges that facilitate access to databases and the collection of better data.

Expansion of the Scientific Base

Although increased university funding to support injury control teaching and research is a worthy goal, there is a need to include motor vehicle injury control. Unfortunately, even the enormous magnitude of the problem and the associated societal costs may not be sufficient to overcome institutional inertia. Universities are struggling with budgetary limitations, but university administrators need to understand the worthiness of this program and adopt it as a growth area. State and national leadership, including funding, will be essential to the successful incorporation of injury control into academia.

Although prevention is the key to injury control, few schools of public health address injury. The prevention of injury involves disciplines beyond those in public health and indeed beyond the health professions entirely. Schools of engineering have been the first to move toward requiring attention to injury control as a condition of accreditation. Requirements to teach courses on injury control should certainly be placed on training programs in public health and safety, as well as in medicine, nursing, law, and public policy. Efforts should be made to incorporate injury control into the standard curricula of such training programs. Traffic injury control must bridge the gaps among medicine, engineering, public health, law, and the behavioral sciences.

University-based "centers of excellence" may provide an example of a multidisciplinary approach to injury control that advances the field's scientific base, trains researchers, and leads to innovative, effective countermeasures. The academic setting lends itself to collaborative research involving a variety of disciplines that together can consider aspects of injury control that cannot be studied in isolation. Such approaches should be encouraged through funding mechanisms, university programs, and peer-reviewed publications.

Another aspect of the academic setting is the geographic concentration of youth whose subsequent lifetime driving and social behaviors can be influenced by university policies. These policies can include alcohol regulations, safety belt requirements while on campus or in university vehicles, use of helmets while riding bicycles and motorcycles on campus, and enforcement of pedestrian right-of-way at crosswalks. Many of these policies — especially those concerned with bicycle and pedestrian safety — also apply to younger, school-aged children.

Citizen Advocacy Groups

A critical element in the continued success of the injury control movement in the United States is the legislative support and national awareness efforts of advocacy groups. These groups represent health, professional, disability, industry, and public interests and provide

leadership in building a constituency and coalition for injury control. Advocacy groups have been needed because of the lack of money and attention devoted to injury in America. This general lack will probably persist for some time, making stronger ties between different advocacy groups even more important.

Leadership, Collaboration, and Coordination

Many advocacy groups in the injury field share common goals. For example, the objectives of organizations concerned with impaired driving are largely shared by many concerned groups, such as the numerous groups within the National Coalition to Prevent Impaired Driving, and by professional groups. The programs of these groups, and those of federal and state agencies, must have more funds if they are to address prevention and intervention.

A national council of advocacy groups should convene and consider common goals and areas of cooperation. This event would add to the cooperation that is emerging in the field. The council could identify areas in which groups may not have common objectives but may not have opposing positions either. The council also could identify the areas in which competing agendas are being pursued. With this approach, common objectives can be pursued more broadly and effectively.

Advocacy groups should continue to foster closer coordination and cooperation on the important areas of injury prevention. These areas should include attention and the granting of priority status to the following:

- Preventing impaired driving.
- Increasing the use of safety belts, child safety seats, and bicycle and motorcycle helmets.
- Abiding by posted speeds and signs.
- Eliminating unsafe use of vehicles in advertising, commercials, television programs, and movies.
- Assuring proper belt and helmet use in advertising, commercials, television programs, and movies.
- Encouraging safety in vehicle purchase decisions.
- Encouraging safe bicycling and appropriate pedestrian behavior.
- Passing effective state laws.
- Supporting enforcement of laws.
- Developing and implementing effective public education programs.
- Increasing media attention and making news of crashes and injuries more accurate.
- Registering disabling injuries.

Public Recognition and Support

Injury control is a prominent area of public health and a priority area for the Nation. If we are going to reduce the economic, social, and family devastation injury produces, advocacy groups can and should play a role in the national program to garner money and attention to the problem and to develop broad-based education and prevention efforts.

New advocacy initiatives are needed to develop the voice and power of youth, older adults, and the lower socioeconomic segments of society. These groups are disproportionately affected by injuries and would benefit from grass roots advocacy directed at community awareness, injury prevention, and local, state, and federal government initiatives.

We have a great deal to gain from leaders in minority communities addressing injury control through family units, churches, and schools. In many instances, advocacy initiatives can be adapted for use in communities made up of minorities or of people with a specific culture and language.

Expansion of the Scientific Base

In many cases, advocacy groups can be effective by challenging conventional assumptions, even though their approaches may seem unscientific or unorthodox. However, it is increasingly important that injury control advocacy be based on sound research findings and the proper interpretation of data. Each advocacy group should regularly assess its programs to ensure that its recommendations are based on sound scientific research. In areas in which additional scientific findings would strengthen advocacy efforts, coordination with health professionals is recommended. This not only offers the benefit of developing links among groups, but also ensures that the most appropriate research findings are used in legislative activities and in defining goals. In addition, this approach can help identify research and data needs that deserve national attention.

References

1. National Center for Health Statistics. Health, United States, 1990. Washington DC: Public Health Service, 1991. Publication No. PHS 91-1232.

2. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress. San Francisco, CA: Institute for Health & Aging; Univ of California, and Injury Prevention Center, The Johns Hopkins Univ, 1989.

3. Fineberg H. Ninth annual Joseph W. Mountin lecture. Director's Bulletin, Epidemiology Program Office. Atlanta GA: Centers for Disease Control, 1989.

4. National Highway Traffic Safety Administration. The effects of the 65 mph speed limit through 1988: a report to Congress. Washington DC: U.S. Department of Transportation, 1989.

5. Graham JD, Vaupel JW. Value of a life: what difference does it make? Risk Analysis 1981;1:89-95.

6. Schwing RC. Longevity benefits and costs of reducing various risks. Technol Forecast Soc Change 1979;13:333-45.

7. Bailey M. Reducing risks to life: measurement of the benefits. Washington DC: American Enterprise Institute, 1980.

8. Morrall JF. Regulating risk: a review of the record. Regulation 1986; November/December:25-34.

9. Budget of the U.S. Government, FY 1992. Washington DC: U.S. Government Printing Office, 1991.

10. Miller TR, Luchter S, Brinkman CP. Crash costs and safety investment. In: Proceedings, 32nd Annual Conference of the Association for the Advancement of Automotive Medicine. Des Plaines IL: Association for the Advancement of Automotive Medicine, 1988.

11. Kahane CJ. An evaluation of door locks and roof crush resistance of passenger cars: federal motor vehicle safety standards 206 and 216. Washington DC: U.S. Department of Transportation, 1989. DOT Publication No. HS 807 489.

12. Kahane CJ. An evaluation of occupant protection in frontal interior impact for unrestrained front seat occupants of cars and light trucks. Washington DC: U.S. Department of Transportation, 1988. DOT Publication No. HS 807 203.

13. Kahane CJ. A preliminary evaluation of seatback locks for two-door passenger cars with folding front seatbacks. Washington DC: U.S. Department of Transportation, 1987. DOT Publication No. HS 807 067.

14. Kahane CJ. An evaluation of child passenger safety: the effectiveness and benefits of safety seats. Washington DC: U.S. Department of Transportation, 1986. DOT Publication No. HS 806 890.

15. Kahane CJ. An evaluation of windshield glazing and installation methods for passenger cars. Washington DC: U.S. Department of Transportation, 1985. DOT Publication No. HS 806 693.

16. Kahane CJ. An evaluation of head restraints: federal motor vehicle safety standard 202. Washington DC: U.S. Department of Transportation, 1982. DOT Publication No. HS 806 108.

17. Kahane CJ. An evaluation of side structure improvements in response to federal motor vehicle safety standard 214. Washington DC: U.S. Department of Transportation, 1982. DOT Publication No. HS 806 314.

18. Kahane CJ. An evaluation of federal motor vehicle safety standards for passenger car steering assemblies, standard 203 - impact protection for the driver, standard 204 - rearward column displacement. Washington DC: U.S. Department of Transportation, 1981. DOT Publication No.HS 805 705.

19. Kahane CJ. An evaluation of standard 214, side door strength. Washington DC: U.S. Department of Transportation, 1979. DOT Publication No. HS 804 858.

20. Federal Highway Administration. 1989 annual report to congress on highway safety improvement programs. Washington DC: Department of Transportation, 1989.

21. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991: DHHS Publication No. (PHS) 91-50212.

22. Public Health Service. Surgeon General's workshop on drunk driving. Washington DC: Office of the Surgeon General, 1988.

23. Evans L. An attempt to categorize the main determinants of traffic safety. Health Educ Res 1990;5:111-24.

24. Viano DC. Statement representing the National Head Injury Foundation and the Association for the Advancement of Automotive Medicine before the Subcommittee on Health and the Environment, Committee on Energy and Commerce, House of Representatives, at Hearings on the Federal Programs of Injury Control;March, 1990.

25. Trankle U, Balau C, Metker T. Risk perception and age-specific accidents of young drivers. Accid Anal Prev 1990;22:119-25.

26. Evans L. Young driver involvement in severe car crashes. Alcohol Drugs Driving 1987; 3(3-4):63-78.

27. Geller ES, Elder J, Hovell, M, Sleet D. Behavioral approaches to drinking-driving interventions. In: Ward W and Lewis FM, editors. Advances in health education and promotion, Vol III. London, England: Jessica Kingsley Press, 1991.

28. Transportation Research Board. Transportation in an aging society: improving mobility and safety for older persons. Washington DC: National Research Council,1988. Special Report #218.

29. Pike JA. Automotive safety - anatomy, injury, testing and regulation. Warrendale PA: Society of Automotive Engineers, 1990.

30. Pike JA. The elderly and vehicle-related injury. In: Effects of aging on driver performance. Warrendale PA: Society of Automotive Engineers, 1988. Special publication SP-762; paper 881753.

31. Waller PF, Hall RG. Literacy: a human factor in driving performance. Warrendale PA: Society of Automotive Engineers, 1980. Paper No. 800385.

32. National Highway Traffic Safety Administration. Preliminary report: the cost of automobile safety regulations: plans and programs. Washington DC: U.S Department of Transportation, 1982.

33. Robertson LS. Automobile safety regulations and death reductions in the United States. Am J Public Health 1981;71:818-22.

34. Graham JD. Technology, behavior and safety: an empirical study of automobile occupant-protection regulation. Policy Sciences 1984; 17: 141-51.

35. National Highway Traffic Safety Administration. 1989 estimates of lives saved. Washington DC: U.S. Department of Transportation, 1990.

36. National Highway Traffic Safety Administration. Occupant protection facts. Washington DC: U.S. Department of Transportation, 1990.

37. National Highway Traffic Safety Administration. Fatal accident reporting system 1989: a review of information on fatal traffic crashes in the United States in 1989. Washington DC: U.S. Department of Transportation, 1991. DOT Publication No. HS 807 693.

38. Williams AF, Zador PL, Harris SS, Karpf RS. The effect of raising the legal minimum drinking age on involvement in fatal crashes. J Leg Stud 1983;12:169-79.

39. Zador PL, Lund AK, Fields M, Weinberg K. Fatal crash involvement and laws against alcohol-impaired driving. J Public Health Policy 1989; Winter:467-85.

40. Graham JD, Evans WE. Traffic safety and the business cycle. Alcohol Drugs Driving 1988;4:31-38.

41. Graham JD, Latimer E. Themes and future directions. In: Graham JD, editor. Preventing automobile injury: new findings from evaluation research. Dover MA: Auburn House, 1988:263-276.

42. Budget of the U.S. Government, FY 1990. Washington DC: U.S. Government Printing Office, 1989.

43. National Highway Traffic Safety Administration. 1990 traffic fatality facts. Washington DC: U.S Department of Transportation, 1990.

44. National Highway Traffic Safety Administration. Observed safety belt use statistics by state. Washington DC: U.S. Department of Transportation, 1988.

45. Steed D. The case for seatbelt use [editorial]. JAMA 1988;260:3651.

46. Wagenaar AC, Maybee RG, Sullivan KP. Mandatory seat belt laws in eight states: a time-series evaluation. J Safety Res 1988;19:51-70.

47. Chorba TL, Reinfurt D, Hulka BS. Efficacy of mandatory seat-belt use legislation:the North Carolina experience from 1983 through 1987. JAMA 1988;260:3593-7.

48. Wagenaar AC, Margolis LH. Effects of a mandatory safety belt law on hospital admissions. Accid Anal Prev 1990;22:253-61.

49. Campbell BJ, Campbell FA. Injury reduction and belt use associated with occupant restraint laws. In: Graham JD, editor. Preventing automobile injury: new findings from evaluation research. Dover MA: Auburn House, 1988:24-50.

50. Williams AF, Lund AK. Mandatory seat belt use laws and occupant crash protection in the United States: present status and future prospects. In: Graham JD, editor. Preventing automobile injury: new findings from evaluation research. Dover MA: Auburn House, 1988;51-72.

51. Chorba TL. Assessing technologies for preventing injuries in motor vehicle crashes. Int J Tech Assess Health Care 1991;7:296-314.

52. Occupational Safety and Health Administration. Notice of proposed rulemaking (29CFR1910). Federal Register 1990;55:28728-40.

53. Sleet DA, Hollenbach K, Hovell M. Applying behavioral principles to motor vehicle occupant protection. Educ Treat Child 1986;9:320-33.

54. Roberts MC, Layfield DA. Promoting child passenger safety: a comparison of two positive methods. J Pediatr Psychol 1987;12:257-71.

55. Margolis LH, Wagenaar AC, Molnar LJ. Recognizing the common problem of child automobile restraint misuse. Pediatrics 1988;81:717-20.

56. Sosin DM, Sacks JJ, Holmgreen P. Head injury-associated deaths from motorcycle crashes: relationship to helmet-use laws. JAMA 1990;264:2395-9.

57. Hertz ES. The effect of helmet law repeal on motorcycle fatalities: a four year update: research notes. Washington DC: National Highway Traffic Safety Administration, National Center for Statistics and Analysis, 1990.

58. Barancik JI, Chatterjee BF, Greene YC, Michenzi EM, Fife D. Northeastern Ohio trauma study: I: magnitude of the problem. Am J Public Health 1983;73:746-51.

59. National Highway Traffic Safety Administration. The effectiveness of motorcycle helmets in preventing fatalities. Washington DC: U.S. Department of Transportation, 1989. DOT Publication No. HS 807 416.

60. Rivara FP, Dicker BG, Bergman AB, Dacey R, Herman C. The public cost of motorcycle trauma. JAMA 1988;260:221-3.

61. McSwain NE, Belles A. Motorcycle helmets - medical costs and the law. J Trauma 1990;30, 1189-99.

62. Evans L. The fraction of traffic fatalities attributable to alcohol. Accid Anal Prev 1990;22:587-602.

63. Soderstrom CA, Trifillis AL, Shankar BS, Clark WE, Cowley RA. Marijuana and alcohol use among 1023 trauma patients. Arch Surg 1988;123:733-7.

64. Phelps CE. Alcohol taxes and highway safety. In: Graham JD, editor. Preventing automobile injury: new findings from evaluation research. Dover MA: Auburn House, 1988: 197-230.

65. Cook PJ. The effect of liquor taxes on drinking: cirrhosis and auto accidents. In: Moore MH, Gerstein DR, editors. Alcohol public policy beyond the shadow of prohibition. Washington DC: National Academy Press, 1981:255-85.

66. Saffer H, Grossman M. Beer taxes, the legal drinking age, and youth motor vehicle fatalities. J Leg Stud 1987;16:351-74.

67. Wagenaar AC. Preventing highway crashes by raising the legal minimum age for drinking: the Michigan experience 6 years later. J Safety Res 1986;17:101-9.

68. Cook PJ, Tauchen G. The effect of minimum drinking age legislation on youthful auto fatalitites, 1970-77. J Leg Stud 1984;13:169-90.

69. O'Malley PM, Wagenaar AC. Effects of minimum drinking age laws on alcohol use, related behaviors, and traffic involvement among American youth: 1976-1987. J Stud Alcohol 1991; 52:478-91.

70. Moskowitz H, Robinson C. Driving-related skills impairment at low blood alcohol levels. In: Noordzij P, Roszbach R, editors. Alcohol, drugs and traffic safety-T86. Amsterdam, Netherlands: Elsevier, 1987:79-86.

71. Federal Highway Administration. Symposium on Effective Highway Accident Countermeasures. Washington DC: U.S. Department of Transportation, 1990.

72. American Association for Automotive Medicine, Committee on Injury Scaling. The abbreviated injury scale 1990 revision. Des Plaines, IL: American Association for Automotive Medicine, 1990.

73. National Highway Traffic Safety Administration. Lives saved by child restraints from 1982 through 1987. Washington DC: U.S. Department of Transportation, 1988 DOT Publication No. HS 807 371.

74. Federal Highway Administration. Fatal and injury accident rates on public roads in the U.S. Washington DC: U.S. Department of Transportation, 1987.

75. Treat JR, Tumbas NS, McDonald ST, Shinar D, Hume RD, Mayer RE, et al. Tri-level study of the causes of traffic accidents. Washington DC: National Highway Traffic Safety Administration, U.S. Department of Transportation, 1977. DOT Publication No. 805 085.

76. MacLaughlin TF, Kessler JW. Pedestrian head impact against the central hood of motor vehicles: test procedure and results. In: Proceedings of the 34th Stapp Car Crash Conference. Warrendale PA: Society of Automotive Engineers, Publication No. P-236, SAE 902315, 1990.

77. Viano DC, King AI, Melvin JW, Weber K. Injury biomechanics research: an essential element in the prevention of trauma. J Biomechanics 1989;22:403-17.

78. Horsch JD. Evaluation of occupant protection from responses measured in laboratory tests. Warrendale PA: Society of Automotive Engineers, 1987. Paper No.870222.

79. Transportation Research Board. Safety belts, airbags, and child restraints. Washington DC: National Research Council, 1989. Special Report #224.

80. Rosenberg ML, Tolsma DD, Kolbe IJ, Kroger F, Cynamon ML, Bowen GS. The facts: lessons learned from the United States. In: Sepulveda J, Fineberg H, Mann J, editors. AIDS education and communication. New York: Oxford University Press, 1991.

81. Sleet DA. Reducing motor vehicle trauma through health promotion programming. Health Educ Q 1984;11:113-25.

82. Sleet DA. Health education approaches to motor vehicle injury prevention. Public Health Rep 1987;102:606-7.

83. Sleet DA. Motor vehicle trauma and safety belt use in the context of public health priorities. J Trauma 1987; 27:695-702.

84. Jonah BA. Preventing road accident casualities: integrating two solitudes. Health Educ Res 1990;5:109-10.

85. Mason JO, Tolsma DD. Personal health promotion. West J Med 1984;141:772-6.

86. Centers for Disease Control. Drinking and driving and binge drinking in selected states, 1982 and 1985 - the behavioral risk factor surveys. MMWR 1987;35:788-91.

87. Howland J. Social norms and drunk driving countermeasures. In: Graham JD, editor. Preventing automobile injury: new findings from evaluation research. Dover MA: Auburn House, 1988.

88. Saltz RG. Research needs and opportunities in server intervention programs. Health Educ Q 1989;16:429-38.

89. Andersen JA, McLellan BA, Pagliarello G, Nelson WR. The relative influence of alcohol and seatbelt usage on the severity of injury from motor vehicle crashes. J Trauma 1990;30:415-7.

90. Sleet DA, Wagenaar AC, Waller PF. Introduction: drinking, driving, and health promotion. Health Ed Q 1989;16:329-33.

91. Pitt R, Guyer B, Hsieh C-C, Malek M. The severity of pedestrian injury in children: an analysis of the pedestrian injury causation study. Accid Anal Prev 1990;22:549-59.

92. Malenfant L, Van Houten R. Increasing the percentage of drivers yielding to pedestrians in three Canadian cities with a multifaceted safety program. Health Educ Res, 1990;5:275-80.

93. Williams AF, Carsten O. Driver age and crash involvement. Am J Public Health 1989;73:326-7.

94. National Highway Traffic Safety Administration. Conference on research and development needed to improve safety and mobility of older drivers. Washington DC: U.S. Department of Transportation, 1989.

95. Agran PF, Dunkle DE. A comparison of police accident reports versus hospital monitoring systems in the study of noncrash events. In: 27th Proceedings of the American Association for Automotive Medicine. Arlington Heights, IL: American Association for Automotive Medicine, 1983.

96. Education Development Center. E codes: the missing link in injury prevention. Newton, MA: Education Development Center, [undated].

97. Haight FA. Induced exposure. Accid Anal Prev 1973; 5:111-26.

98. National Safe Kids Campaign. Mandating E codes on hospital discharge summaries. Leadership Q 1990;1:3-8.

99. Sniezek JE, Finklea JF, Graitcer PL. Injury coding and hospital discharge data. JAMA 1989;262:2270-2.

100. National Highway Traffic Safety Administration. Driver performance data book. Washington DC: U.S. Department of Transportation, 1987.

101. General Motors Research Laboratories. Side impact protection: GM tackles the next safety frontier. SEARCH 1989;24(3):1-8.

102. Ampofo-Boateng K, Thomson JA. Child pedestrian accidents: a case for preventive medicine. Health Educ Res 1990;5:265-74.

103. Transportation Research Board. Safety research for a changing highway environment. Washington DC: National Research Council, 1990. Special Report #229.

104. Committee on Trauma Research, Commission on Life Sciences, National Research Council, and the Institute of Medicine. Injury in America: a continuing public health problem. Washington DC: National Academy Press, 1985.

105. National Committee for Injury Prevention and Control. Injury prevention: meeting the challenge. Washington, DC: National Academy of Sciences, 1989.

106. Chorba TL, Vinicor F. Enactment of mandatory seatbelt-use legislation: an analysis of the political process in North Carolina. N C Med J 1990;51:599-607.

107. National Highway Traffic Safety Administration. State legislative fact sheets, 1990. Washington DC: U.S. Department of Transportation, 1991.

108. National Highway Traffic Safety Administration. Moving America safely: NHTSA priority plan for the implementation of proven interventions, 1990-1992. Washington DC: U.S. Department of Transportation, 1991.

109. Federal Highway Administration. Effective highway accident countermeasures action plan. Washington DC: U.S. Department of Transportation, 1991.

110. National Highway Traffic Safety Administration. Research and development program plan, 1992-1996. Washington DC: U.S. Department of Transportation,1990.

111. Viano DC. A blueprint for injury control in the United States. Public Health Rep 1990;105:329-33.

112. Williams AF. Observed child restraint use in automobiles. Am J Dis Child 1976;130:1311.

113. Liebermann HM. Pediatric automobile restraints: pediatrics and the academy. Pediatrics 1976;58:316.

Appendix A:
Healthy People 2000:
Health Objectives for the Nation
Excerpt: Objectives Concerning Motor Vehicle Injuries

Appendix A: Healthy People 2000: Health Objectives for the Nation Excerpt: Objectives Concerning Motor Vehicle Injuries

9.3	Reduce deaths caused by motor vehicle crashes to no more than 1.9 per 100 million vehicle miles traveled and 16.8 per 100,000 people. (Baseline: 2.4 per 100 million vehicle miles traveled (VMT) and 18.8 per 100,000 people (age adjusted) in 1987)
9.9	Reduce nonfatal head injuries so that hospitalizations for this condition are no more than 106 per 100,000 people. (Baseline: 125 per 100,000 in 1988)
9.10	Reduce nonfatal spinal cord injuries so that hospitalizations for this condition are no more than 5 per 100,000 people. (Baseline: 5.9 per 100,000 in 1988)
9.11	Reduce the incidence of secondary disabilities associated with injuries of the head and spinal cord to no more than 16 and 2.6 per 100,000 people, respectively. (Baseline: 20 per 100,000 for serious head injuries and 3.2 per 100,000 for spinal cord injuries in 1986)
9.12	Increase use of occupant protection systems, such as safety belts, inflatable safety restraints, and child safety seats, to at least 85 percent of motor vehicle occupants. (Baseline: 42 percent in 1988)
9.13	Increase use of helmets to at least 80 percent of motorcyclists and at least 50 percent of bicyclists. (Baseline: 60 percent of motorcyclists in 1988 and an estimated 8 percent of bicyclists in 1984)
9.14	Extend to 50 states laws requiring safety belt and motorcycle helmet use for all ages. (Baseline: 33 States and the District of Columbia in 1989 for automobiles; 22 States, the District of Columbia, and Puerto Rico for motorcycles)
9.20	Increase to at least 30 the number of states that have design standards for signs, signals, markings, lighting, and other characteristics of the roadway environment to improve the visual stimuli and protect the safety of older drivers and pedestrians. (Baseline data available in 1992)
4.1	Reduce deaths caused by alcohol-related motor vehicle crashes to no more than 8.5 per 100,000 people. (Age-adjusted baseline: 9.8 per 100,000 in 1987)
4.8	Reduce alcohol consumption by people aged 14 and older to an annual average of no more than 2 gallons of ethanol per person. (Baseline: 2.54 gallons of ethanol in 1987)

4.15	Extend to 50 states administrative driver's license suspension/revocation laws or programs of equal effectiveness for people determined to have been driving under the influence of intoxicants. (Baseline: 28 states and the District of Columbia in 1990)
4.16	Increase to 50 the number of states that have enacted and enforce policies, beyond those in existence in 1989, to reduce access to alcoholic beverages by minors.
4.17	Increase to at least 20 the number of states that have enacted statutes to restrict promotion of alcoholic beverages that is focused principally on young audiences. (Baseline data available in 1992)
4.18	Extend to 50 states legal blood alcohol concentration tolerance levels of .04 percent for motor vehicle drivers aged 21 and older and .00 percent for those younger than age 21. (Baseline: 0 states in 1990)

Appendix B:
List of Documents with Recommendations Relevant to Motor Vehicle Injury Prevention

Appendix B: List of Documents with Recommendations Relevant to Motor Vehicle Injury Prevention

American Association of State Highway and Transportation Officials (AASHTO), Standing Committee on Highway Traffic Safety. Highway Safety Strategic Plan, 1991-2000. McLean VA: AASHTO, 1990.

Committee on Trauma Research. Injury in America: a continuing public health problem. Washington DC: National Academy Press, 1985.

Federal Highway Administration. Action plan: effective highway accident countermeasures. Washington DC: U.S. Department of Transportation, 1990.

Federal Highway Administration, Office of Highway Safety. The 1990 annual report on highway safety improvement programs: report of the Secretary of Transportation to the U.S. Congress. Washington DC: U.S. Department of Transportation, 1990.

Federal Highway Administration, Offices of Highway Safety and Highway Information Management. Highway safety performance - 1988: fatal and injury accident rates on public roads in the United States. Washington DC: U.S. Department of Transportation, 1990.

National Safety Council. Commitment to action: conclusions and recommendations of the Highway Safety Forum on Older Drivers and Pedestrians and Younger Drivers. Chicago IL: National Safety Council, 1989.

National Highway Traffic Safety Administration. Consensus report on impaired driving. Washington DC: U.S. Department of Transportation, 1988.

National Highway Traffic Safety Administration (NHTSA) and National Association of Governor's Highway Safety Representatives (NAGHSR). Summary of proceedings of the National Occupant Protection Conference. Washington DC: NHTSA, NAGHSR, 1990.

National Highway Traffic Safety Administration. Proceedings of the conference on research and development needed to improve safety and mobility of older drivers. Washington DC: U.S. Department of Transportation, 1989.

National Highway Traffic Safety Administration. Child passenger safety plan. Washington DC: U.S. Department of Transportation, 1989.

National Highway Traffic Safety Administration. Moving America safely: NHTSA's priority plan, 1990-92. Washington DC: U.S. Department of Transportation, 1991.

National Highway Traffic Safety Administration. Heavy truck safety study. Washington DC: U.S. Department of Transportation, 1987.

National Highway Traffic Safety Administration. Safety program for light trucks and sports utility vehicles. Washington DC: U.S. Department of Transportation, 1990.

National Highway Traffic Safety Administration. Research and development (R&D) program plan, 1992-1996. Washington DC: U.S. Department of Transportation, 1990.

National Highway Traffic Safety Administration. Young adult highway safety plan. Washington DC: U.S. Department of Transportation, 1990.

National Highway Traffic Safety Administration. Traffic safety plan for older persons. Washington DC: U.S. Department of Transportation, 1988.

National Highway Traffic Safety Administration. Highway safety program advisories. Washington DC: U.S. Department of Transportation, 1991.

National Highway Traffic Safety Administration. Highway safety: moving America into the 21st Century. Washington DC: U.S. Department of Transportation, 1990.

National Highway Traffic Safety Administration. State legislative fact sheets. Washington DC: U.S. Department of Transportation, 1990.

Rice DP, MacKenzie EJ and Associates. Cost of injury in the United States: a report to Congress. San Francisco, CA: Institute for Health and Aging, University of California, and Injury Prevention Center, The Johns Hopkins University, 1989.

Transportation Research Board. Transportation in an aging society. Washington DC: Transportation Research Board, 1988.

Transportation Research Board. Safety research for a changing highway environment: Strategic Transportation Research Study: Highway Safety. Special Report 229. Washington DC: Transportation Research Board, 1990.

Trinca GW, Johnston IR, Campbell BJ, Haight F, Knight P, Mackay M, et al. Reducing traffic injury: a global challenge. Melbourne, Australia: A.H. Massina & Co., 1988.

U.S. Department of Transportation. Traffic safety summit: summary of proceedings. Washington DC: U.S. Department of Transportation, 1990.

Public Health Service. Surgeon General's workshop on drunk driving. Washington DC: Office of the Surgeon General, 1988.

U.S. Department of Transportation. Moving America: new directions, new opportunities: a statement of national transportation policy and strategies for action. Washington DC: U.S. Department of Transportation, 1990.

Viano DC. A blueprint for injury control in the United States. Public Health Rep 1990; 105:329-33.

Prevention of Violence and Injuries Due to Violence

Prevention of Violence and Injuries Due to Violence — Contributors—

Felton (Tony) Earls, M.D., Chairperson, Harvard School of Public Health,Cambridge, MA

Ronald G. Slaby, Ph.D.,* Background Paper (Interpersonal Violence), Education Development Center, Newton, MA, Harvard University, Cambridge, MA.

Anthony Spirito, Ph.D.,* Background Paper (Suicide), Rhode Island Hospital, Providence, RI

Linda E. Saltzman, Ph.D., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Timothy N. Thornton, Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Alan Berman, Ph.D., Washington Psychological Center, Washington, DC

Lucy Davidson, M.D., Emory University School of Medicine, Atlanta, GA

Jeffrey Fagan, Ph.D., Rutgers University, Newark, NJ

Andy Goodman, M.D., M.P.H., New York City Department of Health, New York, NY

Darnell Hawkins, Ph.D., J.D., Black Studies Program, University of Illinois at Chicago, Chicago, IL

Jess F. Kraus, Ph.D., M.P.H., U.C.L.A. School of Public Health, Los Angeles, CA

Colin Loftin, Ph.D., University of Maryland, College Park, MD

Eve Moscicki, Sc.D., M.P.H, National Institute of Mental Health, Rockville, MD

Peter Muehrer, Ph.D., National Institute of Mental Health, Rockville, MD

Patrick O'Carroll, M.D., M.P.H., Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Howard Sudak, M.D., Case Western Reserve University, Cleveland, OH

Christy Visher, Ph.D., National Institute of Justice, Washington, DC

*Coauthor of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Cathy Spatz Widom, Ph.D., Indiana University, Bloomington, IN

Garen Wintemute, M.D., M.P.H., University of California at Davis School of Medicine, Sacramento, CA

Katie Baer, M.P.H., Macro International, Inc., Atlanta, GA

Introduction and Overview

The health impact of self-directed and interpersonal violence in the United States is staggering, and the need for action to address this problem has never been greater. This paper presents an agenda for reducing injuries and deaths due to interpersonal violence and suicidal behavior.

Here we briefly review the dimensions of the health problem due to self-directed and interpersonal violence, discuss the complexity of the etiology of injuries due to violence, and review the potential for progress by applying public health perspectives and principles to the prevention of intentional injuries. Finally, we present the areas of emphasis that the panel chose for its prevention agenda and describe the structure of the main body of this paper.

Unfortunately, no entirely acceptable or accepted terminology exists for this class of injuries. Injuries from self-directed and interpersonal violence have been called "intentional injuries," to distinguish them from "unintentional injuries," such as drowning or injuries resulting from unintended motor vehicle crashes, falls, and the like. This term is problematic, however, because injuries can result from behavior that is unquestionably violent — such as shaking an infant who will not stop crying — but that is not based on any **intent** to cause injury, per se. On the other hand, the "shaken baby syndrome" clearly is not an "unintentional injury" in the same sense as injuries resulting from a motor vehicle crash. The terms "violent injuries" and "injuries due to violence" have also been used, but for some people these terms connote all traumatic deaths (intentional or otherwise), whereas for others, the word "violence" connotes only interpersonal violence, not suicidal behavior.

We will not resolve this issue here. For our purposes, we use the terms "intentional injuries," "violent injuries," and "injuries due to violence" interchangeably to indicate injuries due to interpersonal violence and suicidal behavior. We use the term "violence" to refer to behaviors — both self-directed and interpersonal — that can result in suicide, homicide, and nonfatal intentional injuries.

Dimensions of the Problem

As a result of the daily barrage of news stories about homicide and suicide, most people are all too aware of the very high levels of violent injury and death in our society. The panel believes that the failure to comprehensively undertake intentional injury prevention has more to do with the absence of a clear agenda for action than with a failure to appreciate the magnitude of the problem. For these reasons, in this introduction, we only briefly review

the magnitude and patterns of violent injury. Specific information on the magnitude of particular types of violence is presented, where relevant, in the main body of this paper. A more in-depth presentation of other background data is found in Appendix A.

Interpersonal Violence

Interpersonal violence is a major public health problem in the United States. Homicide is the 12th leading cause of death in the United States, accounting for 22,032 deaths in 1988 (1), and it is the 6th leading cause of premature mortality (i.e., years of potential life lost (YPLL) before age 65) (2).

Interpersonal violence is a distinctive and disturbing aspect of American society. A recent comparison of the international rates of homicide among males 15 to 24 years of age in 21 developed countries showed that the U.S. homicide rate is not only the highest among all industrialized countries, it is also 4.4 times higher than that of the next highest country (Scotland) and many times higher than the rates in other developed countries (3) (Figure 1).

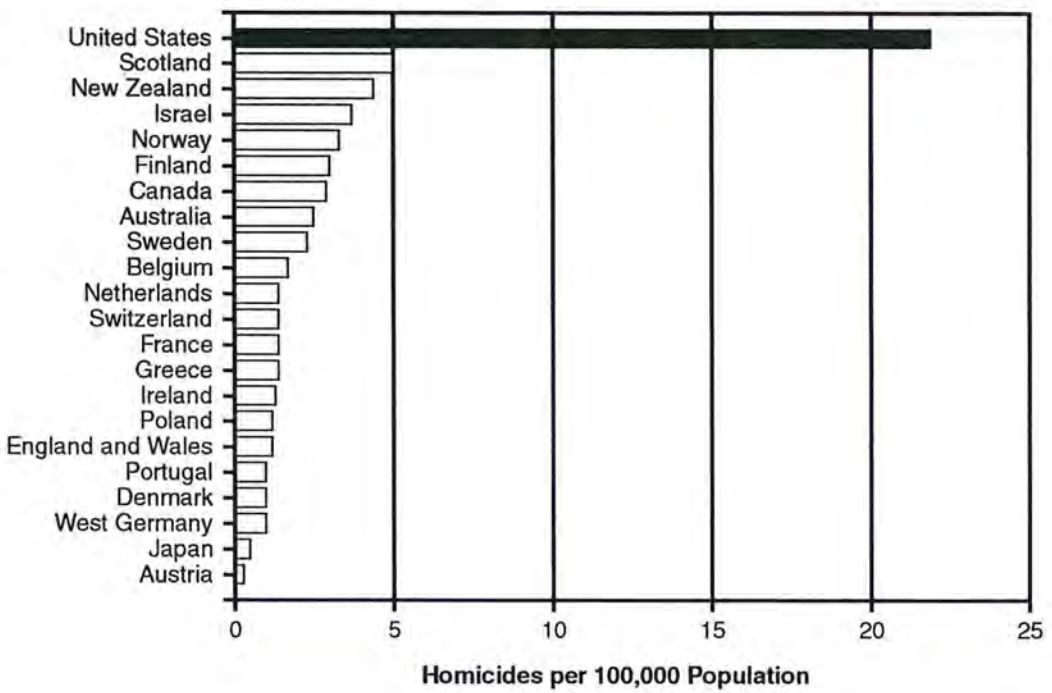
Child abuse and neglect is an important cause of morbidity among infants and young children. In 1986, an estimated 1.6 million children experienced some form of abuse and neglect, and an estimated 160,000 were seriously injured or impaired (4, 5).

Blacks and other minorities are at particularly high risk of injury and death due to interpersonal violence. Black males are more than seven times more likely than white males to die from homicide (6). Homicide rates are particularly high for young black men, among whom rates have sharply increased in recent years (Figure 2) (7). The rate of spouse homicide among black couples is 8.4 times higher than that among white couples (8). Although national reporting of homicide by ethnicity is incomplete, the homicide rate for Hispanics from five southwestern states for 1977 to 1982 was nearly three times that for non-Hispanic whites (9). A major factor that accounts for much of the excess rates of homicide among blacks and Hispanics appears to be the poverty that characterizes many black and Hispanic communities in the United States (10-13).

Although males are at much higher overall risk of injury and death due to interpersonal violence than females, females are at much higher risk of nonfatal injuries due to rape, child sexual abuse, and assaults by intimate partners. Acts of physical aggression between spouses occur in one of six homes each year (14, 15). Of these incidents, more than one in three are severe assaults involving such acts as punching, kicking, hitting with an object, beating up, and assaults with a gun or a knife. About two-thirds of those reporting at least one incident of marital violence in national surveys also report that multiple incidents of such violence occurred in the year preceding the survey.

Figure 1

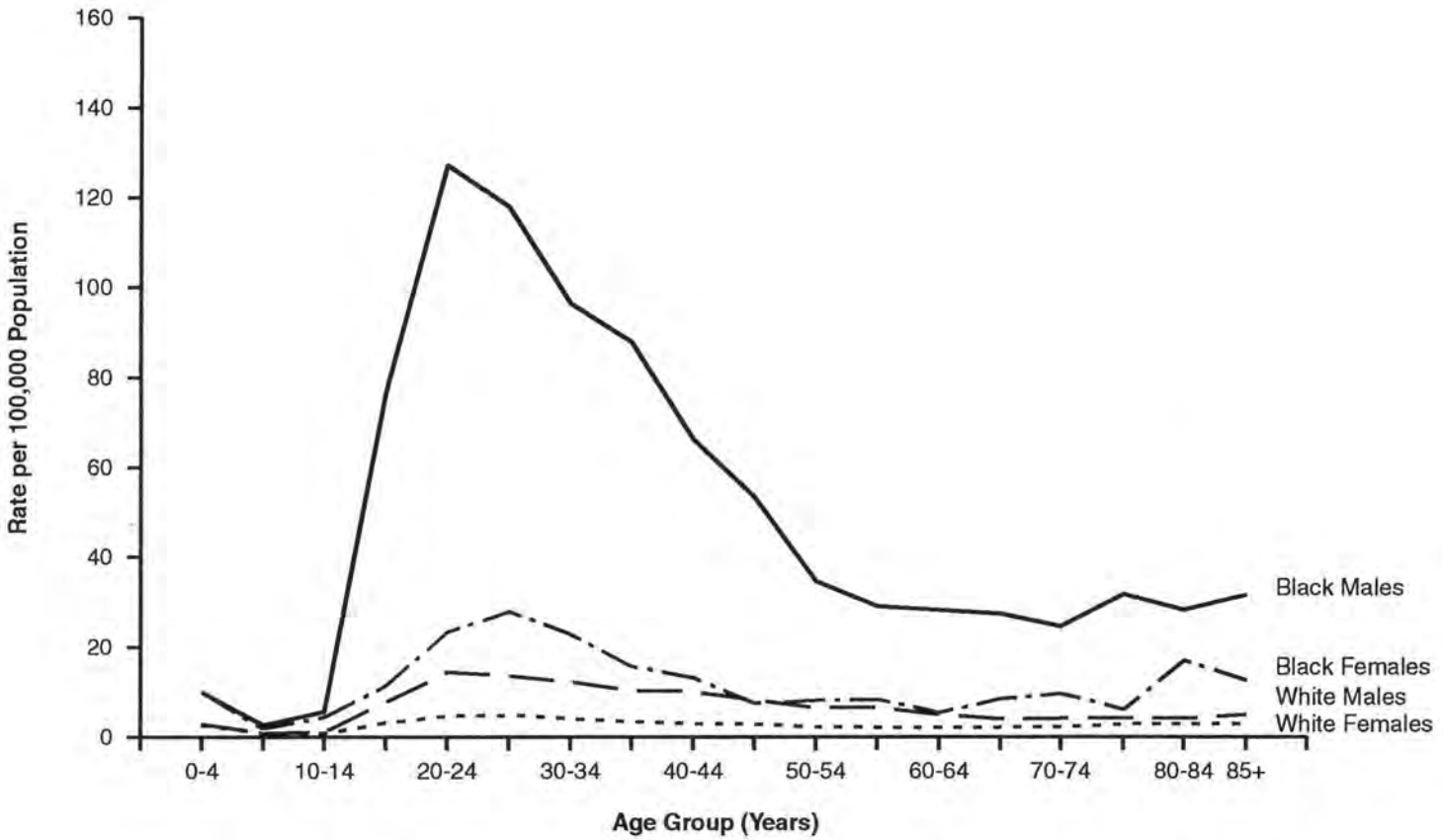
Variation in International Homicide Rates for Males 15 through 24 Years of Age in 1986 or 1987



Data sources: National Center for Health Statistics, World Health Organization, and country reports.

Figure 2

U.S. Homicide Rates By Age Group, Race, and Sex, 1988



Data Source: National Center for Health Statistics

Suicide and Attempted Suicide

Suicide is the eighth leading cause of death in the United States. About 20% of all deaths due to injury are suicides (16). In 1988, 30,407 persons committed suicide in the United States (1). The corresponding age-adjusted suicide rate in 1988 was 11.4/100,000, down from 11.7/100,000 in 1979 (1). However, since 1950, rates of suicide among young people (15 to 24 years of age) have virtually tripled, and suicide is now the third leading cause of death for this age group (1). Among the elderly, after several decades of declining rates of suicide, rates have been increasing since 1979.

Suicide rates are higher for males than for females across all age groups (Figure 3). Suicide rates are generally higher for whites than for blacks, although the disparity between white and black rates is not nearly as pronounced for suicide as for homicide. In recent years, the relative differences between suicide rates for white and black males have narrowed somewhat because of increases in the rate among black males. Overall, American Indians have consistently higher suicide rates than the total U.S. population (17); certain tribes have particularly high rates (18).

Suicide attempters have been studied to advance our understanding of completed suicide, but suicide attempts should also be viewed as a significant injury problem in their own right. The lifetime prevalence estimates for self-reported attempted suicide among adults vary from 1.1% to 4.2%; as many as 3 of every 1,000 adults surveyed report having attempted suicide in the preceding year (19).

Multiple, Complex Causes of Violence: Implications for Prevention

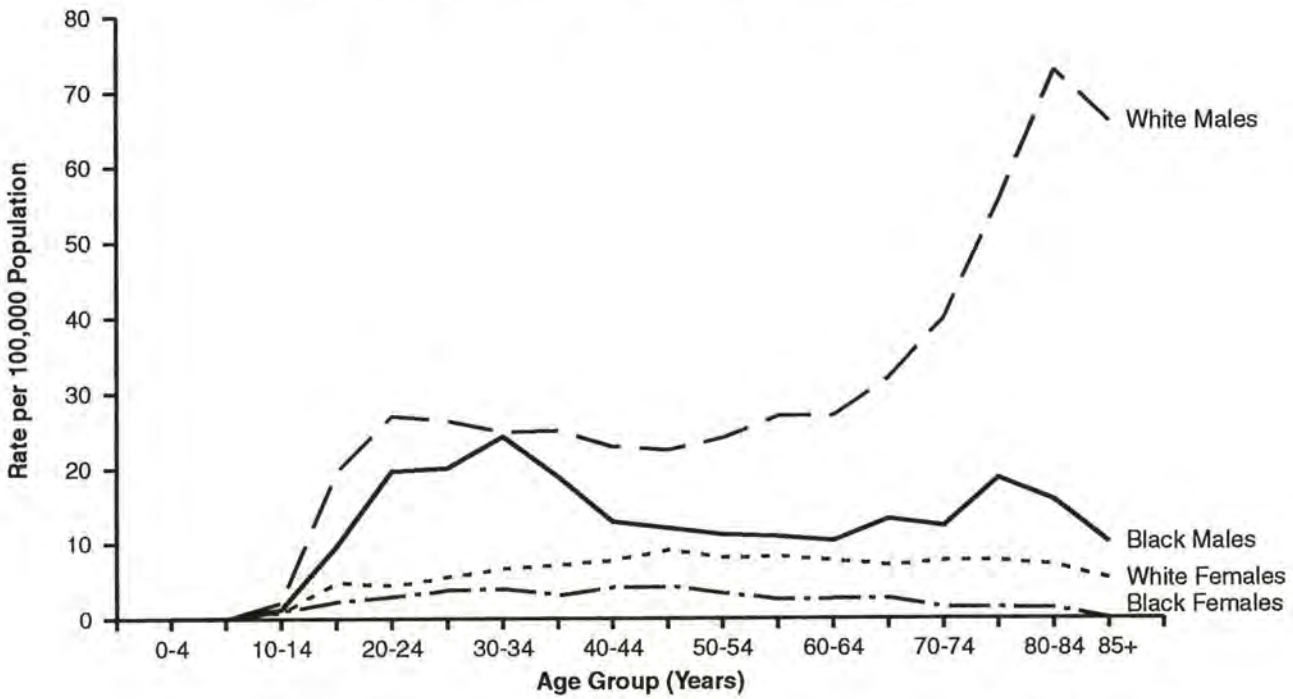
Most people will grant that the causes of violence and violent injuries probably differ across the various contexts in which violence occurs (e.g., wife beating, attempted suicide, physical fighting among acquaintances, and physical child abuse). Even within a single, seemingly homogeneous context, however, the causal mechanisms leading to injury are many and complex.

For example, consider the case of a young man killed in a drive-by shooting in the context of gang violence. Calls for increased efforts to suppress gangs or to apprehend and punish those who commit such violence often follow such tragedies. Implicit in this reaction is the assumption that such tragedies occur because gangs are not being sufficiently suppressed or that current punishments are not sure enough or severe enough to deter such violence.

Many other factors, however, are involved in the causal chain leading to that young man's being killed in that place in that way. In no particular order of importance, these other factors might include the following: ready access of the perpetrators to highly lethal weapons; the demand for crack or other addicting drugs among those living in that area; the

Figure 3

U.S. Suicide Rates By Age Group, Race, and Sex, 1988



Data Source: National Center for Health Statistics

illicit trafficking in such drugs by gang members; the lack of alternative ways for gang members to develop self-esteem or a sense of belonging; the lack of opportunities for jobs that might build the self-esteem of vulnerable adolescents, help them resist the lure of drugs, or at least give them the means to move away from highly violent neighborhoods; a culture that glorifies violence as a means of attaining desired ends; childhood experiences among the perpetrators of the killing that contribute to the adoption of violence and aggression as an appropriate behavior pattern; and the dearth of useful information and guidance for community members about controlling gang violence.

The complexity of the causes of violence and violent injuries has several important implications. First, it implies that no single, comprehensive solution will prevent all violence or even all incidents of a certain type of violence. In the example just cited, increasing police efforts to suppress gangs might contribute to the prevention of gang violence in the short term. But such efforts will not prevent all gang violence, as long as the other contributing causes that we mentioned are not addressed. Those who seek to identify the one "real" cause of a particular type of violence (in order to design the one, comprehensively effective preventive intervention) will inevitably be disappointed, since no single factor is a necessary component in the etiology of all injuries due to violence.

This dilemma has an encouraging flip side: because the causes of violent injuries are complex and multifaceted, there are multiple points in the causal chain where preventive interventions could be applied. Having recognized that no single type of intervention is likely to be universally effective, we can turn our attention to a much more appropriate question: Which **combination** of the many potential interventions is likely to be most effective (as well as feasible) in preventing violent injuries? This question can be broken down into a series of more specific questions: Which points in the causal chain are particularly vulnerable to interruption? Which interventions are likely to contribute to the prevention of a large proportion of a given type of violent injury? Which are likely to be effective across different types of violent injuries? What sorts of interventions will result in immediate reductions in such injuries? In long-term reductions? Which of the potential interventions are feasible and most readily adopted? Finally, what are the costs of the various promising interventions, relative to their likely effectiveness? These are the questions we asked ourselves in preparing the recommendations in this paper.

The risk of violent injuries, particularly from interpersonal violence, has been clearly associated with certain large-scale social problems such as poverty, racism, sexism, unemployment, and a lack of educational opportunities. We join those who state that, in the long-term, progress toward reducing these social ills would result in substantial reductions in the burden of violent injuries in this society. For this reason, and many others, these social issues should be addressed. Given the many potential points of opportunity for preventing violence, however, coupled with the need for immediate action to reduce current levels of violent injuries and deaths, we need not — and should not — wait to take action until we have solved these large-scale social problems. We must address these social ills at the same

time that we take whatever immediate actions are possible to prevent further injuries and deaths due to violence.

In this paper, we have largely focused on factors that are both clearly linked with the risk of injury and death due to violence and that are also apparently amenable to preventive efforts or public health action in the near term. We have made every effort to incorporate into our recommendations the recognition that certain populations (e.g., minorities or females beaten by husbands or intimate partners) are in particular need of prevention resources, and we believe that all of our recommendations (if adopted) will contribute to the prevention of injuries due to violence among these high-risk populations. Although poverty, racism, and other large-scale social problems are certainly important contributors to violence, we have not made recommendations for addressing these social ills in this paper.

Potential for Progress Through the Public Health Approach

Many people from several professional disciplines have worked for years to prevent suicide, homicide, and nonfatal injuries due to violence. Public health professionals have only recently joined this effort. Because suicide rates are vastly higher among persons with mental disorders than among the general population, mental health practitioners have worked for many years to prevent suicide by diagnosing depression, alcoholism, schizophrenia, and other mental disorders and by treating persons with these conditions. This clinical approach has been our society's main strategy for preventing suicide, and it continues to be a centrally important strategy. Similarly, criminologists and criminal justice professionals have long explored the possibilities of preventing homicide and other interpersonal assaults through such mechanisms as incarcerating and rehabilitating offenders and deterring future violence by increasing the perceived threat of punishment. As with the clinically oriented approach to suicide prevention, this criminal justice approach remains an important mainstay of our society's efforts to prevent interpersonal violence.

The most important new perspective that the field of public health brings to this issue is a focus, from the very outset, on the outcome of interest — in this case, reducing the morbidity and mortality due to violence — rather than on any particular method or discipline for achieving that outcome. This emphasis on measurable outcomes is reflected in the Year 2000 Objectives (Appendix B). By focusing on the outcome of interest first, public health practitioners are free to consider preventive actions across whatever disciplines and domains that might reasonably be expected to contribute to the effort. These disciplines would include, of course, mental health, criminology, and criminal justice. But we need not be constrained to working only with the tools and methods of mental health and criminal justice, if actions within other domains might help prevent injuries due to violence.

Another important perspective that derives from the public health focus on health outcomes is an emphasis on **action**. The Year 2000 Objectives, for example, are meant to help state

and local health departments set priorities and direct their actions to reduce morbidity and mortality. The effectiveness of their prevention efforts is measured in terms of progress toward these health objectives; lack of progress should mean (at least, theoretically) that efforts would be amplified or modified, or, where appropriate, new action would be taken. Health departments, however, have been slow to take action in addressing health objectives related to the prevention of suicide, homicide, and nonfatal injuries due to violence. One important reason for this lack of action is that, despite clear health objectives, until now no agenda has been set to guide the actions of public health professionals. This paper is meant, in part, to address that deficiency.

The relatively recent involvement of public health in the prevention of intentional injuries already appears to have yielded some tangible benefits. For example, the resurgence of interest in the prevention of firearm injuries is due, in part, to the greater visibility that public health officials have brought to the enormous health consequences of firearm injuries (20, 21). State and local health departments are increasingly mobilizing to prevent injuries due to violence. And guidelines for preventing certain types of intentional injuries have been published (22) or will soon be published (23). These guidelines are based on current scientific evidence and real-world practical experience.

Major Topics of Emphasis

The panel was charged with developing an agenda for the prevention of all categories of intentional injuries. Rather than recommending steps to prevent specific types of intentional injury (e.g., from wife abuse, suicide, child abuse, or acquaintance violence), we sought to develop a largely cross-cutting set of high-priority recommendations relevant to the prevention of both self-directed and interpersonal violence.

We recognize that, in taking this broad, cross-cutting approach, we might have missed or underemphasized issues and opportunities for prevention that are specific to a particular type of intentional injury. Certainly, there are issues related to suicide prevention that are not relevant to the prevention of interpersonal injuries, and vice versa. We believed, however, that an integrated, comprehensive agenda for preventing intentional injuries was needed most at this stage in the development of the larger field of injury control. We also believed that such an agenda could serve as the foundation upon which other recommendations specific to the prevention of particular injuries could be built. We hope that those interested in preventing certain types of intentional injury will adapt and expand upon our recommendations, as appropriate.

We structured our recommendations around a major area of emphasis — the need for a coordinated approach and structure for planning and implementing a comprehensive violence prevention effort — and four special areas of emphasis: (a) injuries from firearm violence, (b) alcohol and other drug (AOD) use and violence, (c) early childhood

experiences that affect the risk of future violent behavior or victimization, and (d) treatable mental disorders associated with an increased risk of suicide. In the next chapter, we explain the importance of each of these emphasis areas to the prevention of intentional injuries, review where we are now with regard to each area, suggest general directions in which to proceed, and recommend specific steps that, cumulatively, create a concrete, prioritized agenda for preventing injuries due to self-directed or interpersonal violence.

An Agenda for Violence Prevention: Where We Are, Where We Want To Be, and How We Get There

In this chapter, we present our recommendations for preventing suicide and homicide, as well as their nonfatal injurious counterparts, suicide attempts and injuries from assaults. We discuss each area of emphasis in three sections: first, we review current knowledge and programs and lay out a rationale for the panel's selection of these emphasis areas ("Where We Are"); next, we discuss the general directions in which the Nation ought to proceed ("Where We Want To Be"); and, finally, we make recommendations designed to decrease morbidity and mortality due to violence ("How We Get There").

An Infrastructure for Preventing Injuries and Deaths Due to Violence

As noted previously, various disciplines have made, and continue to make, substantial contributions to the understanding of violent injuries and deaths. However, despite the enormous health toll due to self-directed and interpersonal violence in the United States, there has been — until recently — no discipline or body of professionals which has *as its primary mission* the reduction of injuries and deaths due to violence. Consequently, there exists no coordinated structure for planning and implementing a comprehensive violence prevention effort. Current violence prevention measures are a patchwork effort at best, with many important opportunities for prevention left unaddressed and no infrastructure through which to address these prevention gaps.

A more comprehensive approach to and structure for violence prevention would be composed of at least five essential components:

- **Targeting prevention resources toward those at high risk.** Because resources for violence prevention are limited and the need among certain high-risk populations is dire, channelling prevention resources efficiently to those in greatest need is essential.
- **Surveillance.** Public health surveillance of injuries due to self-directed or interpersonal violence is of central importance to health planning, risk-factor research, and program evaluation. Yet such surveillance is limited in some important respects and practically nonexistent in others.
- **Empowering communities.** Preventing violent injuries ultimately depends on developing effective prevention programs at the community level. We need to make prevention resources, information, and experience available to communities in a way that empowers community leaders throughout the country to develop their own violence prevention programs.

- **Training.** Very few individuals have received training in all the various disciplines that relate to the prevention of injuries due to violence. If we are to address the prevention of violence more comprehensively, we must ensure that more people receive broader training.
- **Evaluation.** Although we know something of the risk factors for violence, we know much less than we would like to know about how to prevent or reduce violence. Determining the effectiveness of new and existing violence prevention programs is critical to a more comprehensive violence prevention effort.

Cumulatively, these five components constitute a general framework or infrastructure for carrying out a violence prevention agenda. The Healthy People 2000 Health Objectives (Appendix B, Objective 7.17) explicitly called for such a coordinated, comprehensive approach to violence prevention. This paper represents one step towards implementing that approach.

Targeting Prevention Resources Toward Those at High Risk

Where We Are

For many years, we have known that certain populations are at extraordinarily high risk of injury due to interpersonal or self-directed violence, but no mechanism is in place to ensure that existing violence prevention resources are targeted toward these high-risk populations. For example, it is well documented that blacks and Hispanics are at enormously higher risk of homicide than the majority white, non-Hispanic population (7, 9). American Indians in reservation states are also at high risk of death from both homicide and suicide (24). Yet, despite this disproportionate burden, there has been no systematic effort to target violence prevention resources toward minority communities.

Similarly, we know that severe husband-to-wife violence (wife-beating) occurs at an annual rate of about 30 per 1,000 married couples (25) and that persons who are victims of physical abuse by their spouses or intimates are at very high risk of future victimization (26). We also know that the use of standardized protocols in certain hospitals increases the accurate identification of victims of wife abuse*(27), and a specific Year 2000 health objective encourages the use of such protocols (Appendix B, Objective 7.12). Yet, despite the known, repetitive nature of violence between spouses and intimates, little is being done to ensure (a) that medical caregivers identify victims and refer them to appropriate counseling or other services and (b) that interventions are used to prevent the victims from being further abused.

*In this paper, "wife abuse" refers to physical abuse of women by their husbands, boyfriends, or other intimates.

In the same vein, suicide attempters are at an enormously increased risk of eventual suicide. In one study with 10 years of follow-up, researchers estimated that 1% to 2% of people who attempt suicide will actually commit suicide each year (28). The risk is especially high for people attempting suicide whose intent and method of attempted suicide most closely resemble those of people who commit suicide (29). Yet few hospitals make much effort to ensure that the suicide attempters they treat are properly identified and receive appropriate follow-up counseling or other treatment.

Health departments have traditionally focused their scarce prevention resources on high-risk populations. Examples include immunizing the elderly against influenza, tracing the contacts of persons with sexually transmitted diseases, and educating groups at high risk of acquired immunodeficiency syndrome (AIDS). Apart from publishing mortality statistics for homicide and suicide, however, health departments have been conspicuously inactive when it comes to the prevention of injuries and deaths due to violence.

In short, it is feasible to identify high-risk people (such as suicide attempters and wife-abuse victims) and communities with high rates of interpersonal violence. Yet, no concerted effort has been made to focus existing resources or target new resources toward such high-risk individuals and communities.

Where We Want To Be

We need to develop new prevention and intervention programs for groups at high risk of violence. These programs must address the specific needs, characteristics, circumstances, and cultural sensitivities of these groups.

Although various elements are necessary for a more comprehensive approach to violence prevention, the first step is to target existing prevention resources toward the individuals and populations at highest risk. When a person can be identified through an attribute that is known to increase the risk of violent injuries, resources can and should be specifically targeted to help that person. In many cases, however, we can only identify populations — rather than particular individuals — that are at increased risk of violent injury. In these cases, prevention resources must be made available to the entire high-risk population, rather than to particular individuals.

As noted, blacks and Hispanics in poor, urban settings are populations at extraordinarily high risk of homicide. Every effort must be made to channel homicide prevention programs and resources toward them, and to develop new, sustained prevention resources as needed. In particular, health departments in communities with high rates of interpersonal violence should devote new resources or reprogram existing resources to develop and maintain violence prevention programs. Close collaboration with community leaders, as well as with other interested agencies such as social services and law enforcement, is essential.

In developing programs to prevent injuries and deaths due to violence in high-risk communities, we must recognize that major reductions in the levels of violence are not likely to occur without addressing the problems of poverty, undereducation, chronic unemployment, unintended pregnancies, lack of personal options for change, poor physical and mental health, and lack of adequate social services. Ideally, violence prevention efforts should be combined with other efforts to improve the health and overall quality of life for people who suffer these problems.

We must also recognize the need to develop violence prevention and intervention programs that are culturally appropriate and designed to address the needs, characteristics, and circumstances of high-risk groups. The Forum on Youth Violence in Minority Communities: Setting the Agenda for Prevention that was held in Atlanta, Georgia, on December 10-12, 1990, provided a model approach. At this forum, 110 participants from public health, criminal justice, and social services, and from academia and minority communities across the country met to set an agenda for preventing youth violence in minority communities. The proceedings from that conference provide a framework for the thoughtful development of violence prevention efforts in minority communities with high rates of interpersonal violence (23).

Examples of populations at particularly high risk for suicide include the very elderly (30), certain Native Alaskan and American Indian tribes (17), and recently incarcerated persons (31). Suicide prevention efforts for these populations must be improved. For example, outreach programs might be targeted at substance abusers or persons with depression or other mental disorders within these high-risk populations in order to increase their referrals to mental health resources.

We need to improve the identification and referral of high-risk individuals to existing services and to develop new or expanded prevention or intervention services as necessary.

If individuals at high risk of violence could be identified, violence prevention measures could be applied more efficiently. One important opportunity for identifying persons at high risk of violent injury is at the point of medical or surgical treatment of those who have already suffered such injuries. Clearly, we must do much more than wait until people are victimized before we intervene. Nevertheless, persons with injuries due to attempted suicide, wife abuse, child abuse, and other forms of violence are treated by the thousands each day in hospital emergency departments throughout the Nation, and we must make a concerted effort to go well beyond the medical or surgical treatment of these injuries.

Caregivers must consistently seek to identify the circumstances surrounding the injury. To identify cases of intentional injury, the "index of suspicion" must be high enough that caregivers ask about the possibility of violence as a cause of the physical injuries they treat. Caregivers must also ensure that victims of violent injury are properly referred, so that victims get appropriate counseling or other services and are protected from the risk of future

violent injuries. Finally, in the case of interpersonal violence, caregivers should actively assist professionals in law enforcement, social work, child protective services, or other disciplines in their efforts to intervene with those who inflicted the injuries.

We need to ensure that state and local health departments become more involved in preventing violence, especially in communities with high rates of violent injury.

In recent years, a few state and local health departments have begun to explore ways to prevent violent injuries. They are considering such actions as conducting surveillance for certain intentional injuries, responding to apparent clusters of suicides, and collaborating with police departments to address gang violence. Such involvement in violence prevention by health departments remains, however, more the exception than the rule.

This lack of involvement is unfortunate, because health departments are in a good position to help coordinate existing services for high-risk individuals and to use new or reprogrammed resources to develop and target broader violence prevention efforts for high-risk groups. The field of injury control in general is becoming more widely accepted as being within the legitimate purview of health departments. Although the prevention of intentional injuries presents unique challenges, this aspect of injury control must not be left out of health departments' wider efforts to prevent injury morbidity and mortality.

How We Get There

Address the specific needs, characteristics, and circumstances of communities with high rates of violent injury by developing culturally appropriate violence prevention and intervention programs for them.

- Incorporate the recommendations for community-based violence prevention from the Forum on Youth Violence in Minority Communities: Setting the Agenda for Prevention (23).

  These recommendations include developing the following: (a) school-based programs, including conflict resolution training, comprehensive school health curricula, and school designs that minimize opportunities for violence; (b) community programs involving linkages among various service agencies, including media campaigns to publicize existing services and raise awareness, mentoring programs for both general and high-risk youths, and programs to create recreational and job opportunities for youths that will help them develop skills, self-esteem, and positive attitudes; (c) programs specifically designed for high-risk youths, including violent youths, gang members (and youths at risk for becoming gang members), youths from families with problems related to violence, and victims, relatives of victims, and witnesses to violence.

(Because these recommendations are published elsewhere, this list is not comprehensive. We encourage you to review the full list of recommendations in the published conference proceedings (23). We have incorporated other appropriate recommendations from the Forum in other sections of this paper.)

As called for in the Healthy People 2000 Health Objectives 7.12 and 7.14 (Appendix B), improve the recognition, referral, and treatment of individuals at high risk for violence (e.g., suicidal persons, victims of violence or neglect, or people who have previously threatened to commit a violent act).

- Initiate or expand training for primary caregivers to enhance their ability to identify high-risk individuals. Use standard protocols when possible. (See also "Training," page 184).
- Involve a wide range of professionals (e.g., clergy, public health nurses, school nurses, teachers, and counselors) in identifying and referring people at high risk.
- Increase clinic outreach services and referral systems for suicide attempters, to encourage attempters to receive appropriate, ongoing clinical treatment and to maximize their compliance with treatment regimens.
- Develop or strengthen systems of mutual referral (e.g., between school and mental health systems).

Expand and improve the coordination of existing services for high-risk individuals and develop, through new or reprogrammed resources, broader violence prevention efforts for high-risk groups.

- Encourage all state and local health departments with populations at high risk of violent injury to devote some portion of their prevention efforts and resources to preventing and controlling injury due to violence.
- Develop violence prevention guidelines for state and local health departments.
- At the national level, expand the Secretary's Advisory Committee on Injury Control to include representatives from public health, criminal justice, education, mental health, and social service agencies.
- Expand access to community services for victims of violence (e.g., shelters for battered women and mental health services for rape victims, suicide attempters, and child abuse victims).
- Expand community mental health services and increase outreach programs in communities with populations at high risk of suicide (e.g., certain American Indian reservations and communities with a large elderly population or with an apparent cluster of youth suicides).

Surveillance

Where We Are

Health event surveillance is the cornerstone of the public health approach to preventing any health problem. Researchers, policy makers, and program managers need surveillance data to (a) assess the magnitude and impact of death and injury due to violence, (b) determine the type and quantity of resources needed to respond to the problem, and (c) develop baseline information for evaluating the effectiveness of violence prevention programs and policies (32). Unfortunately, current public health surveillance methods for homicide and suicide are limited in certain important respects, whereas surveillance for nonfatal injuries due to self-directed and interpersonal violence is practically nonexistent.

National estimates of the number of fatalities due to homicide and suicide are collected by the National Center for Health Statistics (NCHS) and, for homicide only, by the Federal Bureau of Investigation (FBI). These data, however, have significant deficiencies. The NCHS data, which are based on information in death certificates, provide little information beyond the decendent's age, race, gender, and county of residence, and the county where the death occurred. Although racial classifications are commonly recorded, ethnic classifications are not consistently recorded, and socioeconomic status (SES) is not recorded at all. Beginning with 1989 death certificates, the educational level of the decedent is recorded.

Some weapon information can be derived from the International Classification of Diseases (ICD) codes, but reliably distinguishing between long guns and handguns is not possible (33). Data on the circumstances surrounding the event, on the victim-offender relationship, and on the offenders' characteristics are not collected by NCHS, although they are readily available at the local level. The FBI's Supplementary Homicide Report (SHR) has been used to complement death certificate data, since the SHR data include information on the circumstances of the homicide, the victim-offender relationship, and the offender's characteristics. Unfortunately, the SHR program suffers from systematic under-coverage (32), and some of the items do not meet minimum standards for valid measurements (34).

Many factors work against the valid and reliable certification of suicide on death certificates. These factors include inadequate information on which to make a determination of suicide as the cause of death, variable training and backgrounds of death certifiers, and certifier bias or error (35, 36).

National surveillance for nonfatal injuries due to interpersonal violence or attempted suicide is extremely limited. The newly implemented Youth Risk Behavior Surveillance System will provide minimal information about physical fighting, weapon carrying, and suicidal behavior among high school-aged adolescents. The National Crime Survey (NCS), a national household survey conducted by the Bureau of the Census for the Bureau of Justice Statistics, and the FBI's Uniform Crime Report (UCR) system provide estimates of the incidence of violent victimization (e.g., assaults, robberies, and rapes) and some information

about circumstances. Neither system provides detailed information on injuries, and both fail to cover significant aspects of violent injuries. The UCR covers only offenses known to the police. When FBI assault reports were compared with contemporaneous hospital records, nearly **four times** as many assaultive injuries were found documented in the hospital records (37). The NCS does not contain records of violence committed against persons who do not wish to report the incident to the interviewer. This is particularly a problem in the area of family violence, resulting in systematic underestimates of the prevalence of this problem (26). These various systems generally do not provide any local-level data, although such data might be of great use in evaluating preventive interventions.

Where We Want To Be

We need to modify existing surveillance tools so as to conduct intentional injury surveillance.

We need to institute surveillance for nonfatal injuries due to self-directed and interpersonal violence wherever possible. Certain existing general injury surveillance systems and trauma registries might be adapted for this purpose. For example, the National Electronic Injury Surveillance System (NEISS) might be modified to allow for surveillance of nonfatal firearm injuries; the feasibility of such a modification is being explored. Surveillance of fatal firearm injuries might appear straightforward, given that such deaths are coded correctly on death certificates. Unfortunately, death certificates lack a great deal of information that might be relevant to prevention, including the make and caliber of the firearm used and whether the gun was recently acquired. The Fatal Accident Reporting System (FARS), which provides extensive surveillance data related to fatal automobile crashes, might be a useful model. A system similar to FARS might be instituted in which all fatalities due to firearm injuries would be investigated and a data set of standard prevention-relevant elements compiled.

Another system that might be profitably modified is the Behavioral Risk Factor Survey (BRFS). Such a survey could provide, for example, data about gun ownership and acquisition patterns, data that might be critical to the scientific evaluation of state or local violence prevention efforts to reduce ready access to guns. The BRFS also might be modified to help monitor fighting behavior, attempted suicide, weapon carrying, or a variety of other nonfatal behaviors that increase the risk of violent injury. Reductions in such behaviors are called for in the Year 2000 Objectives (Appendix B, Objectives 7.8, 7.9, and 7.10), and the BRFS might be of great use in monitoring progress toward those objectives. Plans are now in place for adding questions on such risk behaviors to the National Health Interview Survey in 1992, and possibly once more before the year 2000. BRFS data about behaviors associated with increased risk of intentional injury would be particularly useful at the local level, where the incidence of health outcomes (such as death or serious injury) is often too low to be of use in evaluations of intervention efficacy. In smaller communities with violence prevention programs, BRFS data could be of enormous value in measuring intermediate indicators of progress.

Many in the field of injury control have called for universal use of external cause-of-injury codes (E-codes) in all hospital discharge records. E-codes were included in the International Classifications of Diseases to provide information about the external cause of injury and death (e.g., suicide, unintentional drowning), as opposed to the more common coding methods that cover physiologic, injury-specific information (e.g, laceration, asphyxiation). After a thorough and systematic review of the Uniform Hospital Discharge Data Set, the Subcommittee on Ambulatory and Hospital Care Statistics of the National Committee on Vital and Health Care Statistics formally recommended that E-codes be included in hospital discharge data sets. The subcommittee recognized that collecting E-code data had several impediments, but concluded that none were insurmountable.

Although E-codes have limitations with regard to intentional injuries, universal E-coding of hospital discharges would nevertheless provide an enormous amount of useful information at the local, as well as national, level.

We need to develop surveillance methods for certain types of intentional injury or violent behavior. In addition, we need to address specific questions of surveillance feasibility and to develop and test new surveillance methods.

The idea of modifying existing surveillance tools is appealing, but new surveillance systems might also be set up for a single type of intentional injury, such as injury due to family and intimate violence or attempted suicide. Such a single-focus approach can never be as useful as comprehensive injury surveillance, but it has several advantages. The surveillance of intentional injuries is by no means straightforward; there are challenging difficulties, for example, in devising workable case definitions and identifying victims who do not wish to be identified. By developing injury-specific surveillance systems, we may be able to systematically address these challenges and to evaluate the sensitivity, specificity, and other attributes of these new surveillance methods (Birkhead and colleagues, unpublished observations). Some communities may also want to consider developing an injury-specific surveillance system if a particular type of intentional injury (e.g., injuries related to gang violence) is especially prevalent.

How We Get There

Establish universal E-coding of all hospital discharges, as called for in the detailed recommendations of the National Committee on Vital and Health Care Statistics.

Modify state behavioral risk factor surveys or establish new surveys to collect relevant information on behaviors and environmental hazards associated with an increased risk of injury due to interpersonal and self-directed violence.

Continue efforts to determine the feasibility and utility of modifying the NEISS in order to collect information about firearm injuries from a representative sample of hospital emergency departments.

Explore the feasibility and utility of developing a FARS-like surveillance system for fatal firearm injuries.

Explore potential modifications to death certificates, or to the death certification process, that would enhance the usefulness of national mortality data for the surveillance of suicide and homicide.

Empowering Communities

Where We Are

Information about the prevention of injuries due to violence is scattered and not readily accessible. In addition, information about existing local suicide- or homicide-prevention programs has generally been disseminated inadequately — often because the information is not known to exist or because it is not available outside the community in which the programs were developed. This information gap and the absence of the broader paradigms for preventing violence discussed in this paper have contributed to a sense among many people living in affected communities that little can be done to prevent violence.

There are certainly examples of violence prevention efforts being developed by various concerned individuals and community groups. For example, in the face of increasing youth suicide rates during the last several decades, community leaders throughout the country have developed many innovative suicide prevention programs. Generally these programs were designed to increase referrals of high-risk persons to existing mental health services, to reduce known or suspected risk factors for youth suicide, or both. Similarly, in the face of high levels of gang violence, concerned members of several affected communities have developed programs to prevent and control gang violence. But as encouraging as such efforts are, much more needs to be done to facilitate similar efforts in communities across the country.

At present, no sustained, long-term funding is available for the development and evaluation of violence prevention programs in high-risk American communities. Some research and demonstration projects have been funded, but this level of support is clearly insufficient, given the magnitude of the problem.

Where We Want To Be

We need to provide information and guidance to community leaders about the development and evaluation of community-based violence prevention programs, as well as provide the necessary technical, financial, and other expertise to translate this information into culturally appropriate violence prevention programs.

Real reductions in the national level of deaths and injuries due to violence will depend on the development of effective violence prevention programs at the community level. Ultimately, all of our scientific research on the causes of violence and even the practical experience of community leaders who have developed local suicide, homicide, or other violence prevention programs are of little value if we do not widely disseminate this information and experience in a way that empowers communities throughout the country to develop and evaluate their own violence prevention programs.

Thus, we need to review and collate what has been learned from the experiences of others in violence prevention as well as our current scientific understanding of the causes of violence and violent injuries and the effectiveness of different violence prevention strategies. We need to effectively transmit this information to people in various levels of government and to those at the community level in a manner that is readily understood and that facilitates action. We also need to ensure that community leaders are provided with the appropriate expertise in program development and violence prevention at the proper time.

In addition to information and guidance about violence prevention, financial resources must be made available to communities so that they can develop prevention programs. Further, if we are to have any lasting impact on the burden of injuries and deaths from violence, these new financial resources must be provided as part of a sustained, long-term commitment to the community, rather than a short-term pilot project. Certainly, we will need short-term pilot studies in order to answer questions about the efficacy of unproven interventions, but our uncertainty about program efficacy must not be used as a blanket excuse for inaction.

How We Get There

Develop and disseminate guidelines for the prevention of violent injuries at the community level.

- Publish guidelines (in progress at CDC) for preventing youth violence, based on recommendations from the Forum on Youth Violence in Minority Communities: Setting the Agenda for Prevention.
- Publish similar guidelines (in progress at CDC) for preventing youth suicide, highlighting the rationale and potential benefits and pitfalls of current youth suicide prevention strategies.

Develop new financial resources and other resources for initiating and sustaining long-term support of community-based violence prevention programs.

- Establish partnerships and coalitions among community groups interested in violence prevention; public health, mental health, social work, and criminal justice agencies; and private foundations.
- Develop mechanisms for providing for sustained, long-term funding of violence prevention demonstration projects.

Training

Where We Are

Most primary health care providers have received little or no training in the proper identification and referral of victims of violence. Unlike persons sustaining other types of injury and disease, victims of violence often obscure the true circumstances surrounding their injuries when they seek treatment. Without deliberate probing as to the underlying causes of the physical injuries, many primary caregivers fail to elicit information about the violent circumstances leading to the injuries and, consequently, fail to refer victims appropriately.

At present, few persons — either in health agencies or in high-risk communities — have both adequate experience and training to mount a comprehensive violence prevention program. This lack of trained personnel is the natural consequence of our current, fragmented approach to violence prevention. Unfortunately, it also represents one of the most formidable barriers to any contemplated broad-scale violence prevention effort.

Given the scope of the problem of injuries — unintentional as well as intentional — in the United States, it may seem surprising that so few persons have been trained in the practice of general injury control. Several academic centers have now been established, partly to address this dearth of trained injury control specialists. Even within the field of injury control, however, very few persons are being trained to work with communities to develop, implement, and evaluate **intentional** injury prevention programs.

Part of the explanation may be that much more work has been done in the prevention of **unintentional** injuries, particularly those related to motor vehicle crashes. Decades of work by W.H. Haddon and others have laid a solid groundwork for a public health approach to injury control (38). Unfortunately, some of the conceptual models that developed from this groundwork seem somewhat awkward and inappropriate when applied to the prevention of intentional injuries. Moreover, whereas enormous strides have been taken in preventing certain classes of unintentional injuries, very few violence preventive interventions have been demonstrated to be effective in reducing violent injuries and deaths. This apparently bleak situation may discourage professionals interested in injury control from specializing in the prevention of intentional injuries.

In addition, although women and minorities suffer substantially from interpersonal violence, they are underrepresented even among the relatively small cadre of persons currently working in the field of intentional injury control.

Where We Want To Be

We need to train physicians and health-care providers in the proper identification, treatment, and referral of victims of self-directed or interpersonal violence.

We need to greatly expand the number of people who are trained in the prevention of injuries and deaths due to violence.

Ideally, those who will work to prevent injuries due to self-inflicted or interpersonal violence, or both, should know something about the risk factors for violence and the interventions that have been shown to be, or seem likely to be, effective; they should have some experience in community organization, as well as a sensitivity to the cultural milieu in which preventive interventions might be undertaken; and they should have some background in relevant aspects of public health practice, including epidemiology, surveillance, health education, and general injury control. Clearly, multidisciplinary training will be a necessary initial step in developing any coordinated effort to prevent injuries due to violence.

We need to recruit more minorities and women in this effort to prevent intentional injuries.

Given the substantial burden of intentional injuries borne by minorities and women, and in keeping with the need to develop culturally appropriate violence prevention programs that address the specific needs, characteristics, and circumstances of affected communities and high-risk groups, we must redouble our efforts to recruit minorities and women into violence prevention research and program development.

How We Get There

Incorporate violence prevention training into the curriculum of all graduate public health programs, and make this training an explicit and required component of all injury control training programs.

Develop and implement teaching modules (for schools of medicine, nursing, social work, and psychology and for continuing education) to help primary caregivers recognize and appropriately refer suicidal persons, victims of violence, and others at high risk of injury due to violence.

Institute fellowship programs to attract new people to the field of intentional injury control. Make particular efforts to recruit minorities and females from all graduate schools of public health.

Initiate and expand the training of primary care providers to enhance their ability to identify high-risk individuals. Use standard protocols when possible. (See also "Targeting Prevention Resources Toward Those at High Risk," page 174).

Evaluation

Where We Are

One of the most formidable barriers to preventing injuries due to violence is our distressing lack of knowledge about what interventions are effective in preventing self-directed and interpersonal violence. Even if we had an infrastructure through which we could conduct surveillance, target prevention resources toward high-risk populations, empower communities to develop their own violence prevention efforts, and train people in violence prevention, our efforts would be wasted if the interventions we put in place were not effective.

This is not to say that we cannot act on our current knowledge base; indeed, in this paper we lay out an agenda for action that we believe is relatively well-grounded in scientific research and injury control experience. Past research on self-inflicted and interpersonal violence **has** identified high-risk groups and highlighted important risk factors that appear to be causally related to violent injuries. But we have had little opportunity to scientifically evaluate the effectiveness of the preventive interventions suggested by this research since (a) very few violence prevention programs have been implemented and (b) those that have been implemented have generally not been evaluated in terms of their impact on violent injuries (CDC Resource guide: Youth Suicide Prevention Programs, unpublished observation). The rigorous evaluation of new and existing violence prevention strategies is one of the most fundamental needs in this field.

We should distinguish between two general types of evaluation: ongoing program monitoring, or process evaluation, and rigorous scientific testing of the effectiveness of a given intervention. The former type should be a fundamental part of every public health program, including, of course, violence prevention programs. Such ongoing process evaluations include describing program activities and the relationship of those activities to program goals and objectives. The evaluation data collected should be sufficient to (a) identify and correct problems in the day-to-day progress of specific interventions; (b) inform members of the community, decision makers, and possible funding sources of progress; and (c) determine whether the program is operating the way it had been planned.

Rigorous, scientific evaluation of the effectiveness of complex, multifaceted programs generally requires the infusion of extensive economic and technical resources. Consequently, such evaluations are carried out only as necessary and not as a routine part of an ongoing program. Nevertheless, before we widely implement strategies that require extensive financial resources, the strategies must be scientifically tested. At present, such precise,

scientific information about the effectiveness of various suggested strategies is largely unavailable.

Where We Want To Be

We need to rigorously test the effectiveness of promising but unproven violence prevention strategies.

We need to ensure that routine, practical measures for ongoing program monitoring or process evaluation are built into new and existing violence prevention programs.

Given the marked disparity between the great magnitude of self-directed and interpersonal violence and the relative paucity of human and financial resources for prevention, we must make the most efficient use of the prevention resources that we do have. Careful scientific evaluation of promising violence prevention strategies and interventions is the best guide to determine whether the incidence of violent injuries and deaths is reduced by our efforts, and at what cost.

Clearly, not every community intervention can or should be the subject of rigorous, university-level evaluation research. On the other hand, it is probably never appropriate to expend resources over a long period on an intervention of unproven efficacy without making some ongoing provision, informal or otherwise, for determining (a) whether the intervention is reaching the targeted group, (b) whether it is well-received by its constituents, and (c) whether specific program goals and objectives are being met. This sort of ongoing program monitoring can be of great value in improving prevention programs, even if it does not definitively demonstrate whether injuries are ultimately reduced by the intervention.

Although such program monitoring can be very useful, it is nevertheless inadequate to guide efforts in violence prevention. In the final analysis, the value of homicide prevention programs and suicide prevention programs must be measured in terms of how effectively they prevent homicide and suicide or nonfatal injuries associated with violence. If the impact of the interventions cannot be measured in terms of health outcomes, it must at least be measured in terms of concrete changes in behavior, such as reductions in the incidence of wife abuse, child abuse, attempted suicide, weapon carrying, or physical fighting.

Violence prevention strategies now in use need to be formally, scientifically, and rigorously evaluated. Many of these programs were thoughtfully designed and implemented on the basis of defensible theories about human behavior or the purported causal mechanisms of violence. Such apparently promising programs might be much more widely implemented if we could back up their theoretical strengths with hard data showing a reduction in the incidence of violence or violent injuries. On the other hand, should careful research

demonstrate that certain programs are not effective or are relatively less effective (given their cost) than other programs, resources could be redirected. For these reasons, we need to identify and scientifically evaluate the efficacy of selected, promising violence prevention strategies.

The potential for outcome evaluation should be built into new violence prevention efforts whenever possible, even if initial resources are insufficient to permit a concurrent, full-scale scientific evaluation. This planning would greatly facilitate future evaluation studies, when and if such resources become available.

How We Get There

When possible, for each of the major categories of violent injury (e.g, suicide, wife abuse, youth violence, rape, child abuse), identify existing programs that employ promising violence prevention strategies and conduct rigorous scientific testing of the effectiveness of these strategies in reducing injuries and deaths due to violence.

For unproven but promising strategies that have not yet been implemented or that have been implemented in a manner that precludes scientific evaluation, develop and rigorously test the efficacy of new prevention programs that are based on these strategies.

Encourage (e.g., through funding mechanisms) all new and existing violence prevention programs to build routine program monitoring measures into their day-to-day activities and to collect data that would facilitate future outcome-based evaluation studies when possible.

Special Areas of Emphasis

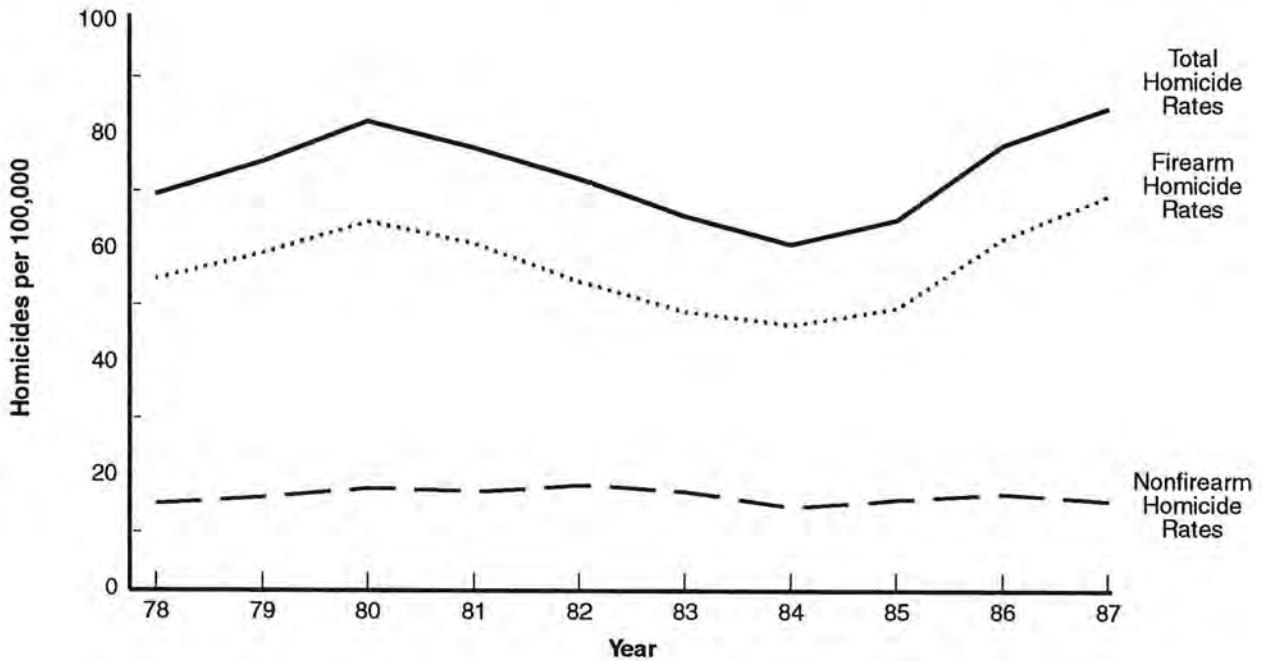
Firearm Violence

Where We Are

Firearm mortality dominates intentional injury statistics in the United States where 61% of the homicides and 59% of the suicides are committed with firearms. Trends in overall rates of violent death are largely determined by firearm violence (defined here as violent acts involving the use of firearms). The burden of firearm violence falls most heavily on minority and disadvantaged populations. Forty-one percent of all deaths among black male adolescents and young adults result from firearm injuries (39). Since 1984, homicide has increased dramatically among these young people, and 96% of the increase is attributable to firearm homicide (Figure 4) (7). The firearm suicide rate in this group more than doubled from 1982 to 1987, whereas the nonfirearm suicide rate actually declined (39).

Figure 4

Homicide Rates Among Black Males 15-24 Years Old, by Weapon Used, 1978-1987 - - United States



Data Source: National Center for Health Statistics

Firearm mortality, principally firearm suicide, is growing among elderly males; a 50-year decline in suicide rates among those over 65 ended in 1982, and the rate is still increasing. Whether this trend can be causally linked increased access to firearms is unclear, however. Since the early 1970s, firearms have been the leading method for committing suicide among females.

Today, firearm deaths rank fourth among all causes of premature death in the United States and first among deaths of black males. Most developed countries report near-negligible numbers of firearm deaths, and their rates of overall violence are far lower than ours.

Deaths related to firearms are only part of the problem. In 1985, for every firearm death there were an estimated 7.5 nonfatal shootings (236,000 altogether), with 28% (65,000) of the injured persons requiring hospitalization (16).

Handguns account for 78% of all violent firearm crimes — even though handguns still make up only about 25% of firearms in the United States and perhaps 40% of recent production. After significant declines in the early 1980s, handgun sales have rebounded; in 1988, about 1,773,000 were produced in this country for sale on the domestic civilian market, and another 664,000 were imported. Each year, some 639,000 Americans "face an offender armed with a handgun," according to the Department of Justice (40). In 1989, 76% of all firearm homicides were committed with handguns (41). Results of several local studies suggest that handguns are used in 60%-70% of firearm suicides (42-46); national data are not available.

The economic impact of firearm injuries arising from interpersonal and self-inflicted violence is enormous. The lifetime cost of firearm deaths and injuries sustained in 1985 is estimated at $863 million for medical care alone and at $14.4 billion for direct and indirect costs combined (16). More than 80% of the medical care costs are paid for with public funds (47, 48).

Research Findings:

Given the prominence of gun deaths in homicide and suicide mortality statistics, many have suggested that reducing ready access to these guns would reduce the number of deaths and injuries due to violence. Several lines of research (reviewed here) support this suggestion including research indicating that many homicides and suicides appear to be committed impulsively; that the methods used depend partly on the weapons immediately available; further, that assaults or suicide attempts with firearms are inherently more lethal than such actions with other methods or weapons. Empirical scientific research also suggests that decreasing ready access to firearms leads to fewer firearm deaths, although perhaps at the cost of increasing nonfatal injuries. Within each of these research areas, important questions need further research.

Research relating to the role of impulsiveness in suicide and homicide. To be sure, certain homicides and suicides are committed with clear premeditation; however, most homicide victims are killed in the course of arguments, usually by people they know — often by spouses or other family members (9). Many of these homicides appear to be committed impulsively, in the heat of violent arguments. The importance of explosive anger and impulsiveness is widely accepted by those who have dealt with many cases of homicide in which victims are killed by relatives or friends. Although we have little direct evidence supporting these anecdotal experiences, it is inconceivable that homicide is **never** committed impulsively in the course of violent conflicts. The widely held perception that impulsiveness is an important element in a substantial number of homicides among family and intimates is probably correct.

Impulsiveness appears to play an important role in youth suicides, too. Unlike adults, most young people do not suffer from concomitant clinical depression when they commit suicide (49). Many youth suicide victims can be classified as having a conduct disorder, an important element of which is impulsiveness. For most adult suicides, clinical depression is a very important risk factor, much more prominent than impulsiveness. This general statement may be less applicable for those attempting suicide with guns, however. In a study of 30 consecutive patients treated in an urban trauma center for self-inflicted gunshot wounds — most or all of which would have been fatal without emergency treatment — researchers found that more than half the patients reported having had suicidal ideation for less than 24 hours, suggesting a relatively high degree of impulsivity (50). For practically all suicides, ambivalence appears to be a common characteristic, suggesting that the determination to commit suicide waxes and wanes over time. If this is true, and if lethal means are not readily available when a person decides to attempt suicide, he or she might either (a) delay the attempt, allowing for the possibility of later deciding against suicide, or (b) use a less lethal means, allowing for a greater possibility of medical rescue.

The relative lethality of assault with firearms versus assault with other weapons or with no weapons. Assaults, robberies, suicide attempts, and other violent encounters result in death more frequently when a gun is used than when another weapon, or no weapon, is used. This fact has been established beyond any doubt, but the question of how to interpret this finding remains. Zimring and others (51) conclude that the direct effect of the lethality of firearms relative to other weapons accounts for the finding. Others (52) have suggested that the prominence of firearm deaths in violence mortality statistics may reflect not the relative lethality of guns, but rather the relatively more murderous or suicidal intent of the assailant or suicide victim. Trying to determine whether "lethality" or "intent" accounts for the predominance of firearms in mortality statistics may be fruitless, because both murderous or suicidal intent **and** the high lethality of weapons probably are important in the etiology of many thousands of firearm homicides and suicides that occur each year in this country. Although research on this issue is incomplete, Cook (20), having reviewed the available evidence relating to interpersonal violence, concluded that "there is persuasive evidence

that these differences in non-gun and gun fatality rates are, in large part, the direct consequence of the different lethality of the weapons, rather than simply a statistical artifact of some other causal process, such as differences in intent that influence both weapon choice and outcome."

Research relating to the outcomes of "natural experiments" — gun laws designed to reduce ready access to guns. Research evaluating the effectiveness of certain types of gun control laws suggests that, when properly enforced, such laws may reduce the incidence of certain types of firearm suicide and homicide. Numerous jurisdictions have tried to regulate the number of guns available or to decrease the number of persons carrying guns in public. In several studies, researchers have suggested that laws designed to reduce public gun carrying actually do decrease the incidence of homicide (53, 54). Recent research data suggest that mandatory sentencing laws (55-57) and restrictive licensing of handguns* have preventive effects on violence and violent injuries .

Of fundamental importance to interpreting many studies of laws designed to decrease access to guns is the fact that local gun regulation may have more effect on the sources from which these guns are obtained than on the actual level of ready access to guns. If availability is restricted locally, guns may be easily acquired in an adjacent jurisdiction that is less restrictive (20). In addition, few gun control laws are actually enforced (53, 54). It has been suggested that strict enforcement of already extant gun laws could also result in lower firearm injury rates.

Research correlating mortality rates with gun availability. Studies relating gun availability with violent injuries are problematic because of the difficulty in assessing and defining "availability" of guns. Geographic differences in gun ownership have been clearly correlated with the fractions of homicides, suicides, and assaults committed with guns (20, 58, 59). Cook (60) found that although high rates of firearm ownership had little effect on overall robbery rates, they were strongly correlated with rates of murder committed during a robbery. Generally, international comparisons of violent death rates and gun density have yielded contradictory or equivocal findings. Sloan and colleagues (61, 62) compared two similar cities that differ primarily in their gun control policies — Seattle, Washington, where guns are easily obtained, and Vancouver, in the Canadian province of British Columbia, which has stringent restrictions on purchasing guns. The researchers found that, whereas overall assaults were similar, fatal assault rates were much higher in Seattle.

The findings of Sloan and colleagues (61, 62) were not as clear for suicide. Although firearm suicides were much more common in Seattle than in Vancouver, overall suicide rates were comparable (i.e., Vancouver had higher rates of nonfirearm suicides). This finding had one important exception: suicide rates among **young** people were excessive in Seattle (where most suicides were committed with firearms) compared with Vancouver. This finding is consistent with the apparently greater role of impulsiveness in suicides among young people.

*See page 241.

The results of these two studies by Sloan and colleagues suggest that the generally greater level of ready access to guns in Seattle contributes to the city's higher overall homicide rate and the higher teenage suicide rate. Because of limitations inherent to study designs that compare apparently similar geographic areas, more research in this area is needed.

Assessments of the relative risks and benefits of ready access to guns. Handguns are usually purchased for protection, yet several studies indicate that firearms kept in the home are far more likely to take the life of a household member than a criminal intruder (46). One study showed that access to firearms in the home is an independent risk factor for adolescent suicide (63). National Crime Survey (NCS) data indicate that each year about 80,000 people use a gun to defend themselves against assault, robbery, rape, or burglary; however, the data also reveal that guns are used to commit about 800,000 violent crimes each year (20).

Research relating to injury control. Environmental modification is an extremely effective tool for preventing injuries, and for many injuries, it is demonstrably the most effective approach. The injury control literature emphasizes that the effectiveness of injury prevention strategies will vary inversely with the effort required to keep people from being harmed and with the degree to which people must make changes in their behavior (64). Providing automatic protection through environmental and product design is therefore likely to be more effective than requiring behavioral change via laws or regulations, which, in turn, is likely to be more effective than educating persons at risk of injury and persuading them to change their behavior. On the basis of this reasoning, injury control professionals have deliberately concentrated their efforts on modifying or eliminating dangerous consumer products rather than on persuading people to use these products more safely.

We have seen important advances in the prevention of many product-related injuries because of environmental interventions and product design changes (e.g., through the use of home smoke detectors, the redesign of automobiles, the use of flame-retardant sleepwear for children and childproof containers for medications, and the lowering of temperature settings on water heaters). This environmental approach has been particularly effective when product-related injuries result from impulsive behavior or when users are impaired because of age, intoxication, or mental or physical illness. Environmental interventions have also been successful in preventing intentional injuries in the limited realms in which they have been tried (e.g., removing the means for suicide from newly incarcerated prisoners and "target-hardening" convenience stores). Guns certainly are a dangerous consumer product. Yet, with few exceptions, the well-established injury control precept of modifying or eliminating dangerous consumer products thus far has not been effectively applied to the prevention of firearm violence.

Programs and Policies:

Several educational or behavioral interventions in place potentially could reduce firearm injuries; such interventions include firearm safety courses, public information campaigns, counseling of potential perpetrators or victims of violence, classroom education, peer

education and mentoring, and crisis intervention (Education Development Center, background paper for Forum on Youth Violence in Minority Communities: Setting the Agenda for Prevention, unpublished observation, Dec. 1990). Such educational strategies are used because they are persuasive and not coercive, but we know little about their effectiveness.

A second type of intervention involves making technological or environmental changes. Current product-based interventions to reduce firearm violence are, however, inadequate. For example, no mandatory design or performance standards exist for firearms manufactured in this country for civilian use. Design features already feasible could result in guns whose triggers could not be pulled by young children and even guns that would instantly indicate when they were loaded. Since passage of the Gun Control Act of 1968, imported firearms must meet a series of "factoring criteria" used to ensure minimal quality. But domestic firearms are exempt, and one researcher has estimated that more than half the firearms manufactured for Americans by American firms would fail these tests of quality (65).

Moreover, whereas the United States requires that imported guns be "particularly suitable for sporting use," no such standard applies to domestic firearms. In the wake of the Bush administration's 1989 decision to prohibit only the importation of paramilitary assault weapons, at least one U.S. company has been established specifically to produce these weapons for domestic sale.

In addition to behavioral/educational and technological/environmental strategies to reduce firearm injuries, legislative or regulatory interventions are also an option. Regulations can apply to the use, possession, and sale or transfer of guns. We have already discussed some research related to gun control legislation, but we also need to mention other regulatory strategies, some of which originated decades ago.

In 1919, a 10% excise tax was levied on the purchase of firearms, partly out of concern that handguns posed a public safety problem (66); authority to regulate firearms has been vested in the Department of the Treasury ever since. The National Firearms Act of 1934 effectively applied excise taxation to limit the availability of automatic weapons.

No agency with a mandate to safeguard the public health has jurisdiction over firearms. Within the Department of the Treasury, the Bureau of Alcohol, Tobacco, and Firearms regulates firearms today. The resources allocated to this agency have never been sufficient for it to accomplish this complicated mission. As a result, many violations of federal limits on commerce in firearms go unpunished. The agency's ability to trace firearms used in crime, an important service for state and local law enforcement, is hampered by a lack of resources and the lack of a central registry of firearm transactions.

Researchers who reviewed state systems for screening handgun purchasers (67) suggest that existing state systems are ineffective because of weak federal regulation of licensed dealers

and manufacturers, incomplete state criminal history files, and the difficulty of regulating used handgun transactions. The hoped-for effect of local restrictions on the purchase and ownership of handguns in reducing firearm violence has been undermined by substantial illegal commerce that introduces handguns purchased in less restrictive jurisdictions (68). Community efforts to establish home rule in this area may not succeed without effective federal regulation.

Support for more vigorous regulation of handguns and their ownership is widespread. For example, most firearm owners (and most members of the National Rifle Association) favor the registration of all handguns and of all newly purchased firearms, regardless of type (69).

Although, traditionally, regulatory authority has been vested in the Department of the Treasury, experience in the United States during the last few decades has established that control of firearm violence is more effective through criminal law enforcement than through taxation (70). During the Reagan administration, an Attorney General's task force recommended a possible transfer of authority over firearms to the Department of Justice (70). Recent legislative initiatives have relied on the Department of Justice for enactment. For example, as mandated by the Anti-Drug Abuse Act of 1988 (71), the department is considering developing a national system to identify felons who attempt to purchase firearms. Similar state systems, especially when coupled with mandatory waiting periods for all gun purchases, have prevented felons and other proscribed persons from purchasing firearms and may have prevented suicides as well.

Where We Want To Be

Because of the predominance of firearm deaths in the vital statistics, the importance of impulsive behavior in suicide and interpersonal violence, the high lethality of firearm violence, the preliminary research linking homicide and suicide to ready access to guns, and the demonstrated effectiveness of environmental interventions in general, we believe that the strategies most likely to produce **immediate** benefit are those related to reducing firearm violence.

Our focus on reducing firearm injuries is consistent with the Healthy People 2000 Health Objectives for the Nation. That document's emphasis on weapon-related injuries underlines a growing conviction that reducing ready access to guns will reduce injuries and death due to violent and abusive behavior. Specific Year 2000 Objectives focus on reducing weapon-related violent death, reducing weapon-carrying by young people, and reducing ready access to handguns and other firearms (Appendix B, Objectives 7.3, 7.10, 7.11). The report notes that "the impulsive nature of many homicides and suicides suggests that a substantial portion of those events might be prevented if immediate access to lethal weapons was reduced, in particular through appropriate storage of guns and ammunition" (31). In explaining the need to reduce weapon-carrying by adolescents 14 to 17 years of age, the

report also notes that "although the question of restricting firearm ownership and usage is contentious in American society, few argue that adolescents should have unsupervised access to firearms or other lethal weapons. Fewer still argue that adolescents should be permitted to carry loaded firearms or other lethal weapons at school or on city streets" (31).

Our recommendations also echo recommendations made in 1985 at the Surgeon General's Workshop on Violence and Public Health (72). That workshop brought together people with a wide range of training, skills, and experiences to develop recommendations for preventing interpersonal violence. Their policy recommendations included a complete and universal ban on the manufacture, importation, sale, and possession of handguns to all persons except for authorized police and military personnel; regulation of the manufacture, distribution, and sale of other lethal weapons; and criminal penalties for possession of any weapon where alcohol is sold or served (72).

As is true for other areas of injury control, there is no single, easy, widely accepted solution to reducing firearm injuries due to violence. A combination of many different approaches will be essential for effectively preventing firearm injuries and deaths. In addition to critically needed research and surveillance efforts, we strongly advocate minimizing ready access to handguns and other firearms through a variety of strategies focused on four broad areas: educational and behavioral change interventions, technological and environmental interventions, improved enforcement of current laws, and new legislative and regulatory efforts.

How We Get There

We developed the following recommendations to provide leaders at the community, state, and federal levels with concrete steps by which to minimize ready access to handguns and other firearms, thereby decreasing the number of homicides, suicides, and intentionally inflicted nonfatal injuries. We should note that reducing ready access to handguns and other firearms is also likely to decrease the rate of **unintentional** firearm injuries and deaths. (Other recommendations to reduce unintentional firearm injuries and deaths are made in the Home and Leisure Panel's position paper. We concur with the recommendations made there and refer readers to that panel's full position paper.) The great variety of these recommended approaches provides needed flexibility to community and other leaders in choosing actions that seem most compelling or that appear to be most appropriate, given the cultural and political environment in which the actions will be taken. Recognizing the importance of improving our understanding of the relationship between access to guns and the risk of intentional injury, we also developed a series of recommendations for research in this area.

Recommendations:

Minimize ready access to handguns and other firearms.

- Promote educational and behavioral modification efforts.
  - Encourage voluntary removal of handguns from households by educating the public about the risks of guns outweighing their benefits in providing household security.
  - Promote secure storage of firearms that remain in the home, to reduce or eliminate a person's ability to rapidly retrieve and fire them.
  - Promote the storage of weapons so that children and adolescents do not have unsupervised access to guns.
  - Develop, implement, and evaluate school- and peer-based programs to limit children's access to and use of handguns.
- Promote technological and environmental efforts.
  - Assist the domestic firearms industry and others in developing less lethal, yet effective, means of providing security against assailants and intruders.
  - Develop, implement, and evaluate pilot programs that employ metal detection or other technologies to prevent firearms from being carried into high-risk settings (e.g., bars, discos, rock concerts, and schools where firearm violence has occurred).
  - Strengthen the current "factoring criteria," by requiring that firearms be designed primarily for sporting purposes. Apply these criteria to domestic and imported firearms.
  - Promote design and performance standards to minimize the risk of firearm injuries. Examples include trigger arresters and loaded-chamber indicators.
- Enhance enforcement of existing legislative and regulatory efforts.
  - Transfer regulatory oversight and law enforcement responsibilities for firearms to an agency with a primary mandate to protect the health of the public; provide this agency with broad authority to regulate the design and manufacture of firearms and ammunition.
  - Increase resources committed to the investigation and prosecution of illegal traffic in firearms.
  - Promote the vigorous enforcement of extant laws prohibiting the carrying of handguns in public, through means that include innovative alternative sentencing measures for those convicted (e.g., sentencing to a county work force), as well as stricter general enforcement of current laws.
  - Establish a national registration system for all handguns, with the registration data available only for use in criminal investigations. Make the possession of unregistered handguns a criminal offense.
  - Establish a central registry of all handgun purchases, again with the collected data available only for use in criminal investigations.

- Initiate new legislative and regulatory efforts.
  - Prohibit the manufacture, importation, and sale of handguns except in special circumstances.
  - Establish a national waiting period for all purchases of firearms, coupled with a mandatory criminal record background check.
  - Establish nationwide restrictive licensing of handgun owners whereby a handgun license would be granted only when a clear, legitimate need for possessing a handgun is demonstrated (e.g., for professional use).
  - Enact an excise tax on firearms and ammunition at a rate sufficient to cover the public cost of firearm injuries.

Improve our knowledge of firearm injuries and the role of ready access to firearms in firearm injuries.

- Improve the quality of surveillance data for firearm injuries, for both morbidity and mortality. Include details (manufacturer, caliber, type) of the firearms involved in violence.
- Improve the assessment of risks, medical and social costs, and benefits of ready access to firearms.
- Rigorously evaluate policy initiatives, including gun control laws and regulations.
- Explore and evaluate alternatives to firearms for home and personal security.
- Promote collaboration among the criminal justice, public health, and medical research sectors, particularly in policy evaluation.

Alcohol and Other Drug Use and Violence

Where We Are

In many cases of both suicide and interpersonal violence, the use of alcohol and other drugs (AODs) appears to be a critically important risk factor. The use of AODs contributes to self-directed and interpersonal violence in a variety of different ways, although the precise mechanisms by which the use of AODs increases the risk of violence have not been exhaustively established. Clearly, however, AOD use plays a prominent role in the causal pathways of many types of violent behaviors, suggesting that interventions addressing the use of AODs have great potential for reducing the incidence of such behaviors.

Research Findings:

AODs and interpersonal violence. Alcohol consumption is associated with an increased risk both of being a victim of violence and of committing violent acts. For example, Wolfgang (73) showed that alcohol consumption was disproportionately present among both victims and perpetrators of homicide. Haberman and Baden (74) found blood or brain alcohol concentrations in excess of .10% in 43% of homicide victims over 18 years of age. In a review

of controlled studies, Hotaling and Sugarman (75) found consistent evidence of a direct association between alcohol consumption and both child abuse and husband-to-wife violence. Ladouceur and Temple (76) showed that acute ingestion of alcohol is associated with sexual assault. Furthermore, alcohol is often used as an excuse for violence in many settings such as bars, sporting events, and social gatherings of adolescents (77).

The association between alcohol and violence is well documented because of the common use of blood alcohol tests on homicide victims; however, far less is known about the association between interpersonal violence and the use of narcotics, marijuana, and other controlled substances. Government officials and the media have attributed high rates of certain types of interpersonal violence in many American cities to high levels of illicit drug use (and commensurately high levels of drug trafficking). Recent increases in reports of child abuse and neglect in some urban settings are correlated with increased birth rates for infants of cocaine-addicted mothers. The correlation raises the concern that such infants may be at increased risk of child neglect or abuse. In this area, however, the evidence is not sufficient for the effects of poverty to be separated from the effects of drug abuse.

AOD use and suicide. After clinical depression, alcoholism is the most commonly reported mental disorder associated with suicide (78, 79), and a strong association between alcoholism and suicide has been established (80, 81). Chronic alcoholism places individuals at a 60 to 120 times higher risk of suicide than persons in the general population, according to a recent review of published follow-up studies of alcoholics (82). From 2% to 3.4% of alcoholics ultimately commit suicide; one-quarter of all suicide victims are reportedly alcoholics (82). Seriously affected alcoholics are at highest risk, with a peak rate for suicide occurring among alcoholics 40 to 49 years old. Comorbidity, or the occurrence of a mental disorder with substance abuse, is a particularly salient interaction. In three studies of suicide attempters (83-85), researchers identified alcohol abuse as the most important factor in eventual suicide. Alcohol has been shown to play a particularly prominent role in the suicides of Alaska Natives (86) and of American Indian adolescents in tribes with high suicide rates (87).

The use of AODs has been identified as a significant risk factor in suicide and attempted suicide during adolescence (88). In comparing adolescent substance abusers at drug abuse treatment facilities with a matched group of pediatric outpatients who did not use drugs, investigators found that substance abusers were three times as likely to have attempted suicide. Adolescent substance abusers who had attempted suicide were more likely to have depressed affect and to have parents who had severe problems, including depression and alcoholism, than did drug users who did not attempt suicide.

Most investigators who have examined the association between alcohol use and suicide have focused on alcoholism per se. Relatively few have assessed the effects that alcohol intoxication may have on the risk of suicide. This question is particularly germane for teenagers and young adults, among whom the prevalence of intermittent alcohol ingestion and abuse can be quite high. Haberman and Baden (74) found blood or brain alcohol concentrations

in excess of .10% in 26% of suicide victims over 18 years of age. Alcohol use is also commonly associated with suicide attempts (89). Such findings suggest the importance of acute alcohol ingestion in suicide, but they generally provide no data on the prevalence of acute alcohol use among appropriate control groups.

Possible mechanisms underlying the association between AODs and violence. In this section, we will describe several mechanisms that might explain how AOD use increases the risk of violent behavior, victimization, or both. We review evidence that AOD use may increase the risk of self-directed and interpersonal violence because of direct and indirect psychopharmacologic effects. We identify two additional ways in which illicit drug use may be associated with increased risk of violent injury, both of which are related to the fact that whereas alcohol is relatively inexpensive and widely available in our society, illicit drugs are not.

Pharmacologic effects of AOD use. The effects of AODs on violence may be mediated through proximal psychopharmacological effects on affective states or psychological states associated with violent behavior. In the case of alcohol, the association with interpersonal violence has been attributed to alcohol's power to change cognition and perception of social cues and to create emotional states that are antecedents to violence (e.g., paranoia). Alcohol use may be associated with persons violently acting out aggressive feelings that might otherwise be controlled. Alcohol use may also be confounded with aggressive and violent life-styles, however. Abuse of barbiturates, whether obtained illegally or by prescription, is strongly associated with aggression (Collins, unpublished paper, 1982). Depending on the circumstances of its use and the personality of its user, phencyclidine (PCP) can cause extremely violent behavior (90). Other drugs, such as amphetamines and cocaine hydrochloride, may also induce changes in affective or cognitive states that contribute to violence. Acute alcohol use may facilitate suicidal acts by reducing instinctive inhibitions against self-harm or by inducing changes in cognition or affective states that are associated with suicide. Additional research is needed to clarify the direct pharmacologic relationship of the use of AODs to suicide and interpersonal violence.

In other cases, the effects of AOD use on violence may be the result of more distal influences on affective or psychological states (88). Depression, paranoia, irritability, and cognitive impairments sometimes follow the long-term ingestion of alcohol and other intoxicants. In addition, withdrawal from chronic opiate use is associated with irritability, paranoia, hostility, and other affective symptoms. These affective and cognitive states can lower the threshold for both self-directed and interpersonal violent behavior.

Systemic violence associated with AOD use. In addition to their potential for contributing directly to violent behavior through their psychological and physiological effects, drugs play important and well-documented indirect roles in interpersonal violence (38). Participation in the sale and trafficking of illicit substances presents heightened risk for both committing violence and being a victim of violence — so-called "systemic violence." Selling illicit substances is an intrinsically violent affair, since it is not regulated by law or traditional forms

of enterprise. Goldstein and colleagues (91) found that drug transactions were the context for most drug-related homicides in New York City in 1988. The risk of being a victim of violence is four times greater for drug sellers than for nonsellers. Fagan and Chin (92) found that drug sellers are frequently robbed of their drugs or the cash they carry. Sellers often resort to violence to control their selling territory, to maintain organizational discipline within selling enterprises, and to punish persons who have committed crimes against them or members of their selling groups.

Economic compulsive violence and AOD use. Persons addicted to narcotics or other drugs must supply their habit, which often requires substantial amounts of money. This leads to the third avenue by which the use of AODs can increase the risk of interpersonal violence: "economic compulsive violence," or the need to commit violent acts such as robbery to obtain money to purchase drugs. This behavioral pattern closely matches that of heroin addicts. Research with opiate users consistently shows that their participation in violence and other crimes is far greater during periods of addiction (93).

Programs and Policies:

At present, this country's major policies for discouraging alcohol use are the prohibition of alcohol sales to minors and the arrest and punishment of people who commit crimes secondary to alcohol abuse (e.g., drunken drivers who cause automobile collisions). In the case of illicit drugs, most of our resources have been directed toward arresting and imprisoning users and traffickers of illicit drugs. So far, relatively few resources have been devoted to the primary prevention of drug addiction or the effective treatment of drug users. Most American cities have only a tiny fraction of the resources needed to treat the many persons addicted to alcohol or illicit drugs.

Where We Want To Be

Given the strong association of the use of AODs with violent injuries, we may be able to prevent injuries due to violence by (a) decreasing the chronic use of AODs in the general population, particularly among people at high risk of violent behavior; and (b) changing the environment associated with AOD use so that it no longer contributes to the risk of violent injury.

To reduce the use of AODs among the general population, we need to do a much better job of delaying the onset of first-time AOD use. We can also reduce the general use of AODs by properly identifying and appropriately treating people who are addicted to AODs and those who show early signs of a drug use problem. We should recognize that not all treatments work for all people and that, to maximize the effectiveness of treatment, we need to match clients with appropriate treatment programs on the basis of culture, race, gender, and other factors.

In our more targeted efforts, we need to focus resources for the treatment and prevention of AOD use on populations known to be at high risk of violent injury. We can implement this approach most easily on a geographic or demographic basis, but occasionally we also may be able to identify and treat high-risk persons, such as alcoholics with concomitant depression or alcoholics and other drug addicts with a history of violent behavior.

Finally, because a substantial proportion of drug users engage in systemic violence (94), we should consider reducing the incidence of violent injuries associated with illicit drug use by developing feasible alternatives to the current system of legal regulation of illicit substances.

We need to conduct more research in order to answer the many questions that remain about the mechanisms underlying the association between the use of AODs and violence.

How We Get There

Recommendations:

Decrease chronic use of AODs by persons at high risk of violent behavior by ensuring that such persons are properly identified and provided with adequate treatment for their drug use disorders.

- Rigorously evaluate successful treatment and maintenance programs to identify effective characteristics and treatment regimens.
- Develop protocols for referring AOD users to appropriate treatment programs.
  - Include criteria for matching individuals with appropriate treatment programs.
  - Coordinate efforts of criminal justice, mental health, and drug treatment agencies whenever possible.
- Eliminate administrative barriers to entering and completing treatment programs, including insurance limitations for users, liability risks for treatment providers, lack of access to child care and obstetric care, and premature termination of maintenance programs.

Prevent or at least delay the initiation of AOD use, especially among people otherwise at high risk of interpersonal or self-directed violence.

- Develop and implement culturally appropriate and regionally specific programs to prevent and delay the initiation of AOD use; to accelerate the process of desistance; and to minimize health risks from AOD use. Rigorously evaluate the effectiveness of these programs.
- Target prevention and early intervention efforts at populations at high risk of AOD use, at users with concurrent mental disorders, and at people with histories of violent behavior, mental disorders, or both.

Reduce the risk of violence associated with AOD use through environmental and regulatory controls on access to AODs.

- Design, implement, and evaluate interventions to control access to AODs through retail alcohol and prescription drug sales.
- Study the efficacy of regulating AOD use to reduce fatalities associated with illicit distribution of controlled substances. Explore feasible alternatives to the legal regulation of illicit substances associated with violence, such as cocaine and heroin.

Study the relationship between AOD use and violence.

- Explore the mechanisms underlying the observed associations among AOD use, mental disorders, and self-directed and interpersonal violence.
- Determine whether treatment of alcoholics and other drug-addicted persons reduces the incidence of self-directed violence, interpersonal violence, or both.

Early Childhood Experiences Affecting Future Risk of Violence

Where We Are

Nearly three decades have passed since "the battered child syndrome" was first brought to public attention (95), but infants and young children continue to suffer substantially from assault and homicide at the hands of their caretakers. Moreover, between 1,000 and 5,000 children may be killed each year by their parents (4, 5). In 1986, an estimated 160,000 children were seriously injured or impaired by abuse and neglect (e.g., loss of consciousness, cessation of breathing, broken bones, schooling loss requiring special education services, third-degree burns), and an additional 953,000 children suffered moderate injuries or impairments (e.g., bruises, depression, or emotional distress not requiring professional treatment) (4). That same year an estimated 155,900 children, both male and female, were sexually abused (4).

It is during the second decade of a child's life that the rates of injuries and deaths due to both serious self-directed and interpersonal violence increase most dramatically (Figures 2 and 3). Among older children and very young teens, the rates of both homicide and suicide are generally very low. The rates of serious self-directed and interpersonal violence increase so steeply during the second decade of life, however, that by age 19, the suicide rate has risen to almost 70% of its maximum lifetime level, and the homicide rate has risen fifteenfold (96). These sharp increases in the rates of suicide and homicide during the teenage years are greater than at any other stage of life. Not only do rates increase most dramatically during the adolescent years relative to other life stages, but absolute rates of both homicide and suicide among adolescents have increased markedly over time. In view of these facts, many researchers have focused on factors that might increase adolescents' risk of violent behavior, violent injury, or both, and many violence prevention professionals are targeting their efforts toward adolescents.

Intervening to prevent violent injuries among adolescents seems like a logical response; however, this approach can be effective only for risk factors that have short induction periods. In other words, if risk factors for suicide and homicide heighten a person's risk in the minutes, days, weeks, or even months after exposure to these factors, then we can reduce that person's risk of suicide and homicide during the adolescent and young adult years by reducing the prevalence of such exposure during adolescence and young adulthood. In fact, certain risk factors for violence do have relatively short induction periods; ready access to handguns is one such risk factor that we have emphasized here.

Increasing evidence, however, suggests that experiences during early childhood can have lifelong effects on the risk of being a victim of interpersonal violence, committing interpersonal violence, and committing suicide. Specifically, being a victim of child abuse, witnessing violence in the home, and viewing high levels of television violence all have been associated with increased risk of violence many years later. In addition, research on child development suggests possible mechanisms by which such early childhood experiences can increase the risk of later violence. Limited research also suggests that interventions with very young children designed to deter aggressive behavior patterns and encourage prosocial behavior may have long-term effects on decreasing violence.

Research Findings:

Early childhood experiences and violence. An increasing body of evidence suggests that the childhood experiences of being abused or witnessing violence increases a person's risk of being involved in violence later. Adults who, as children, witnessed violence in their family of origin have been found to be at increased risk both of physically abusing their spouses or intimates and of being the victim of such abuse (75, 97, 98).

The notion that "violence breeds violence" was first suggested nearly 30 years ago (99). Growing evidence indicates that the childhood experience of being abused by an adult increases the risk of perpetrating violent behavior toward others both immediately afterwards and later in life (100-103).

Each year public agencies identify many physically abused children, but these children represent only a small portion of all children who are physically harmed. Interviews from a nationally representative sample of families show that in 1985, 23 per 1,000 — a minimum of 1.5 million — American children were physically abused by their parents (including those kicked, bit, hit with a fist, beat up, burned or scalded, and threatened with or injured by a gun or knife) (104). If hitting a child with an object such as a stick or belt is also included, the estimates are that 110 per 1,000 children were abused, representing 6.9 million abused children (104).

Children as young as 1 to 3 years of age who have been physically abused at home were found to be more than twice as likely as nonabused children to physically assault both their classmates and their adult caretakers at school (105). In a direct test of the hypothesis that

violence breeds violence across generations, Widom found that individuals identified by court records as abused or neglected during childhood were 42% more likely than others to perpetuate this cycle of violence as evidenced by being arrested for a violent crime at some point during their lives (102). This effect held even when important demographic variables such as age, sex, and race were controlled.

In a recent prospective study of 5-year-old children who had been physically harmed, researchers examined the potential mechanisms by which physical abuse in childhood may lead to the development of aggressive behavior (106). The experience of physical abuse, as reported through maternal interviews, was found to increase the risk of children's aggressive behavior in school 6 months after the study began, even when investigators controlled for family ecological factors (such as poverty, marital violence, and family instability) and children's biological factors (such as early health problems and temperament). "Harmed" children were found to develop distinctly "biased and deficient" patterns of solving social problems. These patterns, in turn, were found to lead (at least in the short-term) to aggressive behavior. The authors caution, however, that although aggressive behavior has been found to be remarkably stable over time, one cannot conclude from the study (which had a relatively short follow-up period) that physical abuse has had stable effects over many years.

Evidence also suggests that abuse in early childhood leads not only to aggressive behavior but also to depression and withdrawal. This emotional distress may, in some cases, lead to suicide or attempted suicide (103, 107).

Early childhood experiences: viewing television and film violence. In the United States, television viewing has become an integral part of most American families' routines. The possibility that children's viewing of television and film violence may increase their risk for aggressive behavior and criminal violence has been a concern for many years, and research into that possibility has had a long and politically charged history (101, 108). The viewing of television and film violence may produce subsequent violence by providing violent role models, by producing attitudes and beliefs that favor the use of violence, and by suggesting that violence is a justifiable way of solving social problems (109).

Heavy viewing of television and film violence appears to affect not only potential perpetrators of violence but also potential victims and bystanders. For example, heavy viewing of television violence has been shown to lead to exaggerated notions of both the appropriateness and the prevalence of violence in the real world (110) and to unrealistic fears of becoming a victim of violence (111). Heavy viewing of television violence has also been found to harden young viewers to expect and passively accept violent behavior displayed by others without acting to prevent or end it (112).

Research data on television violence are sometimes contradictory. Some recent findings from longitudinal research, however, support the argument that viewing television violence

during early childhood can have long-term and cumulative effects, as well as immediate effects. The viewing of television violence by boys at age 8 has been found to predict, independently of many demographic factors, the frequency and extent of their subsequent display of serious acts of interpersonal violence as many as 22 years later (109). In addition, in a cross-national study of American and Finnish grade school children over a 3-year period, researchers found that the more television violence a particular child watched in any given year, the more likely he or she was to show an increase in aggressive behavior during the next year (109).

The effects of television violence have also been examined along with certain family factors. Boys exposed to high levels of violence from two or more sources (e.g., television violence, maternal abuse, and paternal abuse) have been found to be more likely to engage in violent criminal behavior than boys exposed to only one source or to no sources of violence (113).

In 1953, the U.S. Senate Subcommittee on Juvenile Delinquency started the first in what has become a long series of public inquiries into the effects of viewing television violence. The reports of the most notable of these investigations are (a) the report from the National Commission on Causes and Prevention of Violence (114) (often referred to as the Eisenhower Report), with the conclusion that viewers of television violence learned how to engage in violent behavior; (b) the 1973 Surgeon General's Commission Report, with the conclusion that fairly substantial experimental evidence exists for short-run causation of aggression among some children and that much less certain evidence from field studies suggests that extensive viewing of violence preceded some aggressive behavior; and (c) the National Institute of Mental Health Report (115), with the conclusion that a causal link between television viewing and aggressive behavior is scientifically established and that television viewing of violence has the potential for creating both immediate and long-term effects. In view of this evidence, the U.S. Congress has suspended antitrust restrictions in an effort to encourage the major television networks to develop their own coordinated response to the problem of television violence and its effects on viewers.

The recently enacted Children's Television Act (1990) now directs the Federal Communications Commission (FCC) to consider in each television station's application for renewal of its broadcast license the extent to which the station has demonstrated compliance with programming requirements that serve "the educational and informational needs of children" and with nonbroadcast efforts that "enhance the educational and informational value of such programming." The new law, derived from research findings, emphasizes that television can help children learn important information, skills, values, and behaviors while entertaining them. Our recommendations in this area rest on the premise that the media and film entertainment industry have the potential and the responsibility to inform and help educate children.

Child development research: on aggression. From as early as the preschool years and throughout later stages of life, highly aggressive or violent individuals commonly show a cognitive pattern involving (a) deficient skills in solving social problems, (b) endorsement

of beliefs that support the use of violence, and (c) problems with controlling impulses. The direction of causality is unclear, because the cognitive factors associated with violent behavior appear to be learned early in childhood and modifiable through direct intervention. Early intervention may, however, produce relatively enduring changes in violent behavior.

For example, highly aggressive children and violent adolescent offenders have been found to define social problems in hostile ways, adopt hostile goals, seek few facts, generate few alternative solutions, anticipate few consequences of aggression, and give high priority to aggressive solutions (101, 116-118). In addition to these skill deficits, highly aggressive children and violent adolescent offenders have been found to hold a variety of beliefs that support the use of violence, such as beliefs that the use of aggression is legitimate and effective, increases self-esteem, and gains social approval (117, 119). Finally, highly aggressive children and adolescent offenders have been found to show problems in controlling impulses (120, 121). Inadequate control of impulses or emotions puts them at risk for behaving hastily or inappropriately.

Interventions to mitigate the effects of childhood experiences associated with violence. Research suggests that socially learned factors that contribute to interpersonal violence can be altered, with a subsequent reduction in violent behavior (101, 122). Promising programs have focused on parental education and training, school-based teaching of nonviolent problem-solving skills, community-based interventions, and critical use and understanding of media. Few programs have been implemented, and fewer still have been evaluated in a comprehensive or long-term manner (101, 122-124).

Programs in parental management training have been systematically developed and investigated by Patterson and his colleagues (125). Based on the view that coercive interaction patterns in the family inadvertently contribute to the development, maintenance, and escalation of violence both within and outside the family, this program focuses on training parents of young children (3-12 years of age) to define and respond to coercive behavior in the home in new, noncoercive ways. The parental management training program is limited by the heavy demand it places on parents to develop skills, but this treatment program has demonstrated broad-based success in reducing aggressive behavior within the home and outside (122); the long-term impact on children's risk of engaging in or becoming the victim of future violence has not been evaluated.

Home visitation programs have been demonstrated to be cost-effective interventions for a variety of health outcomes in children, including the reduction of child abuse and neglect (126). Because of the demonstrated link between early child abuse and neglect and later violent behavior (102), home-visitation prevention programs may decrease children's risk for violence in the future, as well as immediately reducing child abuse and neglect. For example, in a home-visitation program designed by Olds and colleagues (127), 400 first-time mothers at high risk of maltreating their children (young single mothers or mothers of a low socioeconomic status) were randomly assigned to four treatment groups offering different services: sensory and developmental screening at the children's 12th and 24th month of life;

free transportation for regular prenatal and well-child care; home visits by nurses during pregnancy; and home visits by nurses during the child's first 2 years of life. Outcomes were assessed via emergency room and social service records, maternal reports of their child's behavior, observations of maternal caregiving, and children's developmental tests. The comprehensive package (all four elements) was found to decrease the incidence of child abuse in the highest-risk group of poor, unmarried, teenage mothers having their first child. Babies of these mothers tended to show improved intellectual functioning on developmental tests at ages 12 and 24 months.

Curricula developed for various grade levels were designed to change children's knowledge and attitudes toward violence and to instill in them interpersonal skills for resolving conflicts nonviolently. One program directly focuses on changing adolescents' behaviors and attitudes toward violence (128). This 10-session high school curriculum teaches students about the magnitude of the violence problem, their vulnerability to violent injury, the role of anger in human interactions, and strategies for nonviolent forms of conflict resolution. Although preliminary studies of the effectiveness of these curricula in reducing violent and abusive behaviors are inconclusive, these efforts seem promising. One study has shown that intervention with violent adolescent offenders can be effective in changing beliefs that justify violent behavior, improving social problem-solving skills, and reducing subsequent aggressive behavior (129). Curricula intended to change children's aggressive behavior patterns and to help them develop nonviolent conflict resolution skills could have a profound impact if targeted toward very young children.

Programs and Policies:

As a result of the growing recognition of the magnitude of the violence problem, laws protecting children were established in all 50 states during the 1960s and 1970s. Child Protective Services (CPS) has been given the primary responsibility of fulfilling the mandate to protect children. Though the laws in each state vary, the process of child protective services is basically similar. When someone suspects that a child is being abused or neglected, that person is supposed to report such suspicions to CPS. A CPS caseworker then conducts an investigation and decides whether the reported incident is a true case. For confirmed cases, CPS then initiates an appropriate intervention, which can range from minimal intervention with the family to complex and prolonged involvement of juvenile and criminal court systems in taking protective custody of the child and to criminal prosecution of the offender.

Unfortunately, the U.S. system for protecting children from parental abuse and neglect has serious problems. Major difficulties include continually burgeoning numbers of reports without concomitant increases in resources; inadequate health, psychological, and social services for children and families; and an overloaded foster care system. In addition, the current system does not in any way emphasize the primary prevention of child abuse and neglect.

At present, few programs address other childhood experiences related to future violence, such as witnessing violence in the home and excessive viewing of television or film violence. Professional organizations concerned with the well-being of children and families (the American Academy of Pediatrics, the American Medical Association, the American Psychological Association, and the National Parent-Teacher Association) have recommended that professionals take a more active role in reducing the impact of violence portrayed in the media (130). Research indicates that although parents rarely monitor the content or extent of their children's television viewing (131), parents can have a major effect on the ways in which television influences their children by directly mediating and regulating their children's television viewing experiences (132).

In addition to home-based interventions, programs to teach "critical viewing skills" may minimize the impact of televised violence (133, 134); the effectiveness of these programs is, however, under evaluation.

Where We Want To Be

The basic values, attitudes, and interpersonal skills acquired early in life are pivotal in developing children's predispositions for violent behavior later in life, and early childhood exposure to factors such as violent behavior, abuse, and neglect have been demonstrated as risk factors for both violent behavior and victimization during adolescence and adulthood. Therefore, at least some portion of our violence prevention efforts must be designed to (a) reduce the prevalence of child abuse and neglect, the witnessing of violence in the home, and the viewing of violence in films and on television; and (b) intervene with children who are exposed to these experiences to ameliorate the consequences.

Current prevention strategies that promote nonviolent values, attitudes, and interpersonal skills are an important but substantially underused component of any long-term strategy to prevent violence. Strategies to mitigate the consequences of exposure to violence, or to risk factors for violence, by targeting young children or their families are similarly underused. The Proceedings of the Forum on Youth Violence in Minority Communities: Setting the Agenda for Prevention provide a detailed discussion of the potential of these strategies and contain recommendations for action (23). Many of the following recommendations were adapted from these proceedings.

How We Get There

Recommendations:

Reduce the incidence of child abuse and neglect and provide treatment for victims of child abuse and neglect to minimize long-term effects.

- Make home visitation programs by nurses widely available for high-risk infants, or develop alternative types of home visitation.

- Increase the availability of and access to long-term therapeutic health, mental health,and social services for abused and neglected children and their families. Such services can include individual psychotherapy, respite day care, therapeutic day care, and residential treatment.
- Improve the identification and surveillance of abused and neglected children.
- Assess the effectiveness of current intervention strategies in preventing future child abuse and neglect and in mitigating the long-term effects of abuse.
- Promote the development of multidisciplinary teams as the units primarily responsible for addressing both fatal and nonfatal child abuse and neglect.

Develop interventions for children living in areas with high levels of violence to decrease the likelihood of future violent behavior, and intervene with children who witness violence to mitigate both long- and short-term effects.

- Intensify and expand efforts to identify children who witness violence, and provide therapeutic services, particularly for those children who witness violence in their family of origin.
- Increase family support services designed to decrease the prevalence of violence in the home. Such services might include the following:
  - Parental education about appropriate discipline techniques, the danger of weapons in the home, anger management, and conflict resolution techniques.
  - Timely crisis intervention for families under stress and at risk for violence.
  - Mentoring programs for children and parents to provide positive psychosocial role models.
- Develop educational interventions that foster in children the skills, values, and behaviors needed to resolve social problems nonviolently.
- Develop parental training programs to teach nonviolent resolution of family conflict.

Develop experiences with the media for children that inform, educate, and foster the skills, values, and behavior needed to prevent violence.

- Call upon the Federal Communications Commission to review each television station's broadcast license renewal application for evidence of its programming and outreach efforts to help prevent violence among children.
- Encourage parents to avoid exposing their children to media that aggrandize violence and self-destructive behavior and to focus instead on media that educate families in the prevention of violence and that depict nonviolent and healthful alternatives.

Assess both the short- and long-term effectiveness of these recommended interventions in reducing the risk of a child being a victim of violence or of exhibiting violent behavior later in life.

Mental Disorders and Self-Directed Violence

Where We Are

Three salient facts establish a compelling argument for focusing attention on mental disorders, especially affective disorders, as a key strategy for preventing self-directed violence. First, depression and other mental disorders have been definitively shown to increase the risk of both attempted and completed suicide. Second, the evidence that treatment for affective disorders effectively reduces the duration of illness is clear and convincing. And third, many people afflicted with clinical depression and other mental disorders are either never properly diagnosed or do not receive appropriate care by mental health professionals.

Although a great variety of mental disorders have been associated with suicide, the panel focused on affective disorders for several reasons. First, depression is the most common psychiatric diagnosis retrospectively assigned to (mostly adult) suicide victims via psychological autopsies. Second, although certain other disorders, such as schizophrenia, are associated with profound increases in the risk of suicide, current treatment may not be effective in reducing suicide risk among individuals with these disorders. Indeed, the rate of suicide among persons with schizophrenia remains high despite current treatment.

Likewise, certain personality disorders, such as conduct disorders, have been associated with an increased risk of suicide, especially among adolescents and young adults (135). Persons with conduct disorders in combination with other mental disorders may be at particularly high risk of suicide. Unfortunately, personality disorders have proven to be very resistant to current treatment methods. Finally, alcoholism and other substance abuse disorders are also considered mental disorders and are clearly of central importance in the causation of many suicides. However, because we have already emphasized the importance of AOD use in the etiology of both suicide and homicide in another section of this chapter, we will not repeat that discussion here.

Here, we focus on the prevention of self-directed, as opposed to interpersonal, violence. Some evidence suggests that persons with certain mental disorders, especially those with substance abuse disorders or those who satisfy criteria for multiple mental disorders, may be at increased risk of behaving violently toward others (136). However, mental disorders have been much more strongly and consistently implicated in the causation of self-directed violence; thus, addressing mental disorders is likely to have its greatest salutary impact on the prevention of suicidal behavior.

Research Findings:

Mental disorders and suicide. Psychological autopsies — interviews with friends and relatives of the deceased person, designed to reconstruct the social and psychological circumstances associated with the suicide (137) — have been used in several major studies to retrospectively study the psychiatric disorders of adults who commit suicide (138-142). In adults, depression has been most commonly found, followed by alcoholism and schizophrenia. In addition, five major follow-up studies, investigators found psychiatric patients to be at 8 to 38 times greater risk for suicide than the populations from which they were drawn (28). The studies varied in whether the study subjects received their original psychiatric care as inpatients or as outpatients and in the duration of the follow-up (1 to 25 years). Overall, patients with affective disorders were at the highest risk.

In psychological autopsy studies (63, 143) and record review studies (144) of youth suicide victims, investigators have identified conduct disorders as common diagnoses, as well as depression and substance abuse. In the largest study to date (135), investigators found that among males, who accounted for 80% of the suicides, antisocial behavior was the most frequent risk factor, occurring in 67% of the sample, followed by a family history of suicide (41%), drug abuse (37%), major depression (21%), and a prior suicide attempt (21%). The coexistence of antisocial and depressive symptoms has been suggested as a particularly high-risk combination for youth suicide (145).

The effectiveness of current treatments for affective disorders. Most adults and many adolescents who complete suicide have mental disorders that can be identified and, in many cases, treated (28, 63, 138, 139, 142, 143, 146-150). The duration of illness among patients with clinical depression — the mental disorder most commonly associated with suicide among adults — has been clearly shown to be reduced by pharmacotherapy and psychotherapy (151-154). Among persons with major depression, 80%-90% can be treated successfully (155). Treatment for persons with bipolar affective disorder has also been shown both to effectively reduce symptoms and to delay the recurrence of symptoms (156-158). Among children with well-defined major depressive disorders, antidepressant therapy has also proven to be effective in reducing symptoms of depression (159).

The proportion of afflicted persons receiving proper diagnosis, referral, and treatment. Despite the clear association of mental disorders with suicide and despite the proven effectiveness of therapy for certain mental disorders, there is only limited evidence that current treatment methods have reduced the suicide rate among the general population. One possible explanation for this is that many people suffering from depression and other affective disorders are never properly diagnosed or, for other reasons, do not receive therapy for their illness. Evidence from the National Institute of Mental Health (NIMH) Epidemiologic Catchment Area Program indicates that less than 20% of all persons with a recent mental disorder and only about 30% of all persons with a mood disorder, such as depression, seek help for their problem (160, 161).

Programs and Policies:

Clinical treatment of mental disorders first requires that persons be identified as needing treatment and be properly referred. Second, treatment for these persons must be available and affordable. Numerous individuals and groups have made patchwork efforts to increase the identification and referral of suicidal persons, but little organized effort has been explicitly directed toward increasing access to clinical care for persons with mental disorders as a means of preventing suicide.

Many communities have implemented outreach efforts to ensure that high-risk individuals receive appropriate treatment or are referred to appropriate mental health practitioners. The efficacy of suicide crisis telephone lines in reducing the overall suicide rate has been questioned, since hotlines are used most frequently by young females, and suicide rates are highest among elderly males (135, 162). Nonetheless, a reduction in suicide rates in certain subgroups that use crisis lines (white females under 24 years of age) has been found (163). In addition, these crisis lines may serve a worthwhile community function by referring distressed individuals to appropriate sources for help.

Recently, a variety of school-based suicide-awareness programs have been implemented, but their efficacy in preventing suicide has not been demonstrated. Educational efforts may improve students' knowledge about suicide but may not affect their attitudes or behavior (49, 164). Recent findings suggest that, for some students, such programs may even have slightly negative effects on their moods (165).

In a recent study of two school-based suicide prevention curricula (166), researchers found that students who reported prior suicide attempts tended to react more negatively to the program than students who did not report prior suicide attempts. That finding is worrisome, since past suicide attempters are a high-risk group. The researchers noted, however, that the programs studied did not negatively alter the high-risk students' fundamental knowledge or attitudes about suicide; rather, they reported that "although none of the attempters rated the programs as upsetting, 2 of 14 (14.3%) attempters reported knowing someone who was upset by the programs." There was no evidence suggesting that students had increased suicidal thinking or behavior in response to the school-based programs.

Given these findings and the small numbers involved in this study — and given the fact that the curricula studied are but two examples of a broad array of school-based suicide prevention programs — it would be premature for us to make sweeping judgments about the potential benefits and dangers of school-based programs. On the other hand, many suicide researchers believe that broad-based primary prevention programs focusing on health enhancement are likely to be of greater value than programs that only address suicide (167). Such broad-based programs might include training in social skills, problem-solving and coping skills, and the management of anger and depression.

Opportunities to identify people at risk for suicide exist in many settings. For example, community nurses have been trained to recognize suicidal behavior in rural clients; some hospital emergency rooms have established standardized protocols for assessing and referring suicide attempters and people with suicidal behavior; and suicide crisis telephone lines are common in many cities (22).

In response to increasing concern about clusters of youth suicide and to mounting evidence concerning suicide "contagion," CDC has published guidelines to help communities control and perhaps even prevent clusters of suicide (22). These guidelines include provisions for identifying potentially high-risk youths and giving them access to community mental health resources. To reduce the likelihood of imitative behavior, the American Association of Suicidology has developed guidelines for the media to use in reporting suicides, and, recently, the Association of State and Territorial Health Officers has published somewhat more extensive guidelines (168). These media guidelines include recommendations for publishing the phone numbers of hot lines, mental health agencies, and other resources in the community, in the hope of lowering barriers to care for those who are suicidal. These media guidelines also contain recommendations for limiting the description of the suicide method, limiting the amount of media coverage, and establishing and publicizing a specific mental health liaison with the media when a suicide crisis occurs.

Where We Want To Be

Because of the powerful association between mental disorders and suicide and the availability of effective treatment for depression and certain other mental disorders closely associated with suicide, we need to do a much better job of identifying persons with these mental disorders and getting them into treatment.

One example of such an effort is the NIMH Depression/Awareness, Recognition, Treatment (D/ART) program. The D/ART program consists of distributing materials specifically developed for an array of gatekeepers and community members and designed to assist in the recognition and understanding of depression. The D/ART materials are to be widely disseminated by NIMH in the hope of increasing referrals of persons who suffer from undiagnosed depression.

How We Get There

Recommendations:

Improve the identification and referral of persons with depression and other treatable mental disorders.

- Disseminate the D/ART materials of the NIMH to potential gatekeepers and community members.
- Develop measures for screening institutionalized and incarcerated populations, to identify their mental health needs and potential for suicidal behavior.

- Develop or modify professional education programs to teach professionals (in education, nursing, medicine, and law enforcement) how to better recognize and refer persons with depression and other treatable mental disorders.
- Coordinate mental health services with other medical and health services, especially alcohol and other drug abuse programs.

Improve access to treatment for people with depression and other treatable mental disorders that are associated with suicide. Increase public health and insurance funding for outpatient treatment of depression and other mental disorders.

Increase the percentage of people with affective disorders who receive effective treatment.

Conduct research to determine the combined effect of antisocial personality (particularly aggressiveness) and affective or other mental disorders on suicide risk.

Conduct controlled research studies to measure the effect of current treatment methods for depression and other mental disorders on the suicide rate in the treated population.

Infrastructure

Targeting Prevention Resources Toward Those at High Risk

Address the specific needs, characteristics, and circumstances of communities with high rates of violent injury by developing culturally appropriate violence prevention and intervention programs for them.

- Incorporate the recommendations for community-based violence prevention from the Forum on Youth Violence in Minority Communities: Setting the Agenda for Prevention (23).

  These recommendations include developing the following: (a) school-based programs, including conflict resolution training, comprehensive school health curricula, and school designs that minimize opportunities for violence; (b) community programs involving linkages among various service agencies, including media campaigns to publicize existing services and raise awareness, mentoring programs for both general and high-risk youths, and programs to create recreational and job opportunities for youths that will help them develop skills, self-esteem, and positive attitudes; (c) programs specifically designed for high-risk youths, including violent youths, gang members (and youths at risk for becoming gang members), youths from families with problems related to violence, and victims, relatives of victims, and witnesses to violence.

As called for in the Healthy People 2000 Health Objectives 7.12 and 7.14 (Appendix B), improve the recognition, referral, and treatment of individuals at high risk for violence (e.g., suicidal persons, victims of violence or neglect, or people who have previously threatened to commit a violent act).

- Initiate or expand training for primary caregivers to enhance their ability to identify high-risk individuals. Use standard protocols when possible. (See also "Training," page 219.)
- Involve a wide range of professionals (e.g., clergy, public health nurses, school nurses, teachers, and counselors) in identifying and referring people at high risk.
- Increase clinic outreach services and referral systems for suicide attempters, to encourage attempters to receive appropriate, ongoing clinical treatment, and to maximize their compliance with treatment regimens.
- Develop or strengthen systems of mutual referral (e.g., between school and mental health systems).

Expand and improve the coordination of existing services for high-risk individuals and develop, through new or reprogrammed resources, broader violence prevention efforts for high-risk groups.

- Encourage all state and local health departments with populations at high risk of violent injury to devote some portion of their prevention efforts and resources to preventing and controlling injury due to violence.
- Develop violence prevention guidelines for state and local health departments.
- At the national level, expand the Secretary's Advisory Committee on Injury Control to include representation from public health, criminal justice, education, mental health, and social service agencies.
- Expand access to community services for victims of violence (e.g., shelters for battered women and mental health services for rape victims, suicide attempters, and child abuse victims).
- Expand community mental health services and increase outreach programs in communities with populations at high risk of suicide (e.g., certain American Indian reservations and communities with a large elderly population or with an apparent cluster of youth suicides).

Surveillance

Establish universal E-coding of all hospital discharges, as called for in the detailed recommendations of the National Committee on Vital and Health Care Statistics.

Modify state behavioral risk-factor surveys or establish new surveys to collect relevant information on behaviors and environmental hazards associated with an increased risk of injury due to interpersonal and self-directed violence.

Continue efforts to determine the feasibility and utility of modifying NEISS in order to collect information about firearm injuries from a representative sample of hospital emergency departments.

Explore the feasibility and utility of developing a FARS-like surveillance system for fatal firearm injuries.

Explore potential modifications to death certificates, or to the death certification process, that would enhance the usefulness of national mortality data for the surveillance of suicide and homicide.

Empowering Communities

Develop and disseminate guidelines for the prevention of violent injuries at the community level.

- Publish guidelines (in progress at CDC) for preventing youth violence, based on recommendations from the Forum on Youth Violence in Minority Communities: Setting the Agenda for Prevention.
- Publish similar guidelines (in progress at CDC) for preventing youth suicide, highlighting the rationale and potential benefits and pitfalls of current youth suicide prevention strategies.

Develop new financial and other resources for developing and sustaining long-term support of community-based violence prevention programs.

- Establish partnerships and coalitions among community groups interested in violence prevention; public health, mental health, social work, and criminal justice agencies; and private foundations.
- Develop mechanisms for providing sustained, long-term funding of violence prevention demonstration projects.

Training

Incorporate violence prevention training into the curriculum of all graduate public health programs, and make this training an explicit and required component of all injury control training programs.

Develop and implement teaching modules (for schools of medicine, nursing, social work, and psychology and for continuing education) to help primary caregivers recognize and appropriately refer suicidal persons, victims of violence, and others at high risk of injury due to violence.

Institute fellowship programs to attract new people to the field of intentional injury control. Make particular efforts to recruit minorities and females from all graduate schools of public health.

Initiate and expand the training of primary care providers to enhance their ability to identify high-risk individuals. Use standard protocols when possible. (See also "Targeting Prevention Resources Toward Those at High Risk," page 174.)

Evaluation

When possible, for each of the major categories of violent injury (e.g, suicide, wife abuse, youth violence, rape, child abuse), identify existing programs that employ promising violence prevention strategies and conduct rigorous scientific testing of the effectiveness of these strategies in reducing injuries and deaths due to violence.

For unproven but promising strategies that have not yet been implemented or that have been implemented in a manner that precludes scientific evaluation, develop and rigorously test the efficacy of new prevention programs that are based on these strategies.

Encourage (e.g., through funding mechanisms) all new and existing violence prevention programs to build routine program evaluation measures into their day-to-day activities and to collect data that would facilitate future outcome-based evaluation studies when possible.

Special Areas of Emphasis

Firearm Violence

Minimize ready access to handguns and other firearms.

- Promote educational and behavioral modification efforts.
  - Encourage voluntary removal of handguns from households by educating the public about the risks of guns outweighing their benefits in providing household security.
  - Promote secure storage of firearms that remain in the home, to reduce or eliminate a person's ability to rapidly retrieve and fire them.
  - Promote the storage of weapons so that children and adolescents do not have unsupervised access to guns.
  - Develop, implement, and evaluate school- and peer-based programs to limit children's access to and use of handguns.
- Promote technological and environmental efforts.
  - Assist the domestic firearms industry and others in developing less lethal yet effective means of providing security against assailants and intruders.
  - Develop, implement, and evaluate pilot programs that employ metal detection or other technologies to prevent firearms from being carried into high-risk settings (e.g., bars, discos, rock concerts, and schools where firearm violence has occurred).
  - Strengthen the current "factoring criteria," by requiring that firearms be designed primarily for sporting purposes. Apply these criteria to domestic and imported firearms.
  - Promote design and performance standards to minimize the risk of firearm injuries. Examples include trigger arresters and loaded-chamber indicators.

- Enhance enforcement of existing legislative and regulatory efforts.
  - Transfer regulatory oversight and law enforcement responsibilities for firearms to an agency with a primary mandate to protect the health of the public; provide this agency with broad authority to regulate the design and manufacture of firearms and ammunition.
  - Increase resources committed to the investigation and prosecution of illegal traffic in firearms.
  - Promote the vigorous enforcement of extant laws prohibiting the carrying of handguns in public, through means that include innovative alternative sentencing measures for those convicted (e.g., sentencing to a county workforce) as well as stricter general enforcement of current laws.
  - Establish a national registration system for all handguns, with the registration data available only for use in criminal investigations. Make the possession of unregistered handguns a criminal offense.
  - Establish a central registry of all handgun purchases, again with the collected data available only for use in criminal investigations.
- Initiate new legislative and regulatory efforts.
  - Prohibit the manufacture, importation, and sale of handguns except in special circumstances.
  - Establish a national waiting period for all purchases of firearms, coupled with a mandatory criminal record background check.
  - Establish nationwide restrictive licensing of handgun owners, whereby a handgun license would be granted only when a clear legitimate need for possessing a handgun is demonstrated (e.g., for professional use).
  - Enact an excise tax on firearms and ammunition at a rate sufficient to cover the public cost of firearm injuries.

Improve our knowledge of firearm injuries and the role of ready access to firearms in firearm injuries.

- Improve the quality of surveillance data for firearm injuries, for both morbidity and mortality. Include details (manufacturer, caliber, type) of the firearms involved in violence.
- Improve the assessment of risks, medical and social costs, and benefits of ready access to firearms.
- Rigorously evaluate policy initiatives, including gun control laws and regulations.
- Explore and evaluate alternatives to firearms for home and personal security.
- Promote collaboration among the criminal justice, public health, and medical research sectors, particularly in policy evaluation.

Alcohol and Other Drug Use and Violence

Decrease chronic use of AODs by persons at high risk of violent behavior by ensuring that such persons are properly identified and provided with adequate treatment for their drug use disorders.

- Rigorously evaluate successful treatment and maintenance programs to identify effective characteristics and treatment regimens.
- Develop protocols for referring AOD users to appropriate treatment programs.
  - Include criteria for matching individuals with appropriate treatment programs.
  - Coordinate efforts of criminal justice, mental health, and drug treatment agencies whenever possible.
- Eliminate administrative barriers to entering and completing treatment programs, including insurance limitations for users, liability risks for treatment providers, lack of access to child care and obstetric care, and premature termination of maintenance programs.

Prevent or at least delay the initiation of AOD use, especially among people otherwise at high risk of interpersonal or self-directed violence.

- Develop and implement culturally appropriate and regionally specific programs to prevent and delay the initiation of AOD use; to accelerate the process of desistance; and to minimize health risks from AOD use. Rigorously evaluate the effectiveness of these programs.
- Target prevention and early intervention efforts at populations at high risk of AOD use, at users with concurrent mental disorders, and at people with histories of violent behavior or mental disorders, or both.

Reduce the risk of violence associated with AOD use through environmental and regulatory controls on access to AODs.

- Design, implement, and evaluate interventions to control access to AODs through retail alcohol and prescription drug sales.
- Study the efficacy of regulating AOD use to reduce fatalities associated with illicit distribution of controlled substances. Explore feasible alternatives to the legal regulation of illicit substances associated with violence, such as cocaine and heroin.

Study the relationship between AOD use and violence.

- Explore the mechanisms underlying the observed associations among AOD use, mental disorders, and self-directed and interpersonal violence.
- Determine whether treatment of alcoholics and other drug-addicted persons reduces the incidence of self-directed violence, interpersonal violence, or both.

Early Childhood Experiences Affecting Future Risk of Violence

Reduce the incidence of child abuse and neglect and provide treatment for victims of child abuse and neglect to minimize long-term effects.

- Make home visitation programs by nurses widely available for high-risk infants, or develop alternative types of home visitation.
- Increase the availability of and access to long-term therapeutic health, mental health, and social services for abused and neglected children and their families. Such services can include individual psychotherapy, respite day care, therapeutic day care, and residential treatment.
- Improve the identification and surveillance of abused and neglected children.
- Assess the effectiveness of current intervention strategies in preventing future child abuse and neglect and in mitigating the long-term effects of abuse.
- Promote the development of multidisciplinary teams as the units primarily responsible for addressing both fatal and nonfatal child abuse and neglect.

Develop interventions for children living in areas with high levels of violence to decrease the likelihood of future violent behavior, and intervene with children who witness violence to mitigate both long- and short-term effects.

- Intensify and expand efforts to identify children who witness violence, and provide therapeutic services, particularly for those children who witness violence in their family of origin.
- Increase family support services designed to decrease the prevalence of violence in the home. Such services might include the following:
  - Parental education about appropriate discipline techniques, the danger of weapons in the home, anger management, and conflict resolution techniques.
  - Timely crisis intervention for families under stress and at risk for violence.
  - Mentoring programs for children and parents to provide positive psychosocial role models.
- Develop educational interventions that foster in children the skills, values, and behaviors needed to resolve social problems nonviolently.
- Develop parental training programs to teach nonviolent resolution of family conflict.

Develop experiences with the media for children that inform, educate, and foster the skills, values, and behavior needed to prevent violence.

- Call upon the Federal Communications Commission to review each television station's broadcast license renewal application for evidence of its programming and outreach efforts to help prevent violence among children.

- Encourage parents to avoid exposing their children to media that aggrandize violence and self-destructive behavior and to focus instead on media that educate families in the prevention of violence and that depict nonviolent and healthful alternatives.

Assess both the short- and long-term effectiveness of these recommended interventions in reducing the risk of a child being a victim of violence or of exhibiting violent behavior later in life.

Mental Disorders and Self-Directed Violence

Improve the identification and referral of persons with depression and other treatable mental disorders.

- Disseminate the D/ART materials of the NIMH to potential gatekeepers and community members.
- Develop measures for screening institutionalized and incarcerated populations, to identify their mental health needs and potential for suicidal behavior.
- Develop or modify professional education programs to teach professionals (in education, nursing, medicine, and law enforcement) how to better recognize and refer persons with depression and other treatable mental disorders.
- Coordinate mental health services with other medical and health services, especially alcohol and other drug abuse programs.

Improve access to treatment for people with depression and other treatable mental disorders that are associated with suicide. Increase public health and insurance funding for outpatient treatment of depression and other mental disorders.

Increase the percentage of people with affective disorders who receive effective treatment.

Conduct research to determine the combined effect of antisocial personality (particularly aggressiveness) and affective or other mental disorders on suicide risk.

Conduct controlled research studies to measure the effect of current treatment methods for depression and other mental disorders on the suicide rate in the treated population.

References

1. National Center for Health Statistics. Advance report of final mortality statistics, 1988. Hyattsville MD: U.S. Department of Health and Human Services, Public Health Services, 1990. Monthly Vital Statistics Report; vol. 39, no. 7 (Suppl).

2. Centers for Disease Control. Premature mortality due to homicide and suicide — United States, 1984: Perspectives in disease prevention and health promotion. MMWR 1987;36:531-4.

3. Fingerhut LA, Kleinman JC. International and interstate comparisons of homicides among young males. JAMA 1990;263:3292-5.

4. National Center on Child Abuse and Neglect (NCCAN). Study of national incidence and prevalence of child abuse and neglect: 1988. Washington DC: Department of Health and Human Services, 1988.

5. Newberger EH. Child abuse. Boston: Little, Brown, 1982.

6. O'Carroll PW, Mercy JA. Patterns and recent trends in black homicide. In: Hawkins DF, editor. Homicide among black Americans. New York: Univ. Press of America, 1986:29-42.

7. Centers for Disease Control. Homicide among young black males — United States, 1978-1987. MMWR 1990;39:869-73.

8. Mercy JA, Saltzman LE. Fatal violence among spouses in the United States, 1976-85. Am J Public Health 1989;79:595-9.

9. Centers for Disease Control. Homicide surveillance: high-risk racial and ethnic groups. Atlanta GA: Centers for Disease Control, 1983.

10. Centerwall BS. Race, socioeconomic status, and domestic violence, Atlanta 1971-72. Am J Public Health 1984;74:813-5.

11. Loftin C, Hill RH. Regional subcultures and homicide: an examination of the Gastil-Hackney thesis. Am Sociol Rev 1974;39:714-24.

12. Parker RN, Smith MD. Deterrence, poverty, and type of homicide. Am J Sociol 1979;85:614-24.

13. Williams KR. Economic sources of homicides: reestimating the effects of poverty and inequality. Am Soc Rev 1984;49:283-9.

14. Straus MA, Gelles RJ. Physical violence in American families: risk factors and adaptations to violence in 8,145 families. New Brunswick: Transaction Publishers, 1990.

15. Gelles RJ, Straus MA. Intimate violence: the definitive study of the causes and consequences of abuse in the American family. New York: Simon and Schuster, 1988.

16. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: report to Congress. San Francisco: Univ. of California, Institute for Health and Aging, and The Johns Hopkins Univ., Injury Prevention Center, 1989.

17. McIntosh J. Suicide among Native Americans: a compilation of findings. J Death Dying 1980-81;11:303-16.

18. McIntosh J. Suicide among Native Americans: further tribal data and considerations. J Death Dying 1983-84;14:215-29.

19. Moscicki EK, O'Carroll PW, Rae DS, Locke BZ, Roy A, Regier DA. Suicide attempts in the Epidemiologic Catchment Area Study. Yale J Biol Med 1988;61:259-68.

20. Cook PJ. The technology of personal violence. In: Tonry M, editor. Crime and justice: a review of research. Chicago: Univ of Chicago Press 1991;14:1-71.

21. Kellermann AL, Lee RK, Mercy JA, Banton J. The epidemiological basis for the prevention of firearm injuries. Annu Rev Public Health 1991;12:17-40.

22. Centers for Disease Control. CDC recommendations for a community plan for the prevention and containment of suicide clusters. MMWR 1988;37 (suppl. no. S-6):1-12.

23. Centers for Disease Control. Proceedings of the Forum on Youth Violence in Minority Communities: Setting the Agenda for Prevention. Public Health Rep 1991;106:225-79.

24. Indian Health Service. Trends in Indian health, 1989. Washington DC: U.S. Department of Health and Human Services, 1989.

25. Straus MA, Gelles RJ. Societal change and change in family violence from 1975 to 1985 as revealed by two national surveys. J Marriage Fam 1986;48:465-79.

26. U.S. Department of Justice. Female victims of violent crime. Washington DC: U.S. Department of Justice, 1991 (NCJ-126826).

27. McLeer SV, Anwar R. A study of battered women presenting in an urban emergency department. Am J Public Health 1989;79:65-6.

28. Monk M. Epidemiology of suicide. Epidemiol Rev 1987;9:51-69.

29. Pallis DJ, Gibbons JS, Pierce DW. Estimating suicide risk among attempted suicide: II. Efficiency of predictive scales after the attempt. Br J Psychiatry 1984;144:139-48.

30. Meehan PJ, Saltzman LE, Sattin RW. Suicides among older United States residents: epidemiologic characteristics and trends. Am J Public Health 1991;81(a):1198-1200.

31. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991: DHHS Publication No. (PHS) 91-50212.

32. Rokaw WM, Mercy JA, Smith JC. Comparing death certificate data with FBI crime reporting statistics on U.S. homicides. Public Health Rep 1990;102:447-55.

33. Moyer LA, Boyle CA, Pollock DA. Validity of death certificates for injury-related causes of death. Am J Epidemiol 1989;130:1024-32.

34. Loftin C. Validity of robbery-murder classification in Baltimore. Violence Victims 1986;1:191-204.

35. Rosenberg ML, Davidson LE, Smith JC, Berman AL, Buzbee H, Gantner G, et al. Operational criteria for the determination of suicide. J Forensic Sci 1988;33:1445-56.

36. O'Carroll PW. A consideration of the validity and reliability of suicide mortality data. Suicide Life Threat Behav 1989;19(1):1-16.

37. Barancik JI, Chatterjee BF, Greene YC, Michenzi EM, Fife D. Northeastern Ohio trauma study: I. Magnitude of the problem. Am J Public Health 1983;73:746-51.

38. National Committee for Injury Prevention and Control. Injury prevention: meeting the challenge. New York: Oxford, 1989:252-60.

39. Fingerhut LA, Kleinman JC. Firearm mortality among children and youth. Hyattsville MD: National Center for Health Statistics, 1989. DHHS publication no. (PHS) 90-1250, 1989. (Advance data no. 178).

40. Rand MR. Special report: handgun crime victims. Washington DC: Department of Justice, Bureau of Justice Statistics, 1990.

41. U.S. Department of Justice. Crime in the United States, 1989. Federal Bureau of Investigation, Uniform Crime Reports. Washington DC: Department of Justice, 1990.

42. Stone IC. Observations and statistics relating to suicide weapons. J Forensic Sci 1987;32:711-6.

43. Stone IC. Observations and statistics relating to suicide weapons: an update. J Forensic Sci 1990;35:10-2.

44. Wintemute GJ, Teret SP, Kraus JF, Wright M. The choice of weapons in firearm suicides. Am J Public Health 1988;78:824-6.

45. Lester D. Use of handguns and long guns in suicide and homicide. Psychol Rep 1989;65:938.

46. Kellerman A, Reay D. Protection or peril? An analysis of firearm-related deaths in the home. N Engl J Med 1986;314:1557-60.

47. Martin MJ, Hunt TK, Hulley SB. The cost of hospitalization for firearm injuries. JAMA 1988;260:3048-50.

48. Wintemute GJ, Wright M. Initial and subsequent hospital costs of firearm injuries. Arch Surgery 1990.

49. Shaffer D, Garland A, Underwood M, Whittle B. An evaluation of three youth suicide prevention programs in New Jersey. Newark: New Jersey State Department of Health and Human Services, 1987.

50. Peterson LG, Peterson M, O'Shanick GJ, Swann A. Self-inflicted gunshot wounds: lethality of method v. intent. Am J Psychiatry 1985;142:228-31.

51. Zimring FE. Is gun control likely to reduce violent killing? U Chicago Law Review 1968;35:721-37.

52. Wright JD, Rossi PH, Daly, K. Under the gun: weapons, crime, and violence in America. New York: Aldine de Guyter, 1983.

53. Pierce GL, Bowers WJ. The Bartley-Fox gun law's short-term impact on crime in Boston. Ann Am Acad Pol Soc Sci 1981;455:120.

54. O'Carroll PW, Loftin C, Waller JB, McDowall D, Bukoff A, Scott RO, et al. Preventing homicides: an evaluation of the efficacy of a Detroit gun ordinance. Am J Public Health 1991;81:576-81.

55. Loftin C, McDowall D, Wiersema B. A comparative study of the preventive effects of mandatory sentencing laws for gun crimes. College Park MD: Violence Research Group, Univ. of Maryland, 1991.

56. Fife D, Abrams WR. Firearms' decreased role in New Jersey homicides after a mandatory sentencing law. J Trauma 1989;29:548-52.

57. McPheters LR, Mann R, Schlagenhauf D. Economic response to a crime deterrence program: mandatory sentencing for robbery with a firearm. Economic Inquiry 1984;22:550.

58. Alexander GR, Massey RM, Gibbs T, Alterkruse J. Firearm-related fatalities: an epidemiologic assessment of violent death. Am J Public Health 1985;75:165-6.

59. Markush RE, Bartolucci AA. Firearms and suicide in the United States. Am J Public Health 1984;74:123-7.

60. Cook PJ. Robbery violence. J Criminal Law Criminol 1987;78:357-74.

61. Sloan JH, Kellerman AL, Reay DT, Ferris JA, Koepsell T, Rivara FP, et al. Handgun regulations, crime, assaults and homicide: a tale of two cities. N Engl J Med 1988;319:1256-62.

62. Sloan JH, Rivara FP, Reay DT, Ferris JA, Kellerman AL. Firearm regulations and rates of suicide: a comparison of two metropolitan areas. N Engl J Med 1990;322:369-73.

63. Brent DA, Perper JA, Goldstein CE, Kolko DJ, Allan MJ, Allman CJ, et al. Risk factors for adolescent suicide: a comparison of adolescent suicide victims with suicidal inpatients. Arch Gen Psychiatry 1988;45:581-8.

64. National Research Council, Institute of Medicine. Injury in America — a continuing public health problem. Washington DC: National Academy Press, 1985.

65. Davis R. U.S. Congress. Senate. Committee of the Judiciary. Subcommittee to Investigate Juvenile Delinquency. Hearings on oversight of 1968 Gun Control Act: Testimony of R. Davis. 94th Cong. 1st sess., 1975.

66. Zimring FE. Firearms and the Federal law: the Gun Control Act of 1968. J Leg Stud 1975;4:133-98.

67. Cook PJ, Blose J. State programs for screening handgun buyers. Ann Am Acad Polit Soc Sci 1981;455:80.

68. Bureau of Alcohol, Tobacco, and Firearms. Project Identification: a study of handguns used in crime. Washington DC: U.S. Department of Treasury, 1976.

69. Harris L. Views of gun owners differ from NRA stands on gun control: the Harris Poll 16. New York: Louis Harris and Associates, 1989.

70. U.S. Department of Justice. Attorney General's task force on violent crime. Washington DC: U.S. Department of Justice, 1981.

71. U.S. Department of Justice. Report to the Attorney General on systems for identifying felons who attempt to purchase firearms. Federal Register 1989;54 (205), 43524-73.

72. U.S. Department of Health and Human Services, Report on the Surgeon General's workshop on violence and public health. Leesburg VA: Department of Health and Human Services 1985.

73. Wolfgang ME. Patterns in criminal homicide. Philadelphia: Univ. of Pennsylvania Press, 1958.

74. Haberman HE, Baden MH. Alcoholism and violent death. Q J Stud Alcohol 1974;35:221-31.

75. Hotaling GT, Sugarman DB. An analysis of risk makers in husband to wife violence: the current state of knowledge. Victims and Violence 1986;1:101-24.

76. Ladoucer P, Temple M. Substance abuse among rapists. Crime Delinquency 1985;31:269-94.

77. Campbell A, Gibbs J, editors. Violent transactions. New York: Basil Blackwell, 1986.

78. Murphy GE. Problems in studying suicide. Psychiatr Dev 1983;1(4):339-50.

79. Miles CP. Conditions predisposing to suicide: a review. J Nerv Ment Dis 1977;164(4):231-46.

80. Roy A, Linnoila M. Alcoholism and suicide. Suicide Life Threat Behav 1986;16(2):244-73.

81. Kendall RE. Alcohol and suicide. Subst Alcohol Actions Misuse 1983;4(2-3):121-7.

82. Murphy GE, Wetzel RD. The lifetime risk of suicide in alcoholism. Arch Gen Psychiatry 1990;47:383-92.

83. Beck AT, Steer RA. Clinical predictions of eventual suicide: a 5- to 10-year prospective study of suicide attempts. J Affective Disord 1989;17:203-9.

84. Cullberg J, Wasserman D, Stefansson CG. Who thinks suicide after a suicide attempt? An 8 to 10 year follow-up in a suburban catchment area. Acta Psychiatr Scand 1988;77:598-603.

85. Hawton K, Fagg J, McKeown SP. Alcoholism, alcohol and attempted suicide. Alcohol Alcohol 1989;24:3-9.

86. Hlady WG, Middaugh JP. Suicides in Alaska: firearms and alcohol. Am J Public Health 1988;78:179-80.

87. Berlin IN. Suicide among American Indian adolescents: an overview. Suicide Life Threat Behav 1987;17:218-32.

88. Berman AL, Schwartz RH. Suicide attempts among adolescent drug users. Am J Dis Child 1990;144:310-14.

89. Petronis KR, Samuels TF, Mosicki ER, Anthony JC. An epidemiologic investigation of potential risk factors for suicide attempts. Soc Psychiatry Psychiatr Epidemiol 1990;25:193-9.

90. Goldstein PJ, Lipton DS, Spunt BJ, Belluci PA, Miller T, Cortez N, et al. Drug related involvement in violent episodes (DRIVE): interim final report to the National Institute on Drug Abuse (Grants DA-03182 and DA-04017). Rockville MD: National Institute on Drug Abuse, 1987.

91. Goldstein PJ, Brownstein HH, Ryan PJ, Belluci PA. Crack and homicide in New York City, 1988: a conceptually based event analysis. Contemp Drug Prob 1989;16:651-87.

92. Fagan J, Chin K. Violence as regulation and social control in the distribution of crack. In: de la Rosa M, Gropper B, Lambert E, editors. Drugs and violence. Rockville MD: National Institute of Drug Abuse, 1990.

93. Tonry M, Wilson JQ, editors. Drugs and crime. Chicago: Univ. of Chicago Press, 1990.

94. Spunt GJ, Goldstein PJ, Bellucci PA, Miller T. Race/ethnicity and gender differences in the drugs-violence relationship. J Psychoactive Drugs 1990;22:293-303.

95. Kempe CH, Silverman F, Steele B, Droegenmuller W, Silver H. The battered child syndrome. JAMA 1962;181:17-24.

96. O'Carroll PW, Smith JC. Suicide and homicide. In: Wallace HM, Ryan G, Oglesby AC, editors. Maternal and child health practices. Oakland CA: Third Party Publishing, 1988:583-97.

97. Jaffe P, Wolfe D, Wilson S, Zak L. Similarities in behavioral and social maladjustment among child victims and witnesses to family violence. Am J Orthopsychiatry 1986;56:142-46.

98. Rosenberg MS, Rossman BBR. The child witness to family violence. In: Ammerman RT, Herson M, editors. Treatment of family violence: a sourcebook. New York: Wiley, 1990:183-210.

99. Curtis GC. Violence breeds violence — perhaps? Am J Psychiatry 1963;120:386-7.

100. Kaufman J, Zigler E. Do abused children become abusive parents? Am J Orthopsychiatry 1987;57:186-92.

101. Parke RD, Slaby RG. The development of aggression. In: Mussen PH, editor. Handbook of child psychology. Vol. 4, 4th ed. New York: Wiley, 1983:547-641.

102. Widom CS. The cycle of violence. Science 1989;244:160-6.

103. Widom CS. Does violence beget violence? A critical examination of the literature. Psychol Bull 1989;106:3-28.

104. Straus MA, Gelles RJ. Societal change and change in family violence from 1975 to 1985 as revealed by two national surveys. J Marriage Fam 1986;48:465-79.

105. George C, Main M. Social interactions of young abused children: approach, avoidance and aggression. Child Dev 1979;50:306-18.

106. Dodge KA, Bates JE, Pettit GS. Mechanisms in the cycle of violence. Science 1990;250:1678-83.

107. Deykin EY, Alpert JT, McNamara JJ. A pilot study of the effect of exposure to child abuse and neglect on adolescent suicidal behavior. Am J Psychiatry 1985;142:1299-303.

108. Liebert RM, Sprafkin J. The early window: effects of television on children and youth. New York: Pergamon Press, 1988.

109. Huesmann LR, Eron LD, Lefkowitz MM, Walder LO. The stability of aggression over time and generations. Develop Psychol 1984;20:1120-34.

110. Gerbner G, Gross L, Jackson-Beeck M, Jeffries-Fox S, Signorielli N. TV violence profile no. 9: cultural indicators. J Commun 1978;28:176-207.

111. Bryant J, Carveth RA, Brown D. Television viewing and anxiety: an experimental examination. J Commun 1981;31:106-19.

112. Thomas MH, Horton RW, Lippincott EC, Drabman RS. Desensitization to portrayals of real-life aggression as a function of exposure to television violence. J Pers Soc Psychol 1977;35:450-8.

113. Heath L, Kruttschnitt C, Ward D. Television and violent criminal behavior: beyond the bobo doll. Violence Victims 1986;1:177-90.

114. National Commission on Causes and Prevention of Violence. To establish justice, to insure domestic tranquility. Washington DC: U.S. Government Printing Office, 1969.

115. National Institute of Mental Health. Television and behavior: ten years of scientific progress and implications for the eighties: I. Summary report. Washington DC: U.S. Department of Health and Human Services, 1982.

116. Dodge, KA. A social information-processing model of social competence in children. In: Perlmutter M, editor. Minnesota Symposium on Child Psychology. Vol. 18. Hillsdale NJ: Lawrence Erlbaum, 1986:77-125.

117. Slaby RG, Guerra NG. Cognitive mediators of aggression in adolescent offenders: 1. Assessment. Dev Psychol 1988;24:580-8.

118. Spivack G, Shure MB. Social adjustment of young children: A cognitive approach to solving real-life problems. San Francisco: Jossey-Bass, 1974.

119. Perry DG, Perry LC, Rasmussen P. Cognitive social learning mediators of aggression. Child Dev 1986;57:700-11.

120. Camp BW, Bash MAS. Think aloud: increasing social and cognitive skills — a problem-solving program for children. Champaign IL: Research Press, 1981.

121. Feindler EL, Marriot SA, Iwata M. Group anger training for junior high school delinquents. Cognitive Ther Res 1984;8:299-311.

122. Kazdin AE. Treatment of antisocial behavior in children: current status and future directions. Psychol Bull 1987;102:187-203.

123. Eron LD. Interventions to mitigate the psychological effects of media violence in aggressive behavior. J Soc Issues 1986;42:155-69.

124. Patterson, GR. Performance models for antisocial boys. Am Psychol 1986;41:432-44.

125. Patterson GR, Chamberlin P, Reid JB. A comparative evaluation of a parent-training program. Behav Ther 1982;13:638-50.

126. Government Accounting Office (GAO). Home visiting: a promising early intervention strategy for at-risk families. Report prepared for the Subcommittee on Labor, Health and Human Services, Labor and Related Agencies of the Senate, Committee on Appropriations. Washington DC: 1990. HRD-90-83.

127. Olds DL, Henderson CR, Tatelbaum R, Chamberlin R. Improving the life-course development of socially disadvantaged mothers: a randomized trial of nurse home visitation. Am J Public Health 1988;78:436-45.

128. Prothrow-Stith D. Interventions, intentional injuries, groups at the greatest risk, violence prevention. Public Health Rep 1987;102:615-6.

129. Guerra NG, Slaby RG. Cognitive mediators of aggression in adolescent offenders: 2. Intervention. Develop Psychol 1990;26:269-77.

130. Murray JP. Television and youth: 25 years of research and controversy. Boys Town NE: Boys Town Center, 1980.

131. Lyle J, Hoffman H. Children's use of television and other media. In: Rubinstein EA, Comstock GA, Murray JP, editors. Television and social behavior. Vol 4. Television in day-to-day life: patterns of use. Washington DC: U.S. Government Printing Office, 1972:129-56.

132. Ableman R. Determinants of parental mediation of children's television viewing. In: Bryant J, editor. Television and the American family. Hillsdale NJ: Lawrence Erlbaum, 1990:311-26.

133. Eron DG, Huesmann LR. Television as a source of maltreatment of children. Sch Psychol Rev 1987;16:195-202.

134. Desmond JR, Singer JL, Singer DG. Family mediation: parental communication patterns and the influences of television on children. In: Bryant J, editor, Television and the American family. Hillsdale NJ: Lawrence Erlbaum, 1990:293-309.

135. Shaffer D, Garland A, Gould M, Fisher P, Trautman P. Preventing teenage suicide: a critical review. J Am Acad Child Adolesc Psychiatry 1988;27:675-87.

136. Swanson JW, Holzer CE, Ganju VK, Jono R. Violence and psychiatric disorder in the community: evidence from the Epidemiologic Catchment Area surveys. Hosp Community Psychiatry 1990;41:761-70.

137. Shneidman ES, Farberow NL. Sample investigations of equivocal deaths. In: Farberow NL, Shneidman ES, editors. The cry for help. New York: McGraw-Hill, 1961.

138. Barraclough B, Bunch J, Nelson B, et al. A hundred cases of suicide: clinical aspects. Br J Psychiatry 1974;125:355-73.

139. Dorpat TL, Ripley HS. A study of suicide in the Seattle area. Compr Psychiatry 1960;1:349-59.

140. Maris RW. Pathways to suicide: a survey of self-destructive behaviors. Baltimore MD: The Johns Hopkins Univ. Press, 1981.

141. Rich CL, Young YG, Fowler RC. San Diego suicide study: I. Young v. old subjects. Arch Gen Psychiatry 1986;43:577-82.

142. Robins E. The final months. New York: Oxford, 1981.

143. Shafii M, Carrigan T, Whittinghill TR, Derrick A. Psychological autopsy of completed suicide in children and adolescents. Am J Psychiatry 1985;142:1061-4.

144. Hoberman H, Garfinkel B. Completed suicide in youth. Can J Psychiatry 1988;33:494-504.

145. Blumenthal SJ, Kupfer DJ. Generalizable treatment strategies for suicidal behavior. Ann N Y Acad Sci 1986;487:327-40.

146. Allebeck P, Wistedt B: Mortality in schizophrenia. Arch Gen Psychiatry 1986;43:650-3.

147. Rosenbaum M. The role of depression in couples involved in murder-suicide and homicide. Am J Psychiatry 1990;147:1036-9.

148. Hagnell O, Lanke J, Rorsman B. Suicide and depression in the male part of the Lundby study. Neuropsychobiology 1982;8:182-7.

149. Blumenthal SJ, Kupfer DJ. Suicide over the life cycle: risk factors, assessment, and treatment of suicidal patients. Washington DC: American Psychiatric Press, 1990.

150. Rich Cl, Fowler RC, Fogerty LA, Young D. San Diego suicide study: III. Relationships between diagnoses and stressors. Arch Gen Psychiatry 1988;45:589-92.

151. Elkin I, Shea T, Watkins JT, Imber SD, Sotsky SM, Colling JF, et al. National Institute of Mental Health Treatment of Depression Collaborative Research Program: general effectiveness of treatments. Arch Gen Psychiatry 1989;46:971-82.

152. Beck AT, Rush AJ, Shaw BF, Emory G. Cognitive therapy of depression. New York: Guilford Press, 1979.

153. Simons AD, Murphy GE, Levine JE, Wetzel RD. Cognitive therapy and pharmacotherapy for depression: sustained improvements over one year. Arch Gen Psychiatry 1986;43:43-9.

154. Conte HR, Plutchik R, Wild KV, Karasu TB. Combined psychotherapy and pharmacotherapy for depression: a systematic analysis of the evidence. Arch Gen Psychiatry 1986;43:471-9.

155. Regier DA, Hirschfeld RMA, Goodwin FK, Burke JD, Lazar JB, Judd LL. The NIMH Depression Awareness, Recognition, and Treatment Program: structure, aims, and scientific basis. Am J Psychiatry 1988;145:1351-7.

156. Goodwin FK. The biology of recurrence: new directions for the pharmacologic bridge. J Clin Psychiatry 1989;50(Suppl):40-7.

157. Post RM. Non-lithium treatment for bipolar disorder. J Clin Psychiatry 1990;51(Suppl):9-19.

158. Post RM, Altshuler LL, Ketter TA, Denicoff D, Weiss SR. Antiepileptic drugs in affective illness: clinical and theoretical implications. Adv Neurol 1991;55:239-77.

159. Biederman J, Jellinek M. Current concepts: psychopharmacology in children. N Engl J Med 1984;310:968-72.

160. Shapiro S, Skinner EA, Kessler LG, Vonkorff M, German PS, Tischler GL, et al. Utilization of health and mental health services: three Epidemiologic Catchment Area sites. Arch Gen Psychiatry 1984;41:971-89.

161. Hough RL, Landsverk JA, Karno M, Burnham A, Timbers DM, Escobar JI, et al. Utilization of health and mental health services by Los Angeles Mexican Americans and non-Hispanic whites. Arch Gen Psychiatry 1987;44:702-9.

162. Dew MA, Bromet ET, Brent D, Greenhouse JB. A quantitative literature review of the effectiveness of suicide prevention centers. J Consult Clin Psychol 1987;55:239-44.

163. Miller HL, Coombs DW, Leeper JD, Barton SN. An analysis of the effects of suicide prevention facilities on suicide rates in the United States. Am J Public Health 1984;74:340-3.

164. Spirito A, Overholser J, Ashworth S, Morgan J, Benedict-Drew C. Evaluation of a suicide awareness curriculum for high school students. J Am Acad Child Adolesc Psychiatry 1988;27:705-11.

165. Overholser JC, Hemstreet A, Spirito A, Vyse S. Suicide awareness programs in the schools: effects of gender and personal experience. J Am Acad Child Adolesc Psychiatry 1989:28:925-30.

166. Shaffer D, Vieland V, Garland A, Rojas M, Underwood M, Busner C. Adolescent suicide attempters. JAMA 1990;264:3151-5.

167. Berman AL, Jobes DA. Adolescent suicide: assessment and intervention. Washington DC: American Psychological Association, 1991.

168. Association of State and Territorial Health Officers, New Jersey Department of Health. Recommendations from a workshop on suicide contagion and the reporting of suicide. Washington DC: U.S. Department of Health and Human Services, 1991.

169. Bureau of Justice Statistics. Criminal victimization in the United States, 1988. A national crime survey report. Washington DC: U.S. Department of Justice, 1990.

170. Guyer B, Lescohier I, Gallagher SS, Hausman A, Azzara CV. Intentional injuries among children and adolescents in Massachusetts. N Engl J Med 1989;321:1584-9.

171. Westat, Inc. Study findings: study of national incidence of child abuse and neglect. Washington DC: U.S. Department of Health and Human Services, 1988.

172. Mercy JA, O'Carroll PW. New directions in violence predictions: the public health arena. Violence Victims 1988;3:285-301.

173. Bureau of Justice Statistics. Intimate victims: a study of violence among friends and relatives. Washington, D.C.: National Institute of Justice, National Crime Survey report. U.S. Department of Justice (SD NCS-N-14, NCJ-62319), 1980.

174. Marin RS, Morycz RK. Victims of elder abuse. In: Ammerman RT, Hersen M, editors. Treatment of family violence. New York: Wiley, 1990:136-64.

175. Hwalek M, Sengstock M, Lawrence R. Assessing the possibility of abuse in the elderly. J Appl Gerontol 1986;5:153-73.

176. Pillemer K. The dangers of dependency: new findings on domestic violence against the elderly. Soc Problems 1985;33:146-58.

177. Pillemer K. Risk factors in elder abuse: results from a case-control study. In: Pillemer KA, Wolf RS, editors. Elder abuse conflict in the family. Dover MA: Auburn House, 1986:239-63.

178. Pillemer K, Finkelhor D. The prevalence of elder abuse: a random sample survey. Gerontologist 1988;28:51-7.

179. Wolf R, Godkin M, Pillemer K. Elder abuse and neglect: final report from three model projects. Worcester MA: Univ. Center on Aging, Univ. of Massachusetts Medical Center, 1984.

180. Schechter S. Women and male violence. Boston: South End, 1982.

181. Schwartz MD. Gender and injury in spousal assault. Sociol Focus 1987;20:61-75.

182. Wilson WJ. The truly disadvantaged: the inner city, the underclass, and public policy. Chicago: Univ. of Chicago Press, 1987.

183. Steele BF, Pollack CB. A psychiatric study of parents who abuse infants and small children. In: Helfer RE, Kempe CH, editors. The battered child. Chicago: Univ. of Chicago Press, 1974:3-21.

184. Makepeace JM. Life events, stress, and courtship violence. Fam Relations 1983;32:101-9.

185. Roscoe B, Benaske N. Courtship violence experienced by abused wives: similarities in patterns of abuse. Fam Relations 1985;34:419-24.

186. Ellis D. Male abuse of a married or cohabitating female partner: application of sociologic theory to research findings. Violence Victims 1989;4:235-56.

187. Gaquin DA. Spouse abuse: data from the National Crime Survey. Victimology: An International J 1978;2:632-42.

188. Browne A, Williams KR. Exploring the effects of resource availability and the likelihood of female-perpetrated homicides. Law Soc Rev 1989;23:75-94.

189. Zahn MA. Homicide in the 20th century: trends, types, and causes. In: Gurr TR, editor. Violence in America. Volume 1: History of violence. Newbury Park, CA: Sage Publishers, 1989.

190. Frieze IH, Browne A. Violence in marriage. In: Ohlin H, Tonry M, editors. Family violence. Vol II. Crime and justice: an annual review of research. Chicago: Univ. of Chicago Press, 1989.

191. Fagan J, Friedman E, Wexler S, Lewis V. The national family violence evaluation: final report. Vol I. Analytic findings. San Francisco: URSA Institute, 1984.

192. Browne A. When battered women kill. New York: MacMillan/Free Press, 1987.

193. Russell DEH. Rape in marriage. New York: MacMillan, 1982.

194. Fagan J, Wexler S. Crime at home and in the streets: the relationship between family and stranger violence. Violence Victims 1987;2:5-23.

195. Shield N, McCall GJ, Hannecke CR. Patterns of family and non-family violence: violent husbands and violent men. Violence Victims 1988;3:83-98.

196. Saltzman LE, Levenson A, Smith JC. Suicides among persons 15-24 years of age, 1970-1984. Centers for Disease Control. In: CDC surveillance summaries. MMWR 1988;37(no.SS-1):61-8.

197. Gould MS, Wallenstein S, Kleinman MR, O'Carroll P, Mercy J. Suicide clusters: an examination of age-specific effects. Am J Public Health 1990;80:211-2.

198. Stafford M, Weishert R. Changing age patterns of U.S. male and female suicide rates, 1934-1983. Suicide Life Threat Behav 1988;18:149-63.

199. Baker FM. Black youth suicide: literature review with a focus on prevention. In: Alcohol, Drug Abuse, and Mental Health Administration: report of the Secretary's Task Force on Youth Suicide. Prevention and interventions in youth suicide. Washington DC: U.S. Government Printing Office, 1989;177-95;DHHS publication no.(ADM)89-1623.

200. Sorenson SB, Golding JM. Suicide ideation and attempts in a community sample of Hispanic and non-Hispanic whites: demographic and psychiatric disorder issues. Suicide Life Threat Behav 1989;19:322-33.

201. Shore JK. American Indian suicide: fact and fantasy. Psychiatry 1975;38:86-91.

202. U.S. Congress, Office of Technology Assessment (OTA). Indian adolescent and mental health. Washington DC: U.S. Government Printing Office, 1990;OTA-H-446.

203. Garrison CZ. The study of suicidal behavior in the schools. Suicide Life Threat Behav 1989;19:120-30.

204. Smith K, Crawford S. Suicidal behavior among normal high school students. Suicide Life Threat Behav 1986;16:313-25.

205. Shaffer D, Garland A, Bacon K. Prevention issues in youth suicide. In: Shaffer D, Philips I, Enzer NB, editors. Prevention of mental disorders, alcohol and other drug use in children and adolescents. OSAP Monograph Z. Rockville MD: Office for Substance Abuse Prevention, 1989:373-412.

206. Harkavy Friedman JM, Asnis GM, Boeck M, DiFiore J. Prevalence of specific suicidal behavior in a high school sample. Am J Psychiatry 1987;144:1203-6.

207. Centers for Disease Control. Attempted suicide among high school students: United States, 1990. MMWR 1991;40:633-635.

Addendum to References:

*Loftin C, McDowall D, Wiersema B, Cottey TJ. Effects of restrictive licensing of handguns on homicide and suicide in the District of Columbia. NEJM 1991; 325:1615-1649.

Appendix A:
Detailed Demographic and Other Patterns of Injuries from Violence

Appendix A: Detailed Demographic and Other Patterns of Injuries from Violence

Interpersonal Violence

Federal Bureau of Investigation (FBI) records indicate that in 1989 in the United States 910,092 serious assaults occurred (41). This number, however, is an underestimate of the magnitude of the problem. Estimates from National Crime Survey (NCS) data indicate that during 1988 in the United States, 4,734,190 assaults occurred among people over 12 years of age who were not institutionalized (169). Of those assaulted, 1,430,160 were estimated to have suffered injuries (169).

Using Massachusetts hospital records for the years 1979 to 1982, researchers estimated that each year 1 of every 130 individuals 19 years of age or younger had been treated for injuries resulting from fights, rapes, child batterings, or other violent assaults (170).

Interpersonal violence is a distinctive and disturbing aspect of American society. A recent comparison of homicide rates among males 15 to 24 years of age in 21 developed countries showed that the U.S. homicide rate is not only the highest for any developed country, it is also 4.4 times higher than that for the country (Scotland) with the next highest rate and many times higher than rates for other developed countries (3) (Figure 1).

Although interpersonal violence occurs within almost every segment of American society, vast differences in violent injury rates are associated with age, sex, race and ethnicity, socioeconomic status, and site of the violent event.

Age. Victims of interpersonal violence are often young. In 1987, more than half the victims (56%) were under age 34, and a quarter (25%) were from 15 to 24 years old (38). Because homicide victims usually die young, homicide ranks sixth among all causes of death in terms of years of potential life lost (YPLL) (2).

Although almost three decades have lapsed since "the battered child syndrome" was first brought to public attention (95), infants and very young children continue to be at a relatively high risk of violent injury and death. In 1986, child abuse and neglect caused 1,100 deaths (171). Each year, an estimated 1.6 million children are seriously injured or impaired by abuse and neglect (4, 5). Common injuries to children from abuse or neglect include head injuries, broken bones, lacerations, intestinal perforations, obstructions from trauma to the abdomen, and third-degree burns (4).

In recent years, rates of homicide among adolescents and young adults have increased markedly (1). Among individuals 15 to 24 years of age, homicide now ranks as the second leading cause of death in the United States (172).

Interpersonal violence among adults takes a wide variety of forms, including sexual violence and intrafamilial abuse. Nearly 9% of all U.S. homicides reported during a 10-year period were perpetrated by the victim's spouse (8), and more than 30% of all incidents of nonfatal violence documented during a 4-year period were attributed to the victim's spouse (173).

Interpersonal violence against elderly people also represents a substantial problem in the United States (174). An estimated 2% of the elderly population experiences physical violence, usually from a relative who lives with and is financially dependent on the victim (175-179).

Sex. Males are far more likely than females to become perpetrators or victims of homicide and many other forms of interpersonal violence. In the United States, males perpetrate 84% of the homicides with male victims and 90% of the homicides with female victims (41). Males are the victims of 76% of all homicides (41).

In contrast, females are more likely than males to become victims of spouse homicide, nonfatal spouse abuse, sexual assault, rape, and childhood sexual abuse. From 1976 to 1985, spouse homicides accounted for 8.8% of all homicides (8). Overall, wives are 1.3 times more likely than husbands to be killed by a legal or common-law spouse; this pattern is reversed, however, among black spouses (8). Nonfatal physical violence between spouses is estimated to occur in one of six homes each year, and females are more likely than males to be injured (15). An estimated 95% of serious assaults by a spouse or intimate partner are against females (180, 181). Special considerations relating to violence against women by husbands and other intimates are reviewed later.

Race and Ethnicity. Black males are more than seven times more likely than white males to become victims of homicide. The rate of spouse homicide among black couples is 8.4 times higher than that among whites couples (8). Although national reporting of homicide victimization by ethnic status is not yet complete, 1977 to 1982 estimates from five southwestern states indicate that the homicide rate for Hispanics was 47% of the rate for blacks, but nearly three times that for non-Hispanic whites. American Indians in reservation states also have a high risk of becoming victims of homicide. When socioeconomic status is taken into account, the disparity between racial/ethnic minority and nonminority groups, as both perpetrators and victims of interpersonal violence, diminishes substantially (10-13).

Age, race, and sex considered together. The lifetime probability of dying from homicide in the United States for four race-sex groups is as follows (FBI Uniform Crime Reporting data, 1989, unpublished observation):

- 1 in 496 for white females
- 1 in 205 for white males
- 1 in 117 for black females
- 1 in 27 for black males

Young black males are at the highest risk of homicide of any age-race-sex group in the United States. In fact, homicide is the leading cause of death for black males 15 to 34 years of age (3, 7).

Socioeconomic factors. Homicide rates in the United States vary markedly according to the economic status of the community (182). Poor, urban inner-city areas tend to have much higher rates of interpersonal violence and homicide than do suburban and rural areas (Mercy and colleagues, conference background paper, 1986, unpublished observation). Children from lower income families (i.e., those earning less than $15,000 per year) are four times more likely to be physically abused than children from higher income families (4). The relationship between low income and child abuse may be due partly to reporting bias, because low income individuals are more likely to be under public and protective scrutiny (14, 183). Many known risk factors for child abuse and neglect are, however, much more prevalent in impoverished communities than elsewhere. In addition, even results of self-report surveys show a higher prevalence of child abuse and neglect among families with lower socioeconomic status (104). Therefore, it is unlikely that all of the association between poverty and child abuse and neglect is the product of such reporting bias.

Workplace as a site for violence. Homicide is one of the top three causes of traumatic death in the workplace. Work-related violence accounts for about 13% of all work-related deaths. Work-related homicide is the leading cause of death among females who die from work-related activities and the third leading cause of death among males who die at work. Homicide deaths in the workplace are most common among those 65 years of age and older, accounting for 2.7 deaths per 100,000 workers. Homicides occur most frequently among people who work in public administration (police officers), retail sales (clerks and proprietors of convenience stores, gas stations, liquor stores, bars, and restaurants), and transportation (taxi and short-haul transport drivers).

Violence among spouses and other intimates. Acts of physical aggression between spouses occur in one of six homes each year (14, 15). Of these incidents, more than a third are severe assaults involving such acts as punching, kicking, hitting with an object, beating up, and assaulting with a gun or knife. In national surveys, about two-thirds of the people reporting at least one incident of marital violence reported that multiple incidents of such violence occurred in the year preceding the survey.

Severe violence by males (as reported by females) is far more common among dating, cohabiting, or engaged couples than among intact married couples (184, 185). Ellis (186) found that females separated from their partners had more severe violent acts directed against them by their partners than did females in other marital or cohabitational statuses. Gaquin (187) also found that separated and divorced females were at higher risk of being harmed by their estranged husbands than were married females.

Injuries and fatalities from partner violence affect females disproportionately. Each year, 2 million females are severely assaulted by their male partners (104), and more than half of the female homicide victims in the United States are killed by partners or ex-partners (188, 189).

Marital rape is an integral part of marital violence (190, 191) and may be an antecedent to marital homicide (192). Among females in San Francisco who had ever been married, 14% said they had been raped by a husband or ex-husband (193).

Several factors may account for the high rates of violence among spouses and intimates, including (a) the large amount of time intimates interact, (b) cultural norms, (c) sex role socialization that may legitimate the use of violence by males, and (d) the privacy of family interactions (and concomitant absence of societal restraints). Research on the overlap between family and stranger violence also suggests that many males who physically attack their female partners are also violent toward individuals outside the family (194, 195).

Suicide and Attempted Suicide

Suicide

Suicide is the eighth leading cause of death in the United States. About 20% of all injury deaths are due to suicide (16). In 1988, 30,407 persons completed suicide (1), and the corresponding age-adjusted suicide rate was 11.4 per 100,000, down from 11.7 per 100,000 in 1979 (1). In 1988, the age-adjusted suicide rate for white males was 21.6 per 100,000, 12.1 for black males, 5.2 for white females, and 2.4 for black females. These figures, however, probably represent underestimates of the problem because suicide is typically underreported.

Age. Recent patterns and trends in suicides among young people and old people are obscured by the aggregate statistics cited previously. Specifically, suicide rates among people 15 to 24 years of age have virtually tripled since 1950. These increases make suicide the third leading cause of death in this age group (1). By 1987, the annual suicide rate was 10.3/100,000 for those 15-19 years old and 15.3 per 100,000 for those 20 to 24 years old. From 1970 to 1984, the rate of increase was 55.2% among 15- to 19-year-olds and 28.9% among 20- to 24-year-olds (196). Suicide clusters (i.e., an excessive number of suicides

occurring over a short time or in relative geographic proximity or both) have also been found to be two to four times more common in the 15- to 19-year and the 20- to 24-year age groups than in all other age groups (197). Such clusters, however, represent only a small proportion of youth suicides.

In the past few decades, suicide rates among older people have generally declined, but suicide rates among young people have increased. The net effect was an artificially stable crude suicide rate. Since 1979, however, after a 40-year period of decline (198), annual suicide rates among persons 65 years and older have been increasing (1). For persons 70 years and older, the highest rates are found among white males (60.0 per 100,000), followed by black males (18.8 per 100,000), white females (6.8 per 100,000), and black females (1.8 per 100,000) (1).

Sex and race. As indicated above, suicide rates for males are higher than for females across all age groups. Whites are consistently at higher risk of suicide than blacks. Although the annual suicide rate for males 15 to 34 years of age is substantially lower among blacks than it is among whites (6.6 per 100,000 vs. 13.7 per 100,000; NCHS 1990), the suicide rate for young black males increased at rates equivalent to or higher than that for young white males during the years 1940 to 1980 (198). Furthermore, several investigators have reported higher suicide rates for young black males than for young white males in specified urban centers (199).

From 1975 to 1980, the average annual suicide rate for Hispanics in five southwestern states was less than half that for whites (9 per 100,000 vs. 19.2 per 100,000). Among Mexican-Americans, being born in Mexico and being Catholic have been related to a lower incidence of suicidal behavior (200). The suicide rate for American Indians and Alaskan Natives varies greatly across Indian tribes, but overall it is much higher than that for the general population (201). Annual rates ranging from 8 per 100,000 to 120 per 100,000 have been reported among Indians living on reservations. The suicide rate for Indian adolescents in 1986 was estimated at 26.3 per 100,000 (202).

Attempted Suicide

We have studied suicide attempters in an effort to understand completed suicide, but suicide attempts also should be viewed as a significant injury problem in their own right. Among suicide attempters, lethality of suicidal intent varies greatly, and some "attempts" are not designed to be lethal. Because most studies of suicide attempts rely on self-reports, without operational definitions, respondents are allowed to use their own meaning of "suicide attempt" (203). Increasing evidence indicates that this approach produces a large overestimate of the number of suicide attempters who actually suffer injury or poisoning from their behavior or who require even minor medical or surgical attention (30). Therefore, the estimates that follow should be interpreted with caution.

A review of population surveys indicates that lifetime prevalence estimates for self-reported attempted suicide among adults vary from 1.1% to 4.2% (19). In the Epidemiologic Catchment Area (ECA) study, which focused on persons 18 years of age and older, the weighted lifetime prevalence was estimated at 2.9%, and the annual prevalence was estimated at 0.3%. Suicide attempts were more commonly reported among females (4.2%) than males (1.5%) and most frequently among persons 25 to 44 years of age (4.0%). Separated and divorced persons (8.5%) had a much higher rate of attempted suicide than married or widowed persons (2.0%). The suicide attempt rate increased systematically from groups with high socioeconomic status (SES) to those with low SES, and the rate was lowest in rural areas. Risk factors for attempting suicide within a 1- to 2-year period include a diagnosis of major depression, current alcoholism, and current cocaine use (89). Results of high school surveys of adolescent suicidal behavior have shown an 8% to 9% prevalence of lifetime self-reported prior suicide attempts (204-206). Again, the prevalence of serious or injurious suicidal behavior appears to be much lower than the overall prevalence of self-reported "attempted suicide" (207).

Appendix B:
Healthy People 2000:
Health Objectives for the Nation
Related to Violent and Abusive Behavior

Appendix B: Healthy People 2000 : Health Objectives for the Nation Related to Violent and Abusive Behavior

7.1	Reduce homicides to no more than 7.2 per 100,000 people. (Age-adjusted baseline: 8.5 per 100,000 in 1987)			
		Homicide Rate (per 100,000)	*1987 Baseline*	2000 Target
	7.1a	Children aged 3 and younger	3.9	3.1
	7.1b	Spouses aged 15-34	1.7	1.4
	7.1c	Black men aged 15-34	90.5	72.4
	7.1d	Hispanic men aged 15-34	53.1	42.5
	7.1e	Black women aged 15-34	20.0	16.0
	7.1f	American Indians and Alaskan Natives in reservation states	14.1	11.3
7.2	Reduce suicides to no more than 10.5 per 100,000 people. (Age-adjusted baseline: 11.7 per 100,000 in 1987)			
		Suicide (per 100,000)	*1987 Baseline*	*2000 Target*
	7.2a	Youth aged 15-19	10.3	8.2
	7.2b	Men aged 20-34	25.2	21.4
	7.2c	White men aged 65 and older	46.1	39.2
	7.2d	American Indians and Alaskan Natives in reservation states	15.0	12.8
7.3	Reduce weapon-related violent deaths to no more than 12.6 per 100,000 people from major causes. (Age-adjusted baseline: 12.9 per 100,000 by firearms; 1.9 per 100,000 by knives, in 1987)			
7.4	Reverse the rising incidence of maltreatment of children younger than age 18, and reduce it to less than 1986 baseline levels. (Baseline: 25.2 per 1,000 in 1986)			
		Incidence of Types of Maltreatment (per 1,000)	*1986 Baseline*	*2000 Target*
	7.4a	Physical abuse	5.7	<5.7
	7.4b	Sexual abuse	2.5	<2.5
	7.4c	Emotional abuse	3.4	<3.4
	7.4d	Neglect	15.9	<15.9
7.5	Reduce physical cases of abuse directed at women by male partners to no more than 27 per 1,000 couples. (Baseline: 30 per 1,000 in 1985)			
7.6	Reduce assault injuries among people aged 12 and older to no more than 10 per 1,000 people. (Baseline: 11.1 per 1,000 in 1986)			

7.7	Reduce rape and attempted rape of women aged 12 and older to no more than 108 per 100,000 women. (Baseline: 120 per 100,000 in 1986)
	Incidence of Rape and Attempted Rape (per 100,000) — 1986 Baseline — *2000 Target* 7.7a Women aged 12-34 — 250 — 225
7.8	Reduce by 15 percent the incidence of injurious suicide attempts among adolescents aged 14 through 17. (Baseline data available in 1991)
7.9	Reduce by 20 percent the incidence of physical fighting among adolescents aged 14 through 17. (Baseline data available in 1991)
7.10	Reduce by 20 percent the incidence of weapon-carrying by adolescents aged 14 through 17. (Baseline data available in 1991)
7.11	Reduce by 20 percent the proportion of people who possess weapons that are inappropriately stored and therefore dangerously available. (Baseline data available in 1992)
7.12	Extend protocols for routinely identifying, treating, and properly referring suicide attempters, victims of sexual assault, and victims of spouse, elder, and child abuse to at least 90 percent of hospital emergency departments. (Baseline data available in 1992)
7.13	Extend to at least 45 States implementation of unexplained child death review systems. (Baseline data available in 1991)
7.14	Increase to at least 30 the number of States in which at least 50 percent of children identified as neglected or physically or sexually abused receive physical and mental evaluation with appropriate followup as a means of breaking the intergenerational cycle of abuse. (Baseline data available in 1993)
7.15	Reduce to less than 10 percent the proportion of battered women and their children turned away from emergency housing due to lack of space. (Baseline: 40 percent in 1987)
7.16	Increase to at least 50 percent the proportion of elementary and secondary schools that teach nonviolent conflict resolution skills, preferably as a part of quality school health education. (Baseline data available in 1991)
7.17	Extend coordinated, comprehensive violence prevention programs to at least 80 percent of local jurisdictions with populations over 100,000. (Baseline data available in 1993)
7.18	Increase to 50 the number of states with officially established protocols that engage mental health, alcohol and drug, and public health authorities with corrections authorities to facilitate identification and appropriate intervention to prevent suicide by jail inmates. (Baseline data available in 1992)

Home and Leisure Injury Prevention

Part 1: Selected Injuries

Part 2: An Infrastructure for Injury Control

Home and Leisure Injury Prevention
— Contributors —

Leon Robertson, Ph.D., Chairperson, Nanlee Research, Branford, CT

Lorann Stallones, Ph.D.,* Colorado State University, Fort Collins, CO

Christine M. Branche-Dorsey, Ph.D., M.S.P.H., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Nancy Nowak, R.N., M.P.H., Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Susan Baker, M.P.H., The Johns Hopkins University, Baltimore, MD

Thomas R. Bender, M.D., M.P.H., National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

Mary Dufour, M.D., M.P.H., National Institute on Alcohol Abuse and Alcoholism, Rockville, MD

John Lumpkin, M.D., M.P.H., Illinois Department of Public Health, Springfield, IL

Elizabeth McLoughlin, Sc.D., San Francisco General Hospital, San Francisco, CA

Sylvia Micik, M.D., North County Health Services, San Marcos, CA

Marcia Ory, Ph.D., M.P.H., National Institute on Aging, Bethesda, MD

Thomas W. Planek, Ph.D., National Safety Council, Chicago, IL

Fred Rivara, M.D. M.P.H., Harborview Injury Prevention and Research Center, Seattle, WA

George W. Rutherford, Jr., M.S., Consumer Product Safety Commission, Bethesda, MD

Peter C. Scheidt, M.D., M.P.H., National Institute for Child Health and Human Development, Rockville, MD

Mark Widome, M.D., M.P.H., Pennsylvania State University College of Medicine, Hershey, PA

Nicole Lezin, M.P.P., Macro International, Inc., Atlanta, GA

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Part 1:
Selected Injuries

Introduction

In 1988, 48,022 Americans died from unintentional injuries not related to motor vehicles. Most injuries occurred in leisure activities and in homes, although an inexact number were occupational (see the Occupational Injury Prevention Panel's report). Although most of the nonfatal injuries are scratches, bruises, and minor burns that heal quickly and are forgotten, significant numbers are quite serious. Thousands more Americans were severely injured but not killed. A national plan for this group of injuries should focus mainly on the factors that cause death, permanent damage (burn scars, brain and spinal cord injury, loss of limbs) or substantial hospitalization and medical care costs (hip fracture).

As members of the Home and Leisure Injury Prevention Panel, we have selected five types of unintentional injuries that deserve attention in the national agenda, either because they contribute enormously to morbidity and mortality or because they highlight the need for us to apply known prevention strategies and to develop research and new prevention strategies:

- Falls
- Drownings
- Poisonings
- Fire- and burn-related injuries
- Firearm injuries

These five injury types are also emphasized in the U.S. Department of Health and Human Services' Health Objectives for the Nation, detailed in the Appendix.

Because of space limitations, we cannot discuss every injury in detail. This does not imply that nothing should or can be done about these other injuries. On the contrary, with all severe injuries we should emphasize better surveillance of circumstances, expertise in the choice of interventions, and the implementation of known solutions for known problems. Less understood problems can be clarified by research. Resources to implement and evaluate these approaches must be identified.

General Scope

In 1986, more than 1,000 U.S. deaths occurred in each of the following categories of injury: falls, drownings, poisonings, fires and burns, choking on food and other substances or objects, firearm use, and machine use in agriculture, industry, building, or maintenance. The numbers of deaths and population-based rates in 1980-1986 for these types are presented

in Table 1, along with data on the aggregated "other" deaths and motor vehicle-related deaths. Despite a slight decrease in some of these rates from 1980 to 1986, in 1986, 48,410 people died from unintentional injuries unrelated to motor vehicles. These deaths accounted for 32% of the total injury deaths.

Costs

In a 1989 report to Congress, the lifetime costs in 1985 were approximately $21.0 billion for falls, $2.8 billion for fire- and burn-related injuries, $8.5 billion for poisonings, $2.1 billion for drownings or near-drownings, and $14.4 billion for firearm injuries (1). Rice and colleagues estimated lifetime costs of injury, using the human capital approach to valuing life. Productivity lost through premature death and disability is considered an indirect cost of injury. These are conservative estimates and do not include costs associated with pain and suffering or property damage from fires and firearm use.

Hospitalization and disability data are not available for several of the categories listed in Table 1 because few hospitalizations for injury are coded by circumstances. The costs of the other types of injuries in Table 1 are not estimated separately in that report because of a lack of detailed information.

Surveillance and Injury Control

The recommendations that follow emphasize the need for surveillance activities for all injuries. Surveillance activities at the federal, state, and local levels that rely on consistent definitions of injury are necessary for our complete understanding of injury control needs. Local investigations of injury events, including mapping of injury conditions, can yield crucial data on incidence, location, and circumstances. In addition, morbidity and mortality data E-coded from uniform hospital discharge data, emergency department data, and medical examiners are needed to describe injury circumstances. Surveillance at the state and local levels is needed to ensure that injury control measures are aimed at populations at highest risk and at the factors that place them at highest risk. Injuries that are not prominent in national data may be so in certain localities.

Two of the difficulties in forming a surveillance plan for a wide variety of injuries are the diversity of possible classifications — the types of energy exchange involved, the various reservoirs and conveyances of energy, the various places injuries occur — and the different characteristics that increase risk among different population groups. For example, drownings and fire- or burn-related injuries predominate among children; poisonings, drownings, and falls frequently involve those 15-64 years old; and falls stand out in persons 65 and older (Table 2) (2).

Number of Deaths and Rate Per Population of Major Causes of Unintentional Injury Deaths
United States, 1980 - 1986

Table 1

	1980	1981	1982	1983	1984	1985	1986
Motor Vehicle	51,930	50,196	44,713	43,428	45,208	44,822	46,867
Per 100,000 Pop.	23.4	22.4	19.7	19.0	19.6	19.2	19.9
Falls	13,294	12,628	12,077	12,024	11,937	12,001	11,444
Per 100,000 Pop.	5.9	5.5	5.2	5.1	5.0	5.0	4.7
Poisonings	4,331	4,523	4,733	4,633	4,911	5,098	5,740
Per 100,000 Pop.	1.9	2.0	1.9	1.9	2.1	2.2	2.4
Drownings	7,257	6,277	6,351	6,353	5,388	5,316	5,700
Per 100,000 Pop.	3.2	2.7	2.7	2.7	2.3	2.2	2.4
Fire- and Burn-Related Injuries	6,016	5,889	5,364	5,167	5,152	5,114	4,969
Per 100,000 Pop.	2.7	2.5	2.3	2.2	2.2	2.1	2.1
Aspiration (Non-food)	1,306	1,263	1,407	1,562	1,786	1,888	1,983
Per 100,000 Pop.	0.6	0.5	0.6	0.7	0.8	0.8	0.8
Aspiration (Food)	1,943	2,068	1,847	1,825	1,755	1,663	1,709
Per 100,000 Pop.	0.9	0.9	0.8	0.8	0.7	0.7	0.7
Firearm	1,955	1,871	1,756	1,695	1,668	1,649	1,452
Per 100,000 Pop.	0.9	0.8	0.8	0.7	0.7	0.7	0.6
Machinery	1,471	1,488	1,403	1,277	1,277	1,288	1,202
Per 100,000 Pop.	0.7	0.6	0.6	0.5	0.5	0.5	0.5
Other	16,215	14,501	14,431	14,524	13,829	14,618	14,211
Per 100,000 Pop.	7.3	6.2	6.2	6.2	5.9	6.0	6.0

Source: (2)

Table 2

Major Unintentional Causes of Injury Deaths (Excluding Motor Vehicles) United States, Percent by Age in 1986

	Age at Death (yrs)			
	0-4	5-14	15-64	65+
Falls	4.6	3.2	11.8	38.7
Poisonings	2.2	2.1	18.3	4.2
Drownings	29.2	34.2	16.7	3.9
Fire- and Burn-Related Injuries	26.1	17.3	8.0	8.5
Aspiration (Nonfood)	5.0	1.1	1.3	7.5
Aspiration (Food)	5.2	1.1	2.0	5.2
Firearms	1.3	11.1	4.9	1.1
Machinery	1.6	2.6	4.3	2.4
Other	24.8	27.3	32.7	28.5

Source: (2)

We are not implying that these injury categories reflect similar circumstances among various age groups. For example, we know that severe injuries from falls among the elderly usually involve relatively low energy exchanges but that severe falls among children are usually from heights. Moreover, different patterns of injury and severity are found in different income groups and in different regions of the country. Nevertheless, there are similarities in injury patterns and approaches to injury control that have permitted substantial reductions of injuries in a few documented cases. These cases can serve as models for preventing other unintentional injuries.

In addition to implementing model interventions, research is needed to develop new ones. For example, research on biomechanics — the study of the mechanical forces that cause trauma to human tissue — has led to safety advances in the motor vehicle field, such as air bags, safety belts, child restraints, and motorcycle helmets. This same type of research can lead to interventions that reduce the severity of falls. For example, hip pads and other devices that prevent or reduce injuries from falls among the elderly are possible topics of biomechanics research. Similarly, biomechanics research can focus on the effects of the muzzle velocity of firearms and the characteristics of ammunition.

Examples of the Model at Work

Successful programs to prevent definable injuries or reduce their severity provide the outline for a plan to accelerate reductions. Programs that have successfully reduced injuries as diverse as aspirin poisoning, burns from ignited sleepwear, and falls from windows have had several common elements: adequate surveillance to define the circumstances of the injury, recognition of an action that would probably reduce incidence or severity, and action by those in a position to initiate intervention.

The following common elements appear to be associated with most of the injury reductions resulting from these interventions (3):

- Surveillance of the injuries reveals that the pattern of injury circumstances is fairly obvious and consistent among exposed populations.
- A countermeasure exists in the form of a product or environmental modification that eliminates the hazard or reduces it demonstrably.
- The countermeasure, its cost, and the need for behavior change are accepted by the public, are sufficiently minor to be of little significance, or are overlooked entirely.
- Manufacturers and designers are persuaded or required to institute countermeasures. (As technology advances, some interventions — such as smoke detectors — represent profitable new markets for manufacturers.)
- The injury-producing product or environment is susceptible to relatively rapid modification or replacement over time.
- The need for behavior change by users is minimal.

In addition, national, state, and community coalitions of professionals as well as political and other leaders are needed in most areas of injury control if the model is to be implemented.

When manufacturers of children's aspirin were made aware that a significant number of child poisonings were the result of ingestion of their product, they reduced the dosage per package and modified the packages to reduce the ability of children to open them. Child poisonings from aspirin thus were reduced 80% (4).

After Congress amended the Flammable Fabrics Act in 1967 to permit broader regulation of clothing, the Information Council on Fabrics Flammability, a consortium of representatives from industry, government, and medicine, worked for passage of the two Children's Sleepwear Standards in 1972 and 1975 (5). The Consumer Product Safety Commission (CPSC) estimated that, in 1982, 97% fewer children aged 0-14 years died from burns caused by clothing ignition than died in 1970.

During the 1960s, personnel at the New York City Health Department noticed that about 30 to 60 children per year were being killed in falls from heights. A surveillance project to identify the circumstances was launched, and the findings indicated that 85% of the deceased children who were less than 5 years old, and 61% of those who were less than 15 years old had fallen from windows in high-rise buildings (6). With the "Children Can't Fly" program, the health department persuaded landlords and apartment owners to install window guards that children could not reach (7) and later required the guards if a tenant requested them. By 1980, the deaths to children from falls from heights were reduced to about four per year (8).

These examples of modest but important successes convince us that a systematic approach to identifying relatively homogeneous injuries, identifying ameliorative approaches that are relatively easy to implement, and organizing responsibility to implement and monitor injury prevention programs can substantially reduce common injuries. Clearly, some causes of injuries are national in scope (aspirin poisoning, ignited sleepwear), whereas others are regional or local (falls from high-rise apartment buildings). Personnel working at each of these levels must recognize their injury reduction roles and coordinate efforts to avoid duplicating their work or working at cross purposes.

Interventions that have reduced injuries or their severity include redesigned refrigerator and freezer doors to prevent child entrapment, ground-fault circuit interrupters, automatic stops for walk-behind lawn mowers, devices to prevent chain-saw kickback, and smoke detectors.

Other injury control efforts that have a reported effectiveness but that have not been uniformly applied include educating nurses and monitoring patient falls in a hospital (9), counseling parents about infant falls (10), installing fences with self-latching gates around public and private pools (11), requiring smoke detectors in homes (12), using breakaway bases for softball (13), organizing the community to prevent burn injuries (14), using group discussion in the community as an educational tool to reduce all injuries (15), requiring flame-retardant sleepwear (16), using child-resistant containers for various substances (17, 18), redesigning coffee maker filters to prevent spills (19), and instituting a community-wide bicycle-helmet program addressing lack of awareness, peer pressure, and cost (20).

Recommendation: Federal, state, and local health agencies, academic institutions, other private and not-for-profit agencies, and community-based organizations interested in home and leisure injury prevention should collaborate on nationwide efforts in surveillance, research, risk-factor assessment, and intervention strategies. Such coordination will promote consistency of data and avoid duplication of effort. These tasks should also focus on people in racial and ethnic minority populations and on women, both to understand risk factors and causes of injuries and to reach these high-risk populations with effective prevention strategies.

Alcohol Policies

Alcohol is implicated as a contributing factor in many types of injuries. Two policies regarding alcohol have been particularly effective — the 21-year-old legal minimum drinking age (21) and alcohol taxation (22). Although the 21-year-old drinking age has been adopted in all states, recent evidence suggests that the law is not being uniformly enforced. Moreover, inflation has eroded the effect of alcohol taxes.

Because these policies affect home and leisure injuries as well as motor vehicle-related injuries, we reiterate and endorse the recommendations of the Surgeon General's Workshop on Drunk Driving (23):

- Equalize federal excise tax rates by ethanol (pure alcohol) content for all beverages by raising rates for beer and wine to that for distilled spirits. Adjust the resulting equalized excise tax rate to reflect the change in the Consumer Price Index since 1970, and, in the future, annually adjust the resulting excise tax rate to reflect changes in the price index for the previous year.
- Strengthen enforcement of underage drinking laws with penalties for purchasers, sellers, and servers.

Falls

Where We Are

Dimensions of the Problem

Accounting for one out of five injuries and one-third of hospitalized injured persons, falls are the leading cause of all nonfatal injuries (1). Fall injuries result in morbidity conditions, such as hip and other fractures and head injuries (especially among children). They are the second leading cause of death from unintentional injuries after motor vehicle crashes (Table 1).

Each year, a fourth of all persons 65 to 74 years of age and a third or more of those aged 75 or older report a fall (24). Falls and fall-related injuries occur at every age, but the vulnerability and the longer recovery periods of old age make falls and other mobility-related injuries a serious threat to the health and functioning of older persons. Each year, more than 10,000 deaths among older persons in the United States are attributed to falls and fall-related injuries (25). The true number of deaths in which a fall is a contributing factor is likely to be much higher because of the way information is reported on death certificates. For example, the immediate cause of death might be pneumonia, which would not have occurred if an elderly person had not been bedridden because of a fall.

In 1985, falls among children ages 0 to 19 accounted for 328 deaths, 122,693 hospital admissions, and 3.6 million emergency department visits (26). Children under the age of 5 are at increased risk for fall injuries (0.5/100,000) (27). The incidence of childhood fall injuries is highest in infancy and declines throughout childhood (0.2/100,000 at ages 5-14). This decline is believed to be associated with the developmental process (28). For babies under 1 year of age, falls often involve furniture such as changing tables or baby walkers. Among toddlers, fatal falls are more common from windows or on stairs. As the child gets older, falls from roofs or playground equipment, bicycles, and horses are more common. When falling from a low surface (bed, walker, changing table, or step), children are at a substantial risk of head injury because of their relatively large head mass. Falls from heights greater than 10 feet are usually from windows for infants and toddlers, and from playing areas (trees, fire escapes, or roofs) for older children (7).

Costs

The total lifetime cost of falls in 1985 was an estimated $37.3 billion (1). With growing recognition of the costs of falls and related injuries, the federal government has recently targeted the reduction of falls among older Americans as a major public health objective (25, 29).

The lifetime cost of injury for people 65 and older is estimated to be $14.9 billion, of which nearly $10 billion can be attributed to falls (1). In addition to costs, fall-related injuries place a considerable physical and psychological burden on older people, their families, and society at large. Although serious fall injuries among children and young people ages 0 to 25 years are less frequent, most injuries during the first several years of life are due to minor falls from low levels. The estimated cost for injuries among this age group is $10.2 million because of their longer life expectancy relative to the elderly population. About 70% of these costs ($7.2 million) are indirect morbidity costs that reflect losses in productivity due to disability in a young population (25). Major cost savings could result from reducing the severity of falls at all ages.

Surveillance

Nonfatal falls associated with products such as floors, stairs, and bicycles are counted in the National Electronic Injury Surveillance System (NEISS), but other falls are not counted except in hospitals with adequate systems for E-coding and tracking injuries.

Research

Research on children's falls has focused on products. One good analytic study, however, has documented the relative risk of falls related to alcohol use among adults (30). Studies have also focused on when and where fall-related injuries occur. For example, in a study of falls among the elderly in Miami Beach, Florida, 74% of the falls occurred during daylight hours and 54% occurred in and around the home. For 38% of those that occurred in the home, more specific information was available: 42% occurred in the bedroom, 34% in the bathroom, 9% in the kitchen, 5% on the stairs, 4% in the living room, and 6% in other areas (31). Although few falls result in serious injuries or deaths, falls and other mobility problems are often associated with loss of confidence in the ability to function independently, restriction of physical and social activities, increased dependence, and an increased need for long-term care (32). Among persons 65 years of age and older, less than 50% of those hospitalized after a fall return home.

Programs

Research has shown that gait and balance disorders, use of psychoactive drugs, exposure to new surroundings, and poor environmental conditions (such as stairways) are risk factors for falls among the elderly (29). Several strategies aimed at reducing known risk factors appear promising and, in fact, are being implemented on a limited basis, albeit without any rigorous testing to document specific outcomes in particular populations. They include the following:

- Multidisciplinary geriatric assessment of older people at risk for falling to identify and ameliorate possible risk factors.
- Careful assessment and monitoring of older people's medication use (particularly drug-drug interactions, including drug-alcohol interactions) to reduce falls and hip fractures (see Year 2000 Objective 9.7 in the Appendix).

- Exercise programs to improve gait, balance, and muscle mass.
- Public and professional education to identify home hazards and stimulate appropriate behaviors.
- Environmental modification of the living quarters of elderly persons consistent with universal design philosophy (with attention to floor surfaces, lighting, bathrooms, stairs, traffic patterns, and accessibility) to reduce or eliminate hazards.
- Close monitoring of older people during the first few weeks of institutionalization and when they are moved to new units.

Promising fall-injury prevention efforts for children are under way at the state and national levels. For example, the Utah Department of Health and the New York City Health Department are successfully targeting injury prevention on playgrounds. A valuable national resource is the CPSC, which provides free handbooks on preventing fall-related injuries on playgrounds. Another national effort, the "National Safe Kids Campaign," promotes helmet use among children who ride bicycles.

To be effective, fall-prevention programs must avoid unintended negative consequences. For example, encouraging physical activity without proper supervision or attention to risk factors in the environment may actually cause injuries. In addition, programs designed to reduce injuries should measure a broad range of outcomes. For example, effects on older persons' quality of life (e.g., their autonomy and independence) are important outcomes. Studies on fall injuries should address as well the variety of circumstances, the seriousness of the injury, and the older person's pattern of life.

Where We Want To Be

Research

Despite the relatively high incidence of fall-related injuries, especially among older people, we are just now beginning to document the complexity of biomedical, behavioral, and environmental risk factors in childhood and later life and to identify strategies for modifying known risk factors. Although our research investment in this area has increased markedly within the past 5 years, many critical research needs remain, including the following: (a) understanding how physiological, behavioral, and environmental factors combine to put particular age groups at special risk; (b) designing and evaluating biomedical, behavioral, and environmental interventions; and (c) integrating efficacious interventions into existing medical and public health services in both community and institutional settings. The heterogeneity of the older population requires that we develop interventions for preventing injuries in relatively healthy people as well as for reducing injuries and their consequences in very frail, functionally disabled populations.

Areas needing further study include the following:

- The accuracy of fall and injury reports.
- Specific locations and circumstances of falls.
- Risk factors and risk relationships, especially the underlying mechanisms of falls and the interaction among risk factors as they change over time.
- Falls on stairs, including types of handrails; lighting; and step height, width, size and placement.
- Fall prevention programs, especially their specific components and any unintended negative effects they may produce.

Programs

The following interventions are known to reduce the incidence or severity of falls and should be targeted at high-risk populations:

- Installing window guards for high-risk houses and tenements, enforced by regulations such as those of New York City's the "Children Can't Fly Program."
- Installing safety equipment, such as gates, where risk of falls is present.
- Educating parents about the potential risks of falls (from baby walkers, stairs, windows, and changing tables).
- Prohibiting the manufacture of baby walkers (33, 34).
- Changing building code standards in order to reduce the space required between bannister railings from 6 to 4 inches.
- Monitoring medication among elderly patients.
- Promoting exercise for agility and strength among the elderly.
- Using sound environmental design in living quarters for the elderly.

The biomedical, behavioral, and environmental interventions being developed hold promise for preventing falls among the elderly, reducing the extent of their injuries, and limiting costly health care expenditures. Efforts to prevent the consequences of osteoporosis, either by strengthening older women's bone structure, increasing their awareness of hazardous behaviors, or instituting creative environmental modifications to buffer the effect of falls, could do much to reduce the estimated $7 billion cost associated with hip fractures or to reduce the incidence of vertebral fractures. For example, a new study suggests that an assessment of ambulatory nursing home residents can reduce their hospitalization that would result in an estimated yearly savings of $600 million (35).

How We Get There

Federal Government

- Support epidemiologic surveillance of fall injuries to identify circumstances and specific locations of falls.
- Support analytic studies of major factors contributing to fall injuries, including biomedical, behavioral, and environmental risk factors for injuries in later life (e.g., mobility, the effects of estrogen and calcium on osteoporosis, the effects of psychoactive and other drugs, the effects of polydrug use, the effects of alcohol use, personal risk factors, and environmental factors) and the interaction of these risk factors with age.
- Fund local injury prevention workers to interpret and act on results of surveillance and analytic studies.
- Develop and disseminate prevention programs.
- Ban baby walkers, which apparently cannot be made safer.
- Develop standards for changing tables and high chairs.
- Develop safety standards for playground equipment.
- Increase support of clinical trials to test strategies for injury reduction and rehabilitation in later life (e.g., avoidance of hazardous behaviors, increased exercise and physical activity, and the use of hip pads or other new devices).

State and Local Governments

- Conduct surveillance of the circumstances and specific locations of fall injuries.
- Develop, revise, or enforce standards for residential facilities for the elderly on the basis of the best evidence of optimal designs for stairs, rails, and grips.
- Require helmet use during recreational activities associated with significant head injury rates, such as bicycling, horseback riding, surfing, and snow skiing.
- Encourage research on optimal living designs, ensure that public and private building designs and codes take injury surveillance results into account, and enforce building code regulations that reduce major factors contributing to fall injury and its severity.

Private Organizations

- Health care providers should encourage increased clinical counseling of parents and caregivers regarding the risk of children falling from elevations, the need to stop using baby walkers, and the need to begin using barriers for stairs.
- Insurance companies should provide financial incentives, such as lower premiums, to encourage consumer compliance with safety standards.

- Health maintenance organizations (HMOs) and pharmacies should more vigilantly monitor the use of prescribed drugs, especially combinations of drugs that are likely to impair vision, gait, coordination, and judgment. In addition, HMOs and pharmacies should consider placing warning labels on drugs that may increase the incidence of falls and injuries among the elderly.
- Businesses should not serve or sell alcohol to intoxicated persons.

Academic and Research Institutions

- Conduct analytic studies mentioned under "Federal Government" (page 273).
- Conduct clinical trials to test strategies (e.g., avoidance of hazardous behaviors, increased exercise and physical activity, and use of hip pads or other new technologies) for fall injury prevention and rehabilitation in later life.
- Conduct analytic studies of stairs, innovative barriers, warnings, and alarms to prevent falls.
- Evaluate how fall injuries might be prevented by the use of hip pads, residential facility standards, and the quantity and quality of residential facility staffing.

Drownings

Where We Are

Dimensions of the Problem

In 1986, drownings (along with poisonings) were the third most common cause of death by unintentional injury in the United States (Table 1).

Drowning rates are highest for children under 5 years of age and for people from 15 to 24 years old (36). Drowning death rates are almost four times greater for males than for females, according to National Center for Health Statistics data for the years 1978 through 1984 (36, 37). The male-female difference in drowning rates is evident in every year from childhood through mature age (37-39).

Native Americans have the highest rates of drowning in the United States. This may reflect the fact that substantial numbers of ative Americans live in Alaska, which has the highest drowning rate of any state (2). The high drowning rate in Alaska has been attributed to the cold temperatures of its natural bodies of water, the swiftness of its rivers, and the fact that so many people travel over water or are employed in jobs that entail exposure to water, like fishing and logging (27). The U.S. rates for blacks are disproportionate as well — twice those of whites (36, 40). However, white children from 1 to 4 years old have twice the drowning rate of black children of this age, largely because of drownings in residential swimming pools. More whites than blacks also drown in boat-related incidents.

Costs

Rice and colleagues (1) estimated the cost of drownings for 1985 at $2.5 billion. In this cost study, drowning was defined as a death resulting from suffocation within 24 hours of submersion in water, and near-drowning was defined as survival beyond 24 hours after suffocation from submersion in water (1). The numbers and costs would have been larger if the definition had included all drowning deaths, no matter how long after the event the death occurred, and submersions that required any life support procedure.

Surveillance

Surveillance systems for drowning are very limited. Few states and municipalities have been willing to make the investment needed to begin such surveillance activities. Where surveillance activities are in place, they do not focus on all conditions for drowning. For example, the Arizona Department of Health Services, in cooperation with Maricopa county and Phoenix city health and safety officials, has developed a drowning surveillance system that

collects data important to our understanding of all components of drowning, both environmental and behavioral (41). The system, however, focuses mainly on drowning among small children in swimming pool settings. Most of the collected information would be relevant to any drowning surveillance system, but it would have to be expanded to include settings other than pools.

Each state needs to institute surveillance systems for injury conditions, including drowning. Such surveillance activities would need to be coordinated nationally in order to standardize definitions and monitor trends. In this way, we could monitor the number of drownings and partial suffocations and the effectiveness of innovative intervention strategies, involving legislation, technology, and education. The type of information to be captured by surveillance systems includes demographic data, the circumstances surrounding the submersion, how the event occurred, the type and condition of any existing barriers, the type and use of flotation equipment, whether alcohol had been consumed, if and when cardiopulmonary resuscitation (CPR) was administered, what type of medical care was given, and the outcome of the incident. Surveillance of the circumstances and locations of drownings is essential for targeting specific interventions to specific circumstances.

Research

We have identified several known and suspected risk factors for drowning. Young children have a different set of risk factors than older persons. Childhood drownings usually occur in swimming pools, bathtubs, and buckets. Lapses in adult supervision caused by chores, socializing, or phone calls are some of the risk factors implicated in drowning among children under 5 years of age. The danger of drowning among children also increases with the number of children present because of the difficulty of supervising several children at once. A lapse in adult supervision does not have to be long — 46% of young pool drowning victims in the CPSC study were out of sight for 5 or fewer minutes (42).

About 16% of drownings are associated with boating. More than 50 million persons engage in various recreational (noncommercial) boating activities on at least 8 days per year (43, 44), and 90% of all recreational boating deaths result from drowning. Unlike motor vehicle operators, recreational boaters are generally not required to be licensed, and many have received no formal training in boat operation and safety procedures. The effectiveness of licensure and training is unknown.

As many as one- to two-thirds of people who die in recreational boating incidents each year are found to have consumed alcohol just before death, although the baseline proportion of recreational boaters using alcohol at the same times and under the same conditions is not known. Therefore, the importance of alcohol as a risk factor for boat-related drownings needs to be clarified.

But we do know something about alcohol. We know that males are more likely than females to drink alcohol when on or near the water. We know also that 36% of boat owners use alcohol during aquatic activities. This finding is similar to results of a 1976 Coast Guard Survey (45), in which 40% of boaters reported having carried alcohol on board during routine outings. Despite alcohol's suspected role in drowning, more research on drinking behaviors and blood alcohol concentrations during aquatic activities is warranted. In a North Carolina study of drownings from 1980 through 1984, 53% of 752 drowning victims 15 years of age and older tested positive for blood alcohol, and 38% had blood alcohol concentrations (BACs) of 100 milligrams per deciliter or more (46).

Programs

Some programs have intervened in drowning. In New York State, for example, the safety guidelines for the operation of public bathing facilities were revised in March 1988 to reflect much of the new information that had been disseminated in research literature on environmental agents in water-related injury (47). Accordingly, for those facilities operated and regulated by the State of New York (natural waters and swimming pools), where safe diving and swimming were judged unavailable, diving boards were removed and diving prohibited, float lines and buoys were modified, and lifesaving equipment was upgraded (47).

Researchers from Australia and New Zealand have found that mandated pool isolation fencing alone has nearly eliminated child drownings in pools in those countries (11, 48). (Inner fencing, also called isolation fencing, means that a fence completely encloses the pool itself, isolating the pool from the house and yard.) No comparable data are available for the United States; however, in a multistate study of drowning and near-drowning conducted by the CPSC in 1987, researchers found that pools in which children drowned were significantly less likely to have had pool isolation fencing than were matched control pools (42). The support for pool isolation fencing is growing. In the CPSC study, researchers found that almost 40% of households with pools and resident children under 5 years of age had pool isolation fencing.

In one study in Phoenix, Arizona, researchers concluded that the presence of a pool isolation fence of adequate height could have prevented 35% of the drownings or near-drownings in pools (41). When combined with the findings about the role of inadequate gates and latches, we can assume that about 51% of the incidents may be prevented by use of passive barriers. Governing bodies in the Phoenix metropolitan area have passed mandatory fencing laws and barrier codes, and an educational campaign by hospitals and fire departments for the high-risk summer season is aimed at increasing the public's awareness of childhood safety relating to water recreation.

Where We Want To Be

Research

We particularly need to know the circumstances of drownings involving Native Americans and blacks and of drownings associated with boating. For example, are blacks and Native Americans who drown less likely to know how to swim? If so, are the waters in which they drown swimmable or do cold or swift waters offset their ability to swim? Does being able to swim a short distance increase or decrease the likelihood that swimmers will get into trouble? We need research to establish firmly the relationship between alcohol use and water recreation injuries, including drowning. More research is also needed on nonpool drownings.

Pool manufacturers have suggested swimming pool safety covers as an additional measure of drowning prevention. Research indicates, however, that children can become trapped and drown under certain types of pool covers and that very young children can drown in puddles of rain water that form on the surface of the cover (27). Pool covers have been accepted as an alternative to inner fencing for retrofit of existing pools without sufficient clearance for fencing. More research is needed, however, to determine the extent of the hazards that pool covers pose and the types of design modifications that could affect them. Research is also needed to determine the effectiveness of design changes such as energy-absorbing pool bottoms. These types of interventions are promising both in preventing drownings and in preventing certain severe but nonfatal injuries, such as spinal cord injuries related to diving.

Often, individuals and organizations have recommended that public education focus on the risks of drowning in all aquatic environments. This has not been evaluated in any state or local program. This untapped area of research should provide long-awaited answers about the effectiveness of programs already in use. Similarly, the effectiveness and timing of swimming programs for children as a strategy for preventing pool drownings has not been determined and warrants further research.

Programs

A pool isolation fence separates a residential pool from the house and yard. Such fences and self-latching gates should be mandated for all newly constructed and extant pools. The pool isolation fence should be at least 5 feet tall and otherwise comply with the CPSC guidelines.

The CPSC warns that inflatable rings, flotation devices, and swimming lessons are not adequate substitutes for adult supervision (27). Data from the Arizona study suggest that although fencing and constant supervision are effective prevention strategies, neither alone will prevent all drownings and near-drownings in backyard pools. Because it is unrealistic to believe that parents can observe a child 100% of the time, the use of passive barriers is

essential. However, many incidents occur when an adult and child are inside a fenced area or already in the water. Therefore, the education of parents about their child's safety at a pool should complement the emphasis on passive barriers to the pool. In addition, pool owners, parents, and other caregivers should be trained in basic rescue techniques and CPR.

Boat-related drownings occur under a variety of circumstances. Even so, there is an all-purpose prevention mechanism that can reduce this problem. Personal flotation devices, or life vests, can prevent many drownings, according to the U.S Coast Guard (27). These devices have been investigated widely, and we know that with their appropriate use during recreational boating, many drownings can be prevented. The Coast Guard and state and local governments, however, must enforce regulations requiring the use of personal flotation devices during all recreational boating activities.

Few states now require standard training or licensure to operate recreational boats. Some states require a boating education course, but these requirements are usually restricted to persons who are under 16 years of age. We still do not know the effect that licensing or education has on boat-related drowning, so further research is needed. Until we know more, states should require that boat operators demonstrate competency to operate boats of the size and engine power that they actually operate (27). At the 1981 National Conference on Injury Control, participants recommended that the sale and consumption of alcoholic beverages at boating, pool, harbor, marina, and beach areas be restricted (49). This proposed restriction still needs to be implemented.

How We Get There

Federal Government

- Advance research on the circumstances and specific locations of drownings and near-drownings that result in hospitalization, with special attention to minority populations, to drownings associated with water other than that in pools, and to potential means of prevention.
- Advance analytic studies of the characteristics of boats and motors involved in drownings and near-drownings.
- Support evaluations of the effectiveness of drowning interventions — swimming lessons by age, pool supervision, the use of certain types of pool covers, the use of barriers to high-incident sites other than pools, diving board removal, and licensure and training for boating.

- Develop, evaluate, and disseminate effective prevention programs.
- Fund analytic studies of alcohol's involvement with drowning in various settings.

State and Local Governments

- Conduct surveillance of circumstances and specific locations of drownings and near-drownings.
- Promote CPR training for all pool owners and for teenagers and adults among populations with high drowning rates.
- Require complete four-sided isolation pool fencing at least 5 feet high with self-closing latches for all swimming pools.
- Promote licensure and standard training for all boat operators.
- Enact and strictly enforce state laws that prohibit persons from operating boats while intoxicated.
- Enforce requirements for having personal flotation devices for all persons on boats.

Private Organizations

- The pool industry should sell safety equipment as part of the pool purchase and should develop new and more effective prevention technology such as energy-absorbing pool bottoms to reduce diving injuries (e.g., head and spinal cord injuries).
- The insurance industry should review actuarial drowning data and write homeowner insurance policies to reflect the presence of pools and spas, the presence of children under 5 years of age where a pool or spa is present, and the presence of protective barriers to pools and spas.
- The American Red Cross and other organizations should promote isolation pool fencing; poolside phones; and CPR training for all pool owners and for teenagers and adults among populations with high drowning rates.
- Private industry should develop technologies such as better personal flotation devices.

Academic and Research Institutions

- Conduct studies mentioned under "Federal Government," page 279.

Poisonings

Where We Are

Dimensions of the Problem

In 1986, about 5,740 people died of unintentional poisoning. Fatal poisonings among young children declined from 226 in 1970 to only 55 in 1985, but poisonings among young adults, associated mainly with drug use, have increased. Nonfatal poisonings occur in substantial numbers among young children — each year 80,000 to 90,000 of these children are seen in emergency rooms and about 20,000 are hospitalized (18).

Costs

In 1985, poisoning was estimated to cost $8.5 billion; these poisonings included some suicides and attempts that were not considered separately from unintentional poisoning (1). This cost does not include nonacute poisoning from lead and other substances.

Surveillance

Data on poisonings are mainly obtained from death certificates and records of poison control centers. Drugs are a major source of fatal poisoning (73%). Prescription and other legal drugs account for most of these poisonings, although cocaine and heroin account for a growing number (50).

Research

Most research on poisoning has been aimed at young children and the effects of poison-prevention packaging, the knowledge and use of ipecac syrup, and the availability of poison control centers. Major reductions in severe poisonings to children are associated with the introduction of child-resistant packaging of drugs and other household chemicals, but some backsliding in the use of such packaging has occurred. Ipecac syrup is effective for many ingested poisons, but it is rarely available to lower-income families or to childless households where children are visiting (27). Poison control centers have been found to be cost-effective but are in jeopardy because of losses in funding. Only 60% of Americans have access to a toll-free phone number for a poison control center.

Where We Want To Be

Research

Better identification of persons at risk for poisoning, particularly young adults, is needed. For example, how many persons who die of poisoning could have been identified by a previous, less severe episode that required medical attention? Drug education campaigns are often undertaken without research on the effects of the education on actual drug use. Research is needed to identify the effective programs and to weed out the ineffective ones.

Programs

Studies in New York State indicate that a net savings in medical care costs of some $18 million is realized from the operation of six regional poison control centers (51). Funding for poison control centers among the states varies widely by amount and by source (52). The legislature provided that the centers be funded from hospital insurance revenues; however, funds are needed for 24-hour-per-day, 7-day-per-week coverage, particularly in rural areas where emergency rooms are often distant.

How We Get There

Federal Government

- Support surveillance of the circumstances and locations of severe and fatal poisonings.
- Support analytic research on the distribution of and access to both legal and illegal drugs.
- Review standards for the packaging of drugs and household chemicals and tighten standards for child-resistant containers that are frequently involved in child poisonings while considering needs of the elderly.

State and Local Governments

- Support continued funding for poison control centers, including funding from insurance and Medicare and Medicaid payments.
- Provide a toll-free telephone number for information on poisons for people who do not have access to a local poison control center.

Private Organizations

- Conduct campaigns to increase the availability of ipecac syrup in all households.
- Cooperate with scientists in the evaluation of campaigns against drug use.
- Discourage advertisers from linking alcohol use to sports activities and from sponsoring television programs glamorizing drug use.

Academic and Research Institutions

- Conduct analytic studies on the extent to which persons at risk for poisoning can be identified.
- Conduct evaluations of the effectiveness of poison prevention and drug use treatment programs.

Fire- and Burn-Related Injuries

Where We Are

Dimensions of the Problem

From 1980 to 1986, deaths from fires and burns declined (Table 1), perhaps largely because of the widespread adoption of smoke detectors. Nevertheless, fires remain a formidable cause of death, resulting in nearly 5,000 deaths in 1986. House fires cause three-fourths of all fire and burn deaths, with smoke inhalation and resulting carbon monoxide poisoning causing two-thirds of these deaths (1).

Each year, some 54,000 persons are hospitalized from burns, and about 1.4 million people experience burns that do not necessitate their being hospitalized (1). A severe nonfatal burn is among the most devastating injuries a person can survive and may result in permanent scarring and disability. Scalds are the most common burn injury; and flame burns are the most severe (53).

Groups at higher risk for fire or burn deaths include the very young, the elderly, and minority populations. Deaths due to house fires are highest among the very young and the elderly (2), whereas clothing ignitions occur mainly among the elderly (54). Children under age 4 are at the highest risk of nonfatal burns (two-thirds from hot-liquid scalds) resulting in hospitalization. Cigarette lighters in the hands of very young children are a major cause of fatal fires (55). Males are at higher risk of both fatal and nonfatal injuries resulting from fires and burns, although the risk differences between the sexes are not as great as for other injuries (56). Elderly black males are at highest risk for death from residential fires; elderly black females are at a higher risk than whites of either sex (53). Eight states — Alabama, Alaska, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, and South Carolina — have particularly elevated fire-related death risks, and fire- and burn-related deaths also tend to cluster in city neighborhoods.

Costs

Lifetime costs for fire- and burn-related injuries in 1985 were estimated to be $3.8 billion — $920 million in direct costs, $1.5 billion in morbidity costs, and $1.4 billion in mortality costs (1).

Surveillance

In many jurisdictions fire departments maintain data on types, locations, ignition sources, and property damage of fires that generate fire department response, and these departments can be a source for data on those fire-related injuries. Other burns (scalds, electrical,

and radiation) are not included, but have specific external-cause-of-injury (E) codes. However, since only a few of all the burn injuries occur in structural fires, hospital discharge records are the most useful source for data on burns. For use in surveillance, these data must be E-coded, since without this E-coding the type of burn (flame, scald, contact, chemical, radiation, or electrical) cannot be distinguished (57).

Research

The most common ignition source in house fires is a cigarette dropped on furniture or bedding (58). Clothing ignition is a major risk factor, particularly among the elderly while cooking (5). Thus, commercially viable flame-resistant housecoats and robes for older adults should be developed. Alcohol is involved in more than 40% of fatal fires (59), but analytic studies to determine relative risk related to general alcohol use have not been done. Gasoline-involved burn injuries accounted for 62% of all admissions of children aged 10-15 years of age at a pediatric burn unit (60). More than two-thirds of the very young children hospitalized for burns were scalded when hot food or drinks were spilled on them (56).

Programs

Cigarettes can be manufactured to be less likely to ignite furniture (58); however, manufacturers have yet to do this.

Smoke detectors and residential sprinklers also save lives. People living in homes without smoke detectors are twice as likely to die in fires as those in homes with detectors (61). Smoke detectors are now present in 83% of U.S. households, but about a third of the detectors do not function because of dead or missing batteries (62). Residential sprinklers, now technologically feasible, could protect all populations, particularly persons impaired by age, disability, or substance abuse. Installation of residential sprinklers is estimated to cost about 1% of the total cost of a new home (63). In addition to saving lives, the use of residential sprinklers could reduce insurance premiums and property damage costs (64).

One state's legislation regulating the temperature settings of new hot water heaters has reduced injuries from exposure to scalding tap water, and resulted in a voluntary industry standard that requires heaters from the factory to be set at 120^{o} F (65). After identifying a particular design of coffee maker involved in many scald burn injuries, Danish doctors facilitated the redesign and aggressive marketing of a new coffee maker, which resulted in a marked reduction in such burns (66). Clothing ignition burns have been reduced by the use of less flammable fabrics and more closely fitted garments (5).

Where We Want To Be

Research

Research is needed to determine possible causes for the high incidence of fire- and burn-related deaths in the eight-state "fire belt" and in particular city neighborhoods. Research should also focus on designing preventive interventions. Possible factors include poor housing construction, extensive use of space heaters, and use of space heaters in trailers.

Special studies and in-depth investigations of burn events, particularly kitchen scalds and gasoline-fire burns, should be conducted to determine whether any product or environmental modifications could prevent these injuries.

Programs

The National Institute of Standards and Technology is developing an ignition-propensity standard for cigarettes. When work is completed, all cigarettes manufactured or sold in the United States should be required to meet this standard.

To assure that smoke detectors are effective, the nation should launch a media campaign to encourage people to replace their smoke detector batteries each fall when they change their clocks to standard time. In addition, the responsiveness of smoke detectors to actual smoke must be checked periodically to identify problems not related to the device's battery and electrical wiring.

Sprinkler systems should be required in all new residential constructions.

All new bathroom faucets and shower heads should contain antiscald devices, and the thermostats on all hot water heaters should be preset at a maximum of 120^{o} F by the manufacturer.

How We Get There

Federal Government

- Support surveillance of the circumstances and specific locations associated with burns that result in fatalities or hospitalizations.
- Support analytic studies of kitchen scalds, coupled with research by engineers and product designers to remedy correctable hazards.

- Advance analytic studies of burns involving gasoline, coupled with research by engineers and product designers to remedy correctable hazards associated with containers and storage.
- Fund the development and evaluation of community-based prevention programs in high-risk urban and minority communities.
- Support research on the problems of burns among older people and the influence of cognitive impairment, mobility, and environmental features as risk factors in order to devise preventive measures.
- Require cigarettes sold in the United States to have a low potential for igniting upholstered furniture.
- Conduct an in-depth investigation of clothing-ignition burns in children to determine if the flammable fabrics standard for children's sleepwear is being undermined by the labelling of sleepwear as daywear.
- Apply the flammable fabrics standard to loose-fitting housecoats and bathrobes now commonly worn by older persons who are burned while cooking and smoking.
- Regulate disposable cigarette lighters to make them child-resistant.

State and Local Governments

- Conduct surveillance of the circumstances and locations associated with burns that result in fatalities or hospitalizations.
- Collaborate with the CDC and CPSC in conducting in-depth investigations of clothing ignitions, kitchen scalds, and burns involving gasoline.
- Require antiscald devices in new showers and tubs.
- Develop or enforce maximum hot water temperature regulations for residential institutions.
- Develop, implement, and enforce codes to address burns in residences, including codes requiring smoke detectors, sprinklers in new housing, and antiscald devices in hot water systems.

Private Organizations

- Safety organizations should form a coalition among themselves and with local fire departments to launch a media campaign encouraging consumers to routinely change batteries in smoke detectors when clocks are changed to standard time each fall.

- Utility companies should check hot water temperatures when meters are read and recommend settings at 120° F or less, if necessary.
- The American Association of Retired Persons should push for the development of flame-retardant clothing for the elderly.
- Insurance companies should support the installation of sprinklers in multifamily homes by reducing insurance premiums (Appendix, see Year 2000 Objective 9.16).

Academic and Research Institutions

- Conduct analytic studies mentioned under "Federal Government," page 287.
- Evaluate fire department, community, and school-based fire and burn injury prevention education.
- Study the characteristics of appliances and utensils that may affect the incidence and severity of burns.

Firearm Injuries

Where We Are

Dimensions of the Problem

In 1986, firearms accounted for 1,452 deaths classified as unintentional (Table 1), but when intentional firearm deaths (homicides and suicides) are included, the total firearm death toll is second only to that for motor vehicle-related deaths. In recent years, more than 31,000 deaths, 65,000 injuries requiring hospitalizations, and an additional 236,000 less severe injuries have occurred annually from firearms (1). Although unintentional injuries from firearms account for only 5% of all firearm deaths, many potential interventions apply to both intentional and unintentional injuries from firearms.

Costs

The *Cost of Injury* report indicated that all firearm injuries (intentional and unintentional) cost the nation about $14.4 billion in 1985 (1). The report did not distinguish between intentional and unintentional injuries.

The firearm death rate is highest among males 15-44 years old, especially among blacks 15-34 years old, white teenagers, and Native Americans (2). Until recently, handguns accounted for more than three-quarters of firearm deaths, but the recent increase in the use of machine guns and assault rifles may have changed the proportion. In the 1960s and 1970s, the increase in firearm deaths paralleled the increase in new firearm sales (67). Newspaper reports suggest that machine pistols and assault rifles increase the numbers of people hit by stray bullets.

Surveillance

Surveillance of the types of guns involved and the circumstances of firearm injuries is needed. How many injuries are sustained while hunting or cleaning weapons? How and where are children injured by firearms? (See Appendix, Year 2000 Objective 9.15.)

Research

Many of the effects of firearm characteristics and gun control apply to unintentional as well as intentional injuries. We have substantial evidence that in firearm deaths the intent of the assailant is usually less important than the lethality of the weapon. For example, the muzzle velocities of firearms and bullets range widely, creating energy ranging from 124 to 4,440 foot pounds at close range, and the fragmentation of bullets in tissue greatly increases the severity of the injury. The international convention (Geneva Convention), requiring that

military bullets be fully jacketed and retain their original shape while moving through tissue, have not been applied to bullets sold for domestic use in the United States (68).

Programs

Most firearm injuries occur in disputes among acquaintances and families in private residences (69). Comparison of assault rates and death rates between the United States and other countries suggests that assault rates are similar but that death rates are much higher because of the availability of firearms in the United States (70,71). The effectiveness of strict state and local gun control laws is limited by the transport of firearms from jurisdictions with little or no regulation.

The regulation of firearms in the United States is a disorganized patchwork of federal, state, and local laws. A few weapons are banned by federal regulation, but such regulations have not kept up with the changes in weapons. Access to firearms is discussed in greater detail in the position paper on violence. Limiting access to firearms is a Year 2000 Objective (see Appendix, Objective 9).

Where We Want To Be

Research

Studies of the circumstances of teenagers' and children's access to firearms in cases where they are injured while playing with firearms should help us devise countermeasures. Better research on the history of the firearms involved in such injuries might identify points where interventions are feasible. Analytic studies are also needed to determine the relative risk of injury from firearms and ammunition by various characteristics, such as firing rate, trigger tension, safety catches and locks, visible indicators that the firearm is loaded, muzzle velocity, and bullet shape and fragmentation. Also needed is research on how firearm injuries affect the psychology and social relationships of individuals and how they affect communities and their economies.

Programs

The public's desire for greater regulation of firearms (72) should be enforced through public policy. Regulation of the characteristics of firearms and ammunition should be commensurate with their effect on the public's heath. Programs that promote safe procedures during target practice, hunting, and the cleaning of firearms are also needed.

How We Get There

We observed that many of the Violence Panel's recommendations apply to unintentional as well as to intentional firearm injuries. (For the full text of the Violence Panel's recommendations, see the panel's position paper.) We fully endorse all of the Violence Panel's recommendations. In particular, we endorse the panel's suggestions regarding the need to (a) minimize ready access to handguns and other firearms through a variety of strategies focused on three broad areas: educational or behavioral change interventions, technological or environmental interventions, and enhanced and new legislative or regulatory effort; and (b) continue rigorous scientific research to delineate with greater precision the risks and benefits of ready access to firearms. In addition, we make the following specific recommendations:

Federal Government

- Recognize firearm injury as a public health problem and establish the regulatory authority for promulgating safety standards for firearms, addressing trigger locks, muzzle velocity, and visible indication as to whether the gun is loaded (see Appendix, Year 2000 Objective 9.15).
- Establish the regulatory authority for promulgating safety standards for all ammunition, applying the international laws (Geneva Convention) and current military ammunition safety standards.
- Support surveillance of firearm injuries, including a history of the involved firearm, its make and model, characteristics of the weapon and ammunition, circumstances of the injury, storage of the weapon, and means of access.
- Support analytic studies of characteristics of firearms and ammunition that are thought to increase the incidence and severity of injury.
- Develop and implement prevention programs, including strategies to store guns in secure facilities outside of homes.
- Evaluate the effects of firearm safety training on injuries.

State and Local Governments

- Collaborate with CDC in increased surveillance.
- Enact legislation requiring waiting periods and background checks for firearm purchases and building codes for firearm storage.
- Enforce extant regulations.

Academic and Research Institutions

- Conduct analytic studies of characteristics of firearms and ammunition involved in injury.
- Conduct evaluation of the effectiveness of firearm education and gun control laws and regulations.
- Conduct research on the psychological, social, and economic effects of firearm injuries on the injured, the shooters, the families of both, and communities.

Part 2:
An Infrastructure for Injury Control

Organizational Structure and Coordination

Where We Are

Need for a National Lead Agency

If injury mortality and morbidity are to be reduced, lead agencies, with the responsibility, authority, and ability to conduct or support injury surveillance and injury control programs, must be established at the national, state, and local levels. Until these agencies are created, progress to reduce the overall injury toll will be limited.

Without lead agencies to provide coordinated focuses of activity, efforts by individuals, professionals, and government agencies remain scattered. Available resources are not maximized, efforts are unnecessarily duplicated, and time, energy, and funds are expended on isolated programs and research efforts that do not reduce injury mortality and morbidity. Effective lead agencies provide the leadership and vision to mobilize and guide the nation at the national, state, and local levels, helping organizations to achieve their injury control goals.

In 1966, the National Academy of Sciences in its classic "white" paper, *Accidental Death and Disability: The Neglected Disease of Modern Society*, recognized this need for leadership (73). The academy recommended a national council "for coordination of information and advice on implementation of measures and regulations now vested in scattered private, industrial, and federal agencies, and for research, public education, and development of improved standards" (73).

Almost 20 years later, in 1985, the National Academy of Sciences again published findings and recommendations on the injury problem in *Injury in America* (74). The key findings were as follows:

- No central agency is responsible for reducing the incidence of injuries.
- Reducing injuries requires coordinated effort among specialists in epidemiology, prevention, biomechanics, treatment, and rehabilitation; the number of specialists now trained in these areas is inadequate.
- The result of the above inadequacies is that research efforts in injury are unfocused, lack continuity, and are undersupported. Many gaps exist in efforts to prevent and treat injury and deal with its aftermath.

The key recommendations called for the following:

- Establishment of a federal center for injury control within CDC to provide a single coordinated focus of activity that would give visibility to the importance of injuries as a public health issue and permit an organized program of effective action to address the problem.
- Establishment of a level of funding for research on injury that is sufficient to meet the magnitude of the problem.

This report led to the creation in 1986 of the Division of Injury Epidemiology and Control (now the Division of Injury Control) within CDC's National Center for Environmental Health and Injury Control.

In 1988, the National Academy of Sciences was asked to review the division's progress and concluded that the "full intent of *Injury in America* cannot be fully realized unless organizational and program corrections are made" (75). The report added that "careful thought must be given to the mixture of skills of staff members and the balance between in-house activities and the extramural program.... There is a need for a national program plan." This analysis set the stage for the division to become the designated lead agency for injury control. To date, the division has fulfilled many but not all of the functions of a national lead agency. Much remains to be done, but with appropriate resource allocation and setting of priorities, the division can continue to move forward.

Other Public and Private Organizations in Injury Control

Numerous private organizations are involved in various aspects of injury control, but they operate independently, often duplicating efforts and not coordinating their efforts to meet common national goals. The CDC should identify these organizations and their roles.

Public agencies and private safety organizations differ markedly in their objectives, range of activities, scope and manner of influence, and means of support. These variables directly influence every phase of injury control, including data collection and interpretation, the selection of intervention strategies, and overall program evaluation. These organization-related differences are further compounded by frequent disagreements between researchers and practitioners about priorities and intervention strategies. The CDC, using its leadership capabilities, must balance these perspectives and integrate them in the overall national strategic plan.

Public Agencies

Administrative and legislative agencies have interest in and responsibility for injury control at the federal, state, and local levels. Some discretionary funds exist, but most funding for injury control requires budgeting and appropriation authority that is approved by both the legislative and executive branches. Federal and state agencies set the overall direction and provide grants to local public and private agencies. These local public health and safety

agencies, often working collaboratively, provide direct services to the public. At present, limitations on funding hinder the activities of public health and safety agencies in injury control.

- Strengths: Federal, state, and local government agencies often have resources, autonomy, influence, and visibility not available to private safety organizations. They have a relatively high degree of flexibility in setting priorities, and they can gain access to injury data that are not available to some private groups. Through their funding and compliance programs, they can markedly affect the direction and amount of injury control activity within the private sector. In particular, government regulation at any level can produce advances in injury control that private efforts could never achieve through voluntary conformity.
- Limitations: Budget cuts, administration changes, or the necessity to show tangible and immediate results can undermine a program's continuity and effectiveness, and make long-range planning difficult. Nongovernmental agencies funded by public funds usually cease activity when government support is no longer present. Public agencies frequently lack the broad-based network necessary to reach private sector groups that communicate directly with at-risk target groups. The regulatory status of some public agencies impairs their perceived acceptability as advisors and educators. Safety regulations must be enforced on a continuing basis or compliance will decline.

Private Agencies

To maintain financial self-sufficiency, agencies are motivated to have a close and responsive relationship with their constituencies, enabling them to develop injury control programs and materials that satisfy user needs. Private safety organizations operate as intermediaries between government and the general public, including business and industry. Their organizational objectives, means of support, and constituencies differ from those of the public sector and among themselves. Some organizations concentrate their efforts in a specific problem area, such as occupational safety and health or fires and burns; others, such as the National Safety Council and its chapters, address the entire range of problems associated with unintentional injury control.

- Strengths: Private safety organizations can influence and support public policy and public agency programs in a nonpartisan fashion. They can marshall local support for injury control programs and, over time, create a social climate that facilitates the success of interventions. Historically, some private agencies have demonstrated more staying power or continuity of program effort than those in the public sector.
- Limitations: Private safety organizations have trouble reaching certain at-risk target groups, particularly those at low socioeconomic levels. Program planning and development is frequently less than optimal because of inadequate data on injury priorities and a lack of contact with professionals with expertise in the interpretation of data. The need to maintain fiscal self-sufficiency can seriously limit private sector organizations' range of activities and overall effectiveness. Because of the voluntary nature of private sector support for injury control, injury control programs often must be designed to correspond

with the interests and activities of cooperating nonsafety organizations, which may frequently change and often do not encompass injury control objectives.

Universities

Universities play an important role in injury control, a role that has not as yet been clearly defined by either the academic world or CDC. The traditional functions of universities — research, teaching, and service — all have the potential to significantly affect injury control in this country. For many years, universities have served as the major focus for biomedical research in trauma care funded by the National Institutes of Health; more recently, some have been the major grantees of CDC's extramural research program. Eight Injury Control Research Centers (ICRCs) have been funded to establish multidisciplinary regional centers that integrate research and training in acute care, trauma care systems development, rehabilitation, and prevention, but they have only begun to function in this capacity and have yet to realize their full potential.

Injury control professionals and specialists need to be trained by universities, that work with state and local health departments. The disciplines of medicine, public health, health sciences, nursing, emergency medical services, engineering, and architecture should be applied to the injury field.

Universities also serve the communities, states, and regions in which they function. Few are now assisting in the development and evaluation of model injury control programs for specific target groups in their communities.

Where We Want To Be

To serve as a national lead agency, CDC's Division of Injury Control should be authorized to carry out the following functions:

- Define the national injury problem for Congress and the nation.
- Monitor the national incidence and distribution of injuries.
- Collaborate with other agencies to determine national injury priorities and implement the research and intervention plan developed from this national agenda to address both injury and system problems.
- Develop a national strategy for establishing a lead agency for injury control within each state and U.S. territory. This strategy should call for the division to (a) provide guidance, resources, and training to help each state and territory form its lead agency and (b) phase in grant support for each state and territory to devise its own injury control plans, to develop local lead agencies, to evaluate its efforts, and to disseminate the results of that evaluation.

- Develop a national strategy to fund and utilize designated ICRCs and injury scholars in an effort to expand the research agenda to include national injury control priorities. The overall research strategy should include a plan for disseminating research data and for translating research into injury control interventions. Consideration should be given to funding the development of new technology to prevent known injury hazards.
- Coordinate the deployment of existing national resources for injury prevention among federal agencies, state agencies, private safety organizations, corporations, and universities.
- Develop model legislation based on the results of national and state injury control data and program evaluation.
- Monitor federal, state, local, and private organizations' progress in meeting national goals and revise national strategies accordingly.
- Monitor what is being done nationally and internationally in the field of injury control and serve as a clearinghouse of information to states, universities, and public and private agencies.
- Maintain the public and political visibility of injury control as a public health priority.

How We Get There

Federal Government

Congress should —

- Establish a national Center for Injury Control. The center should serve as the nation's lead agency for injury control.
- Appropriate adequate funding, at least $100 to $200 million, for the center to carry out a national injury control initiative.

The CDC should —

- Staff the Center for Injury Control with professionals who have expertise in injury epidemiology, surveillance, research, program and system development, and evaluation.
- Establish a national strategic plan that describes the activities of the center and sets the priorities of the grants program so that they will meet the national agenda.
- Provide technical assistance, resources, and funding to states to create lead agencies that can carry out injury control programs at the state and local levels. Provide expert on-site technical assistance to assist states in surveillance, program development, and evaluation.
- Develop a national strategy to incorporate training in injury control within the disciplines of medicine, public health, nursing, health education, engineering, emergency medical services, public safety, social work, law, and business management.

- Develop mechanisms to translate injury research into injury control interventions.
- Establish lead agencies with the responsibility, authority, and capability of conducting or supporting injury surveillance and injury control programs at the national, state, and local levels.
- At the national level, CDC, as the lead agency, should define the national injury problem for the nation, determine national injury priorities, and use national expertise to create a national injury control plan. The CDC should develop a national strategy to carry out the plan by establishing state and local lead agencies; coordinating federal and state agencies, private safety organizations, corporations, and universities; and supporting research in injury and its control.

State Government

Many state laws authorizing state and local health departments have not been revised for more than half a century. The authority and responsibilities assigned to health agencies often do not reflect current mortality and morbidity patterns. State legislatures should revise public health laws so that the priorities of state and local health departments correlate with the severity of particular injury problems.

Training and Research

Where We Are

Injury in America states that a major impediment to injury control is a shortage of health professionals and other scientists with relevant training in injury control: "without knowledgeable and interested persons trained in the sciences relevant to research and programmatic efforts, the injury toll from local, regional, and national conditions will continue" (74).

There is an extraordinary need to train existing and future injury control personnel in public and private agencies at every level — federal, state, and local. The results of a recent survey of training needs of public health and traffic safety professionals indicate that the training needs are extensive and that the opportunities for meeting those needs are few. Nearly 100% of public health professionals reported that they needed additional training. In addition to learning about specific injuries and the science of injury control, both public health and traffic safety professionals wanted training in "long-range planning, using data for planning, and advocating legislation and regulations" (76).

The need for training has also been documented elsewhere. The Year 2000 Objectives for the Nation recommend that schools of public health include injury control in their curricula and increase faculty development and fellowships (25). Results of a survey conducted by the Education Development Center in 1989 (76) showed, however, that although nearly half of the schools of public health that responded now offer an elective course devoted to a particular cause of injury, "few provide overview courses on injury epidemiology and prevention." Most importantly, injury control is not integrated into traditional course offerings. Reported barriers were lack of faculty expertise and interest, lack of training materials, lack of resources, competing priorities, and lack of student demand.

The CDC now funds eight ICRCs in universities throughout the country. These centers educate graduate students in injury control research. Courses in injury prevention are often conducted for Master of Public Health (MPH) students. Two ICRCs at The Johns Hopkins University School of Public Health and Hygiene and the University of Alabama at Birmingham (UAB) conduct a training course every year for professionals of any discipline who are working to improve their knowledge and skills in injury control. In addition, the University of Alabama at Birmingham has a unique minority training program financed in part by the Nationwide Insurance Company. This program focuses on research techniques related to minority injury issues and provides summer training sabbaticals for minority faculty members and their students from historically black colleges and universities.

In addition, the University of Michigan School of Public Health conducts a summer course in injury epidemiology and control, and the Public Health Service's Indian Health Service has begun an injury control specialist fellowship that includes a week at The Johns Hopkins University, the 3-week course at the University of Michigan, and a week of field training in surveillance and the choice of countermeasures. In addition, several of the 15 CDC-funded state and community-based capacity-building grantees have conducted a variety of injury control training programs for local public health professionals. Additionally, the Education Development Center has developed a curriculum accompanied by slides, called "Educating Professionals in Injury Control," which universities, health departments, and other agencies may purchase and use to educate students and staff. State and local governments can play an important role in both training and research.

The CDC's Role in Training: In 1984, at the Association of Schools of Public Health CDC conference on injury control training, participants agreed that because training funds are limited, practitioners should receive first priority. Conference participants concluded that the most appropriate role for CDC in injury control training is curriculum development, resource identification, and technical assistance.

Epidemiology: Epidemiology is a key component of injury control. Epidemiologists study the characteristics of individuals, the environment, and exposure to injury agents that increase the risk for injury; conduct surveillance; and evaluate the effectiveness of prevention programs. Epidemiologists have powerful analytic and experimental tools to apply to the field of injury control. These tools, applied by injury epidemiologists, will enable the injury control movement to progress beyond merely describing problems.

Engineering: Engineers design the products and processes involved in most injuries. Yet in many engineering schools, product and process safety is not integrated into the curriculum.

Ergonomics: The basic premise of ergonomics, which includes human factors, in the realm of injury control is that the human-made environment should be arranged or designed for human use. A number of factors are considered in the design process, including (a) human characteristics, (b) human expectations, (c) human behaviors, and (d) the environment in which humans live and work. A number of universities offer graduate programs for educating students about the knowledge base and methodologies for fitting the environment to the human rather than forcing the human to conform to the environment. The most common titles for these programs are ergonomics, human factors engineering, human engineering, human factors psychology, industrial hygiene, safety, and work or exercise physiology.

Architecture: The environment is recognized as an important contributor to the risk of injury, particularly injury occurring in the home and workplace. Considerable progress in injury prevention could be achieved by improving structural design standards, individual practices, and urban planning. For example, housing should be designed to minimize the risk of injury due to fires and falls, and community designs can promote child safety at road intersections.

Health Communication: Professionals trained in the principles and techniques of health education and risk communication are needed to convey clear and accurate information on hazards, risks, and preventive options. Populations at risk and those who represent them — risk managers, policy makers, and the general public — need such information. Enhanced communication among appropriate or participating sectors of society in an increasingly risk-literate population will make it possible to change attitudes and perceptions about the value of measures to control and prevent injury hazards.

School Health: There has been some discussion about using school health education to promote injury control among school-aged children. Some school health education programs have been shown to be effective in addressing some health problems (e.g., teenage pregnancy), but none has been proven to be effective for injury control. If school health education in injury control is attempted, it is important that such education be rigorously evaluated by injury control professionals.

Where We Want To Be

In each of these disciplines, financial support is needed to improve curricula on injury control and to begin integrating more injury control material into undergraduate and graduate training programs. The development of a trained cadre of injury control investigators and practitioners requires investment in curricula development and education.

Once a cadre of individuals has been developed, adequate support must be given to their research and intervention programs. This support should be at many levels: research to identify risk factors and injury hazards, development of safer products and environments, implementation of prevention programs, and evaluation of their effectiveness. Funding should be undertaken with the understanding that not all programs will succeed; however, advances in the field will be made only through supporting new, innovative ideas for injury prevention and control.

During the next decade, advances in injury control will require adequate resources to accomplish the tasks we have outlined. Money alone, however, is not enough to accomplish the national goals of injury reduction. The critical factor is having knowledgeable and skilled

leaders who understand the science of injury control, program planning, and evaluation. A substantial cadre of professional people with expertise in injury control can be created by building on injury specialties within established disciplines, such as epidemiology, engineering, ergonomics, behavioral sciences, architecture, and health communication.

How We Get There

Federal Government

Training

- The CDC should develop and implement a strategic plan for national training based on the national injury control strategy and sound educational principles. The plan should also be based on workforce needs, the roles and responsibilities of injury control professionals and the tasks they perform, existing training resources, faculty and learning materials, and training gaps and needs. The plan's goals should be to target specific audiences, establish learning objectives, develop model curricula, integrate injury control training into ongoing professional education, and establish evaluation criteria.

To accomplish this, CDC should —

- Convene a group with appropriate expertise to work with CDC to devise a national injury control training plan.
- Hire staff with expertise in educational technology to administer the development and implementation of the plan.
- Provide a program to make grants for the development of components of the training plan.
- Work with federal agencies that fund related professional training to require that such training include an injury control component or module (e.g., maternal and child health, preventive medicine, nursing, epidemiology, rehabilitation, trauma, and occupational health training programs).
- Work with existing injury control training programs to help fill identified training gaps.
- Create incentives for faculty and students, such as scholarships and fellowships in epidemiology, engineering, architecture, ergonomics, behavioral sciences, and health communications.
- Appropriate sufficient funds to increase coordinated injury-related research and training within other relevant federal agencies. The goal is to integrate injury research and training with other priority issues such as child health, aging, and alcohol and drug use.

- Require and fund ICRCs to train their state and local health department staff as injury control professionals, and faculties at medical, public health and related professional schools.
- Require and fund training of program staff as a component of state capacity-building grants.
- Designate and fund a resource center that would collect and disseminate injury control curricula, learning materials, and aids and that would serve as a technical resource.
- Support the development of model curricula, instructor training manuals, and learning materials and disseminate these nationally.

Research

- Injury control research priority projects — both intramural and extramural — must undergo scientific peer review to assure the strongest scientific base possible, laying the foundation for sound public health decision making.
- The research agenda for the various federal agencies supporting research on injuries should be coordinated. As the lead agency for injury control in the federal government, CDC should collect information on the programs of other agencies and keep each agency abreast of what the others are doing and of the gaps identified in this report. The CDC's Advisory Committee for Injury Prevention and Control should review the various research programs at least annually and recommend the following year's program emphasis for research proposals. Research into the effectiveness and costs of injury control interventions and problems associated with their implementation should be given top priority.
- Federal resources should be invested in established programs and other communication channels to maximize national awareness about known injury risks and effective interventions. Communication specialists should be encouraged to emphasize the importance of injury relative to other public health problems afflicting society and to publicize available approaches to reduce the injury toll. The goal is to ensure that adequate resources are allocated and applied to injury control.

Academic and Research Institutions

- Educational institutions with injury epidemiology and control specialties and curricula should be granted the resources to expand such programs; those without such programs should be offered financial incentives to start them.
- Engineering schools with existing injury prevention specialties, such as safety, should be provided the resources needed to expand; those without such programs should be given financial incentives to start them. The potential role of products and processes in injury control should be integrated into engineering curricula.

- Ergonomics programs should be funded to strengthen their research and course work in the area of injury prevention, and stipends for students interested in emphasizing injury prevention in their studies should be established. Ergonomics should be integrated into machine-design courses in engineering schools.
- Architectural design schools with programs emphasizing human factors and injury prevention should be provided the resources needed to expand; those without such programs should be given financial incentives to start them.
- Schools should provide stipends for graduate students in the injury control field. At first, these efforts should provide support for postgraduate and fellowship training in injury epidemiology, safety engineering, ergonomics, architecture, health communication, and safety management.

Surveillance

Where We Are

Surveillance has been defined as "the ongoing and systematic collection, analysis, and interpretation of health data in the process of describing and monitoring a health event" (76). In injury control, these data are useful to a broader community than that typically concerned with health data. For example, manufacturers and builders need to know what modifications in their products and structures could reduce injuries. Farmers, industries, and small businesses need to know how injuries to their families or employees can be reduced. Insurance companies need to know how to use rates as incentives for risk reduction and what technical assistance to provide to their policyholders to reduce their losses. Regulatory agencies need to know about patterns of injuries so that they can identify any gaps in regulatory responsibility or action. State governments need to know about the injuries that cluster by location and about certain population characteristics so that they can identify state and local agencies (private and public) that need technical and other support. Local governments need the same information within their jurisdictions. Hospital, health, and other professional groups, nonprofit associations and foundations, and advocacy groups need to know how they can contribute to injury reductions. Researchers need to direct their investigations to priority areas as resources diminish.

To monitor trends in injuries and identify those associated with particular populations, products, or locations, people in the injury field have developed various injury surveillance systems. The extent of data collected on injuries in these systems varies by type of injury, severity of injury, and the agency collecting the data. The National Highway Traffic Safety Administration collects detailed data on drivers, passengers, vehicles, and environmental conditions related to fatal injuries on public roads. The National Transportation Safety Board collects similar data on fatal aircraft injuries. No detailed data on other fatal injuries are collected at the national level, but the National Center for Health Statistics tabulates incidence and demographic characteristics from death certificate files, and several agencies use these data to monitor trends. The CPSC uses the National Electronic Injury Surveillance System (NEISS) to collect data on product-related injuries to persons treated in the emergency departments of a national sample of hospitals. The CPSC and other federal, state, and local government agencies periodically conduct special in-depth investigations of injuries associated with particular products. Several product modifications or bans have resulted from the identification of hazards through the use of NEISS. Some states are also examining the use of trauma registries in monitoring injuries. In addition, numerous state and local police and highway departments identify high-risk motor-vehicle crash locations that need to be made safer, but they rarely identify sites where severe injuries, rather than clusters of property damage, occurred.

In most hospital records, injuries to persons requiring hospitalization are coded according to diagnosis (N-code) but rarely by external cause (E-code), except in a few states or agencies (such as the Indian Health Service) where E-codes are required. A sample of hospitals' data is compiled in the National Hospital Discharge Data system.

Occasionally, a federal agency, private organization, corporation, or trade association uses injury rates from surveillance data to imply that the risk of a given product or process is acceptable because the injury rate is similar to, or lower than, that of some other tacitly accepted product or process. Decisions on risk should not be based on these data. The decision to modify a product or process to reduce injury should be based on its effect on injury reduction and the feasibility of the modification, in view of the public's willingness to pay for it.

Current surveillance systems are limited because we have no national standards for injury surveillance and no national guidelines for E-coding, trauma care data systems, and other registries. Instead, each state surveillance system is evolving separately and diversely. If data are to be useful, we must collect them by using case criteria and minimum data sets with defined, uniform elements.

Where We Want To Be

The Indian Health Service, a few state governments, and some local agencies and hospitals are beginning to collect more detailed data to identify where, to whom, and how injuries occur at local levels. The power of these systems for injury control has been demonstrated. The Indian Health Service system includes as a part of its surveillance a list of simple steps that can be taken to prevent or reduce the severity of injuries (77). We know that clusters of injuries can be reduced by employing inexpensive countermeasures identified through surveillance. For example, in a 2-year period, a 2-mile stretch of road on the White River Apache Reservation had 37 pedestrian injuries at night. In the next 2 years, after lights were installed (at a cost of about $39,000), only two such injuries occurred. In 7 years, on the Blackfeet Reservation in Montana, 59 severe motor vehicle injuries, including 19 deaths, occurred at night on a 2-mile stretch of road. In the 2 years after lights and limited access curbing were installed at locations pinpointed by the surveillance (at a cost of $6,500), only two severe crashes occurred (77).

Similarly, on the basis of the surveillance of children falling out of windows, the New York City Health Department targeted high-rise residential buildings for the installation of window barriers. Deaths dropped from 30 to 50 per year in the 1960s to about four per year in the 1980s. In addition, traffic engineers in New York City identified a section of Queens Boulevard that had a concentration of elderly pedestrian deaths and achieved reductions by making modest changes in signs and striping and by educating elderly persons in the community (77).

These different approaches to surveillance lead us to ask this question: What are the most efficient and effective ways to investigate injuries in sufficient detail so that we can choose which ones to target and which countermeasures to employ? One approach is to gather data on whom, how, and where all severe injuries (e.g., fatal and hospitalizations) occur, paying particular attention to sites (e.g., road sections and locations of falls in houses) and populations. Such an approach is based on the known clustering of motor vehicle-, fall-, and fire-related injuries by location and the need to choose among specific countermeasures, depending on the circumstances. For example, there is no need to launch a program to encourage people to place skid strips in bathtubs if most severe falls in households in a given community occur on poorly lighted basement stairs or icy sidewalks. Another approach is to gather minimal data, such as E-codes in fatal and hospital data sets, and then target only the most frequent types of injuries for detailed studies.

At the very least, data on fatal injuries not associated with motor vehicle crashes should be assembled in a uniform manner by state, as in the Fatal Accident Reporting System for motor vehicle crashes. The data are usually available in coroner files but are not coded systematically. States should track data on environmental circumstances, type of energy involved, and medium by which the energy was conveyed. This tracking system should include specific identifications and descriptions (e.g., make, model, serial number, dimensions) for items such as guns, ignition sources in fires, stairs in falls, and pools in drownings, as well as data on the characteristics and activities of the persons killed. National surveillance standards for injury control are direly needed.

How We Get There

Federal Government

- E-codes can be included inexpensively in hospital discharge records and should be required for reimbursement by federal and private health insurance systems. Two separate fields for E-codes should be required — for cause and place of occurrence. CDC should study the extent and use of these data at state and local levels.
- The CDC should support research on the cost-effectiveness of competing surveillance systems, including choice of countermeasures, prevention strategies, injury reduction, and levels of severity. This could be done by conducting comparative studies employing different surveillance approaches used by health departments and other agencies.
- Congress should fund CDC, perhaps through the National Center for Health Statistics, to contract with the states to collect data on fatal injuries that do not involve motor vehicle injuries equivalent to the data collected in the Fatal Accident Reporting System (FARS) for on-road motor vehicles. The CDC also needs funds for disseminating this information through an annual report and purchasable computer files. Data better than those in FARS should be developed on the mechanisms of injuries and the part(s) of the body injured.

- Congress should direct regulatory agencies to use cost-effectiveness in deciding whether a product or process should be regulated. Decisions to regulate should be based on studies of the specific effects of injury reduction efforts, not relative risk, and on the public's willingness to pay for the reduced risk.

State Governments

- State legislatures should mandate the use of a common identifier, such as a social security number, in data files on injuries collected by police, coroners, medical examiners, hospital staffs, and fire fighters.
- Health departments should produce biannual or annual reports of deaths and hospital discharge data, cross-tabulated by N-codes and E-codes for counties and cities to bring attention to the extent and location of specific problems and missing E-code information.

References

1. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress, 1989. San Francisco CA: Institute for Health & Aging, University of California, and Injury Prevention Center, The Johns Hopkins University, 1989.

2. Baker SP, O'Neill B, Karpf R. The injury fact book, 2nd ed. New York NY: Oxford University Press. In press.

3. Planek TW. Home accidents: a continuing social problem. Accid Anal Prev 1982;14(2):107-20.

4. Done AK. Aspirin overdosage: incidence, diagnosis, and management. Pediatrics 1978;59(Suppl):890.

5. Tinsworth DK. Hazard data related to the flammability of wearing apparel. Washington DC: US Consumer Product Safety Commission, 1985.

6. Bergner L, Mayer S, Harris D. Falls from heights: a childhood epidemic in an urban area. Am J Public Health 1971;61:90-6.

7. Speigel CN, Lindaman FC. Children can't fly: a program to prevent childhood morbidity and mortality from window falls. Am J Public Health 1977;67:1143-7.

8. Bergner L. Environmental factors in injury control: preventing falls from heights. In: Bergman AB, editor. Preventing childhood injuries. Columbus OH: Ross Laboratories, 1982.

9. Morton D. Five years of fewer falls. Am J Nurs 1989;2:204-5.

10. Kravitz H. Prevention of falls in infancy by counseling mothers. Ill Med J 1973;144:570-3.

11. Pearn J, Nixon J. Prevention of childhood drowning accidents. Med J Austr 1977;1:616-8.

12. McLoughlin E, Marchone M, Hanger L, German P, Baker SP. Smoke detector legislation: its effect on owner-occupied homes. Am J Public Health 1985;75(8):858-62.

13. Janda DH, Wojtys EM, Hankin FM, Benedict ME. Softball sliding injuries: a prospective study comparing standard and modified bases. JAMA 1988;259(12):1848-50.

14. Garner LM, Love DM, Jones SB. A community action approach for prevention of burns: burn injury prevention pilot-demonstration project, November 1966-October 1969. Washington DC: Government Printing Office, 1972; DHEWpublication No.(HSM) 72-10008.

15. Ingraham NR, Polk LD. Accident control research-demonstration project: A project designed to demonstrate and test the group discussion process as an educational method within the field of accident prevention in a selected community in Philadelphia, Pennsylvania, June 1961-October 1964. Philadelphia PA: Accident Control Section, Division of Environmental Health, Community Health Services, Philadelphia Department of Public Health, 1964.

16. McLoughlin E, Clarke N, Stahl K, Crawford JD. One pediatric burn unit's experience with sleep-wear related injuries. Pediatrics 1977;60(4):405-9.

17. Palmisano P. Targeted intervention in the control of accidental overdoses in children. Public Health Rep 1981;96(2):150-6.

18. Centers for Disease Control. Unintentional poisoning among young children — United States. MMWR 1983;32(9):529-31.

19. Sorenson B. Prevention of burns and scalds in a developed country. J Trauma 1976;16(4):249-58.

20. DiGuiseppi CG, Rivara FR, Koepsell TD, Polissar L. Bicycle helmet use by children: evaluation of a community-wide helmet campaign. JAMA 1989;262(16):2256-61.

21. Jones NE, Pieper CF, Robertson LS. The effect of legal drinking age on fatal injuries of adolescents and young adults. Proceedings of the American Public Health Association Annual Meeting, 1989. Washington DC: American Public Health Association, 1990.

22. Cook PJ. The effects of liquor taxes on drinking, cirrhosis and auto accidents. In: Alcohol and public policy: beyond the shadow of prohibition. Washington DC: National Academy Press, 1981.

23. Office of the Surgeon General. Proceedings of the Surgeon General's Workshop on Drunk Driving, 1989. Washington DC: US Department of Health and Human Services, Public Health Service, 1989.

24. Nevitt MC, Cummings SR, Kidd S, Black D. Risk factors for recurrent nonsyncopal falls: a prospective study. JAMA 1989;26:2663-8.

25. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: US Government Printing Office, 1991: DHHS Publication No. (PHS) 91-50212.

26. Guyer B, Ellers B. Childhood injuries in the United States: mortality, morbidity, and cost. Am J Dis Child 1990;144:649-52.

27. National Committee for Injury Prevention and Control. Injury prevention: meeting the challenge. New York: Oxford University Press, 1989.

28. Gallagher SS, Guyer B, Kotelchuck M, Bass J, Lovejoy FH, McLoughlin E, et al. A strategy for the reduction of childhood injuries in Massachuetts: SCIPP. N Engl J Med 1982;307:1015-9.

29. Public Health Service. Proceedings of the Surgeon General's Report on Health Promotion and Aging. Washington DC: Office of the Surgeon General, 1988.

30. Honkanen R, Ertama L, Juosmanen P, Linnoila M, Alha A, Visuri T. The role of alcohol in accidental falls. J Stud Alcohol 1983;44(2):231-45.

31. DeVito CA, Lambert DA, Sattin RW, Bacchelli S, Ros A, Rodriguez JG. Fall injuries among the elderly: community-based surveillance. J Am Geriatr Soc 1988;36:1029-35.

32. Hadley E, Radebaugh TS, Suzman R. Falls and gait disorders among the elderly: a challenge for research. Clin Geriatr Med 1985;1(3):497-500.

33. Reidner MJ, Schwartz C, Newman J. Patterns of walker use and walker injury. Pediatrics 1986;78:488-93.

34. Kauffman I, Ridenour M. Influence of an infant walker on onset and quality of walking pattern of locomotion. Percept Mot Skills 1977;45:1323-9.

35. Rubenstein LZ. Geriatric medicine. JAMA 1990;263(19):2644-6.

36. Gulaid JA, Sattin RW. Drowning in the United States, 1978-1984. MMWR 1988;37:27-33.

37. O'Carroll PW, Alkon E, Weiss B. Drowning mortality in Los Angeles County, 1976 to 1984. JAMA 1988;260:380-3.

38. Quan L, Gore EJ, Wentz K, Allen J, Novack AH. Ten-year study of pediatric drownings and near-drownings in King County, Washington: lessons in injury prevention. Pediatrics 1989;83:1035-40.

39. Wintemute GJ, Kraus JF, Teret SP, Wright MA. The epidemiology of drownings in adulthood: implications for prevention. Am J Prev Med 1988;4:343-8.

40. Wintemute GJ, Kraus JF, Teret SP, Wright M. Drowning in childhood and adolescence: a population-based study. Am J Public Health 1987;77(7):830-2.

41. Centers for Disease Control. Child drownings and near drownings associated with swimming pools — Maricopa County, Arizona, 1988 and 1989. MMWR 1990; 39(26):441-2.

42. Present P. Child drowning study: a report on the epidemiology of drownings in residential pools to children under age five. Washington DC: Directorate for Epidemiology, US Consumer Product Safety Commission, 1987.

43. Centers for Disease Control. Recreational boating fatalities — Ohio, 1983-1986. MMWR 1987;36(21):321-4.

44. Smith GS, Kraus JF. Alcohol and residential, recreational and occupational injuries: a review of the epidemiologic evidence. Annu Rev Public Health 1988;9:99-121.

45. Wright SJ. SOS: alcohol, drugs and boating. Alcohol Health Res World 1985;9:28-33.

46. Patetta MJ, Biddinger PW. Characteristics of drowning deaths in North Carolina. Public Health Rep 1988;103(4):406-11.

47. New York State Department of Health. Safety plan guideline for the operation of public bathing facilities. In: State sanitary code. Public Health Law 225, March 1988.

48. Langley J. Fencing of private swimming pools in New Zealand. Community Health Stud 1983;7:285-9.

49. Centers for Disease Control. Aquatic deaths and injuries — United States. MMWR 1982;31(31):417-9.

50. National Safety Council. Accident facts 1989. Chicago: National Safety Council, 1990.

51. New York State Department of Health. Report to the legislature on regional poison control centers. Albany NY: New York State Health Department, 1989.

52. American Association of Poison Control Centers, Legislative Review and Governmental Affairs Committee. Poison control legislation and state governmental funding in the United States. Vet Hum Toxicol 1985;27(2):120-4.

53. McLoughlin E, McGuire A. The causes, cost, and prevention of childhood burn injuries. Am J Dis of Child 1990;144:677-83.

54. Gulaid JA, Sacks JJ, Sattin RW. Deaths from residential fires among older people, United States, 1984. J Am Geriatr Soc 1989;37:331-4.

55. Harwood B. Fire hazards involving children playing with cigarette lighters. Washington DC: US Consumer Product Safety Commission, 1987.

56. Burn Foundation. Burn causes and treatment costs from 1987 burn center admission data. Philadelphia PA: Burn Foundation, 1988.

57. HCFA. International classification of diseases, ninth revision, ICD-9: clinical modification. Department of Health and Human Services Publication No. (PHS) 80-1260, Washington DC: 1989.

58. Technical Study Group. Toward a less fire-prone cigarette: final report of the Technical Study Group on Cigarette and Little Cigar Fire Safety. Washington DC: Consumer Product Safety Commission, 1987.

59. Birky MM, Halpin BM, Caplan YH, Fisher RS, McAllister JM, Dixon AM. Fire fatality study. Fire Mater 1979;4(3):211-7.

60. Cole M, Herndon DN, Desai MH, Abston S. Gasoline explosions, gasoline sniffing: an epidemic in young adolescents. J Burn Care Rehabil 1986;7:532-4.

61. Hall JR Jr. A decade of detectors: measuring the effect. Fire J 1985;79:37-43.

62. Robertson LS. Injuries: causes, control strategies and public policy. Lexington MA: DC Heath, 1983.

63. Hall JR Jr. U.S. experience with smoke detectors. Quincy MA: National Fire Protection Association, 1988.

64. Coleman R, Johnson T, Randall J. Why Johnny can't afford a house. Operation Life Safety Newsletter; July 1990.

65. US Fire Administration. Residential fire sprinklers retrofit demonstration project: final report, phase II: single-family structures. Washington DC: U.S. Government Printing Office, 1990.

66. Sorensen B, Werner H, Asmussen CF. Coffee scalds: pursuant prophylaxis. Burns 1977;3:166-70.

67. Wintemute G. Firearms as a cause of death in the United States, 1920-1982. J Trauma 1987; 27:532-6.

68. DeMuth WE Jr. Bullet velocity and design as determinants of wounding capability. J Trauma 1966;6:222.

69. Kellerman AL, Reay DT. Protection or peril? An analysis of firearm-related deaths in the home. N Engl J Med 1986;314(24):1557-60.

70. Baker SP. Without guns, do people kill people? Am J Public Health 1985;75:587-8.

71. Sloan JH, Kellermann AL, Reay DT, Ferris JA, Koepsell T, Rivara FP, et al. Handgun regulations, crime, assaults, and homicide: a tale of two cities. N Engl J Med 1988;319:1256-62.

72. Gould LC, Gardner GT, Deluca DR, Tiemann AR, Doob LW, Stolwijk JAJ. Perceptions of technological risks and benefits. New York: Russell Sage Foundation, 1988.

73. National Academy of Sciences. Accidental death and disability: the neglected disease of modern society. Washington DC: National Academy Press, 1966.

74. Committee on Trauma Research, Commission on Life Sciences, National Research Council, and the Institute of Medicine. Injury in America: a continuing public health problem. Washington DC: National Academy Press, 1985.

75. Committee to Review the Status and Progress of the Injury Control Program at the Centers for Disease Control. Injury Control. Washington DC: National Academy Press, 1988.

76. Dana AJ, Gallagher SS, Vince CJ. Survey of injury prevention curricula in schools of public health. Paper presented at the Annual Meeting of the American Public Health Association, October 2, 1990, New York.

77. Robertson LS. Injury epidemiology. New York: Oxford University Press, 1991.

Appendix:
Healthy People 2000:
Health Objectives for the Nation
Unintentional Injuries

Appendix: Healthy People 2000 Health Objectives for the Nation

Unintentional Injuries

9.1	Reduce deaths caused by unintentional injuries to no more than 29.3 per 100,000 people. (Age-adjusted baseline: 34.5 per 100,000 in 1987)
9.2	Reduce nonfatal unintentional injuries so that hospitalizations for this condition are no more than 754 per 100,000 people. (Baseline: 887 per 100,000 in 1988)
9.4	Reduce deaths from falls and fall-related injuries to no more than 2.3 per 100,000. (Age-adjusted baseline: 2.7 per 100,000 in 1987)
9.5	Reduce drowning deaths to no more than 1.3 per 100,000 people. (Age-adjusted baseline: 2.1 per 100,000 in 1987)
9.6	Reduce residential fire deaths to no more than 1.2 per 100,000 people. (Age-adjusted baseline: 1.5 per 100,000 in 1987)
9.7	Reduce hip fractures among people aged 65 and older so that hospitalizations for this condition are no more than 620 per 100,000 people. (Baseline: 714 per 100,000 in 1988)
9.8	Reduce nonfatal poisoning to no more than 88 emergency department treatments per 100,000 people. (Baseline: 103 per 100,000 in 1986)
9.9	Reduce nonfatal head injuries so that hospitalizations for this condition are no more than 106 per 100,000 people. (Baseline: 125 per 100,000 in 1988)
9.10	Reduce nonfatal spinal cord injuries so that hospitalizations for this condition are no more than 4.5 per 100,000 people. (Baseline: 5.3 per 100,000 in 1988)
9.11	Reduce the incidence of secondary disabilities associated with injuries of the head and spinal cord to no more than 16 and 2.6 per 100,000 people, respectively. (Baseline: 20 per 100,000 for serious head injuries and 3.2 per 100,000 for spinal cord injuries in 1986)
9.15	Enact in 50 States laws requiring that new handguns be designed to minimize the likelihood of discharge by children. (Baseline: 0 States in 1989)
9.16	Extend to 2,000 jurisdictions the number whose codes address the installation of fire suppression sprinkler systems in those residences at highest risk for fires. (Baseline data available in 1991)
9.17	Increase the presence of functional smoke detectors to at least one on each habitable floor of all inhabited residential dwellings. (Baseline: 81 percent in 1989)
9.18	Provide academic instruction on injury prevention and control, preferably as part of quality school health education, in at least 50 percent of public school systems (grades K through 12). (Baseline data available in 1991)

9.21	Increase to at least 50 percent the proportion of primary care providers who routinely provide age appropriate counseling on safety precautions to prevent unintentional injury. (Baseline data available in 1991)
9.22	Extend to 50 states emergency medical services and trauma systems linking prehospital, hospital, and rehabilitation services in order to prevent trauma deaths and long-term disability. (Baseline: 2 States in 1987)

Occupational Injury Prevention

Occupational Injury Prevention
— Contributors—

Susan P. Baker, M.P.H., Chairperson, The Johns Hopkins University, Baltimore, MD

Carol Conroy, Ph.D., M.P.H.,* California Public Health Foundation, Berkeley, CA

Janet J. Johnston, Ph.D., Division of Safety Research, National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

Thomas R. Bender, M.D., M.P.H., Division of Safety Research, National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, WV

Gwendolyn Cattledge, M.S.E.H., Ph.D., Executive Secretary, Division of Safety Research, National Institute for Occupational Safety and Health, Centers for Disease Control,Morgantown, WV

George S.T. Chu, Dr.P.H., California OSHA, San Francisco, CA

David DeJoy, Ph.D., University of Georgia, Athens, GA

Richard Duffy, M.S., International Association of Firefighters, AFL-CIO-CLC, Washington, DC

William M. Eisenberg, Bureau of Labor Statistics, Department of Labor, Washington, DC

Donald Elisburg, J.D., Center to Protect Workers' Rights, Washington, DC

James C. Fell, National Highway Traffic Safety Administration, Washington, DC

Lawrence J. Fine, M.D., Division of Surveillance, Hazard Evaluations and Field Studies, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, OH

Susan Goodwin Gerberich, Ph.D., University of Minnesota, Minneapolis, MN

Joseph A. Kinney, National Safe Workplace Institute, Chicago, IL

Jess F. Kraus, Ph.D., M.P.H., University of California - Los Angeles, Los Angeles, CA

William Marine, M.D., M.P.H., University of Colorado, Denver, CO

Vernon McDougall, International Brotherhood of Teamsters, Washington, DC

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Earl Pollack, Sc.D., George Washington University, Rockville, MD

Gordon R. Reeve, Ph.D., M.P.H., Ford Motor Company, Dearborn, MI

Richard H. Roettger, M.D., United States Air Force Medical Center, Lackland AFB, TX

Carol W. Runyan, Ph.D., M.P.H., University of North Carolina, Chapel Hill, NC

Thomas Seymour, Occupational Safety and Health Administration, Department of Labor, Washington, DC

Gordon S. Smith, M.B., Ch.B., M.P.H., The Johns Hopkins University, Baltimore, MD

Emily Spieler, J.D., West Virginia University College of Law, Morgantown, WV

Lorann Stallones, M.P.H., Ph.D., Colorado State University, Fort Collins, CO

Janice Travnick, Kemper Insurance, Long Grove, IL

James L. Weeks, Sc.D., Laborers' Health & Safety Fund of North America, Washington, DC

Craig Zwerling, M.D., Ph.D., M.P.H., University of Iowa, Iowa City, IA

Mary Ann Fenley, Macro International, Inc., Atlanta, GA

Where We Are

Occupational injuries are an important part of the injury problem in the United States, although recently they have generally been given less attention by public health professionals than injuries that occur in other settings, such as the home, the highway, or recreational settings. There are widely divergent estimates of the absolute numbers and rates of fatal and nonfatal work-related injuries with some of the reasons for the discrepancies being variations in definitions, worker populations included, methods of case ascertainment, and data sources (1). The current picture provided by occupational injury statistics reflects the limited use in the past of epidemiologic principles and the lack of a public health approach in addressing the occupational injury problem (2).

A work-related injury is one that is attributable to work activities arising directly out of and in the course of employment. Work activities are those duties or tasks that produce a product or result, or are done in exchange for money, goods, services, profit, or advantage. In some countries, such as Australia, injuries of bystanders resulting from the actions of others at work are considered work-related. In some countries, injuries occurring during a worker's commute to or from work are considered occupational injuries. There is currently no standard definition of work-related injury in this country; however, how it is defined affects surveillance and research as well as prevention strategies.

Dimension of the Problem

On the day that 7 crew members were killed in the explosion of the space shuttle Challenger, at least 16 other U.S. workers were also killed at work, and thousands more were injured. However, only the seven who died on the space shuttle received the attention of the media and a stunned public. This contrast illustrates the lack of media attention and public concern bestowed on workers who die or are disabled as a result of occupational injury, possibly because their injuries or deaths are not so spectacular, but possibly because the risk of injury may be perceived as an acceptable risk of working. However, occupational injuries should not be regarded as inherent in the workplace, nor should they be acceptable.

Occupational injury is an enormous and costly problem. Most incidents resulting in worker injuries are preventable and could be averted if known prevention strategies were more widely implemented. Until the public recognizes the importance of occupational injuries and demands safe work environments — and is supported in these demands by government, employers, and workers — reasonable protection of all workers will not be ensured.

The most effective interventions to date for reducing injuries have been those involving engineering, biomechanics, and environmental designs, the mainstays of the safety science approach to injury prevention. However, the potential for reducing work-related injury through these efforts is greatly enhanced when epidemiologic techniques are used to identify risk factors and evaluate preventive strategies and programs. Crucial to the process of solving occupational injury problems is interdisciplinary action, which spans the range from identification to widespread implementation of effective preventive strategies and requires the collaborative efforts of managers, workers, researchers, planners, and support staff from a variety of organizations and disciplines. Government, industry, labor, universities, workers, and the public must focus attention on this problem and coordinate their efforts toward effective injury prevention in the workplace.

In addition to the necessary research conducted in universities and implementation of prevention strategies in worksites, the public needs to be informed and convinced of the importance of work-related injury. Private and public organizations involved in occupational injury surveillance, research, and prevention activities should develop ways to communicate risk information using the latest information about crafting risk messages and reaching intended audiences, available dissemination channels, and the variety of potential media. Broadcast and print media, which have influenced public awareness of other public health problems and risk areas, have yet to fully convey the importance of occupational injury as a significant public health problem.

The future workers of our country should not wait until they enter the work force to learn about prevention of injuries. Just as preventive health-related information, such as information on the importance of exercise and nutrition, has been stressed in school curricula from elementary schools through universities, information on injury and injury prevention concepts could conceivably be introduced in elementary school science curricula and most certainly in secondary school science, industrial arts, and vocational-technical programs. Programs aimed at incorporating occupational safety and health components in the curricula of university engineering and medical schools are under way.

Finally, because of the close interaction between home and the workplace, interventions implemented in the workplace, even though they target workers, also provide an avenue for reaching workers' families. Many of the principles of injury prevention applicable in work settings are also applicable outside the workplace. However, the workplace provides a unique opportunity to implement, monitor, and demonstrate the effectiveness of many prevention strategies that are difficult to implement and evaluate elsewhere. Employers can design or modify jobs or processes, enforce the implementation of specific rules and procedures, provide and require the use of protective equipment, develop and provide specialized training, and otherwise structure and control the workplace environment to reduce injuries. In the absence of voluntary employer action, government regulators, corporate policymakers, insurers, unions, and other employee advocates can exert pressure on employers to reduce injuries through workplace management.

Ultimately, the goal of occupational injury control is the protection of workers, individually and in groups. The process of injury control, therefore, must involve workers and empower them to participate in the prevention of injuries.

There are varying estimates of the number of work-related injuries and deaths and much debate about their validity and importance. However, one thing is certain: these deaths and injuries — whatever the true number — are intolerable.

Despite the limitations, existing data indicate that the magnitude of occupational injury is staggering. Between 7,000 and 11,000 workers are fatally injured on the job each year (3,4). Every year about 7 of every 100 workers sustain nonfatal injuries while at work. In 1989 alone, almost two million workers sustained injuries that resulted in disability (4). The cost of occupational injury that same year was conservatively estimated at more than $48 billion (4). A more recent study by the RAND Corporation places the cost at over $83 billion for 1989 alone (5). Moreover, the pain, suffering, decreased quality of life, and stress associated with injury, as well as the financial cost to the worker, the family, and society are among the consequences of injury that are nearly impossible to measure (6).

Fatal Occupational Injury

The National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control (CDC), uses the National Traumatic Occupational Fatality (NTOF) data base based on death certificates that indicated injury at work (7). The NTOF data for 1980 to 1985 indicate that about 7,000 work-injury fatalities occur in the United States each year (3). However, the validity of these data depend upon accurate and consistent cause-of-death identification and the consistent completion of a single variable on the death certificate. Because this reporting is not uniformly accurate and consistent, NTOF data undercount the number of occupation-related deaths. Table 1 shows the number of worker deaths within major industry groups associated with leading causes of death. These data cover 1980 through 1986. Table 2 shows the rate (per 100,000 workers) of deaths within major industry groups associated with leading causes of death for the same 7 years. Table 3 shows the number and rate (per 100,000 workers) of worker deaths from occupational injury by cause and sex for 1980 through 1985.

The National Safety Council (NSC) estimated that 10,400 work-related deaths occurred in 1989 (4). This estimate is based on deaths in a work force in excess of 114 million and reflects several reporting mechanisms long used by the NSC. The reporting sources for the National Safety Council include the National Center for Health Statistics, state vital statistics departments, and state industrial commissions, although the method for obtaining the NSC estimate is difficult to validate. The NSC estimate does not include worker deaths resulting from intentional injuries (homicides and suicides), a problem of recent concern.

Table 1
Traumatic Occupation-Related Fatalities By Leading Causes of Death* and Major Industry Group,**
U. S. Civilian Labor Force
(National Traumatic Occupational Fatality Data Base, 1980-1986)

	Total+	Agriculture/ Forestry/ Fish	Mining	Construction	Manufacturing	Transportation	Wholesale Trade	Retail Trade	Finance/ Insurance/ Real Estate	Service	Public Administration
Motor Vehicle (E810-E829,E846-E849)	9,865	789	285	957	675	3,752	308	417	91	629	577
Machinery (E919)	6,060	1,852	421	977	854	389	58	87	38	218	69
Homicide (E960-E969)++	5,344	152	24	212	300	481	129	1,756	134	795	502
Falls (E880-E888)	4,215	244	108	1,938	439	267	42	92	39	290	80
Electrocution (E925)	3,296	361	141	1,165	272	489	29	56	11	153	53
Struck by Falling Object (E916)	2,929	369	315	590	719	237	22	44	9	151	38
Air Transport (E840-E845)	1,844	131	33	61	94	630	16	32	49	193	390
Unknown/undet. (E980-E989, Blank)	1,555	164	55	197	191	262	19	108	13	125	87
Suicide (E950-E959)	1,297	89	10	99	111	76	17	197	46	290	84
Explosion (E923, E921)	1,246	39	159	152	271	113	12	46	2	104	31
Flying Object/Caught (E917-E918)	1,095	99	83	197	206	148	16	25	5	49	15
Other	1,057	102	23	130	204	103	11	66	10	90	104
Natural Environ. (E900-E909, E928)	1,038	248	96	158	133	85	11	21	5	67	31
Water Transport (E830-E838)	888	288	14	45	29	167	9	42	1	51	54
Suffocation (E911-E913)	864	95	57	332	79	57	9	15	5	35	17
Fire (E890-E899)	829	64	56	99	164	48	14	46	6	92	55
Poisoning (E850-E858, E860-E869)	696	58	57	72	114	67	11	28	5	86	25
Drowning (E910)	647	116	29	86	44	70	4	10	3	96	41
Rail Transport (E800-E807)	324	4	8	15	18	245	1	2	2	4	2
Total	45,089	5,264	1,974	7,482	4,917	7,686	738	3,090	474	3,518	2,255

* International Classification of Diseases, Ninth Revision - Supplementary Classification of External Causes of Injury and Poisoning.
** Standard Industrial Classification Manual, 1987.
\+ Totals include cases for which industry could not be classified (17%).
++ Homicide data for New York, Oklahoma, Louisiana and Nebraska were not available.
Shading denotes the three leading causes of death in each industry group.

Table 2
Traumatic Occupational Fatality Rates (per 100,000 workers) By Leading Causes of Death* and Major Industry Group,**
U. S. Civilian Labor Force
(National Traumatic Occupational Fatality Data Base, 1980-1986)

	Total+	Agriculture/ Forestry/ Fish	Mining	Construction	Manufacturing	Transportation	Whosesale Trade	Retail Trade	Finance Insurance RealEstate	Service	Public Administration
Motor Vehicle (E810-E829, E846-E849)	1.65	3.04	4.05	3.21	0.49	11.44	0.82	0.38	0.23	0.46	1.64
Machinery (E919)	1.01	7.14	5.99	3.28	0.62	1.19	0.15	0.08	0.10	0.16	0.20
Homicide (E960-E969)++	0.89	0.59	0.34	0.71	0.22	1.47	0.34	1.58	0.34	0.58	1.43
Falls (E880-E888)	0.70	0.94	1.54	6.51	0.32	0.81	0.11	0.08	0.10	0.21	0.23
Electrocution (E925)	0.55	1.39	2.01	3.91	0.20	1.49	0.08	0.05	0.03	0.11	0.15
Struck by Falling Object (E916)	0.49	1.42	4.48	1.98	0.52	0.72	0.06	0.04	0.02	0.11	0.11
Air Transport (E840-E845)	0.31	0.51	0.47	0.20	0.07	1.92	0.04	0.03	0.12	0.14	1.11
Unknown/undet. (E980-E989, Blank)	0.26	0.63	0.78	0.66	0.14	0.80	0.05	0.10	0.03	0.09	0.25
Suicide (E950-E959)	0.22	0.34	0.14	0.33	0.08	0.23	0.05	0.18	0.12	0.21	0.24
Explosion (E923, E921)	0.21	0.15	2.26	0.51	0.20	0.34	0.03	0.04	0.01	0.08	0.09
Flying Object/Caught (E917-E918)	0.18	0.38	1.18	0.66	0.15	0.45	0.04	0.02	0.01	0.04	0.04
Other	0.18	0.39	0.33	0.44	0.15	0.31	0.03	0.06	0.03	0.07	0.29
Natural/Environ. (E900-E909, E928)	0.17	0.96	1.37	0.53	0.10	0.26	0.03	0.02	0.01	0.05	0.09
Water Transport (E830-E838)	0.15	1.11	0.20	0.15	0.02	0.51	0.02	0.04	0.003	0.04	0.15
Suffocation (E911-E913)	0.14	0.37	0.81	1.11	0.06	0.17	0.02	0.01	0.01	0.03	0.05
Fire (E890-E899)	0.14	0.25	0.80	0.33	0.12	0.15	0.04	0.04	0.02	0.07	0.16
Poisoning (E850-E858, E860-E869)	0.12	0.22	0.81	0.24	0.08	0.20	0.03	0.03	0.01	0.06	0.07
Drowning (E910)	0.11	0.45	0.41	0.29	0.03	0.21	0.01	0.01	0.01	0.07	0.12
Rail Transport (E800-E807)	0.05	0.02	0.11	0.05	0.01	0.75	0.003	0.002	0.01	0.003	0.006
Total	7.54	20.30	28.08	25.13	3.58	23.44	1.96	2.78	1.19	2.56	6.41

* International Classification of Diseases, Ninth Revision - Supplementary Classification of External Causes of Injury and Poisoning.
** Standard Industrial Classification Manual, 1987.
\+ Totals include cases for which industry could not be classified (17%).
++ Homicide data for New York, Oklahoma, Louisiana and Nebraska were not available.
Shading denotes the three leading causes of death in each industry group.

In 1989, the Bureau of Labor Statistics (BLS), which excludes public sector employees, the self-employed, and employees of companies with fewer than 11 workers, reported about 3,300 deaths in the population of workers that it surveys (6). The BLS estimate is based on a survey sample of approximately 280,000 individual employers, with a 94% response rate. In addition to omitting many groups of workers, the BLS sampling scheme results in estimates that tend to disproportionately reflect the experience of large companies. Fatality estimates are made on the basis of data from establishments with 11 or more employees only. As discussed in the report by the National Academy of Sciences (9), the BLS greatly undercounts occupational deaths.

Nonfatal Occupational Injury

Limited data are available on the frequency of nonfatal work-related injuries, and no data are available on work-related injuries requiring hospitalization. The BLS estimated that about 6.4 million injuries (7 per 100 full-time workers) occurred during 1988 (10). The estimate includes recordable injuries (including deaths), injuries resulting in days away from work or restricted activity, and injuries without lost workdays. According to the estimate, nearly 2.9 million injuries resulted in lost workdays. A report sponsored by the National Academy of Sciences (9) concluded that there was considerable underreporting in the BLS annual survey. Another source of nonfatal occupational injury data is based on a sample of approximately 66 emergency rooms from the Consumer Product Safety Commission's (CPSC) National Electronic Injury Surveillance System (NEISS), which collected data for the National Institute of Occupational Safety and Health (NIOSH) during 1981-1986. The authors of an unpublished NIOSH study based on this sample estimated that over 3.8 million occupational injuries of varying severity and outcome are treated every year in U.S. emergency departments. Because this estimate is an extrapolation, the true number may be much higher. The NSC defines a disabling injury as one that causes death, permanent disability, or any degree of temporary total functional disability beyond the day of the injury. The NSC also estimates that there were 1,700,000 disabling injuries in 1989 among workers in the United States (4).

Lost Workday Rates

Estimates of lost workdays depend on the data source used to count injuries. The National Safety Council estimates days lost from injuries during 1989 to be 75 million, which includes those lost because of injuries that occurred in 1989, as well as in previous years (4). According to the Bureau of Labor Statistics, among the nearly 3.0 million injuries in 1989 that resulted in lost workdays, the average lost workdays per case was 20, or a total of 60 million lost workdays in the population of workers that BLS reports on (10). Although the number of lost workdays is used as a criterion for reporting injuries or as a proxy for severity, such uses may be misleading because of the employer's incentive to return injured workers to the workplace to avoid "reportable" injuries, even if they cannot perform their usual tasks.

Table 3
Deaths and Death Rates from Occupational Injury, by Cause and Sex, 1980-1985

Cause	Male		Female		Total	
	Deaths	Rate*	Deaths	Rate*	Deaths	Rate*
Motor vehicle, traffic	6,809	1.99	493	0.19	7,302**	1.20
Motor vehicle, nontraffic	768	0.22	31	0.01	799	0.13
Aviation	1,480	0.43	78	0.03	1,558	0.26
Railway	262	0.08	4	0.00	266	0.04
Water transport	583	0.17	11	0.00	594	0.10
Drownings/suffocation	1,202	0.35	38	0.01	1,240	0.20
Poisonings	493	0.14	7	0.00	500	0.08
Falls	3,378	0.99	113	0.04	3,491	0.57
Fire and Flames	627	0.18	55	0.02	582	0.11
Firearm	181	0.05	12	0.00	193	0.03
Natural/Environmental factor	394	0.12	30	0.01	424	0.07
Falling object	2,342	0.68	19	0.01	2,361	0.39
Struck against	531	0.16	10	0.00	541	0.09
Caught in/between	333	0.10	9	0.00	342	0.06
Machinery	4,950	1.45	93	0.03	5,043	0.83
Explosive	770	0.22	44	0.02	814	0.13
Explosion of pressure vessel	212	0.05	5	0.00	217	0.04
Electric current	2,695	0.79	15	0.01	2,710	0.45
Suicide	1,017	0.30	113	0.04	1,130	0.19
Homicide	3,586	1.05	861	0.32	4,447	0.73
Other and unspecified	1,445	0.42	111	0.04	1,556	0.26
TOTAL	34,058	9.94	2,152	0.81	36,210	5.95

Source: Injury Fact Book, 2nd Ed. (8).

*Per 100,000

**Data from the Fatal Accident Reporting System (FARS) maintained by the U.S. Department of Transportation indicate that there may be as many as 3,000 deaths per year resulting from occupational motor-vehicle crashes, rather than the approximately 1,200 per year indicated here (8).

Costs: Economic Impact of the Problem

The costs of occupational injuries go well beyond the financial burden of medical treatment. Pain, suffering, altered quality of life, stress and its resulting illnesses, together with loss of earning power are among the consequences of injury that are nearly impossible to quantify (6,11). Furthermore, the effects of an injury spread to other individuals with whom the seriously injured person and his or her family interact, compounding the problem of determining the cost of work-related injury.

Even economic costs are not easily tabulated. One recent report to Congress (12) identified the costs of injury by major cause but did not include data on the total economic burden of occupational injury because such data are not available. Similarly, insurance administration costs associated with workers' compensation and product liability are not easily identified, nor are long-term morbidity costs, including the costs of follow-up health care, residential care, legal assistance, and property damage. Productivity losses associated with disabling injury include losses related to production disruption, equipment and property damage, the selection and training of replacement workers, and injury investigation.

The NSC estimated that the overall cost of work-related injuries incurred in 1989 was more than $48 billion. This is an underestimate of the actual cost for several reasons, including underreporting of injuries (6,13), the exclusion of intentional injuries (14-16), and the fact that neither children less than 14 years of age nor workers often not included under traditional compensation programs (e.g., the self-employed and public sector workers) were not considered. People operating small family farms, who constitute a large proportion of all farm workers in many states, are one important population of workers not universally covered (17).

A recent unpublished study* reported estimates of over $21 billion (based on 1989 dollars) spent annually for medical care, lost productivity, and administrative processing of work-related injuries. The authors state that this should be considered only part of the total cost for all work-related injuries because it does not include fatal injuries (which they report to be about 11,000 per year) or those injuries that did not result in at least 3 lost workdays (over 9 million per year). Another report put the cost at over $83 billion dollars for the same year (5).

Considering the enormous cost to society (and industry) that occupational injury imposes, cost-benefit studies of injury prevention programs can help illustrate the savings associated with injury prevention. In the petroleum industry, the introduction of equipment that permitted automatic connection and disconnection of pipes (without worker involvement) on offshore drilling rigs resulted in significant decreases in injuries and paid for itself within 6 years (18).

*Rossman SB, Miller TR, Douglass JB. The costs of occupational traumaic and cumulative injuries. Research supported by the National Institute for Occupational Safety and Health, Centers for Disease Control. (CDC Grant No. R49/CCR 303675-02) March 1991.

International Perspective

There is considerable variation among nations in the numbers, rates, severity, and external causes of occupational injuries. In its Year Book of Labor Statistics, the International Labor Organization (Geneva) publishes tables of the numbers of work injuries and the rates of fatal occupational injuries by industry for many countries. In most countries, however, injury statistics are compiled as a by-product of administrative work processes and labor regulations. The definitions, coverage, and methods used to compile these data vary so widely from nation to nation that comparisons are difficult. However, many countries have developed injury prevention strategies that represent a valuable source of information and data for programs for injury prevention.

A few developed countries (such as Sweden) have comprehensive surveillance systems or registries to identify and monitor work-related injuries and fatalities nationwide for the specific purpose of developing injury prevention strategies and policies. In developing countries, most of the labor force works in environments that have minimal or no safety standards. Because of the overall poor socioeconomic status of these countries and because of their efforts to industrialize rapidly, governments, companies, and even workers may compromise safety. The risk of being injured at work is likely to be greater in less technologically advanced environments where safety measures are often sacrificed in hopes of increasing productivity and saving money. Of course, risk for injury may increase as a function of production pressures in technologically advanced environments as well.

Comparisons among geographic or economic sectors afford the opportunity to share experiences and information on effective injury prevention programs. In Sweden, in response to an observation that injuries caused by chain saws occurred frequently, modifications were developed in the 1960s to make chain saws safer. This is in contrast to the United States where responsibility at the federal level for occupational safety was not recognized until the passing of the Federal Coal Mine Health and Safety Act in 1969 and the Occupational Safety and Health Act (OSH Act) in 1970. Examining these differences relating to national policy may uncover important new prevention strategies or verify the effectiveness of certain current prevention programs. Finally, the low occupational-injury rates in some countries give hope that, if the problem of occupational injuries is approached properly, rates may be lowered in this country also.

Commitment to the Goal: Preventing Occupational Injury

The United States has yet to organize and coordinate a successful, multidisciplinary, multiorganizational approach to preventing occupational injury. Collaborative efforts are essential to improve research and more effectively implement interventions (19).

Unfortunately, funds for research and training programs are scarce. The dearth of people well-trained in injury epidemiology and safety engineering is a major problem. The resources available for occupational injury prevention and control in the United States pale in comparison with those available in western Europe. For example, agencies involved in occupational safety and health in Finland and Sweden have budgets (per worker) almost 20 times that of NIOSH (19).

Occupational injury prevention is linked to organizational commitment to workplace safety. Employers, employees, and others responsible for or interested in protecting workers should know and understand the risks workers face and how to reduce or eliminate those risks. Just as systematic methods are employed in identifying risk through surveillance and in developing preventive strategies, systematic methods can and should be employed in communicating information on risk and injury prevention.

The results of studies have demonstrated that not only does management commitment to safety decrease the number of work-related injuries, it is also cost-effective. Therefore, to improve occupational safety and health in the 1990s, senior company executive involvement is necessary (20). The John Deere Company, for example, attributes a 74% decrease in their OSHA-recordable injury rate from 1975 to 1984 to the establishment of facility-based occupational health and safety goals supported by management (21). Other examples include an automobile parts manufacturing company that, after implementing material handling procedures in 1986, experienced a 73% reduction in annual injury-related worker compensation claims compared with 1985 (22).

The link between injury prevention and improved quality and increased productivity needs to be explored and documented, because proof of this relationship will strengthen organizational commitment to workplace safety. Within the context of a production process, the occurrence of an injury is typically the culmination of a series of events beginning with some variation in the process. Once these events happen, the occurrence of an injury is predictable within a broad time frame, but its actual occurrence at a given time or during a particular shift is not predictable, and the injury is typically (and incorrectly) seen as a random event. Considered in this perspective, the consistent production of a high-quality product is incompatible with a high rate of injuries.

Commitment to workplace safety within an organization should result in workplace design factors being considered in the bidding specifications for the equipment that will be purchased or constructed for the production process. For example, the purchasing agent must realize that the specifications related to safety features cannot be negotiated away for a lower price or faster delivery schedule. For existing operations, process reviews should involve a team approach (engineering, quality, and safety) with input from operators who have actually been running the process. Construction contracts should have an injury prevention component built into the contract bid process in the same way financial stability

is included. Potential bidders should be required to demonstrate a low rate of injuries among their workers, sufficient injury-prevention activities, and compliance with safety standards, or they should be eliminated from the bidding process.

Labor-management agreements are also important for promoting workplace safety. These relationships are governed by collective bargaining contracts and regulatory and labor relations statutes, which create important rights and responsibilities. Workplace safety is a common feature of labor-management contracts, which often provide for health and safety committees. Many national and international unions also have their own programs and staff for promoting workplace safety.

Surveillance Issues

The need for developing injury surveillance systems and using epidemiologic data as the basis for targeting and developing prevention strategies is clearly stated in *Injury in America* (23). Carefully designed surveillance of occupational injuries and fatalities is essential not only to document accurately the magnitude of the injury problem and identify potential risk factors, but also to target interventions and to evaluate the effectiveness of specific programs and interventions (24,25). An example of reporting selected occupational conditions, such as carpal tunnel syndrome, is the Sentinel Event Notification System for Occupational Risk (SENSOR) project developed by NIOSH and implemented in many states (26). This project relies on local health care providers to identify and report selected conditions to their state health departments. Action based on surveillance results is part of the system and allows rapid intervention at a local level. At present, SENSOR involves only ten states, and carpal tunnel syndrome is the only nonfatal injury condition currently reported, although some states are planning to target fatal and nonfatal agricultural injuries for reporting under NIOSH funding. Fatal occupational injuries are reported in the Fatal Accident Circumstances and Epidemiology (FACE) project developed by NIOSH. The FACE project relies on detailed and standardized investigation of selected electrocutions, deaths related to confined spaces, and fatal falls to identify opportunities for intervention and prevention.

While there are limited surveillance systems for identifying both occupational mortality (3,4,9,27-29) and morbidity (4,13,30-33), there is no standardized comprehensive system for accurately identifying working populations and the workers within these populations injured or killed. Although existing surveillance systems are not perfect, they may be useful to identify patterns of injury occurrence while new and improved systems are designed and established. Overlap between surveillance needs and data collected for other purposes has resulted in the shared use of some established systems. For example, some workers' compensation programs use a first-report-of-injury form that is designed for employer's reports to OSHA.

In addition to the lack of standardized, comprehensive national data, few companies use occupational injury surveillance systems (except for workers' compensation claims and the OSHA log of injuries) that permit them to identify the causes that most often result in serious injury to their workers. One of the significant needs of those who conduct occupational injury surveillance and etiologic research is standardized coding systems. This is true both at the company level, where the nurse may have different surveillance results than the safety officer, and at the national level, where NIOSH may have different surveillance results than the BLS. Company-based recordkeeping required by OSHA and data that are collected by BLS use the American National Standard Institute (ANSI) Z16.2 coding system. However, medical personnel within companies and the National Center for Health Statistics (NCHS) use the International Classification of Disease (ICD) coding system. Both systems are useful, and the ability to link or use both coding systems in a single data set would increase the usefulness of these data.

Another important need is the inclusion of a brief description of the circumstances of injury. This can best be accomplished with a paragraph summarizing the event that can later be printed out for cases of interest or searched for retrieval of cases including one or more of the key words.

Ultimately, a surveillance system should allow users to promptly identify specific workplaces, hazards, employers, or groups of workers with excessive numbers of injuries. The purpose of this identification should be efficient, targeted prevention efforts. To accomplish this may require obtaining data on injuries that are specific to workplaces or employers.

Research Issues

As previously stated, no comprehensive data system currently exists to identify accurately the magnitude and specific nature of the occupational injury morbidity and mortality problem; information on risk factors and details of the circumstances of nonfatal injuries are particularly deficient. Several methods have been used to ascertain the magnitude of the occupational injury problem. These include surveillance efforts mentioned in the previous section and descriptive studies that have examined occupational injury mortality (34-37) and morbidity (19,30,38-43) among various populations and subgroups. The vast majority of efforts identified in the literature on occupational injury have consisted of case reports (44-46) or surveys, frequently without relevant population-at-risk data. Although limited, these efforts provide a basis for subsequent studies on the causes of occupational injury. Such efforts may be particularly important for documenting unusual occurrences and identifying new injury problems, a process that, in turn, facilitates the appropriate design and conduct of analytic studies of specific risk factors and ultimately the development and implementation of prevention strategies.

The difficulties in describing the magnitude and epidemiology of work-related injuries are related directly to the problems of definition, case ascertainment, information retrieval, and communication of results. Standardization of information would ensure that information is available without regard to fault, administrative judgment, or other factors that could change the classification of cases. One of the best surveillance systems is the Fatal Accident Reporting System (FARS) maintained by the U.S. Department of Transportation. This system provides standardized, accurate, detailed information on all deaths due to motor vehicle crashes. Although it is not a good system for identifying occupational injury cases (because that particular data element is dependent upon what the death certificate reports), aspects of FARS could be used as models for systems addressing occupational injuries (47).

In many states, workers' compensation records provide the only source of detailed data on occupational injuries. These records are a source of information regarding the severity and frequency of injuries in specific industries and working environments and may be useful at a local level. However, because of wide variations among states regarding what constitutes a compensable claim and which workers are excluded from coverage, these data are less useful at a national level. The Bureau of Labor Statistics has attempted to standardize the states' information through its Supplemental Data System (SDS) and Work Injury Reports (WIR) programs, which use uniform coding systems and investigative techniques. These programs may be eliminated soon; however, the BLS is developing improved programs to take their place, which will use uniform case definitions and coding in a redesigned system.

There is a lack of comprehensive population-based studies of occupational injury, including morbidity studies, among a variety of industries to determine the extent of the problem more accurately. Available occupational injury data generally do not include sufficient information on agents and sources of injury, worker characteristics, or incident circumstances to generate specific hypotheses for subsequent risk factor research.

In 1983 NIOSH compiled a list of the 10 leading occupational injuries and illnesses in the United States. These 10 injury and illness categories were considered "leading" problems because they occur frequently, are often severe (i.e., fatal or disabling), and are, for the most part, preventable or amenable to prevention. During a national symposium in 1985, multidisciplinary committees developed prevention strategies for the first 5 of these top 10 problems. Among the problems identified were severe occupational traumatic injuries. This category includes a wide range of injuries (amputations, severe lacerations, burns, etc.) and numerous external causes (e.g., falls, motor vehicles, electricity). Although preventing all injuries in the workplace is clearly a long-term goal, progress toward that goal can begin by focusing attention on the most serious problems. Therefore, research priorities should focus on (a) injuries that often result in death or severe disability, (b) injuries that occur in high-risk occupations or industries, and (c) easily preventable injuries that occur frequently, even if they are less severe.

Because more traumatic occupational deaths identified in NTOF data from 1980 to 1985 are attributed to motor vehicle crashes, machinery, homicides, falls, and electricity than to any other causes, such deaths are priority targets. Although the proportion varies depending upon the source of data, motor vehicle crashes probably cause over one-third of all occupational deaths per year (4). Many deaths related to motor vehicles are not coded as the result of work-related injuries and thus are not included in NTOF data. The authors of one study also noted that motor vehicles are a primary cause of nonfatal injury for those workers who must drive or who are exposed to motor vehicles as a part of their job (48).

Machine-related occupational injuries are usually caused by powered hand tools, fixed machinery, and work vehicles such as forklifts and tractors. According to NTOF data for 1980-1985, 13% of all occupational deaths (nearly 850 deaths per year) are related to machines. Sources of nonfatal injury data, specifically the BLS Supplementary Data Systems and the National Electronic Injury Surveillance System, suggest that almost 6% and 12% of occupational nonfatal injuries, respectively, involve machines. The most hazardous machinery includes tractors and other agricultural machines, which were involved in over 600 deaths in 1988; lifting machines such as cranes and forklifts, which were involved in over 180 deaths that year (8); and machines that are often associated with amputations.

Occupational assault and homicide involve a variety of weapons, but firearms cause the great majority of fatalities (34). Although little information is available on the number of nonfatal intentional injuries occurring at work (15), homicide accounts for about 13% of all fatalities in the workplace (7) and is the first or second leading category of fatal occupational injury in 5 of the 10 major industry groups (Table 1). Among women who die in the workplace, 42% are victims of homicide (49). These high homicide rates point to the need for more research and for implementing prevention strategies.

Falling from elevations is a frequent cause of injury and death for workers in many different occupations and industries. During 1980-1985, over 2,700 workers, primarily in the construction industry, were killed in falls from elevations (NTOF data). Because people who are injured in falls often suffer permanent neurological damage such as paralysis or lower back injury, preventing even nonfatal falls deserves a high priority.

Electrical injuries result when a worker is exposed to an electrical current. Injury can be caused by electrical burn or electrocution. Approximately 500 occupational electrocutions occur each year according to NTOF data from 1980 through 1985. Electrical energy is present in virtually all workplaces, although certain occupational groups are at higher risk because of greater exposure through specific job tasks (e.g., line mechanics). Approximately 165 workers are electrocuted each year in construction-related occupations. Agriculture occupations also have at least 50 reported deaths per year due to electrocution and another 80 occur in the transportation industry. Many electrocutions occur when booms, ladders, pipes, or other metallic objects come in contact with powerlines. Unpublished BLS data indicate that about 2,200 electricity-related injuries occur per year in the population of workers covered by their estimates, suggesting a total of approximately 4,000 injuries for the

entire U.S. workforce. Permanent disfigurement, disability, and potential psychological trauma accompanying a severe electrical burn make electricity an important cause of even nonfatal injury.

Acute back injuries account for a substantial proportion of workers' compensation claims and should be targeted. Work-related eye injuries, which occur frequently and are often severe enough to cause loss of vision, are easily prevented and ought to be targeted. Other leading causes of occupational injury that should receive priority attention include blunt force trauma due to being struck by objects, aviation-related injury, injury from explosions, suffocation from mechanical compression (e.g., trench cave-ins), and asphyxiation (in confined spaces) and drowning.

Another research area that warrants expansion is the evaluation of prevention strategies. It is not enough simply to design and implement prevention strategies; it is necessary to evaluate these strategies to ensure they are having the intended effect. Although a strategy may be carefully designed to prevent injuries, unrecognized factors often diminish or eliminate a strategy's effectiveness once implemented. In addition, all strategies should be evaluated to ensure that their use does not result in increased risk for another injury. The results of such evaluations can help in the redesign or modification of injury prevention strategies.

Prevention Issues

Although much remains to be learned through research about effective countermeasures, there are already a number of known prevention strategies that can be implemented now.

One approach to preventing injury is to address the three phases of injury (pre-event, event, postevent) to target the timing of the intervention or to develop prevention strategies. When coupled with the traditional epidemiologic model of agent, host, environment, and vehicle/vector, this provides a matrix framework upon which to develop countermeasures. A combination of measures from all three phases should be used, with preference given to the most effective measure.

Automatic (passive) protection and engineering controls are generally more effective than active protection, which requires workers to participate in their own injury prevention (50). Seat belts are an example of active protection because, although installation of seat belts is required by regulation, the driver must physically attach the manual seat belt or correctly position the automatic seat belt. This requires a conscious effort, putting the burden of protection on the driver. Air bags, on the other hand, provide automatic protection to vehicle occupants because they do not require the occupant's participation. Requiring that all vehicles used for work purposes (fleet vehicles) be equipped with air bags would

automatically provide a measure of protection to the vehicle occupants. For maximum protection, people should use seat belts even in a car with air bags; it has been shown that the presence of air bags does not result in decreased use of seat belts (51).

Despite the great difficulty of changing individual behavior, there has been much emphasis on workers' behavior as the cause of injury and a corresponding tendency to blame the worker, often incorrectly. Automatic (passive) protection is too seldom used in the more hazardous industries such as agriculture and construction, despite the fact that it is more effective than "active" measures requiring effort on the part of each individual worker. In addition to air bags, examples of passive protection include machine guards and new types of syringes and other needle protective devices that prevent needlestick injury among hospital workers. Engineering controls are available for many known hazards but have not been systematically applied and evaluated.

The difficulties in designing interventions relate to the necessity for collaborative research and interactions among scientists from many different disciplines. After risk factors are identified through epidemiologic research, the development of interventions requires a multidisciplinary approach involving engineering, biomechanics, and the behavioral sciences. Laboratory research for developing injury interventions has not kept pace with laboratory capabilities supporting health-related problems in the workplace. For example, computer simulation could be used to establish a basis for improved performance for engineering controls in different workplace environments. Also, occupational hazards that are often not detectable by workers could be detected by using sensors that could be developed in the laboratory. There remains a need for laboratories that focus on developing passive worker protection systems.

Several studies have evaluated employee perception of job hazards or injury risk. In one study, the authors noted that the perceived risk of injury was high for the use of vehicles, machinery, tools, and for falls (52). In another study, researchers used data from several different sources, including the Quality of Employment Survey (1977), the National Longitudinal Survey of Young Men (1978), and the National Longitudinal Survey of Young Women (1980). When compared with BLS injury and illness data, the data from these studies showed a significant association between general worker dissatisfaction with work and reporting of hazards by women (53). This author also noted higher rates of dissatisfaction among workers in more hazardous industries and suggested that workers are generally aware of occupational hazards. Such employees may have valuable insight and should be included in developing prevention strategies.

Lack of employer compliance with Occupational Safety and Health Administration (OSHA) standards is a barrier to effective injury prevention. In a study by NIOSH, based on the National Occupational Exposure Survey, researchers found that only 72% of companies included in the survey complied with OSHA record-keeping requirements (54). Surprisingly, companies that were established prior to 1970 (OSH Act implementation) more often maintained OSHA logs. Additionally, data collected under the NIOSH Fatal

Accident Circumstances and Epidemiology (FACE) project indicated that, of the deaths investigated, most might have been prevented if existing OSHA standards or known safe work practices had been implemented (unpublished FACE data, 1990). This problem is compounded by the fact that most existing OSHA standards and accepted safe work practices have not been systematically evaluated for effectiveness and many causes of workplace injury are not addressed by OSHA regulation (e.g., homicide, which is surpassed only by motor vehicles and machinery as a cause of work-related death). Furthermore, many workers in small companies or who are self-employed are at especially high risk of injury (e.g., farmers and commercial fishermen) but are not under OSHA jurisdiction and may not know that OSHA consultation is available to them.

Government Regulation

In the context of occupational injuries there is a unique opportunity to enforce prevention strategies by legally requiring that employers comply with safety standards set by OSHA or other government agencies.

Government regulation by both federal and state agencies is a necessary but not sufficient part of an effort to prevent occupational injuries. OSHA, as the principal federal regulatory agency with this mission, has two principal functions: promulgating standards and enforcing them with inspections and penalties for noncompliance. Safety standards require employers to take certain steps, such as guarding machines, erecting barricades, maintaining walking and working surfaces, and providing adequate exits and fire suppression equipment. Under OSHA regulations, employers also have a "general duty" to provide for a safe workplace, regardless of whether a specific standard exists. Employers are also legally required to conduct certain medical examinations, inform workers about chemical hazards, make and maintain records, and report fatalities and serious injuries. OSHA inspectors have the authority to enter and inspect workplaces and may issue civil penalty citations if violations of standards are found, but workplaces with 10 or fewer employees are exempt from general schedule inspections. Under OSHA regulations, employers may also be prosecuted for criminal charges. Disputes are adjudicated in federal courts. Some nonfederal jurisdictions also prosecute employers on criminal charges based on serious injuries to workers (55).

Although the OSH Act requires employers and employees to comply with OSHA standards and provides for enforcement of such standards by OSHA, the U.S. Congress intended that the goals of the law would be achieved by all parties working cooperatively towards reducing occupational injuries. The law was to build upon the advances made through employer and employee initiatives and to stimulate employers and employees to institute new and more effective programs. The OSHA Voluntary Protection Program (VPP) has reported success in reducing injuries, although some of the success may be due to self selection of participating companies. In 1988, 94% of the sites participating in VPP had injury incidence rates below their 1987 BLS industry classification rates. Many also showed a decrease in rates of injuries resulting in lost workdays and an increase in injuries avoided.

With limited resources, OSHA's enforcement program is largely reactive. The majority of OSHA inspections are driven by fatalities, catastrophes (where five or more employees are injured), or complaints. With any additional resources, OSHA attempts to target more hazardous industries. Inspections are conducted with no advance notice, and sanctions are imposed after a first-instance violation to provide incentives to employers to remain in compliance with OSHA standards.

The general structure and function of the Mine Safety and Health Administration (MSHA), which has jurisdiction over the mining industry, is the same as OSHA's although there are some important differences. For instance, all underground mines, with no exceptions, must be inspected four times each year, and all surface mines must be inspected twice each year. Furthermore, MSHA inspectors must issue citations if violations are found and may close down all or part of a mine if an imminent danger is found. Under OSHA, issuing citations is not mandatory, and workplaces can be closed only with a court order.

Other regulatory agencies with authority that results in preventing injuries include the National Highway Transportation Safety Administration (NHTSA), the Federal Aviation Agency (FAA), the Federal Railroad Administration (FRA), and the U.S. Coast Guard (USCG), all in the U.S. Department of Transportation. These agencies regulate transportation on highways, airways, railways, and waterways, respectively, which are workplaces for many people. Their regulatory functions include specifications for vehicle and aircraft safety and licensing pilots and captains. Their emphasis is typically on the safety of the travelling public rather than on the prevention of injury to workers, such as truck drivers. As a result, strategies to protect workers have sometimes been neglected.

Other agencies concerned with injury prevention include the Nuclear Regulatory Commission, which regulates nuclear power plants; the Environmental Protection Agency, which regulates the use of pesticides and the use and disposal of other toxic substances; and the Department of Energy, which is responsible for safety and health in its nuclear weapons facilities.

Regulation is more likely to be effective if vigorously and conscientiously enforced. For example, regulation initiated with the passage of the Federal Coal Mine Health and Safety Act of 1969 was followed by a significant reduction in the rate of fatal mine injuries (56). When adjusted for the effects of rate changes in workers compensation, injury rates at specific workplaces showed a decrease for a year following OSHA inspections (57). An analysis of workplace fatalities in California showed that a limited but not insignificant number of deaths could have been prevented with stronger enforcement (58).

Where We Want To Be

To be most effective, efforts to control occupational injury must be well integrated with other injury control efforts at the federal, state, and local levels, including efforts of both public and private entities. To do this, common frameworks for understanding injury occurrence and prevention must be applied. Furthermore, the special concerns associated with occupational injury surveillance, research, and prevention need to be incorporated into all other elements of a national program. This includes (a) identifying occupationally related variables in injury surveillance efforts throughout the spectrum of fatal and nonfatal injury; (b) designing, evaluating, and redesigning high-quality prevention programs that address workers' on- and off-the-job safety; (c) providing acute care and rehabilitation services appropriate to specific occupational groups and injury problems; and (d) educating the public, decision-makers, management and labor, and key professional groups about occupational injury.

With the changing nature of work, the nature of risks changes also. A predominant characteristic of U.S. employment growth in the last several decades has been the rapid growth in the service-producing sector and the decline in the goods-producing industries. Projections for the years 1988-2000 show this trend continuing (59). Major occupational groups projected to grow faster than the overall 15.3% for total employment (1988-2000) include technical and related support occupations; professional specialty occupations; executive, administrative, and managerial occupations; service occupations; and marketing and sales occupations (60). Especially noteworthy is the projected 4.8% decline in agricultural occupations and only 1.5% increase among operators, fabricators, and laborers. Another trend is that nearly two women for every man will continue to enter the U.S. labor force and that by the year 2000, women will comprise 47% of the U.S. work force instead of the current 45%. Other groups whose representation in the labor force will increase are older workers, immigrants, non-English-speaking workers, and other minorities. One impact of these trends is that the effects of injury prevention programs will be difficult to evaluate.

Dimension of the Problem

Year 2000 Occupational Safety and Health Objectives

The Occupational Safety and Health Act of 1970 was intended to provide workers with a safe and healthful work environment. To determine if we are achieving this goal, it is necessary to monitor whether the numbers and rates of injuries and deaths are changing over time compared with a baseline of known occurrence and to evaluate whether prevention strategies are effective. It is also necessary, because of limited resources, to set

long-term goals that include priorities for preventing occupational injuries. Such goals are contained in the Year 2000 Health Objectives for occupational safety and health, which were developed by the Department of Health and Human Services (61).

Unfortunately, many Year 2000 Objectives are predicated on baseline data that reflect limited identification and ascertainment of the injuries of interest. In addition, the Year 2000 Objectives are oriented towards only those injuries currently monitored by OSHA or BLS and thus exclude injuries to some high-risk occupational groups (such as the self-employed). Because improvements in surveillance systems will affect (increase) the reported numbers and rates of injuries, evaluating the true change in injury occurrence will be difficult. Thus any evaluation of success in meeting the Year 2000 Objectives should take into consideration this more comprehensive reporting of injuries.

In addition to these objectives, it is important to examine sex-, age-, and race-specific occupational injury rates, as many demographic variables do affect the risk of injury or influence the injury outcome. For example, the Year 2000 Objectives may be attained because fatal injuries decrease among white males, while other risk groups with different exposures or risk factors may not be affected at all. This lack of homogeneity of effect may affect whether these objectives are truly achieved for all worker groups by the year 2000. Table 4 lists selected Year 2000 Objectives relating to occupational safety and health.

Ideally, all occupational injury should be considered unacceptable, especially severe traumatic occupational injury resulting in death: objectives that call for reductions should be considered minimal goals (Objectives 1 and 2 in Table 4).

Table 4
Selected Occupational Safety and Health Objectives from *Healthy People 2000*

1.	Reduce annual deaths from work-related injuries to no more than 4 per 100,000 full-time workers. (Baseline: 6 per 100,000 during 1983-87)
2.	Reduce annual work-related injuries resulting in medical treatment, lost time from work, or restricted work activity to no more than 6 cases per 100 full-time workers. (Baseline: 7.7 per 100 in 1987)
3.	Implement occupational safety and health plans in 50 states for the identification, management, and prevention of leading work-related diseases and injuries within the state. (Baseline: 10 states in 1989)
4.	Increase to at least 70% the proportion of worksites with 50 or more employees that have implemented programs on worker health and safety.
5.	Establish in 50 states either public health or labor department programs that provide consultation and assistance to small businesses attempting to implement safety and health programs for their employees.
6.	Increase to 75% the proportion of primary care providers who routinely elicit information about occupational health exposures as a part of the patient history and who provide relevant counseling.

Four industries (agriculture, forestry, and fishing; mining; construction; and transportation, communication, and public utilities) account for less than 20% of the workforce but contribute a disproportionate share of deaths — over 50% of occupational deaths, representing average annual rates of 20-28 per 100,000 workers (NTOF, 1980-86).

It is important to distinguish between nonfatal and fatal injuries for the purposes of prevention strategies and goals; Objective 2 in Table 4 addresses this issue. Although the goal of primary prevention is to decrease injury occurrence regardless of outcome, etiologic studies may be needed to evaluate nonfatal and fatal injury separately because of different external causes and risk factors. For example, in the meatpacking industry, a prevention program that is designed to reduce nonfatal injuries related to materials handling and the use of knives may not decrease the number of deaths to these workers (62).

Top priority should be given to requiring that all states implement occupational safety and health programs that go beyond current state or federal OSHA plans (Objective 3 in Table 4). Such plans should be specific for each state, focusing on each state's most prevalent occupational injury and illness problems. The plans should include surveillance activity with identification and follow-up of high-priority industries and workers.

Objective 4 in Table 3 calls for the proportion of worksites (with at least 50 employees) having worker safety and health programs to be increased to 70%. Aspects of these programs should include written safety and health policies, specific safe work procedures for hazardous tasks, personal protection requirements, provisions for training, and such activities as hazard identification and communication programs. Joint labor-management safety and health committees may provide mechanisms for development and implementation of such programs in some companies.

Objective 5 in Table 4 relates directly to businesses or employers with few employees: all states (either through the state health department or the state labor department) are to establish consultation and assistance programs to aid small businesses in supporting occupational safety and health programs for their employees. This is especially important because businesses with 10 or fewer employees are excluded from OSHA scheduled inspections even though they account for 74% of all U.S. businesses, according to the National Occupational Exposure Survey: Analysis Management Interview (63). The authors of one study noted that since OSHA was established, the involvement of many state health departments in occupational safety and health has decreased (64). These authors also cited a NIOSH survey that called for involving local agencies in technical assistance, training, and research activities, including surveillance and epidemiologic studies.

BLS estimates have consistently shown that large firms with more than 500 employees have lower injury rates than do small firms. A 10-year (1977-1986) analysis of OSHA investigations by establishment size shows that establishments with fewer than 20 employees have the highest average injury rate (10 per 100,000) compared with less than 5 per 100,000 for

establishments with 20-99 employees, and 3 or less per 100,000 for establishments with 100 or more employees (65). Similar high rates of 10 per 100,000 were seen during a 6-year period in Colorado for firms with fewer than 500 employees compared with rates of less than 2 per 100,000 for larger firms (27). Employees of establishments with fewer than 20 employees accounted for 44% of the deaths in the OSHA investigation study and 37% of the deaths in the Colorado study. A Japan-based study, which showed an occupational fatality rate comparable with that of the United States, also noted a higher risk for small companies. This was attributed partially to the fact that larger companies may contract out more hazardous job tasks to smaller companies (66). This points to the need to develop interventions for small firms, with the greatest challenge being employers with a workforce of fewer than 11 and those who are self-employed.

Objective 6 in Table 4 is to increase to at least 75% the proportion of primary care providers who ask specific questions about occupational safety and health problems during medical history questions and physical examinations. In addition to their more traditional occupational health role of treatment and counseling, physicians and occupational health nurses should also become more actively engaged in injury prevention at all levels, including identifying unusual or new workplace hazards that result in injuries, educating not only the injured worker but also management regarding hazards, and advocating for the implementation of effective prevention strategies (67).

A comprehensive strategy to attain these six objectives must address the marked differences between rural and urban deaths due to occupational injury. NTOF rates tend to be considerably higher in rural than in urban states. For example, from 1980 to 1985, the highest rates (per 100,000 workers) were in rural states — Alaska (34.2), Wyoming (32.5), Montana (22.6), and Idaho (18.2) while the lowest rates were in heavily populated states — Connecticut (1.6), Massachusetts (2.4), New York (2.7), Rhode Island (3.1), and New Jersey (3.7). Although few studies have examined rural and urban differences within a state, one finding from the Colorado surveillance study was that the rate of fatal occupational injuries in the 53 rural counties was 5.4 times higher than that in the 6-county Denver area (20.2 versus 3.8 per 100,000 workers). Whereas only 17% of the statewide workforce is in the 53 rural counties, 47% of the incidents leading to occupational injury deaths occurred there (27).

Through its rulemaking authority, OSHA is encouraging employers to institute safety and health programs. Beginning with OSHA's Hazard Communication Standard (1987), all employers were required to establish and operate a program to keep employees aware of the hazards of chemicals in their workplace. A natural extension of the Hazard Communication Standard would be a requirement that employers provide workers with information regarding major injury hazards and with methods for controlling the hazards and thereby reducing worker risk of workplace injury. The Hazard Communication Standard was followed by the Hazardous Waste Operations and Emergency Response Standard, which is the first OSHA standard that requires certain employers to develop and implement a complete safety and health program. Other examples include OSHA's Emergency Planning

and Fire Protection Standard, OSHA's Lockout Standard, and OSHA's "Red Meat Guidelines." In addition, in the late 1980s, OSHA issued its program management guidelines for assisting employers in setting up Occupational Safety and Health Programs. OSHA has continued this trend with proposed rulemaking for Process Safety Management for Highly Hazardous Chemicals (1990), which proposes that employers perform self-audits (inspections) to ensure that their own safety program is being properly followed. These programs require employers to monitor the effectiveness of their own programs and their status of compliance with OSHA standards. Employers who achieve a high level of compliance may see reduced injuries in the workplace, although the effectiveness of many safety standards and the overall effectiveness of the OSHA program have not been systematically studied and demonstrated.

Commitment to the Goal: Education To Help Prevent Occupational Injury

Everyone in our society must be committed to the goal of occupational injury prevention. In the following sections, tasks and responsibilities of various organizations and groups are outlined. However, there is one overriding activity that must be accomplished: that is, to make the American public — and particularly top management of U.S. businesses — aware of the effect of occupational injury on our society and convince everyone that this is unacceptable.

One of the ways this can be accomplished is for the federal government to support a national, grass-roots initiative designed to broaden the public's appreciation of the need for occupational injury control and the understanding of injury control strategies. Such an effort can and should be patterned after existing federal programs for grass-roots groups (68).

We should also educate our children, our country's future workforce. This should begin in the early grades, continue in secondary schools, and be an inherent part of business, engineering, agriculture, medicine and allied health fields, and related areas of undergraduate and graduate programs of colleges and universities.

Researchers and practitioners must be trained in the disciplines that can positively impact injury control, particularly epidemiology and safety engineering. To influence safety practices change in a specific industry, injury prevention researchers and practitioners must also be conversant with the engineering and process control concepts and terminology pertinent to that industry. Modern occupational injury professionals must have the training and skills to develop injury surveillance systems, identify high-risk occupations and activities, recognize and reduce hazards, develop and evaluate prevention programs, and help shape and communicate policies and strategies to reduce the probability of injury.

Above all, information about injury risk and prevention must be provided to the worker. Worker right-to-know legislation should be enhanced so that it mandates giving basic information about potential job hazards to all workers, sets up mechanisms for reporting, and facilitates mitigation of specific hazards. Communicating the risks of occupational injury to special groups of workers, such as those who do not speak English, must go beyond translating existing English brochures into other languages. Aggressive outreach programs are necessary to ensure that this information reaches these workers. Populations outside the mainstream of the American worker require unconventional methods, which may include the use of ethnic language newspapers and radio and television broadcasts. Points of contact may also include hiring halls and street corners where employers recruit daily laborers.

Surveillance Issues

A comprehensive, national occupational injury reporting system should be developed to improve the timeliness, accuracy, and completeness of occupational injury surveillance at all levels — from the plant, facility, and company level to the level at which national trends are monitored and research priorities are established. By law, all occupational fatalities must be reported to OSHA. Ideally, all fatalities would be reported by employers and investigated by federal OSHA or state agencies according to standard fatality investigation protocols. All injuries would be recorded and submitted to the appropriate monitoring agencies. Ideally, all injuries would be reported by employees and recorded and investigated by employers, and techniques for hazard and exposure surveillance would be in place to guide prevention and research activities. Other fatality and injury reporting systems should be adjusted to enable injury prevention specialists to identify work-related injuries. For example, death certificates should include accurate "injury at work," occupation, and industry information, both on the hard copy and in all computerized vital statistics files.

The Occupational Safety and Health Act of 1970 requires the Secretary of Labor, in consultation with the Secretary of Health and Human Services, to develop and maintain an effective program to collect, compile, and analyze statistics on occupational injuries and illnesses. To improve inadequacies of the current system (10), the Bureau of Labor Statistics (in cooperation with many state governments) is developing a three-part survey program that (a) counts the number and frequency of work-related injuries and illnesses nationwide, (b) develops profiles of worker and case characteristics for lost worktime incidents in selected states, and (c) focuses on the circumstances surrounding those work-related injuries and develops injury prevention techniques from the perspective of the injured worker. This proposed nationwide survey would be based on a uniform set of definitions for recordable injury and illness cases and their characteristics.

Since 1971, the Bureau of Labor Statistics has developed fatality estimates as part of its annual sample survey of occupational injuries and illnesses. However, these estimates have undercounted many occupational fatalities (3,10,34). The Bureau is currently designing a

Census of Fatal Occupational Injuries that will be used to coordinate and integrate information from death certificates, workers' compensation reports, and other administrative records. Besides private wage and salaried workers, the fatality count will include the self-employed, farmers on small farms, and workers in the public sector. In addition to providing more accurate counts of fatalities, this approach will permit more detailed analysis of the circumstances surrounding the incident and of the victim's characteristics than did past BLS surveillance data.

The NIOSH Division of Safety Research conducts surveillance of fatal occupational injuries (through the NTOF project) and field investigations of selected occupational fatalities (through the FACE project) to obtain case-specific information for research and prevention efforts. NIOSH is developing a program that will expand and integrate these projects to collect more timely and detailed data to support more quantitative research. In conjunction with the current objective of assisting states to develop the capacity to conduct occupational health and safety research, NIOSH plans to initiate a state-based fatal occupational injury identification and investigation network. Integrating surveillance and investigative data at a state level, with timely information transfer on a national basis, will increase the validity and completeness of these data at the national level and will also enable states to develop projects and policies tailored to their specific needs. Such national surveillance systems should first be established for the most severe injuries; the first step would be to improve fatality reporting and the second to develop a method to record all hospital discharge data. In addition, in company-level data, injuries should be categorized as those causing death, those causing hospitalization, and those causing lost worktime.

Conventional surveillance methods may fail to identify certain segments of the population at especially high risk for occupational injury, such as workers in some small businesses, or workers in the underground economy such as "sweatshops" and other places of employment that exploit undocumented workers. Methods must be developed for preventing injuries among these workers without exposing them to employer or immigration service retaliation.

Research Issues

Research should be planned and conducted by researchers and organizations representing multiple approaches and disciplines but sharing common priorities, objectives, and communication channels.

Epidemiologists and statisticians in government, universities, and other public and private organizations, should coordinate their data collection and analysis efforts to (a) improve and standardize occupational injury surveillance systems, (b) systematically and comprehensively describe the occupational injury experience in the United States, and (c) develop and test hypotheses aimed at identifying injury risk factors via the study of specific injury problems in specific populations. Public and private sector administrators, policymakers,

management, and labor should join forces at the national level to set priorities for research and prevention efforts.

Engineers, ergonomists, safety professionals, industrial hygienists, and experts in biomechanics and the behavioral sciences should address the most compelling problem areas by studying the components of workplace systems (including people), and the processes, tasks, and tools involved to identify potential causal mechanisms, opportunities for intervention, and potentially applicable prevention strategies.

Teams of engineers and other technical specialists should use emerging modeling and computer simulation technologies to study the processes, forces, and factors operating in the workplace and to move the consideration of system safety more and more into the conceptual and design phases of system development. Research and development efforts should emphasize "passive" rather than "active" measures of prevention, such as the design of workstation and worker protective systems incorporating intelligent microenvironments that feature sensors, microprocessors, adaptive protective mechanisms, and display and imaging technology to protect workers and warn them of hazardous conditions or their onset.

Evaluative research should be increased dramatically as the wide array of potential preventive strategies, including existing or planned safety regulations and information dissemination/risk communication efforts, need to be tested for relative effectiveness under variable conditions and workplace characteristics.

The close collaboration of specialists, particularly those of the engineering-oriented disciplines with epidemiologists and statisticians, will be critical to the design of research that leads to the identification, implementation, communication, and evaluation of injury prevention strategies. Epidemiology offers a perspective on the phenomena associated with injury that augments the engineering perspective, and vice versa.

Prevention Issues

Initial prevention efforts should include implementing and evaluating available injury control technologies and strategies. Applicable standards and other guidance should be closely followed and compliance stringently enforced. Programs emphasizing the transfer and sharing of effective preventive technology, among companies and countries alike, should be developed or expanded, with a particular emphasis on making cost-effective injury prevention technology available to businesses that could not otherwise afford it.

The mandates of OSHA and NIOSH should be expanded to include all workers, including the self-employed, those employed by small companies, and those with jobs in transportation

and the public sector. Even though other agencies have jurisdiction over some aspects of safety, OSHA should still address all situations involving worker safety. For example, even though the Department of Transportation has jurisdiction over the safety of the travelling public, OSHA should address issues concerning the safety of workers who travel as part of their jobs.

Model safety programs should be widely available for adoption and adaptation by specific employers, with public and private sector worker safety organizations tending more toward consultative and cooperative roles.

The legal and moral rights of workers and unions to act to prevent injuries and to participate in hazard abatement should be expanded (while also providing reasonable protection for employer interests). Workers' rights should include the following:

- Enhanced worker right-to-know legislation that provides basic information about job hazards and the mechanisms for reporting and facilitating mitigation of specific hazards.
- Strengthened protection for workers who refuse to perform hazardous work that may violate safety standards or which exposes them to risk of serious injury or death.
- Enforcement of the right of individual workers to challenge retaliatory discharge for exercising their rights under the OSH Act.
- A mandate for worker participation in worksite inspections by regulatory agencies, including "walkaround pay" for participation in all phases of an inspection (from initial interview through closing conference).
- Expanded worker participation in OSHA proceedings from issuance of a citation through final adjudication.
- Right of access to the worksite for workers, their representatives, and consultants to investigate hazards and injuries.

As corporate leaders, industrial planners, equipment and tool manufacturers, union leaders, employers, and others making decisions that affect workplace safety grow more aware of the benefits of safe, injury-free systems, prevention should evolve from its reliance on education, personal protection, safeguarding, and retrofitting to the design of intrinsically safe systems incorporating integral, nonobtrusive, passive controls.

How We Get There

A Summary of Recommendations

The following recommendations are based on four changes needed to realize the goal of preventing occupational injury. These changes are (a) increased research on the factors associated with high injury risk, which requires increased resources (money and personnel); (b) increased education about occupational injuries aimed at workers, employers, the public, and legislative bodies that set research priorities; (c) increased collaboration and coordination to eliminate gaps, redundancy, and adversarial relationships (whether among governmental agencies or between labor and management); and (d) improved leadership in preventing injuries by promoting compliance with OSHA standards and by implementing preventive strategies that have proved effective.

Federal Organizations

Congress

Congress should appropriate the funds necessary to support occupational injury surveillance and research as it recently did in appropriating money for NIOSH to conduct research in agricultural and construction safety and health. Congress should also increase resources (budget and staff) for government agencies funding or conducting occupational injury research or other prevention-related activities, such as developing and enforcing job safety standards.

Congress should also increase resources that are needed for training occupational injury prevention specialists; these resources should go to academic and research centers such as the NIOSH Educational Resource Centers.

Congress should adequately fund efforts by the Department of Labor (specifically OSHA and BLS) to improve and maintain a surveillance system that uses standardized coding and includes workers' compensation claims from all states in order to support research based upon these data.

In addition to appropriating funds, Congress can play an important role by providing legislative mandates promoting occupational injury prevention and research. Congress should create a legislative mandate to allow OSHA to increase responsibility, authority, and activities for the safety of all U.S. workers, including employees in small businesses, the self-employed, and all workers in transportation, agriculture, and the public sector. In addition, Congress should pass legislation that expands criminal prosecution (not merely

monetary penalties) for employers whose willful disregard for human life and welfare results in fatal or serious injuries to workers. Congress should also mandate the legal right for workers to participate actively in their own injury prevention, including their right of access to the worksite for investigating hazards. Congress should also strengthen the protection for workers who refuse to perform hazardous work.

Federal Agencies

All organizations within the Public Health Service should help parties involved in occupational injury prevention activities, including private sector organizations, to communicate to the public that occupational injury is a serious issue. Many federal government agencies are directly responsible for or are indirectly involved in occupational injury prevention. These agencies need to collaborate to promote occupational injury prevention as a high priority in all federal agency programs.

The federal government (as a large employer) should also set an example with its own programs to reduce injuries to government workers (e.g., purchasing only cars equipped with air bags for government fleets) and to workers employed by contractors paid by federal dollars. All federally sponsored loans and contracts should be denied to employers with a record of noncompliance with OSHA standards or who lack injury prevention programs. Audits should be conducted to determine compliance with OSHA standards as well as countermeasures that are known to be effective. All federal construction contracts should have an injury prevention component built into the contract bidding process in the same manner that financial stability is included. Potential bidders should be required to demonstrate a low rate of injuries, sufficient injury prevention activities, and compliance with safety standards, or they should be eliminated from the bidding process. NIOSH should serve as a model and should help other government agencies develop injury prevention programs.

Government agencies should develop an award program for employers or trade associations that demonstrate effective injury prevention efforts. This program should be highly publicized to provide an incentive for companies to accurately identify, report, and record occupational injuries and then develop prevention programs that provide examples of positive cost-benefit studies for injury prevention.

Documentation of effectiveness of prevention strategies, like the documentation of vaccine efficacy in preventing infectious diseases, should be mandated at the federal level, with augmentation in funding to mount an effective program.

Under NIOSH's leadership, Department of Labor (DOL) and other federal agencies and academic researchers involved in occupational safety and health research should collaborate in designing a model surveillance system for recording injury morbidity and mortality. To conserve scarce resources and to promote consistency of data, those involved should avoid duplication of efforts. Groups that have overlapping data needs should cooperate and coordinate to produce a single data collection instrument that would be the basis for a

central national system. The model surveillance system should cover all needs of different groups. Data elements and coding criteria should be standardized. A set of data elements and coding criteria that would be common to existing occupational injury surveillance systems should be developed and used. National systems such as the NTOF, BLS, and FACE databases, the National Council for Compensation Insurers database, state-based surveillance systems and workers compensation data, and local trauma registries may be used in designing model systems. A surveillance system similar to that of the Mine Safety and Health Administration, which requires reporting of all injuries, hours worked, number of employees at risk, and near-hits or events that could have resulted in a severe injury should be considered.

While this strategy defines a coherent plan for accumulating better surveillance data, there are steps feasible now that can help us move towards improved surveillance. The first step is for NIOSH to expand existing national surveillance systems to include reporting of sentinel, nonfatal injuries (e.g., those requiring hospitalization), especially for high-risk industries such as agriculture or construction. In addition, NIOSH should expand the FACE project in all states to include all causes of traumatic occupational fatalities. The BLS should continue to develop its Census of Fatal Occupational Injuries program and establish its revised Occupational Safety and Health Survey.

The second step is to identify and enumerate workers at risk; NIOSH needs to work with the BLS and the Bureau of Census to improve the enumeration or estimates of all worker populations, especially those currently not included in BLS data systems. Better denominator data or the number of workers in given occupations, are necessary to understand fully the magnitude of the problem.

NIOSH, as the lead federal agency mandated to conduct research on occupational injuries, should expand its program more into research and interventions as opposed to surveillance. NIOSH should also identify and study populations of workers at high risk that have been inadequately addressed (e.g., workers in small businesses, the self-employed, children and adolescents, minority workers, public sector employees, and temporary, migrant, or seasonal workers).

NIOSH needs to expand its dissemination of information to include those who are at risk of injury, the workers. Work hazards and the strategies aimed at preventing injuries associated with these hazards should be communicated to workers as well as employers.

OSHA needs to expand its program of standard development, standard enforcement, inspection, and evaluation. First, OSHA should conduct random inspections of small companies, including those currently excluded from federal OSHA compliance (e.g., small farms with less than 11 employees). OSHA should also target inspection strategies and evaluate which inspection plans work best for different industries.

OSHA should also increase enforcement of the general duty clause for workers to whom no standards apply, such as those whose workplace is a motor vehicle. OSHA programs should be developed for public sector workers in every state, because these workers are not currently regulated by federal OSHA. Such programs should include workers in highway departments, correctional institutions, and state hospitals.

OSHA should enforce increased compliance with its existing standards. In addition, OSHA, in collaboration with NIOSH and MSHA, should develop methods for quantitatively evaluating standards; ineffective standards should be modified and re-evaluated. Standards should also be developed to address hazards not covered by existing standards, such as newly identified hazards. For example, standards could be developed to reduce the risk of intentional injury in situations such as the shooting of taxi drivers and workers at convenience stores. Information dissemination efforts, worker education and training, and specific regulatory processes should also be evaluated at the federal level. If in certain settings, these measures are found to be ineffective, they should be revised. However, if there is reasonable evidence that a strategy is effective, it should be implemented immediately rather than waiting for definitive proof of its effectiveness.

OSHA needs to use injury data (obtained through BLS and NIOSH surveillance and research activities) to set rulemaking priorities that will lead to new and improved standards. OSHA should extend the concept of hazard communication by promulgating a standard that requires employers to provide workers with information regarding major injury hazards and methods for controlling the hazards. Worker right-to-know legislation should be enhanced to ensure that all workers have basic information regarding potential job hazards and mechanisms for reporting and facilitating mitigation of specific hazards.

Vital statistics data provide information on occupational deaths; however, these data could be considerably more useful if modified to be better adapted for use in occupational mortality surveillance. NCHS should provide states with resources and encourage states to routinely complete the injury-at-work box on death certificates and expand efforts to provide training on how to complete this item. All death certificates that indicate injury at work should include the decedent's usual and current occupation and should be industry coded and computerized with coding rules developed by NIOSH, NCHS, and the Bureau of the Census.

Agriculture has been shown to be a high-risk industry, yet OSHA has no jurisdiction to regulate many farms. The U.S. Department of Agriculture (USDA) should collaborate with NIOSH in its outreach effort to improve safety and health in agriculture and rural small businesses (for states with USDA jurisdiction over small business).

State and Local Government

State, county, and local governments need to focus on occupational injury priorities within their boundaries in addition to supporting and responding to the need for standardized, national data. Each state should designate a lead agency to coordinate occupational injury prevention and control activities involving all relevant state agencies that deal with health, labor, workers' compensation, highway safety, emergency medical services, vital statistics, law enforcement, and agriculture. These agencies should cooperate in identifying research needs, using state data to identify risk factors for occupational injury, and developing and evaluating prevention strategies. Occupational injury control activities should be coordinated with all other injury control activities at the state and local level. Although attention to occupational injury historically has been separated from other areas of injury research and control, efforts to prevent occupational injury must be well integrated with other injury prevention efforts at the state and local level (in addition to the federal level) as well as private and public programs. To facilitate this integration, officials must apply common standards for studying and preventing all injuries.

The focus of centers for injury research or prevention should be expanded to include occupational injury. In addition to their other activities, these centers should train professionals in occupational injury prevention, provide continuing education credits in occupational injury prevention, and support research directed towards occupational injury.

State health departments or other state agencies should be actively involved in the onsite investigation of all work-related deaths, especially those not investigated by OSHA, MSHA, or the National Traffic Safety Board. These deaths should be investigated in a similar manner to deaths from communicable diseases. Surveillance data and copies of the investigative reports should be provided to federal agencies such as OSHA and NIOSH. Worker injury prevention programs should be developed at the city, county, or state level for workers who are in the public sector.

Local prosecuting attorneys and law enforcement officials should be encouraged to investigate severe injuries (resulting in death or permanent disability) and to pursue criminal prosecution of employers who willfully violate OSHA standards or show evidence of criminal negligence.

Medical examiners and coroners in states and counties should indicate on their investigation forms whether a death is work-related and should code and computerize this information to facilitate research based upon these data. State vital statistics departments should also code and computerize this information. State agencies should require that injury-at-work information be included on hospital discharge records in addition to external cause-of-injury coding.

State and local permit and licensing requirements (e.g., for construction permits) should include worker safety as the primary consideration in the application process.

Employees and Unions

Employees and unions need to exercise their right to a safe workplace by becoming more active in all aspects of workplace safety. A key to employees' preventing occupational injuries is the right to refuse tasks that expose them to serious hazards or that violate established safety standards. Unions should promote occupational injury prevention through increased involvement in OSHA standard setting and enforcement and through collective bargaining that places the highest priority on safe working conditions for employees. Unions and employers should work together to address effectively the safety and health concerns of all members and employees. Common areas of interest include developing and establishing injury surveillance systems and ensuring that employers implement and evaluate comprehensive injury prevention programs. Another way that workers can actively participate is by identifying and reporting potential hazards in their workplaces. Workers should also actively participate in federal efforts to develop injury prevention priorities and strategy.

Unions should help promote occupational injury prevention for workers who do not work in a defined workplace or within a corporate structure. Nonunion employees should, individually and in groups, fully use their rights to promote safe workplaces. In all work settings, employees share with employers the responsibility for safe work practices. Unions should energetically work to convince their members to comply with company, state, and federal safety rules.

Workers should participate (with full salary) in all phases of worksite inspections by regulatory agencies, from the initial interview through the closing conference. In addition, workers should become actively involved in OSHA proceedings, from the issuance of a citation to the company through the final adjudication. Workers should also exercise their rights under the OSH Act to file their own legal actions, such as challenging retaliatory discipline or discrimination for exercising their safety and health rights.

Employers and Companies

While it has been clearly established that employers have assumed their responsibility to comply with OSHA standards, they should also incorporate other injury prevention strategies into their corporate policy and practice. For instance, companies should establish safety and health committees and begin processes that involve and empower workers to monitor overall work-related safety and health conditions. Committees should include employee representatives as well as representatives from the occupational safety and health team (e.g., physicians, nurses, injury prevention and safety specialists, industrial hygienists, and safety engineers).

Employers, in collaboration with employees and unions, should establish plant- and company-based surveillance and research systems, based on and consistent or comparable with the national systems. These should be used to develop and evaluate injury prevention strategies. Employers, employees, and union members should work together to ensure that

potential hazards are systematically identified and that training programs are built around job hazard analyses. An example of productive collaboration between workers/unions and employer/management is the joint programs of the United Autoworkers and the Ford Motor Company. Using money set aside by collective bargaining agreements, they established a National Joint Committee on Health and Safety that has since conducted several specialized health and safety training programs. A recent program includes training over 100,000 hourly workers and their supervisors to recognize potential hazards at each work station and instructing these workers on the procedures to follow to have the company eliminate such hazards.

All work-related injuries, not only those resulting in lost time, should be identified, reported, and recorded. Employers should support worker- or union-developed studies and research needs. Comprehensive studies on both mortality and morbidity associated with different job tasks within different industries should be emphasized. Hazards should be identified before they result in injury to a worker. This is especially important as a company introduces new technology into the workplace. Before and during this transition, the company must evaluate the impact this new technology will have on worker safety.

Minor injuries and near-hits often precede more severe outcomes and generally indicate inefficient and/or degraded process control. Given an appropriate safety climate, workers and supervisors can play very beneficial roles in detecting hazards and suggesting corrective actions. Employers should encourage workers to identify and report hazards. Employers or labor-management committees (where feasible) should investigate all injuries and near-hit events, and immediately begin to develop procedures that prevent recurrence, rather than waiting until many workers have been injured before beginning data analysis. Prevention strategies should emphasize engineering controls and injury countermeasures that do not place the burden of responsibility upon the worker at risk. Although it is preferable that employers use "state-of-the-art" countermeasures, they often must settle for the most effective ones that their resources will permit.

Companies should incorporate injury surveillance, research, and prevention into the corporate medical, safety engineering, or other appropriate existing organizational structures. Although most companies do not have the resources to have an epidemiologist trained in occupational injury, each company should have someone on its staff who is responsible for the surveillance of injuries and for safety engineering (such as hazard identification and engineering controls). These persons should be dedicated to preventing occupational injuries using the public health approach.

Companies should develop expertise in identifying major hazards and high-risk work activities and in evaluating injury prevention programs (by hiring experts, training their staff, or consulting with academic researchers). As the larger companies with more resources develop this capacity, they should disseminate information on effective prevention strategies to smaller companies. Company representatives should attend industry-wide professional

meetings and share information about effective injury prevention countermeasures and cost- benefit studies.

Companies should develop, implement, and enforce a comprehensive injury prevention program that includes training for employees. This training should include not only the specific skills needed to perform a particular job when the process is operating normally, but also information on what to do when the process malfunctions or needs adjustment or repair. All employees should also receive orientation to general safe work practices and education relevant to their job duties and the environment in which they work. This training should be immediately given to all new employees and to veteran employees on a continuing basis. Programs currently available to help companies develop safety programs include the Network for Employers for Traffic Safety (NETS), which was designed to assist employers establish comprehensive highway safety programs for employees.

Employers should make safety a part of all company activities and procedures from procurement to quality assurance. Workplace design factors must be considered in the bidding specifications for the equipment that will be purchased or constructed for the production process. For example, purchasing agents must not negotiate away specifications related to safety features in exchange for a lower price or faster delivery schedule. For existing operations, process reviews should involve a team approach (engineering, quality, and safety), with input from operators who have actually been running the process. Occupational safety and health should be the "bottom line" component of all company activities.

Companies should emphasize prevention efforts that focus on implementing and evaluating available injury control technologies and strategies. Applicable standards and other guidance should be closely followed and compliance stringently enforced.

Employers should assume an active role in modifying the workplace to help people who receive a permanent disability return to work. Returning to work after incurring a disability is an important part of the injured person's adjustment and reintegration into society. Because there is greater potential to control the work environment (compared to the community), it is possible to place the burden of responsibility for enabling the disabled person to return to work on the employer rather than the disabled worker. Employers should develop and implement rehabilitation programs that comply with requirements outlined in the Americans with Disabilities Act.

As part of the company program to prevent disability associated with workplace injury, the company should provide emergency medical care at the worksite for all those injured at work. This care may range from an occupational health nurse and physician onsite at all times to local emergency medical services that can reach the worksite rapidly enough to provide early intervention after injury.

All publicly owned companies should include a report on occupational safety and health in their annual reports and should have annual safety conferences that are chaired by the company executive officer.

Insurance Companies

Insurance companies can directly benefit from decreased injury in the workplace and can contribute to this decrease in several ways. Insurance companies should provide policy holders with information about the financial benefits of injury prevention programs. Insurance companies that provide workers' compensation to large and small companies could provide the expertise to enable these companies to develop and implement prevention strategies.

Insurance companies should cooperate with other organizations and their clients to encourage sharing of data and prevention strategies and help increase cooperation and collaboration between government agencies and other groups. Officials operating state and federal workers' compensation programs should work with other federal and state officials to standardize, refine, and analyze data collected through injury reports from workers and employers.

Academic and Research Centers

The federal government currently sponsors a number of research and training centers around the country, including the Educational Resource Centers (ERCs) and Centers for Excellence sponsored by CDC's NIOSH and the Injury Control Research Centers sponsored by CDC's National Center for Environmental Health and Injury Control. These centers should offer multidisciplinary and comprehensive training in the prevention and control of occupational injury. Their graduates should have the knowledge and skills to develop and implement effective occupational safety and health programs and the means to evaluate the impact of such programs. These programs should be linked with state and local agencies involved in occupational safety and health; collaborative activities with local and regional industry should be encouraged and supported; and outreach activities should be conducted for current and future labor and business leaders and managers.

Using a multidisciplinary approach, academic and research centers should conduct research on injury occurrence, risk factors, and prevention strategies. Epidemiologists and biostatisticians should lead the way in identifying and describing cases through surveillance and research, identifying risk factors through analytic epidemiology, and evaluating preventive strategies. An important component of occupational injury surveillance and research is the development of a standardized definition of work-related injury. Academic researchers should work with NIOSH and DOL to develop a definition that would cover all the needs of different groups and that would be consistent or at least translate across different data sources and surveillance systems.

Research efforts should focus on injuries that most often result in death or severe disability (e.g., brain and spinal cord injuries, burns, and amputations) because of their impact on the individual, family, and society. Research should also focus on high-risk industries and occupations (agriculture, construction, transportation, mining, laborers, truck drivers, etc.); on high-risk states or regions (e.g., rural areas); and high-frequency injuries, regardless of severity, that can be easily prevented. As surveillance capabilities improve, other problem areas will be identified.

Researchers should examine sex-, age-, and race-specific rates, as well as how other variables affect risk of injury. Special emphasis should be placed on conducting research concerning older, part-time, and self-employed workers; public sector workers; military employees; women; and minorities. Because fewer members of these groups are at risk or because estimating the number at risk is especially difficult, these populations are often excluded from studies. As an adequate baseline of descriptive information becomes available through the surveillance and research activities described, researchers should begin to test etiologic hypotheses and determine the causal pathway of occupational injuries by using more rigorous, quantitative studies.

Laboratory-based researchers should emphasize the development of "passive" rather than "active" prevention strategies. NIOSH researchers, in concert with researchers in academic institutions and industry, should develop the necessary laboratory capabilities for developing and evaluating passive worker protection systems, ergonomics, biomechanics, safety hazard sensors, and the human factors involved in occupational injury. Laboratory researchers should make increased use of technological tools in injury prevention research (e.g., computer simulation to simulate the workplace and predict injury on the basis of changes in the job task or workplace).

In addition to conducting occupational injury research, academic institutions must work toward incorporating principles of injury prevention into curricula for business, architecture, engineering, medical, public health, agriculture, and nursing schools. Improved prevention-oriented curricula must be developed for safety engineers and other professionals. Medical schools should substantially increase training in occupational medicine for students, and occupational injury prevention should be included on board examinations in relevant specialties such as internal medicine and orthopedics. To be accredited, schools of public health should be required to offer coursework devoted to occupational injury control; they should also ensure that all students are exposed to information about injury epidemiology and control within their core, required courses. The nation's business schools, which have neglected important opportunities in injury prevention, should be encouraged to focus on occupational safety and health and to make injury prevention a curriculum priority.

Occupational and injury prevention information should be included in curricula beginning at the elementary and high school levels, particularly in secondary school science, industrial arts, home economics, and vocational-technical programs. Instructors of these courses or components should teach the scientific concepts that form the basis for injury prevention.

They should also emphasize that occupational injuries are preventable and can most effectively be prevented by designing the working environment, equipment, and tasks to minimize hazards. Vocational counselors should receive training in the injury risks faced in various occupations.

Once there is research supporting prevention strategies, these strategies should be implemented and evaluated to determine their effectiveness. Academic and research centers should develop and evaluate injury prevention and control strategies in collaboration with federal and state agencies and representatives of the private sector, including employers, workers, and advocacy groups.

Advocacy Groups

Advocacy groups can play an important role in helping to focus the attention of the public and legislators on the problem of occupational injury. Advocacy groups should help promote state and federal legislation that enhances the protection of workers and ensures that more funding will be provided for training and research (similar to what has occurred with the AIDS movement). Advocacy groups should also develop a national grass roots organization (similar to Mothers Against Drunk Driving) to educate the public on the problem of occupational injuries. In addition, advocacy groups should work with employers in the private sector to establish occupational injury prevention as a top priority.

Media

People who work in the media can educate both workers and the general public by improving reporting of circumstances, economic and social costs, and preventability of occupational injury; by disseminating summaries of studies to major news groups; and by advertising the magnitude of the problem. Journalists and other media personnel could help establish occupational injury as an important public health problem by increasing visibility through promoting public service announcements that portray behaviors and actions which incorporate occupational injury prevention principles. Media personnel could also help by dispelling the current myths on injury causation.

Professional Associations

Professional associations should also help educate the public. These associations (e.g., Association of State and Territorial Health Officers or Council of State and Territorial Epidemiologists) should help state health departments implement surveillance systems and support legislation relating to occupational injury prevention.

The Council of Professional Associations on Federal Statistics should enlist the participation of BLS, NIOSH, OSHA, NCHS, and congressional staff to develop ways of obtaining appropriate data for national surveillance and research of occupational injuries.

Different professional associations need to develop methods for exchanging information (e.g., soliciting papers for professional conferences from members of disciplines related to injury prevention). Professional associations that might be involved in this exchange include the American Public Health Association, the American Society of Safety Engineers, and the American Association of Occupational Health Nurses. Associations of health-care professionals that provide or require continuing education credits to members should include credits in occupational injury prevention.

Private Foundations

Private foundations should give high priority to funding research and education directed towards preventing occupational injuries.

Conclusion

Occupational injury is a public health problem that demands immediate attention. Although there are constraints that have diminished our past and affect our present success in preventing injuries to U.S. workers, there are also data and prevention strategies available now that should be used to protect workers today. We must improve our surveillance and research capabilities, and we must develop, implement, and evaluate successful countermeasures to injury. The recommendations included in this chapter provide a template that can help us move towards the goal of preventing work-related injury in the United States.

References

1. Kraus JF. Fatal and nonfatal injuries in occupational settings: a review. Annu Rev Public Health 1985; 6:403-18.

2. Smith GS. Injuries as a preventable disease: the control of occupational injuries from the medical and public health perspective. Ergonomics 1987;30(2):213-20.

3. Bell CA, Stout NA, Bender TR, Conroy CS, Crouse WE, Myers JR. Fatal occupational injuries in the United States, 1980 through 1985. JAMA 1990; 263(22):3047-50.

4. National Safety Council. Accident facts. Chicago: National Safety Council, 1990.

5. Hensler DR et al. Compensation for accidental injuries in the United States. Santa Monica CA: RAND Institute for Civil Justice, 1991.

6. National Committee for Injury Prevention and Control. Injury prevention: meeting the challenge. Am J Prev Med (Suppl) 1989;5(3):177-91.

7. Kraus JF. Homicide while at work: persons, industries, and occupations at high risk. Am J Public Health 1987; 77(10):1285-8.

8. Baker SP, et al. Injury fact book, 2nd ed. New York: Oxford University Press, 1991.

9. Pollack ES, Keining DG. Counting injuries and illnesses in the workplace: proposals for a better system. Washington DC: National Academy Press, 1987.

10. U.S. Department of Labor. Occupational injuries and illnesses in the United States by industry, 1988. Bulletin 2366. Washington DC: Bureau of Labor Statistics, 1990.

11. French MT. Estimating the full cost of workplace injuries. Am J Public Health 1990;80(9):1118-9.

12. Rice DP, MacKenzie EJ, and associates. Cost of injury in the United States: a report to Congress. San Francisco: Institute for Health and Aging, University of California, and Injury Prevention Center, The Johns Hopkins University, 1989.

13. Barancik JI, Kramer CF, Thode HC, Jr. Epidemiology of nonfatal occupational injuries: magnitude of the problem. In: Annual meeting abstracts. New York: American Public Health Association, 1990:163.

14. Conroy C. Suicide in the workplace: incidence, victim characteristics, and external cause of death. J Occup Med 1989; 31(10):847-51.

15. Hales T, Seligman PJ, Newman SC, Timbrook LL. Occupational injuries due to violence. J Occup Med 1988;30(6):411-8.

16. Seligman PJ, Newman SC, Timbrook LL, Halperin WE. Sexual assault of women at work. Am J Ind Med 1987;12:445-50.

17. Gunderson PD, et al. Injury surveillance in agriculture. Am J Ind Med 1990;18:169-78.

18. Mohr DL, Clemmer D. Evaluation of an occupational injury intervention in the petroleum industry. Accid Anal Prev 1989;21(3):263-71.

19. Beyond neglect: the problem of occupational disease in the U.S. - Labor Day 90 Report. Chicago: National Safe Workplace Institute, 1990.

20. Gibson RL. Occupational medicine in the eighties: decade of change. Occup Med 1988;3(3):391-408.

21. Lanclanese FW. Training: vital to safety's success. Rekindle (ISFSI) 1984; (Oct.):11-13.

22. Oleske DM, Brewer RD, Doan P, Hahn J. An epidemiologic evaluation of the injury experience of a cohort of automotive parts workers: a model for surveillance in small industries. J Occup Accid 1989;10(4):239-53.

23. Committee on Trauma Research. Injury in America: a continuing public health problem. Washington DC: National Academy Press, 1985.

24. Gerberich SG, Gibson RW, San Juan L, Carr P. Minnesota Injury Prevention and Control Program II. Minneapolis: Minnesota Department of Health, 1990.

25. Gerberich SG, Gibson RW, Carr P. Minnesota Injury Prevention and Control Program I. Minneapolis: Minnesota Department of Health, 1987.

26. Baker EL. Sentinel Event Notification System for Occupational Risks (SENSOR): the concept. Am J Public Health 1989;79(Suppl):18-20.

27. Marine WM, Garrett C, Keefer SM, Vancil R, Hoffman R, McKenzie L. Occupational injury deaths in Colorado, 1982-1987. Denver: Colorado Department of Health, 1990.

28. Stanbury M, Goldoft M. Use of OSHA inspections data for fatal occupational injury surveillance in New Jersey. Am J Public Health 1990;80(2):200.

29. Stout-Wiegand N. Fatal occupational injuries in U.S. industries, 1984: comparison of two national surveillance systems. Am J Public Health 1988;78(9):1215-7.

30. U.S. Department of Justice, Office of Justice Program. Bureau of Justice Statistics. National Crime Survey (data base). Washington DC: U.S. Department of Justice.

31. Ohio Industrial Commission. Ohio 1987 occupational injury and illness statistics. Columbus OH: Division of Safety and Hygiene, 1987.

32. Seligman PJ, Halperin WE, Mullan RJ, Frazier TM. Occupational lead poisoning in Ohio: surveillance using workers' compensation data. Am J Public Health 1986;76(11):1299-302.

33. Sinks T, Mathias CGT, Halperin W, Timbrook C, Newman S. Surveillance of work-related cold injuries using workers' compensation claims. J Occup Med 1988;30(6):492-502.

34. Baker SP, Samkoff JS, Fisher RS, VanBuren CB. Fatal occupational injuries. JAMA 1982;248:692-7.

35. Goodman RA, Sikes RK, Rogers DL, Mickey JL. Fatalities associated with farm tractor injuries: an epidemiologic study. Public Health Rep 1985;100:100-3, 329-33.

36. Karlson TA, Noren J. Farm tractor fatalities: the failure of voluntary safety standards. Am J Public Health 1979;69(2):146-9.

37. Parkinson DK, Gauss WF, Perper JA, Elliott SA. Traumatic workplace deaths in Allegheny County, Pennsylvania, 1983 and 1984. J Occup Med 1986;28:100-2.

38. Clemmer DI, Diem JE. Major mishaps among mobile offshore drilling units. Int J Epidemiol 1985;14:106-12.

39. Gerberich SG, et al. Olmsted Agricultural Trauma Study (OATS): report to the Centers for Disease Control. Atlanta: Centers for Disease Control, 1990.

40. Jagger J, Hunt EH, Brand-Elnagger J, Pearson RD. Rates of needlestick injury caused by various devices in a university hospital. N Engl J Med 1988;319:284-8.

41. Murphy DJ, Huizina MA. A new approach to collecting farm accident data. J Safety Res 1989;20:21-9.

42. Olson DK, Gerberich SG. Traumatic amputations in the workplace. J Occup Med 1986;28(7):480-5.

43. Rivara F. Fatal and nonfatal farm injuries to children and adolescents in the United States. Pediatrics 1985;76(4):567-73.

44. Beatty M, Zook E, Russell R, Kinkead L. Grain auger injuries: the replacement of the corn picker injury? Plast Reconstr Surg 1982;(Jan): 96-102.

45. Edmondson MB. Caustic alkali ingestions by farm children. Pediatrics 1987;79(3):413-6.

46. Helgerson S, Micham S. Farm workers electrocuted when irrigation pipes contact powerlines. Public Health Rep 1988;100(3):325-8.

47. National Highway Transportation Safety Administration. Fatal Accident Reporting System 1989: a decade of progress. Washington DC: U.S. Department of Transportation, 1991.

48. Runyan CW, Baker SP. Occupational motor vehicle injury morbidity among municipal employees. J Occup Med 1988;30(11):883-6.

49. Centers for Disease Control. Occupational homicides among women -United States, 1980-1985. MMWR 1990;39(32):544-5,551-2.

50. Wigglesworth EC. Occupational injuries: an exploratory analysis of successful Australian strategies. Med J Aust 1976;1:335-9.

51. Williams AF, Wells JK, Lund AK. Seat belt use in cars with air bags. Am J Public Health 1990;80:1514-6.

52. Shilling S, Brackbill RM. Occupational health and safety risks and potential health consequences perceived by U.S. workers, 1985. Public Health Rep 1987;102(1):36-46.

53. Robinson JC. Worker responses to workplace hazards. J Health Polit Policy Law 1987;12(4):665-82.

54. Seligman PJ, Sieber WK, Pedersen DH, Sundin DS, Frazier TM. Compliance with OSHA record-keeping requirements. Am J Public Health 1988;78(9):1218-9.

55. Reiner I, Chatten-Brown J. Deterring death in the workplace: the prosecutor's perspective. Law Med Health Care 1989;17:23-31.

56. Weeks JL, Fox M. Fatality rates and regulatory policies in bituminous coal mining, United States, 1959-1981. Am J Public Health 1983;73:1278-80.

57. Robertson LS, Keeve JP. Worker injuries: the effects of workers' compensation and OSHA inspections. J Health Polit Policy Law 1983;8:581-97.

58. Mendeloff J. The role of OSHA violations in serious workplace accidents. J Occup Med 1984;26:353-60.

59. Kutscher RE. Outlook 2000: projections, summary and emerging issues. Monthly Labor Rev 1989;112:42-65.

60. Silvestri G, Lukasiewicz J. Outlook 2000: projections of occupational employment, 1988-2000. Monthly Labor Rev 1989;112:42-65.

61. Public Health Service. Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991:DHHS Publication No. (PHS) 91-50212.

62. Conroy C. Work-related injuries in the meatpacking industry. J Safety Res 1989;20:47-53.

63. National Institute for Occupational Safety and Health. National Occupational Exposure Survey: analysis management interview (vol. 3). Atlanta: Centers for Disease Control, 1990.

64. Key MM. State and local health departments: forgotten resources in occupational safety and health. J Occup Med 1985;27(5):379-85.

65. Mendeloff JM, Kagey BT. Using Occupational Safety and Health Administration accident investigations to study patterns in work facilities. J Occup Med 1990;32:1117-23.

66. Reich MR, Frumkin H. An overview of Japanese occupational health. Am J Public Health 1988;78(7):809-16.

67. Smith GS. The physician's role in injury prevention. J Gen Intern Med 1990; 5:567-70.

68. Worksafe: California workers at risk — a call for action. a report to the governor and the California Legislature. Sacramento: California Department of Health, 1989.

Trauma Care Systems

Trauma Care Systems
— Contributors—

A. Brent Eastman, M.D.,* Cochairperson, Scripps Memorial Hospital, La Jolla, CA

C. William Schwab, M.D.,* Cochairperson, Hospital of the University of Pennsylvania, Philadelphia, PA

Joseph L. Annest, Ph.D., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Charles Aprahamian, M.D., Medical College of Wisconsin, Milwaukee, WI

Mary Beachley, R.N., Society of Trauma Nurses, Frederick, MD

Bruce Browner, M.D., University of Texas Medical School, Houston, TX

Paul Burlack, Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Howard Champion, M.D., Washington Hospital Center, Washington, D.C.

Gail Cooper, Emergency Medical Services, San Diego, CA

David Heppel, M.D., Maternal and Child Health Bureau, Rockville, MD

Lenworth Jacobs, M.D., Hartford Hospital, Hartford, CT

Ellen J. MacKenzie, Ph.D., Johns Hopkins Health Services Research and Development Center, Baltimore, MD

Ronald Maier, M.D., Harborview Medical Center, University of Washington, Seattle, WA

Ricardo Martinez, M.D., Stanford University Medical Center, Stanford, CA

Kimball Maull, M.D., University of Tennessee Medical Center, Knoxville, TN

Thom Mayer, M.D., Fairfax Hospital, Falls Church, VA

Susan McHenry, Division of Emergency Medical Services, Virginia Department of Health, Richmond, VA

Stuart Reynolds, M.D., Havre, MT

Richard Roettger, M.D., Wilford Hall, USAF Medical Center, Lackland AFB, TX

*Coauthor of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Sue Ryan, National Highway Traffic Safety Administration, Washington, DC

Steven Shackford, M.D., College of Medicine, University of Vermont, Burlington, VT

Joseph Tepas, M.D., University of Florida, Jacksonville, FL

Harold Wilkinson, M.D., University of Massachusetts Medical Center, Worcester, MA

Nancy Burton, M.P.H., Macro International, Inc., Atlanta, GA

Where We Are

Introduction

The absence of clear modern definitions of the words "injury" and "trauma" has prompted the need to clarify how these terms are used in this paper. **Trauma** is the medical term for a bodily injury or wound and covers a broad spectrum of severity, ranging from minor to critical. In this document, discussion focuses primarily on those bodily injuries that are caused by an external force and treated in acute care institutions. **Major trauma** is a subset of injuries that encompasses the most severe or critical types of injury and therefore requires a systems (i.e., a trauma care system) approach and the resources of a trauma center, when available, in order to save life or limb.

The impact of trauma on Americans is great: injuries, both intentional and unintentional, take a large toll on our society in terms of death and disability, and they create major problems in lost productivity and medical care costs. Trauma is the leading cause of death in the United States. Children die of injury more often than of all diseases combined. Each year, one in four Americans will be injured seriously enough to require medical treatment. The toll in death, disability, and economic loss resulting from trauma is huge and mounting yearly, whereas our Nation's ability to manage the problem is declining. Legislation to implement trauma care systems is inadequate, established trauma centers are closing, and the motivation for health care professionals to enter the field is diminishing.

And yet, trauma care systems — the locally coordinated approach to swift identification of injured persons and subsequent transportation to optimal care — are known to be spectacularly successful in reducing preventable deaths and associated losses. Systems such as those in place in Maryland, Virginia, Pennsylvania, and California save life and limb hundreds of times each day. Many citizens assume that if they are severely injured, an ambulance will promptly arrive and take them to the nearest hospital, which will be ready and waiting to provide optimal treatment for their injuries. However, large geographical gaps among "systems" create a situation in which an injured person's likelihood of survival often depends on where and even what time of day the person happens to be injured.

Trauma care systems need (a) to be cost-effective and (b) to provide optimal medical care to all persons. Ideally, trauma care systems provide a continuum of care including prevention, prehospital care, acute care, and rehabilitation. Effective trauma care can best be accomplished by an integrated system that encompasses all hospitals treating injured persons. This can be described as an inclusive system. A comprehensive systems approach can minimize geographic or geopolitical constraints and provide high-quality medical care to all Americans.

This paper, with contributions from 22 trauma experts,

- Examines the current status of trauma care systems in the United States (**Where We Are**);
- Describes the ideal trauma care system (**Where We Want To Be**);
- Outlines the main challenges before us and offers solutions (**How We Get There**).

Where We Are

Today's trauma care systems are exclusive, in that they have focused on the identification of major trauma patients and their triage to a trauma center. This effort has been successful where implemented, creating islands of excellence scattered through the country. Such systems unequivocally save lives, but their survival is threatened by high costs and poor reimbursement.

Where We Want To Be

Inclusive trauma care systems are the ideal for the future; they address the needs of all injured patients and identify the roles of the institutions that serve them. Inherent in the concept of inclusive systems is the belief that rural as well as urban trauma patients should receive optimal care. Also imperative is the development and maintenance of a national uniform data set for trauma care that includes case criteria and definitions for performance and outcome measures pertinent to prehospital, hospital, and rehabilitation services.

Accompanying the data set, there should be national guidelines for standardized methods of the collection, analysis, and reporting of trauma data appropriate for use by all emergency medical services (EMS) systems, acute care institutions, and specialty institutions. These national standards for trauma care data systems will facilitate the development of a data base useful for system evaluation, quality of care assessment, patient outcome studies, and accurate cost analysis. Equitable payment plans are vital to the success of trauma care centers. Only when the cost-effectiveness of trauma care systems is proven will long-term viability be assured.

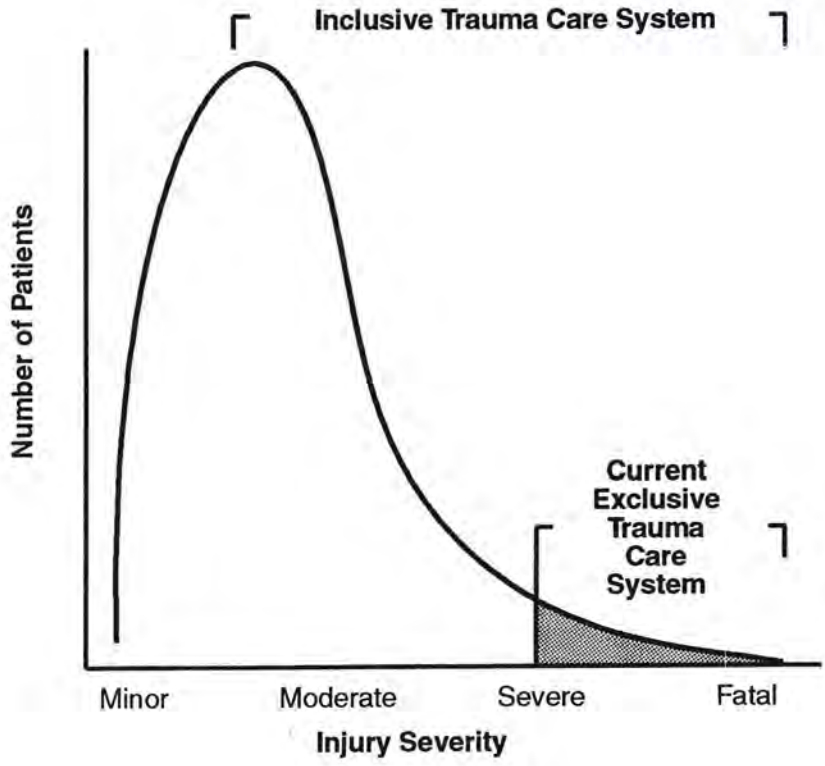
How We Get There

Many challenges must be met if all injured persons are to receive optimal trauma care. This paper identifies potential solutions that might help effect change. Trauma is preventable, and all trauma care systems must have a major commitment to injury prevention programs. Today's trauma systems are driven by the "major" (severely injured) trauma patient who requires immediate treatment, optimally at a trauma center hospital, in order to save life or limb (Figure 1). In designing and developing these systems, some planners have excluded nontrauma center hospitals from consideration of how the system will meet the community's trauma care needs. The scope of the trauma care system needs to be expanded to include **all** hospitals that provide care to persons who are injured in the geographic region served by the system. This inclusive approach to trauma care systems, in which all acute care

hospitals participate, has the capacity to prevent mortality and minimize morbidity and disability following injury, whether the injury is minor or major. The goals of the inclusive trauma care system are to match each hospital's trauma care resources with the needs of injured persons, to ensure flexibility within the system so that patients with different needs gain access to care at the appropriate hospital, and to strive continuously to provide optimal care to the population it serves.

Figure 1

Scope of Trauma Care System



Historical Perspective

Throughout history, injury has been a major problem (1). Some of man's earliest writings, Homer's *Iliad* (2) and Edwin Smith's *Papyrus* (3), document a variety of injuries and the treatments rendered. The art of healing and the foundations of surgery arose from care of injured persons. Hippocrates believed war to be the proper school for surgeons, and the greatest advances in injury care and trauma care systems have resulted from experience gained in treating persons wounded in military conflicts. The first hospitals were built to support the Roman legions, not the general public. The earliest "trauma centers" were strategically placed to care for Rome's armies. Each era has added knowledge to the care of the injured, but it was not until the 20th century, in particular the last 25 years, that trauma care systems evolved as the optimal way to care for injured patients (4). Consistent with the

field's military origins, the turning point for the "systems" approach to trauma care came with the Vietnam conflict, when it was shown that rapid transport to definitive care facilities saved lives (5, 6). This concept has been central to the development of civilian trauma care systems.

Efforts to regionalize trauma care have been under way for nearly 2 decades. With the enactment of the Emergency Medical Services System (EMSS) Act in 1973, a major national effort to upgrade and regionalize trauma care services began. The argument for a national initiative was based, to a large extent, on the availability of technologies for resuscitation, transportation, and treatment that could be expected to save lives and reduce disability. The application of this technology was impeded because hospitals, prehospital care providers, police, and other emergency service agencies within regions did not coordinate their services. The EMSS Act of 1973 was extended in 1976 and 1979 and provided more than $200 million to state and local areas to upgrade equipment and to develop a regional approach to communications, transportation, and specialty treatment.

During the last 10 years, substantial progress has been made in developing guidelines and criteria for an optimal trauma care system. Both the American College of Surgeons Committee on Trauma (ACS COT) (7) and the American College of Emergency Physicians (ACEP) (8) have contributed criteria establishing the minimal requirements for trauma centers and the necessary components for a comprehensive regional system to deal with injury. The National Highway Traffic Safety Administration has produced a community guide for trauma system development (9). Some states (e.g., Maryland, Virginia, Pennsylvania, and California) have established trauma center designation and accreditation mechanisms for hospitals dedicated to the delivery of high-quality trauma care.

Ironically, just when trauma care centers have been proven to work, trauma centers are closing and trauma systems are failing. Grossly inadequate reimbursement for services rendered has driven health care professionals and institutions away from this most challenging area of medical care (10, 11).

As we enter the 1990s, we have the unprecedented opportunity to solve one of our major public health problems: care of the injured patient. The problem has been defined, the solutions identified, and we now have the opportunity to provide a life-saving trauma care system for all injured Americans.

Current Status

Each year in the United States an estimated 25,000 people die needlessly because of lack of a trauma care system (12). For every death, 3 persons are severely disabled and 75 are temporarily disabled (12). The unnecessary cost in terms of human life, human suffering, and health care dollars is staggering.

One of the proven ways to reduce the toll of injury is to implement regionalized trauma care systems throughout the United States (8, 9, 13-20). Trauma care systems must meet unique geographic and regional needs and yet be cost-effective and provide optimal care. To develop successful inclusive trauma care systems throughout the United States, the following challenges must be addressed:

Public Perception

In general, the public is unaware of the complexities of providing adequate injury care, especially for major trauma, and even less aware of the importance of trauma care systems. The general perception is that an ambulance will arrive and take the patient to a nearby hospital, where the patient will receive optimal and appropriate care. The public generally does not recognize that major trauma patients require highly specialized care from the time they receive prehospital emergency medical service until they complete rehabilitation (9).

Current Status of Trauma Care Systems

No consistent data exist on the present status of trauma care systems in the United States. However, some general conclusions can be drawn from several recent studies on this issue (9, 21, 22). The number of hospitals claiming trauma center status exceeds 350 (7). However, no uniformly applied standards exist for trauma centers (i.e., a definition for what constitutes a trauma center). The most widely used standards are those of the ACS COT (7). The actual designation process (i.e., verification and accreditation) varies, ranging from verification by the ACS COT to designation by state or regional health authorities. In a 1986 study by the National Association of State EMS Directors, 18 states reported trauma center designation by a state authority, 6 states reported trauma center designation by other-than-state authority, and 27 states reported no trauma center designations (21). What was meant by trauma center or trauma system verification, however, was not clearly defined. Designation of a trauma center does not necessarily indicate an operational trauma care system. A trauma center is only one component of an operational trauma care system.

Impact of Uncompensated Care

Despite the proven efficacy of trauma care systems (13-20), the problem of uncompensated and undercompensated care has been a major impediment to the viability of existing systems and to the development of new systems. The negative impact has been greatest in large metropolitan areas where many trauma centers have closed (11, 23).

Although further work is needed to better understand how multiple factors interact to influence trauma center closures, most researchers and hospital administrators would agree that the rising costs of providing uncompensated care for the critically injured have played the most significant role. The growing number of uninsured trauma patients and the inadequacies of current hospital payment programs are contributing to significant financial losses for hospitals that provide care to the injured. Trauma centers bear a disproportionate share of the burden of uncompensated care because they care for the most critically injured, and therefore the most costly patients. At the same time, a larger proportion of their patient population is likely to be uninsured, underinsured, or covered under public programs such as Medicaid that traditionally pay hospitals at rates significantly below cost (11).

A significant percentage of all uncompensated trauma care is attributed to the uninsured. In 1987 an estimated 31.5 million persons under the age of 65 had no health insurance (24). Young adults aged 18 to 24 are most likely to be uninsured, and they are also at highest risk of being hospitalized for treatment of an injury. Conservative estimates indicate that 12% of all hospital charges for trauma care delivered in U.S. acute care hospitals accrue among the uninsured. This translates into well over $1 billion in uncompensated hospital care for trauma (25) or about 12% of the total $8.3 billion in unsponsored acute care provided in hospitals in 1988 (11). As stated before, many health care providers believe that the proportion of uninsured patients is much higher in trauma centers than in nontrauma centers, which places trauma centers at particularly high financial risk. This is especially true in urban areas where violent crime, drug-related intentional injury, and indigent populations are concentrated.

Inadequate reimbursement by state-run Medicaid programs is another important source of uncompensated care for trauma centers. As with the uninsured, trauma centers appear to treat a higher proportion of Medicaid patients than nontrauma center hospitals. In addition, a significant proportion of trauma center patients become Medicaid-eligible under "medically needy" programs. These programs offer limited coverage to patients who incur high medical expenses in relation to their personal assets. Since reimbursement rates under these programs are often lower than rates under conventional Medicaid entitlement programs, care of these patients represents an additional financial loss to trauma centers (11).

Several studies have documented the negative financial impact of diagnostic-related group (DRG)-based payment on individual hospitals with a Level I trauma center designation (23, 26-30). If DRG-based payments were used more broadly by state Medicaid programs and private insurers, then even more trauma centers that treat a disproportionately high share of the critically injured would suffer significant losses in revenues. Attempts to refine DRG classification by using measures of case severity — such as an abbreviated injury scale (AIS) or injury severity score (ISS) based on discharge diagnoses — have met with only modest success (31, 32). Alternative case-mix classifications such as Patient Management Categories (PMCs) show promise but will require further validation (33-35).

In summary, the economic crisis in trauma care must be addressed and solutions developed if the citizens of the United States are to have access to trauma care systems that function to reduce death, disability, and costs of injury.

Establishing a Mandate for Trauma Care Systems

The solutions to challenges relating to the establishment and implementation of inclusive trauma care systems do not rely solely on new research, but to a large extent on the implementation and refinement of what is already known (36). Trauma care systems have been most successful when the following initiatives have been in place:

- *Legislative action.* Legislation that mandates the establishment and functioning of all parts of the trauma system — prehospital care, trauma center designation, communication systems, quality assurance, and meaningful trauma prevention programs. State legislatures must establish a designating authority and give legal status to trauma centers to treat all major trauma patients. Legislative action should also provide funding for the trauma care system and for uncompensated trauma care (37).
- *Leadership by the regional EMS agency.* A legislative mandate that establishes a lead EMS agency to provide support and commitment for a successful trauma care system. This agency can monitor the "consumers" of trauma care (trauma patients) and adjust the system to meet their needs. The lead agency, usually a governmental entity, is charged with establishing trauma care standards, implementing triage guidelines, evaluating system performance, and ensuring that the right patient gets to the right place at the right time. The lead EMS agency must mobilize the public and trauma care professionals to support implementation of the system.
- *System funding.* Trauma care systems are costly to develop and maintain. Financial plans must ensure that all components of the system are developed and implemented to work efficiently and effectively (38).

Although, as of 1990, a few operational statewide trauma care systems are in place, most citizens do not have the assurance or advantage of prompt trauma center care. Our goal is to guarantee optimal care for all injured patients, regardless of when or where their injuries occur.

Rural Trauma Care

Rural areas of the country have unique problems in developing and maintaining trauma systems. A major challenge is the development of rural trauma systems that effectively address these problems (39). Rural trauma care faces unique logistical problems, including long distances, difficult access, adverse weather conditions, and sparse population density. The characteristics of the rural geographic environment, coupled with small populations, result in numerous remote hospitals that divide limited financial and professional resources. Furthermore, rural health care providers are infrequently faced with providing care to major trauma patients. These factors hinder most rural health care providers from developing and maintaining experience and proficiency in trauma management.

The discovery of the injured person and initial contact with the emergency system are significant problems in the rural setting. Once prehospital care of the injured person begins, prolonged response and transport times may be detrimental to the outcome of the trauma patient. The patient injured in this remote locale must be delivered to the region's only hospital, where the medical and nursing staff has limited experience and less than optimal facilities to deal with major trauma patients (40). In some rural and wilderness areas, there may be no surgeons available to initiate resuscitation and perform lifesaving procedures. This may result in delays in the recognition and treatment of major trauma patients. Coordinated and readily available transport systems (fixed wing aircraft or helicopters for long distances) are effective and efficient means of transportation; however, they are not always available. In addition to scarce resources for acute care of the severely injured patient, appropriate rehabilitation is usually limited.

Urban Trauma Care

The problems of trauma care in urban settings differ from the problems in rural settings. Large population densities contained within limited geographical spaces are associated with violent crime, drug-related crime, gang warfare, and indigence. Trauma care systems use triage guidelines to direct major trauma patients to trauma centers. In urban settings, the sheer numbers of seriously injured patients may overwhelm both prehospital providers and acute care facilities.

Indigent populations tend to be concentrated in urban areas and thus, when injured, create additional financial burdens for urban trauma centers. Nontrauma center hospitals, aware of the financial disincentives, may choose not to participate in the trauma care system and thus further contribute to the patient load and financial losses of existing trauma centers (11).

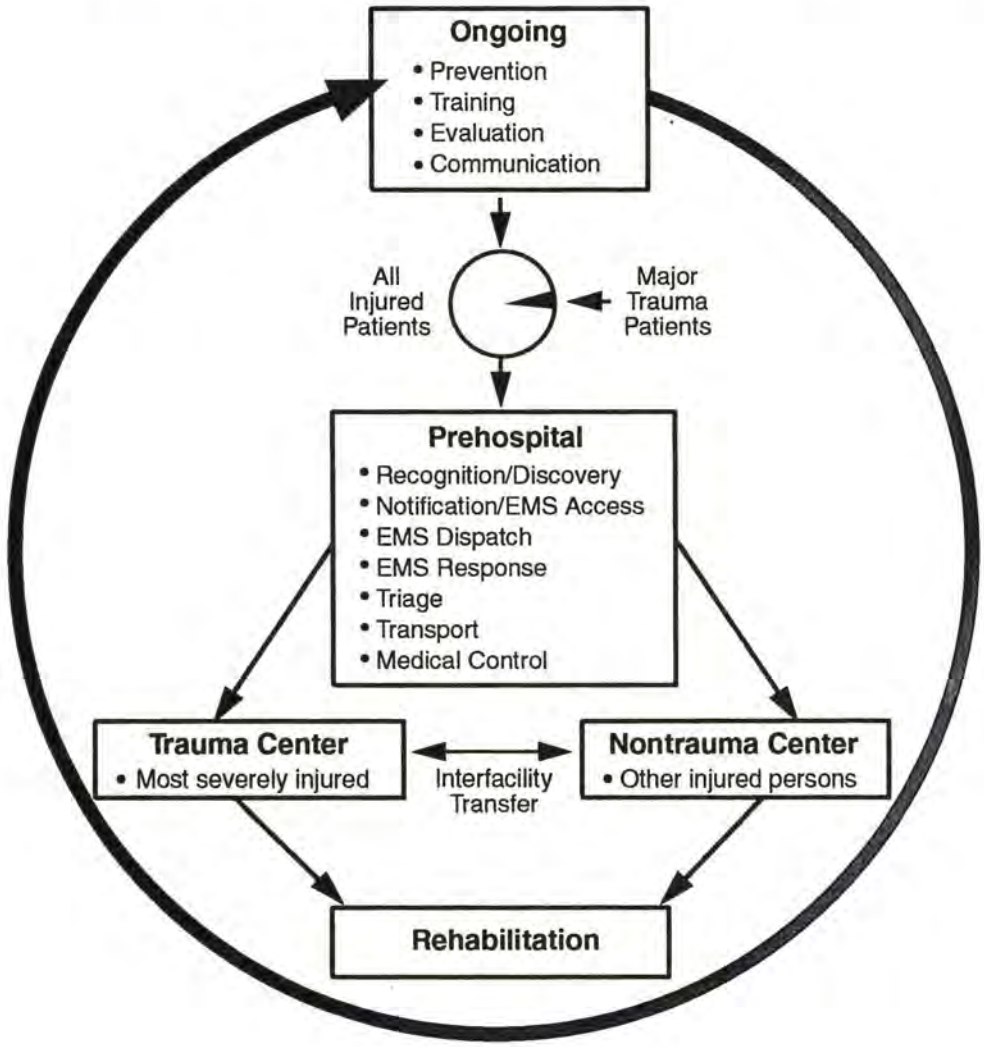
University hospitals responsible for health professional education and training are largely urban institutions. If such institutions are also designated trauma centers, their educational mission may be impaired by the cost and work load of caring for major trauma patients (26).

Components of an Optimal Trauma Care System

The optimal trauma care system must have the capacity to prevent mortality and minimize morbidity. To function at its best, the trauma care system must be integrated into the overall emergency medical service (EMS) system; it must be prompt, appropriate, efficient, proficient, and effective. The components of the system should be managed in such a way as to provide a continuum of care and to allow for measurement of success. An optimal trauma care system would include the following components (Figure 2) (8).

- **Prevention:** Mechanisms for preventing injury through public policy, information and education, and environmental changes. Ideally, the public would demand more legislation to promote prevention.
- **Recognition and Discovery:** Methods, such as crash- and injury-occurrence surveillance technology, designed to ensure prompt recognition of injury occurrence and immediate access to the system. A training program for citizens in (a) first aid, (b) how to access the trauma care system, and (c) techniques to work safely at the injury scene with the patient and the EMS system should be available.
- **Notification/EMS Access:** Universal and easy access, through contemporary telecommunications, to the trauma system for all injured persons, regardless of locale. The 911, or preferably enhanced 911, telephone system (see glossary) should be available everywhere.
- **EMS Dispatch:** A dispatch system that would be directed through a central regional agency by using medically trained personnel and state-of-the-art equipment to guarantee the most appropriate EMS response.
- **EMS Response:** Appropriate care and expertise at the scene of the injury. EMS personnel would render care, triage, and transport the patient expeditiously to the most appropriate facility.
- **Triage:** Accurate triage would direct the destination for hospital care on the basis of patient need and not on geopolitical issues.
- **Transport:** A system that guarantees rapid delivery of the injured person to the region's most appropriate facility.
- **Communications:** An on-line and minute-to-minute communication system with up-to-date technology and equipment. Communication among the prehospital care provider, medical control physician, and personnel at the receiving trauma care facility is required.
- **Training:** Quality training and continuing education must be available and accessible to all levels of EMS providers within the system.

Figure 2
Components of an Optimal Trauma Care System (41)



- **Medical Control:** Physician-supervised prehospital activities to ensure efficient and proficient triage, transport, and care of injured persons, as well as ongoing quality assurance of the trauma care system.
- **Definitive Injury Care Facilities:** A system to identify regional trauma care facilities and check their availability to receive trauma patients.
- **Interfacility Transfer:** Cooperative agreements and criteria for interfacility transfer of severely injured persons.
- **Rehabilitation:** Appropriate rehabilitation facilities assure the greatest opportunity for a patient to return to a productive lifestyle. Highly structured and integrated rehabilitation services should begin immediately in the acute care hospital.

- **Evaluation:** Appropriate data collection, analysis, and reporting; and mechanisms for ongoing system evaluation and improvement, including long-term follow-up to assess the late effects of injury and the influence of trauma care.

Systems Planning

Establishment of an effective, comprehensive, coordinated trauma care system, including prehospital, hospital, and rehabilitation services (42), will require a trauma care needs assessment, identification of trauma care resources, and development and implementation of a trauma care system plan (9).

Complete and Accurate Data Base

A complete and accurate data base is a prerequisite to system planning. Data on demographics, magnitude of the problem, present resources, and operational cost of the system are required. Linking these data with other data bases could be cost-effective and would provide additional information for planning and evaluation. Existing data bases such as statewide hospital discharge data, Fatal Accident Reporting System data, police accident reports, and National Highway Traffic Safety Administration (NHTSA) investigations should be used to provide epidemiologic and demographic data for use in developing prevention and intervention strategies.

Assessment of the system must involve evaluation of the resources available from prevention activities through acute response, specialized care and rehabilitation efforts. Methods are needed to assess the current provisions of care and outcomes of injured patients for all phases of trauma care. Such methods would emphasize prevention, morbidity, long-term disability, and cost-effectiveness as outcome measures.

Defining the Resource Requirements

Essential to developing a successful trauma care system is a well-established EMS system. Prehospital resource requirements should be identified. Hospital resource requirements should be determined (i.e., the number and distribution of acute care hospitals and the estimated number of trauma centers, personnel, and equipment).

There must be trauma triage protocols, transfer agreements, and a statewide inclusive, uniform data set. Also important to the development of an effective trauma care system are community awareness, public education, and a coalition of health care professionals (including highway safety personnel) to assist in the design, development, and implementation of the system. Essential factors are governmental and business education, involvement, and funding.

Resource Assessment

Resource assessment entails collecting statewide data to identify the existing levels and distribution of personnel, facilities, and equipment. The present structure of a potential trauma care system can be measured by physical and human resources (i.e., number and distribution of ambulances, emergency medical technicians, paramedics, hospital beds, physicians, nurses, and other components). Existing state data bases are available (e.g., Department of Licensing, Department of Social and Health Services, and the State Hospital Commission) to provide information on physical resources. These data systems are inexpensive, accessible, and involve relatively little time to maintain. Questionnaires or site visits can supplement these data with additional information, such as staffing arrangements, communication capabilities and emergency department and intensive care unit (ICU) capabilities.

The volume and distribution of the major trauma population needs to be matched with available and appropriate resources. Where available, hospital discharge data from state abstract reporting systems for cases identified through discharge diagnosis (ICD-9 codes 800-900) as representative of major trauma can be used to profile trauma patients in terms of distribution, types and external causes (ICD-9 codes E800-E999) of injury, demographics, procedure mix, payer mix, length of stay, and outcome. A recent study in Maryland suggests that there are limitations in using E-codes in hospital discharge data to characterize severely injured persons and that these limitations need to be addressed (43). In addition, currently, only six states (Arizona, California, New York, Rhode Island, Vermont, Washington) have mandatory E-coding of discharge diagnosis.

Additional data are needed to investigate the existing educational process and the requirements and opportunities for training all trauma care providers. The availability of educational mobile units to reach rural areas is imperative so that emergency medical technicians (EMTs) and nurses in rural settings can maintain their skills and knowledge. The capacity of regional trauma facilities and specialty centers to educate all levels of trauma care providers needs to be assessed.

Developing a System Plan

An effective plan for a trauma care system includes several critical elements:

Mandate for Trauma Systems and a Lead Agency

Federal legislation should establish injury as a national priority and the federal government should assist states in the coordination of trauma care system planning and development. State statutes should provide the legislative authority to establish a lead agency with the authority to implement a trauma care system and designate trauma centers. State trauma care system legislation should include provisions for establishment or adoption of optimal standards, regional trauma care planning, integration with other EMS components, system

data collection and analysis, protected access to prehospital data, mechanisms for system funding, and protection of the designated lead agency from antitrust litigation (9).

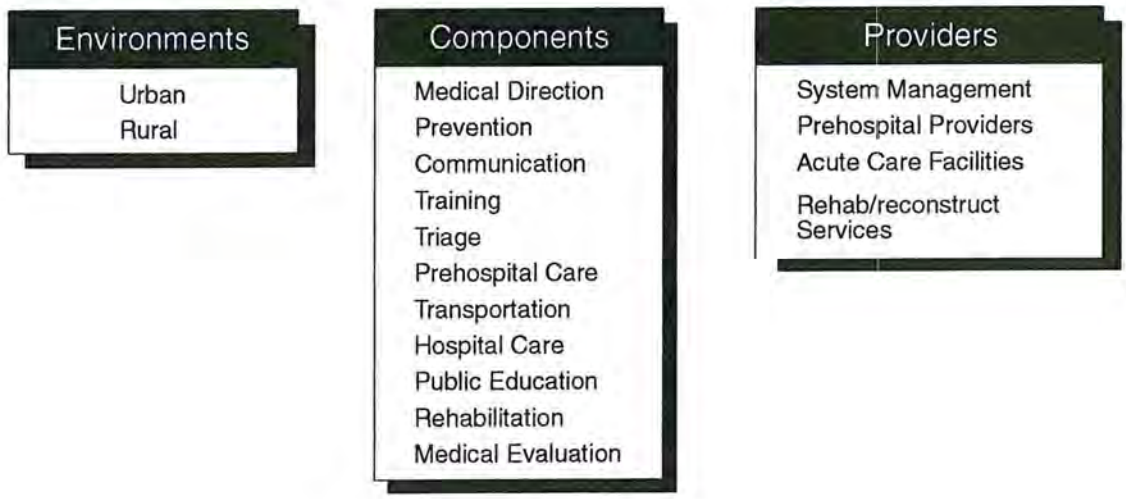
Lead agencies for contiguous countries, states, and counties must ensure a cooperative regional plan aimed primarily at benefiting the public and ignoring geopolitical boundaries. In general, the lead agency should function at the state level so that resources and services can be coordinated and allocated statewide.

Trauma Care Guidelines and Standards

Development or adoption of appropriate trauma care guidelines and system standards is essential to an effective trauma care system. The most widely recognized system guidelines are the "Guidelines for Trauma Care Systems," published in *Annals of Emergency Medicine* (8) (Figure 3), and the *Resources for Optimal Care of the Injured Patient* (7). The latter emphasizes trauma center criteria.

Figure 3

Structure of a Trauma Care System



NHTSA has taken those guidelines and developed a "how to" manual for states and communities: *Development of Trauma Systems: A State and Community Guide* (9), a curriculum for a 1-day NHTSA training program. This training program focuses on how to

(a) put the trauma system together, (b) build community consensus, (c) integrate EMS components, and (d) evaluate the system's cost-effectiveness. The program provides a framework for developing trauma systems.

Trauma Center Designation

An integral component of any trauma care system plan is the identification of hospitals that have made a commitment to provide optimal care for the injured patient. The concept of taking severely injured patients to the nearest hospital is no longer acceptable. Formal trauma center designation is necessary in order to provide a framework for patient triage or transfer to the most appropriate facility. Center designation provides a mechanism for hospitals to confirm their commitment to meeting and adhering to a certain standard of care.

In planning for regional or statewide trauma care systems, consideration must be given to how many and at what level hospitals should be designated as trauma centers. This decision should be based on maintenance of skill and experience, assessment of available resources (physicians, nurses, facilities), cost-effectiveness, population density, and geography, with special consideration of rural needs and the realities of rural medical practice (9). It should be noted that most injured persons need care, but not all need trauma center care.

Trauma System Accreditation and Recognition

An organized trauma system integrates the emergency medicine and health care systems. All hospitals should recognize and acknowledge designated trauma centers for their special capabilities. Hospitals not designated as trauma centers should serve as "trauma receiving hospitals" for some injured patients. All hospitals should participate in a statewide trauma care data system.

System Planning for Disaster

A well-coordinated, effective trauma care system can provide many of the necessary resources as well as the framework for responding to disasters and mass casualty incidents (44-46). Integration of these resources must occur well in advance of any disaster. Yet, disaster planning is often missing, or, if done, neglects essential elements needed for coordination of the response (47). As with all emergency health care situations, geopolitical boundaries should not be allowed to interfere with an integrated regional disaster approach.

Special Populations

Pediatrics: Pediatric trauma care must be integrated into all aspects of acute care programs. This requires that all health care providers remain fully trained regarding the needs of the injured child and mandates that child health care providers, including pediatric surgeons, become involved in and foster development of specialized curricula on caring for the injured child. Development of protocols and advancement of care depend on a valid and contemporary data set, such as the National Pediatric Trauma Registry (NPTR). Mortality due to

pediatric trauma is similar to that for adults, but the long-term societal impact of disability in the extremely young age group highlights the need for optimal care. Mechanisms of outcome assessment other than mortality that address disability, recovery, and long-term longitudinal follow-up are necessary. Closed-head injury impact and the effect of such impacts on lifetime learning and functional disabilities need to be better documented and quantified. Rapid involvement in appropriate rehabilitation and psychological support systems is necessary to optimize outcome.

Geriatrics: During the 1990s, there will be about a 20% increase in the number of Americans over age 65 years. This has substantial implications for organized regional trauma care systems. Although there has been a general increase in the life expectancy of the elderly, the same is not true for the injured elderly. Although the elderly make up only 11% of the population, the injured elderly consume a disproportionate fraction of hospital resources (about 25%) and account for a disproportionate share of deaths in the hospital (18%) (48).

Case-control studies have shown that for persons injured after age 55 years, mortality increases sharply, length of stay in the hospital and ICU doubles, and cardiopulmonary complications are much more likely (49). About 60% of the elderly injured cannot function independently at hospital discharge, and 30% to 40% are discharged to nursing homes (48). Risk factors for poor outcome among this patient population include age, preexisting cardiopulmonary disease, injury severity, and the likelihood of infective complications. Current estimates of resource consumption by the injured elderly are likely to be severe underestimates of their actual consumption. Many of these patients are admitted to the hospital with relatively minor-to-moderate injuries, but subsequently develop complications.

Patients with Injuries Associated with Violence or Drug Abuse: Patients with injuries that are self-inflicted, the result of interpersonal violence, or related to drug abuse represent 20% to 25% of hospital admissions nationally (49) and are a major source of undercompensated and uncompensated care. Enhanced education of government officials and legislators is needed to ensure appropriate funding for the care of these patients. More injury prevention efforts need to focus on this group. Society must deal with the difficult issues of injuries related to drugs and firearms. Prevention efforts in these areas would result in tremendous savings in our trauma care systems.

Rural: Although the minority of the U.S. patient population is from rural areas, rural areas encompass the vast majority of the land mass of the United States and pose some challenging aspects for trauma care in the 1990s. The death rate from motor vehicle crashes, the largest cause of trauma mortality, is inversely proportional to population density (50, 51). Rural areas have several obstacles that need attention, including lack of 911 access, transportation difficulties, and lack of continuing medical education (52). Providing effective continuing medical education to rural health care professionals in areas with a low incidence of injuries is difficult and often erratic (53).

All hospitals involved in treating injured persons, particularly those in the rural areas, should be in an inclusive system of care facilities. Each facility should provide that level of specialized care within its capability. Incentives should be available to all levels of providers and facilities to promote regionalization and participation in the system. Regionalization of tertiary trauma care should be accomplished by adherence to trauma care and transfer protocols. Similarly, "return transfer" from regional trauma centers to local facilities should be based on standards for timely and safe return of patients to their home environment.

Other Groups with Special Needs: Burn, spinal cord injury, rehabilitation, and other specialized centers are recognized for their ability to improve outcome. Criteria and accreditation standards for specialty centers need to be developed. More rehabilitation, home care, and ambulatory care facilities are needed to ease the current demand on acute care facilities and specialty centers.

Systems Operations

Once the system plan for regional trauma care is complete, it should be implemented and maintained through direction of the lead agency and appropriate regional allocation of health care personnel and equipment. The operational plan should include all components necessary to accomplish the goals of injury prevention, control, and care. Implementing plans for a trauma care system that provides appropriate response to and treatment for all injured patients is driven by the availability of resources and the need to provide optimal care to the major trauma patient. Essential operational components of trauma care systems, as discussed at the beginning of this chapter, need to be integrated into an already established emergency medical services system. Successful systems operations need to be especially concerned with the following:

Public Information and Education

Public information and education should support the system by building political constituencies and promoting injury control programs. System support through advocacy groups is necessary to inform the public regarding the nature and magnitude of the problem, to act as an advocate and catalyst to system development, and to educate health care professionals.

Prehospital and Hospital Standards and Training

In developing standards, the goals are to improve the quality of care and to minimize variation in prehospital and hospital care among and within geographic areas. Crucial to the system is the lead hospital or trauma center that must function as a local resource center and that, with the lead agency, must provide, implement, and coordinate all components of the system. These include (a) maintaining systems compliance with preestablished standards, (b) instituting research and teaching programs, and (c) implementing a system-wide quality assurance program.

Trauma Triage

In the prehospital setting, triage is the attempt to decide which patients are injured severely enough to require trauma center care (41). Severe injuries may threaten the loss of life or limb or may cause long-term disability, all of which have serious consequences and demand a specialized system of care. Effective triage is essential to efficient system operation, both in the prehospital setting and in the early hospital phase. Unfortunately, prehospital triage criteria are not exact, and problems of overtriage and undertriage exist. The criteria used for triage assessment must be evaluated periodically in the quality assurance process so that overtriage and undertriage rates can be assessed and adjustments made to minimize preventable death and disability (41).

Overtriage (i.e., directing more patients to trauma centers than actually need such specialized care) results in overburdening trauma centers, especially in urban settings, and in underusing the resources and expertise of the other hospitals in the system. Undertriage means that fewer patients are directed to a trauma center than is warranted by the severity of their injuries. Therefore, some major trauma patients are directed to a nontrauma center hospital.

Bypass, the act of directing a patient past a closer medical care facility in order to receive optimal care at a facility that may be farther away, should be based on explicit protocols that consider the patient's needs, the level of available trauma care, and the need for regional resource coordination. This system-wide resource coordination ensures that patients are transported to the closest appropriate facility, taking into consideration a hospital's readiness to accept trauma patients, availability of physician specialists, and closure due to disaster at the hospital.

Medical Control and Direction

Medical control is the key link between prehospital care and the hospital. Medical control provides for medical supervision and system accountability as well as a systematic approach to patient care through preestablished policies, procedures, and treatment protocols (off-line) (8, 9, 54). Off-line medical control in most trauma care systems is provided by the state or local medical director. The medical director is responsible for broad development and implementation of system protocols, including destination decisions, triage, and standard operating guidelines for system participants. System protocols are meant to complement medical protocols and address specific system operations.

On-line medical control is through direct voice communication between field and hospital personnel. On-line medical direction may be provided by the nearest facility, a regional base hospital, or by the receiving facility. The emergency physician and prehospital personnel interact to provide the patient with the benefit of both continuity of care and immediate on-line consultation.

Transportation

The majority of injured patients in this country are transported to trauma centers via ground ambulances (55). Although air transport and helicopter ambulance services have proliferated during the last 10 years, these medical transport services should be seen as an adjunct and should be integrated into the regional ground EMS and trauma transport system. The transportation system should provide the framework for getting the right patient to the right place at the right time (56). The transport system should be configured differently in rural and urban communities and should be based on personnel training, equipment, population density, and the topography of a given area.

Hospitals

In contrast to today's trauma care systems, which tend to be exclusive and focus only on trauma centers, the ideal trauma care system is inclusive. In inclusive systems, all hospitals (even primary care clinics) within the trauma care system must be involved. An appropriate designation process will determine how many and which hospitals should function as trauma centers. These hospitals should receive and care for the most critically injured patients. However, those hospitals will serve only a small percentage of the total injured patient population. Having such an inclusive system enables even the smallest nontrauma center facility to commit resources, collect data, and participate in the optimal care and triage of injured patients. Including these small facilities requires them to meet standards and adhere to triage protocols. Intrinsic to efficient functioning, these small facilities must be able to transfer patients to a trauma center rapidly and effectively when necessary. Of equal importance is the return of less critically injured patients from trauma centers to originating hospitals. This is particularly true if the originating hospital has adequate rehabilitation facilities. If instituted appropriately, this process could free acute care beds from crowded trauma centers and distribute the cost of care of the injured patient throughout the system. This process could also result in a sense of cooperation between hospitals, facilitate information exchange, and lessen the fear of patient loss from the small community physician and hospital. Development and implementation of an inclusive trauma care system would require incentives for participation and major changes in reimbursement procedures by both government and private payers.

All acute care and rehabilitation facilities receiving injured patients should submit data to regional and statewide trauma care data systems (57). Appropriate information from regional and state data bases should be made available to hospitals to allow for research, internal quality assurance, and assessment of care.

Rehabilitation facilities should be designated and those with specialty capabilities utilized on a regional and statewide basis. Like other facilities in the system, rehabilitation facilities should contribute data to national and regional registries so that the care they provide can

be evaluated. Other specialty centers such as regional burn centers should also be incorporated into the system. Methods for recognizing the need to transfer a patient from one specialty center to another must be developed and tested to ensure appropriate and cost-effective use of resources.

Systems Evaluation

A structural framework exists for quality assurance and evaluation of medical care. This framework, however, is generally confined to hospitals. Within a trauma care system, the structural framework for trauma care evaluation is broader. Evaluation of care requires an analysis of the multidisciplinary components that interface throughout the continuum of care delivered to injured people (58).

A national uniform data set could be the basis on which to standardize the data needed to evaluate trauma care systems and to assess the quality of care. Consistent, accurate data are essential to system evaluation. Trauma care data systems should be used to measure the effectiveness of the system. Data must be analyzed from both a clinical and operational perspective, with primary emphasis on optimum patient outcome as the indicator of quality of care.

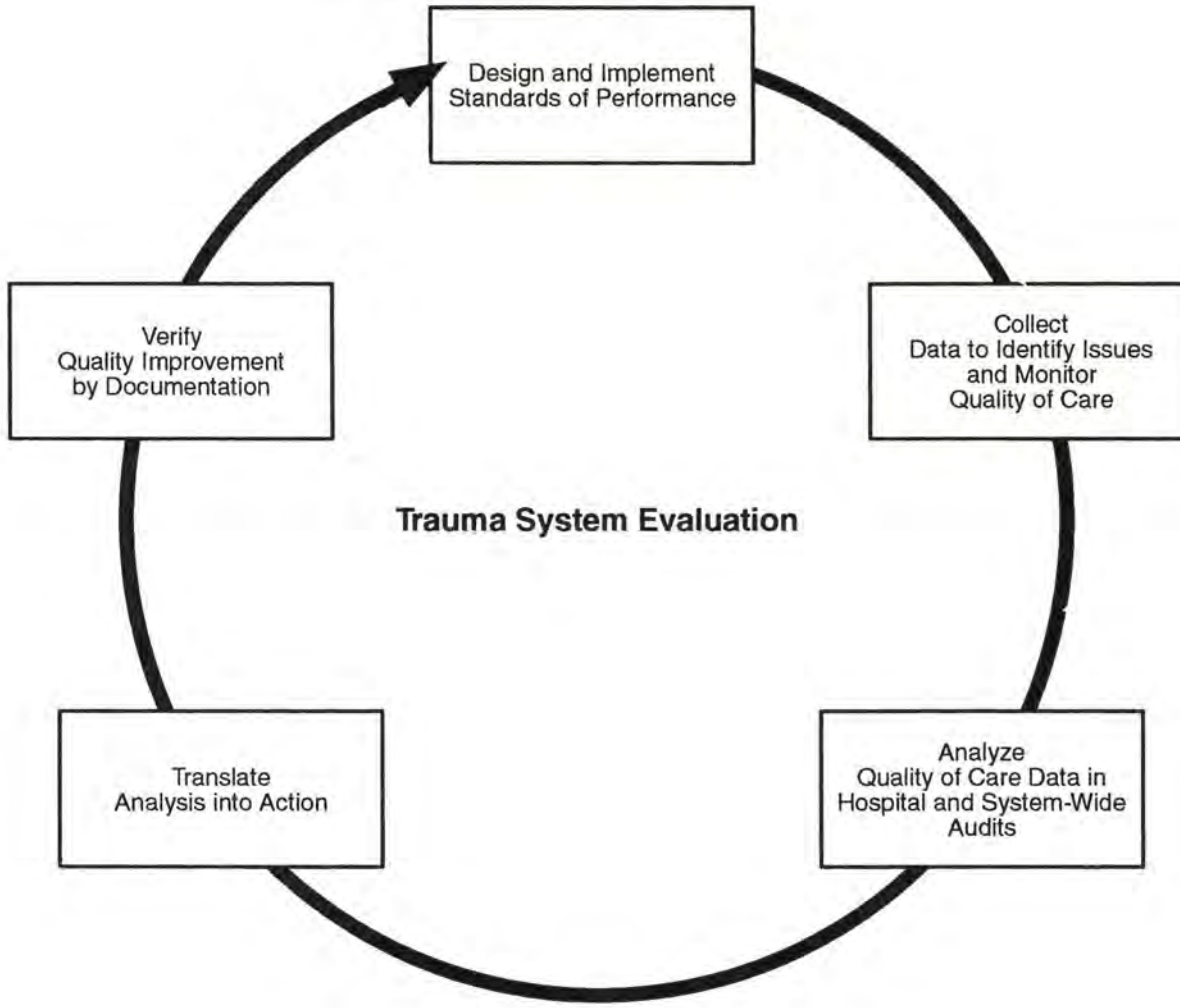
Trauma system evaluation (Figure 4), specifically the system's quality assurance components, should occur regularly and should include a review of the following aspects:

- Ability to meet system goals and objectives.
- Compliance with or the ability to validate or reevaluate and appropriately change the system standards.
- Consistent cooperation in systems operation and information flow among system participants.
- Ability to foster continuous quality of care improvement with the ultimate goal of optimum patient outcome in each phase of care.

Data analysis alone does not constitute change. The analysis should be translated into action plans with predetermined outcome objectives. These data must be population-based, and should also allow for monitoring (a) trends in the occurrence of traumatic injuries and (b) the effectiveness of prevention strategies.

Quality assurance (QA) activities are an essential management tool to assure that the best possible medical care is delivered to the patient. Periodic analysis and redesign of the trauma system should occur as a result of changes in goals and objectives, evaluation of standards, QA outcome data, current research, and evaluation process findings (Figure 4).

Figure 4
Trauma System Evaluation (58)



The American College of Surgeons Committee on Trauma has outlined essential facets of the trauma QA process (7).

The American College of Emergency Physicians has developed guidelines for trauma care systems quality assurance to assist in the essential role of ongoing monitoring and evaluation

of the trauma care system (59). These guidelines are for facility-based quality assurance, which focus almost exclusively on specific trauma hospitals (7). Trauma system QA evaluates specific components of the trauma care system and their relationship with each other. These guidelines are not intended to replace detailed quality assurance activities in either the prehospital or in-hospital phase of care, but rather to focus on the broader system management issues, which are extremely important to the long-term viability of any trauma care system.

Some states have developed trauma care systems, but no national standards for measuring quality of trauma care exist. All persons, however, have a right to expect a similar level of trauma care no matter where in the country they may be injured. Assessment of quality of care on the basis of patient outcome has been vaguely defined by overall death rates, morbidity rates, average length of hospital stay, development of complications, and the use of the Trauma Score and Injury Severity Score (TRISS) methodology (11). However, no set definition of quality trauma care is used in this country.

Challenges Facing Trauma Care Systems

Although substantial progress has been made in developing guidelines and criteria for optimal trauma care systems, there are concerns that as we enter the 1990s, regionalization efforts may have lost momentum or even reversed direction. Ironically, at the same time that evidence in support of the efficacy of trauma care systems accumulates, increasing numbers of trauma centers are closing. By one account, some 40 hospitals closed their trauma centers in recent years because of a myriad of political, organizational, and economic factors (11). This section summarizes the challenges facing trauma systems today.

Ensuring Adequate Financing for Trauma Care Systems

The financial incentives for professionals and facilities participating in trauma care are minimal. As pointed out previously, the reasons for the financial aspects of trauma care are multiple and complex. Trauma patients are largely uninsured or covered by public programs that pay hospitals significantly below costs (11, 60). DRG-based reimbursement schemes, which have been adopted by state Medicaid programs and some private insurers, are inadequate (26).

Trauma centers suffer from both a high proportion of uninsured patients and poor reimbursement in relation to high costs for many patients covered by government and managed care providers (26). The net impact was recently illustrated in a study of 16 acute care hospitals that maintain trauma centers (60). Reimbursement by payer class for the trauma center patients versus general hospital patients in these institutions was compared, and the results are presented graphically in Figures 5a and 5b.

The horizontal axis indicates the proportion of charges for patients in each payer class, and the vertical axis indicates the percent of total costs recovered within each payer class. Surpluses are generated in the commercial insurance and worker's compensation classes, but losses are generated in all other classes. Among the hospitals reporting, the surpluses in both general hospital and trauma center patient populations are relatively similar, but the financial losses in the trauma center patient population greatly outweigh those in the general hospital patient population.

Several solutions have been proposed to address the problems of uncompensated trauma care. They include federal, state, and local options. These options are briefly summarized here; they are discussed in more detail in the monograph by Champion and Mabee (11).

Figure 5a

Trauma Center Patient Population

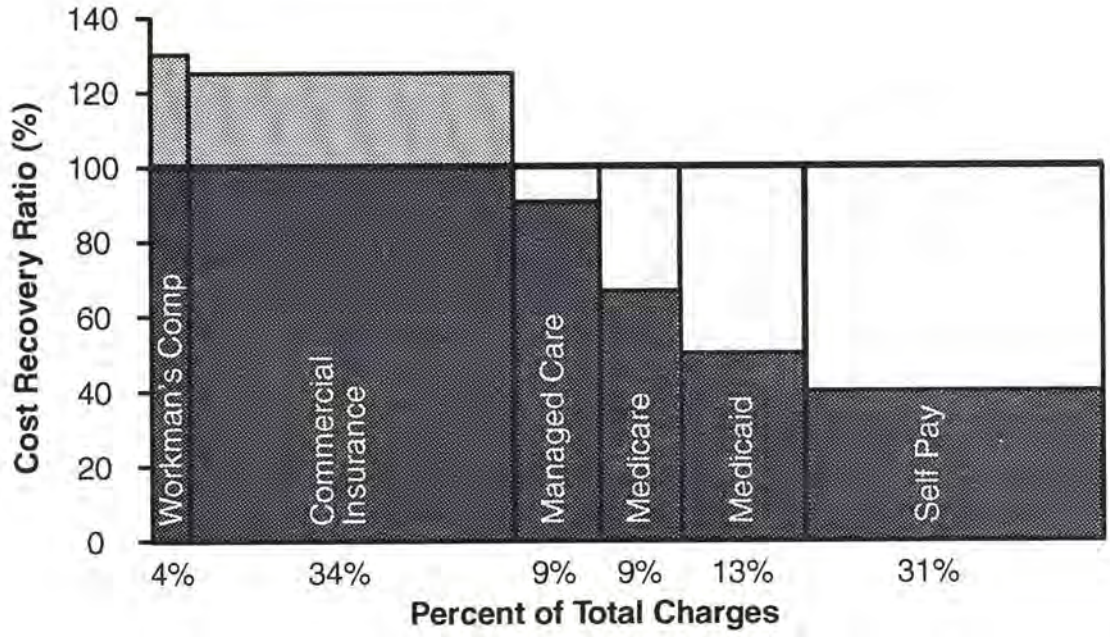
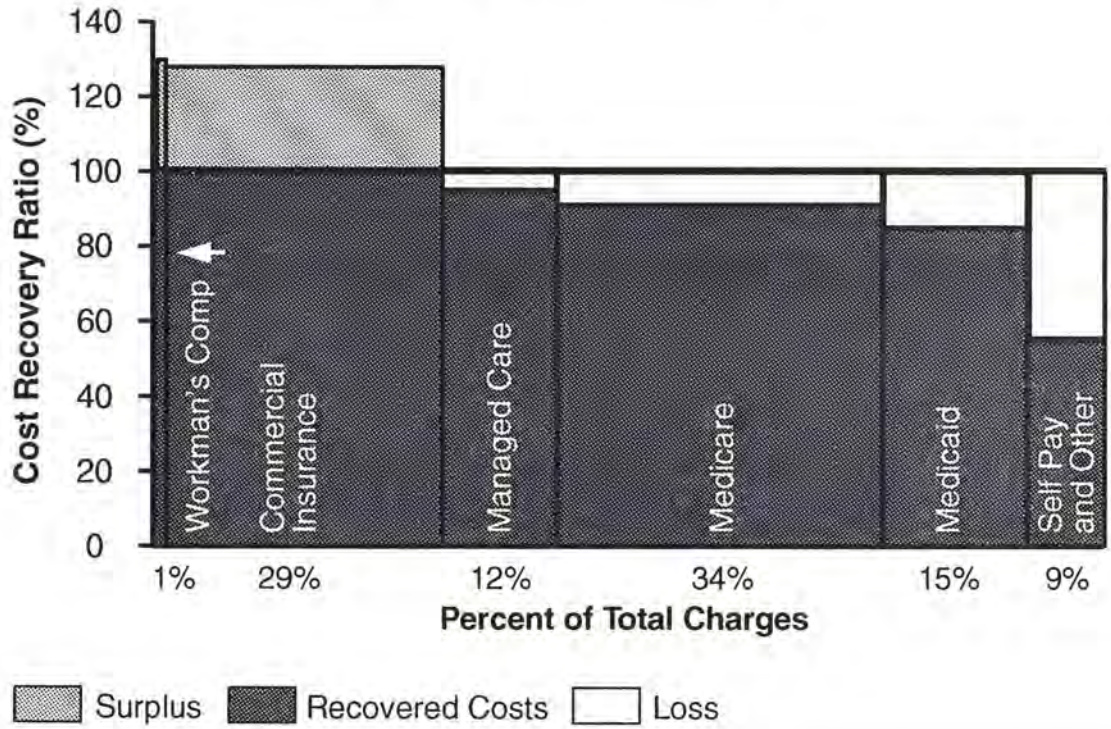


Figure 5b

Hospital Patient Population



One attractive option is the development of a trauma financing pool that would reimburse trauma centers that meet certain performance criteria. Revenues for the pool would be generated at the federal and state levels as well as by the private sector (principally insurance companies). States could raise revenues by increasing driver license and motor vehicle registration fees and taxing automobile liability insurance.

Federal revenues, on the other hand, could be generated by increased federal tax on alcohol, vehicles, and firearms, the major contributors to injury in this country. Since hospital treatment for alcohol-related injuries contributes significantly to societal costs, a clear case can be made for earmarking a proportion of these additional alcohol tax revenues to assist in covering the costs of uncompensated trauma care.

Several states have already established trauma financing pools to subsidize hospitals that treat a disproportionate share of indigent patients (61). Still other states have established indigent care pools to address the problem of uncompensated care more broadly. It will be important to monitor the relative success of these programs and to more broadly implement strategies that work to reduce the financial burden of uncompensated care.

Both Medicare and Medicaid coverage need to be expanded so that the costs of care rendered will be adequately covered. This is especially true for severely injured people who have no other health insurance. All prospective hospital payment systems (DRG-based) need a similar adjustment to account for severity of injury and intensity of care. These hospital systems, similar to the federal programs, should also provide adequate reimbursement to the professionals and institutions rendering care.

Ensuring Adequate Financing for Trauma Care Systems - Committee Recommendations:

Conduct a comprehensive evaluation of reimbursement problems and provide financial support for trauma care systems.

- Evaluate the cost-effectiveness of trauma care systems.
- Address the issue of uncompensated and undercompensated care.
- Expand Medicaid and Medicare coverage for trauma care.
- Ensure adequate reimbursement for care rendered at accredited trauma centers.
- Define and implement methods for improving automobile insurers support for care of those injured in motor vehicle crashes, including no-fault insurers.
- Establish trauma financing pools (such as taxation on alcohol, vehicles, and firearms) specifically to fund trauma care systems.
- Study and define the differences between the economics of rural and urban systems.

Organizational and Political Barriers

Many organizational and political barriers impede the effective planning and operation of trauma care systems. Foremost among these barriers are those created by an increasingly competitive health care market. These barriers also make it difficult to establish integrated systems of care, including prehospital, hospital, and rehabilitation services as specified in the PHS Year 2000 Objective (42).

In an inclusive trauma care system, every hospital that treats injured patients should be recognized as an integral part of the overall system. Recent studies suggest that major trauma requiring the resources of a trauma center accounts for only a small percentage (12%) of all injury. Even though trauma care represents a disproportionate share of hospital costs, more than 75% of hospital revenues are generated from the less severely injured patients who can be and should be appropriately treated at nontrauma center hospitals (30). Data such as these, developed locally and in more detail, should help to reduce some fears that regionalizing trauma care would adversely affect the revenues of nontrauma center hospitals.

One of the most difficult challenges facing trauma systems is the development and implementation of triage guidelines that are effective in getting the right patient to the right level of hospital care. The largely unanswered question is, to what extent can we improve our ability to send trauma patients to trauma centers with minimal disruption of the normal flow of less severely injured to the nontrauma center hospital. Theoretically, the resolution of this question could encourage all hospitals to accept an inclusive system.

An additional concern facing trauma systems is the potentially negative impact of statutory controls over the interhospital transfer of indigent patients. Federal law requires that hospitals (a) screen emergency department patients to identify those with emergency conditions and (b) stabilize the patient before transferring the patient to a hospital with the medical capabilities necessary to treat the condition. The same law requires trauma centers to accept all patients who need trauma center care if the trauma center has the capacity to treat the patient. Although the law was designed with good intentions, it will no doubt greatly increase the financial burden from uncompensated care on the Nation's trauma centers. Trauma systems must work closely with lawmakers to ensure not only that patients needing the resources of a trauma center have access to such care, but also that trauma centers do not suffer unfair burdens in providing such treatment.

Baseline and subsequent data on the epidemiology of trauma and on the patterns in which trauma centers are used should also be used to define more effectively an optimal configuration of both prehospital and hospital resources. It has been suggested that some trauma centers have closed because the volume of major trauma patients treated was not sufficient to maintain a cost-efficient facility. More work is needed to define the "optimal" volume and mix of trauma patients needed to maintain a high-quality and cost-efficient trauma center.

Organizational and Political Barriers - Committee Recommendations:

Develop, implement, and evaluate an inclusive trauma care system in the United States.

- Provide adequate federal funding to implement the Trauma Care Systems Planning and Development Act of 1990 (37). This should include the following:
  - Establish and operate a national clearinghouse on injury surveillance and methods of evaluating trauma system performance.
    - Develop appropriate, modern trauma care systems and EMS systems through sharing information.
    - Collect, compile, and disseminate information on the achievements and problems of providing trauma care and EMS, especially distinguishing between the unique needs of rural and urban areas.
    - Provide technical assistance relating to trauma care and EMS to state and local agencies.
    - Sponsor workshops and conferences on trauma care and EMS.
  - Develop and implement a national uniform data set for trauma care, including system performance and patient outcome measurements for prehospital, hospital, and rehabilitation services, and establish guidelines for states to collect, analyze, and report these data.
- Establish and maintain national standards for trauma care data systems that facilitate aggregation, analysis, and reporting of standardized data at the local, state, and regional levels.
- Develop and implement inclusive trauma care systems that involve all acute care institutions.
  - Identify and provide incentives to encourage participation in the systems.
- Establish an effective triage scheme and triage criteria.
- Ensure universal access to EMS (911) and a trauma care system (including trauma centers).
- Initiate rehabilitation services during acute care treatment of injured persons.
- Establish an integrated system of care, including prehospital, hospital, and rehabilitation services (42).
- Expand the availability of NHTSA Development of Trauma Systems (DOTS) training in states and communities.

Implementing Cost-Effective Trauma Care Systems

Perhaps one of the most important challenges facing trauma systems is the development of data to document the costs and benefits of a regionalized approach to trauma care. Because relatively young and productive members of society are the predominant population

exposed to trauma, investing in trauma care systems that save the lives of injured persons and return them to productive lifestyles is a wise investment for society and government. Further studies are necessary, however, to demonstrate that such is the case. In particular, the exact way an investment in trauma care systems affects society should be researched. Cost-benefit studies must be designed to determine what methods work best and at what cost. Only with these data will it be possible to effectively advocate for policies and programs aimed at promoting regional systems of care.

There is also a need to develop more effective and cost-efficient organizational strategies for managing the trauma patient within an integrated, coordinated, and inclusive system of care. Increased attention should be given not only on ways to facilitate transfers from nontrauma centers to trauma centers but also on ways to encourage return transfers from trauma centers to local community hospitals as early as possible. Such a process would (a) help to distribute bed usage and the cost of care throughout the system, (b) develop a sense of cooperation among providers, (c) facilitate an interchange of ideas and information, and (d) lessen the community hospital's fear of patient loss. Criteria indicating when each type of transfer is needed must be developed and tested prospectively to ensure that resources are used appropriately and cost-effectively. The overall effectiveness of directing limited resources at prevention rather than acute care and prolonged postinjury care must be assessed.

***Implementing Cost-Effective Trauma Care Systems - Committee Recommendations*:**

Study, identify, implement, and evaluate cost-effective measures for trauma care systems.

- Improve the cost-effectiveness of trauma care systems.
- Improve trauma patient transfer criteria within the system.
- Develop and implement data acquisition and a trauma care data system that monitors and ensures cost-effectiveness.
- Develop and implement prevention programs to decrease the need for trauma care.

Systems Evaluation

Increasing pressures on hospitals to contain costs and compete for patients, and the changing structure of the health care system raise new concerns about the adequacy and performance of regionalized systems of trauma care. These concerns underscore the need for improved measures of system performance that can be applied on a timely and routine basis. Performance must be measured not only in terms of *structural characteristics* (e.g., is the number and distribution of facilities and helicopters adequate?) but, more importantly, in terms of *process* (e.g., are system resources used appropriately?) and *outcome* (e.g., how much has mortality and morbidity been reduced?).

In reviewing current system evaluation methods, there appear to be three overriding challenges for the 1990s. First, there is a need to develop population-based data that can

provide basic utilization and outcome information on all injured patients, regardless of where they are treated. Considerable progress has been made in the development and implementation of trauma center-based registries (62). Although the data obtained for a selected group of severely injured patients are useful for trauma center-based QA and research, their usefulness for examining patterns of utilization and system performance is limited because data on trauma patients treated at nontrauma center hospitals are excluded.

A second challenge is the development and validation of methods and measures for routinely evaluating system performance. Methods for hospital-based QA have been developed and widely implemented (49, 63, 64). Complementary methods for system QA need to be developed and evaluated (31).

Finally, methods are needed for linking resource availability and use (i.e., process) with patient outcome, with an emphasis on morbidity, mortality, and long-term disability. As increasing pressure for fiscal responsibility and accountability is placed on health care systems, those systems must demonstrate the relationship between improved patient outcome and use of resources.

Population-based data for monitoring and evaluating trauma care can be acquired by two strategies that are not mutually exclusive: (a) extension of trauma registry coverage to **all** acute care hospitals, both trauma centers and nontrauma centers, that serve defined populations and (b) linkage of existing data sources such as trauma registries, uniform hospital discharge data, ambulance run reports, law enforcement records, vital statistics, and medical examiners' and coroners' records to provide comprehensive coverage of defined populations. These strategies need to be evaluated in terms of their cost, administrative and political feasibility, and their overall utility for trauma care system planning and evaluation.

Development of national standards for trauma data systems will facilitate aggregation and analysis of data reported by multiple sources (65). Trauma data system standards should include a single set of case criteria and a uniform, minimum set of data elements for monitoring and evaluating trauma care. These standards will require periodic modification to reflect revisions in coding systems, improvements in data analytic methods, and lessons learned from practical experience and research.

Systems Evaluation - Committee Recommendations:

Develop, implement, and evaluate a national uniform data set for trauma care. National standards for case criteria and for collecting, analyzing, and reporting trauma care data should be appropriate for use by all acute care institutions.

- Develop and implement national standards for case criteria and data set content for system performance and patient outcome measures relevant to prehospital, hospital, and rehabilitation services.

- Develop national guidelines for standardized methods of collection, analysis, and reporting of trauma data.
- Develop, validate, and implement methods and measures for routinely evaluating trauma system performance.
- Link resource availability and use to patient outcome, with an emphasis on morbidity, mortality, and long-term disability.
- Evaluate the feasibility of aggregating trauma data regionally or statewide to provide basic utilization and outcome information on all injured patients, regardless of where they were injured.
- Evaluate the use of trauma care data for epidemiologic research and as a public health tool for the design, development, and evaluation of intervention and prevention strategies.

Availability and Training of Health Professionals in Trauma Care

Although trauma is the leading public health problem in this Nation, a recent survey of general surgery program directors throughout the United States (66) revealed that medical school curricula provide extremely limited coverage of injury and trauma care systems. The same study showed a tremendous inconsistency in the amount of experience commonly offered to surgical residents during their postgraduate training. In general, the deans and faculties of medical, nursing, and allied health schools have little knowledge of the magnitude and significance of the trauma problem. Curricula at these schools lack formal instruction in injury prevention and trauma care systems.

Severe shortages of professionals dedicated to the treatment of trauma exist in the United States. Among the disincentives for working in the trauma field is the lack of adequate reward for working long hours at night and on weekends. In contrast to the situation in Canada and many European countries, public and private third party payers in the United States do not provide added payments to professionals delivering services during evening, nights, weekends, or holidays. In general, in the United States the physical and emotional stress and the disruption of personal and professional schedules associated with emergency work at off hours have been regarded as a "cost of doing business." In reality, however, physicians and other health care professionals must be compensated for this off-hour work load.

The high number of law suits initiated by emergency patients has led to high malpractice insurance premiums for certain specialties, such as neurosurgery, obstetrics, and orthopaedic surgery. These high malpractice premiums discourage physicians from specializing in trauma care. In some areas, such as Florida, some physicians have chosen to confine themselves exclusively to a nonemergency practice to reduce their malpractice expenses.

The Physician Payment Review Commission is developing a fee schedule for Medicare that will be based on a resource-based relative value scale initially developed by Hsiao and

colleagues (67). This method of determining reimbursement incorporates a consideration of the time and intensity of the service along with the costs of resources and malpractice insurance. Some problems outlined above regarding physician reimbursement for trauma care can be addressed if proper attention is given to the time, intensity, and personal costs associated with trauma care.

Financial losses associated with caring for large numbers of uninsured or underinsured trauma patients have caused many hospitals to withdraw from the trauma market. In many urban centers, this has resulted in trauma care being concentrated at large, municipal hospitals with already limited financial resources. These institutions have difficulties paying competitive salaries to their employees, resulting in low levels of staffing and high turnover.

The financial disincentives described above are further compounded by certain occupational hazards, most notably, increased exposure to HBV (hepatitis) and extensive contact with HIV (AIDS). Approximately 6% of the trauma population test HIV positive, although rates vary depending on the patient mix of the population studied (68-70). Because of the blood and body secretions associated with injury, trauma care providers are exposed to a greater risk of contracting these diseases than are other providers. Despite the development of safety standards, all methods of protection have shortcomings and are far from being foolproof. Exposure to either HIV or HBV is potentially lethal. Trauma care systems must work to reduce these risks for health care providers.

Trauma care training for the general public and prehospital personnel is needed to ensure optimal care of injured persons at the scene of the injury and during transportation to the most appropriate acute care hospital. Citizens should be trained in the immediate management of a trauma incident, including preventing further harm, accessing the trauma system, clearing the airway, and stopping external bleeding. First responders, generally law enforcement officers and emergency medical technicians (EMTs), provide most prehospital trauma care in the United States, and training of these personnel is based largely on curricula developed and disseminated by the U.S. Department of Transportation (DOT). Studies of the knowledge and skill requirements of prehospital personnel and evaluations of the impact of training on patient outcomes are needed so that DOT standard curricula can be further developed. Basic and advanced trauma life support courses, developed in conjunction with professional medical groups, can provide valuable continuing education for prehospital personnel. Instruction in trauma care protocols and triage guidelines for prehospital personnel is an essential component of trauma systems.

There continues to be a shortage of registered nurses, especially in critical care. This shortage is expected to continue in the 1990s and will affect future needs for nurses in acute care, rehabilitation, and long-term care facilities. This shortage of nurses has an impact on trauma care systems, since trauma patients require intense and lengthy nursing care. There are some disincentives for nurses working in EMS or trauma care that are related to the

occupational hazards of exposure to violent acts from patients, exposure to HIV and HBV, and the stressful work load. Recruitment and retention of qualified nurses in all phases of trauma care (acute care, rehabilitation, and home care) must be a priority in any trauma system.

Trauma nursing needs to be included in nursing school curricula at all levels. Nurses need to be trained for advanced positions in trauma care, such as nurse practitioners for acute care and rehabilitation, clinical specialists for case management, and nurse researchers. Continuing education and training for nurses practicing in all phases of trauma care are needed to address the specific needs of the trauma patient and the specific functions that nurses perform as part of the trauma care team. Quality continuing education programs should be accessible to all trauma nurses in the United States, including those in rural areas.

Finally, trauma physicians and other trauma care professionals are not adequately recognized in academic circles. Physicians and other trauma care professionals of various specialties who routinely carry large clinical burdens are often at a disadvantage for promotion, since obtaining research grants and publishing research papers is still emphasized in academia. The accumulation of frustrations in all these areas lead many talented and experienced traumatologists to leave academic medicine and trauma care. They are then lost not only as trauma care providers but as researchers, teachers, and leaders in this field.

Availability and Training of Health Professionals in Trauma Care - Committee Recommendations:

Establish programs for training and educating the public and all health professionals in the field of trauma care, including injury prevention, research, and prehospital, hospital, and rehabilitation services.

- Establish a "citizens" trauma care education course.
- Promote careers in trauma care.
- Broaden education and training for all trauma care professionals.
- Influence schools of prehospital care, medicine, nursing, and allied health to recognize injury as a national health problem and to include curricula to educate health care professionals about the problem.
- Ensure academic recognition and credibility for the field of trauma care — increase grants for trauma system research and trauma education, including fellowships, endowed chairs, and professorships.
- Develop and initiate trauma training programs for rural health care providers.

Provide incentives for professionals in the field of trauma care.

- Extend the "good samaritan" law to cover all trauma care.

- Develop methods for fairly compensating trauma care professionals — all payer system and emergency fee schedule.
- Implement compensation for "off" hours, intensity of work, and risk.

Optimal Trauma Systems for Rural America

Inclusive trauma care systems are particularly important in rural areas. Usually, rural medical institutions are small and have a working relationship with larger hospitals to which they sometimes refer patients. The development of rural systems should take into account these existing referral patterns and their effectiveness. The use of formal standards for interfacility transfer needs to be promoted to ensure timely transport of the rural trauma patient to the trauma center and reciprocal return of that patient to his or her local environment and local hospital upon stabilization for rehabilitation as necessary and appropriate. The unchangeable environmental impediments, such as geography, long distances, and adverse weather conditions, must be considered in the development of optimal rural trauma systems.

The challenge is to provide appropriate, ongoing, and recurrent trauma training to prehospital and hospital rural health care providers. Without this training, their skills will decline.

Optimal Trauma Systems for Rural America - Committee Recommendations:

Identify the problems of providing optimal trauma care to the rural population.

- Identify and establish linkages between all regional trauma care resources.
- Study and implement effective and efficient transfer systems (including mode of transportation) among all levels of regional resources.
- Evaluate the problems of discovery and access to care.
- Develop and initiate trauma care training programs for rural health care providers.
- Define optimal and affordable trauma care resources for each type and size of rural institution.

Optimal Trauma Systems for Urban America

The problems of trauma care in urban America are different from those in rural settings. In larger cities many trauma care problems are due to large population densities with high concentrations of people who are unemployed, violent, or elderly. Injured persons from among these groups place heavy financial burdens on the urban hospitals rendering trauma care. High numbers of seriously injured patients often overwhelm both prehospital and hospital providers to the point that the system fails to give optimal care. The poor financial profile of many injured people makes obtaining adequate rehabilitation for their physical and psychological problems difficult. Acute care beds become crowded with patients

needing nonacute care, and the already overcrowded urban hospital has further problems admitting and caring for nontrauma patients. Administrators of nontrauma center hospitals, aware of these problems, may choose not to participate in the trauma care system and thus compound the patient load and the financial losses of the participating trauma centers.

Last, university hospitals and professional schools that function as urban trauma centers risk having their educational and research roles impaired by the financial costs and heavy work loads of rendering trauma care.

Optimal Trauma Systems for Urban America - Committee Recommendations:

Study and define the problems of urban trauma care, especially systems overload.

- Evaluate the economics of urban trauma care and provide adequate funding for institutional and professional care.
- Study violence and develop solutions to the medical problems associated with it.
- Study and refine triage criteria to increase specificity of use of the trauma center.
- Develop a back-up system for the overload problems of urban university hospitals.

Pediatric Trauma

The unique requirements for care of the injured child must be integrated throughout all aspects of the inclusive system. These requirements include the following:

- Appropriate training for all health care providers in the special requirements and unique characteristics of the injured child.
- Leadership of pediatric specialists in implementing, updating, and disseminating current principles of management of the injured child.
- Cooperation among providers and pediatric specialists in the development of protocols for triage, resuscitation, transport, and rehabilitation.
- Intense research into the causes of childhood injuries, especially those caused by behavioral and environmental factors; active and passive programs for injury prevention; and the effect of injury on developmental and functional disabilities.

The critical preventive aspects of pediatric trauma require special attention. Prevention programs to increase the use of passenger restraints (especially for infants) and bicycle helmets, sports injury prevention programs, and other similar projects need further support and implementation. Improved social programs to prevent child abuse and protect the abused child are essential. Adolescent injury and suicide prevention programs need more emphasis. Since every injured child represents a potentially significant loss to society, all of these programs must be constantly monitored and refined. Refinements should be based on objective information collected through a system of nationwide data surveillance. A contemporary data base that can be analyzed periodically must be established to

ensure that the present system functions optimally and that the principles of care remain current and correct.

Pediatric Trauma - Committee Recommendations:

Study, evaluate, identify, and implement solutions to problems associated with pediatric trauma care.

- Establish programs of training and education for all health care providers in pediatric trauma care, including prevention, research, and rehabilitation.
- Develop a uniform national data set for pediatric trauma care.
- Develop national standards for pediatric trauma care with special reference to those cases requiring specialty centers and rehabilitation referral.
- Study the long-term effect of pediatric trauma on the individual, family, and society.
- Increase injury prevention efforts with special reference to unintentional injury to children, child abuse, and teen suicide.

Geriatric Trauma

Better data on the size, scope, and cost of geriatric trauma care are needed. Further investigation of the impact of co-morbid factors on injury occurrence and patient outcome are needed, including assessment of resource utilization by elderly patients. Injury types and distributions specific to the elderly require identification. Recovery rates are needed, particularly those relating to patient outcomes and requirements for rehabilitation after major or critical injury. Definitions of nonsurvivable injuries need to be obtained through research efforts and then accepted by society.

Efforts to focus attention on elderly injured persons require the following:

- Focused prevention activities. Among the elderly, falls are the leading cause of death due to injury; prescription and over-the-counter drugs and alcohol use are often the cause of falls. Many prevention activities do not focus on the geriatric population.
- Inhospital therapeutics. Most medical experts support an aggressive initial approach to the care of elderly injured. For example, aggressive early management of cardiopulmonary problems to optimize peripheral oxygen delivery improves patient outcome (71). However, this type of aggressive approach must be coupled with the ability to limit therapy that appears fruitless.
- Aggressive patient management. The goal of maximum mobility at hospital discharge warrants more investigation and support. Home health care and continued physical therapy should be available and accessible to all elderly injured persons.
- Financing health care for the elderly could pose a major problem, since Medicare reimbursement is based on Diagnostic Related Groups (DRGs) that do not adequately recognize and characterize injury. It is impossible to abstract a complete set of injured

patients from a DRG data bank, and DRGs do not adequately represent the resources consumed by the elderly injured. Results of numerous studies have shown that patients with certain diagnosed injuries treated at Level I and Level II trauma centers result in hospital losses of up to $10,000 per patient, depending on age and the severity of the injuries. If trauma system development is to survive through the 1990s, major changes in the DRG system are needed to account for the nature and severity of injury.

***Geriatric Trauma - Committee Recommendations*:**

Study, evaluate, and identify solutions to problems associated with geriatric trauma care.

- Develop and implement ongoing prevention activities for the elderly.
- Practice aggressive management of the elderly injured patient with the goal of maximum mobility at hospital discharge.
- Support home health care and continued physical therapy for elderly injured persons.
- Refine DRGs to reflect the cost of treating elderly injured persons.

Ethical, Moral, and Legal Issues

Trauma care systems are increasingly faced with difficult ethical, moral, and legal challenges because of their success in saving lives. Families and health care providers are often faced with delicate decisions about artificial life sustaining procedures for patients who are incompetent to make these decisions themselves. In addition, organ procurement, organ donation, and do-not-resuscitate orders are complex for both health care professionals and family members. Although living wills and durable powers of attorney for health care can help in making these decisions, the public and health care professionals are not sufficiently informed as to their advantages and disadvantages. Currently, no single set of criteria for determining death in potential organ donors is accepted by the medical profession and the public (72). These ethical problems require study and collaboration by the medical, legal, and patient advocate communities. Trauma care systems must first educate health care providers about the legal, moral, and ethical aspects of these decisions and then educate the public.

Ethical, Moral and Legal Issues - Committee Recommendations:

Foster collaborative study on the ethical, moral, and legal dilemmas facing trauma care today. Items for study include the removal of artificial life-sustaining technology, organ donation and procurement, and further development of criteria for determining death in trauma patients who are potential organ donors.

- Educate health care professionals and the public about these issues.

Role of Trauma Care Systems in Primary Prevention and Rehabilitation

Trauma care professionals must integrate their activities with those of public health professionals who work to prevent injuries and with the rehabilitation community to ensure that

the results of good trauma care translate into better long-term outcomes and an improved quality of life for patients.

Health care professionals involved in the management of trauma patients are in an excellent position to promote policies that can prevent injury. In addition to their first-hand knowledge of the consequences of injury they have the potential to establish data bases that can provide the basic information for understanding the epidemiology of injuries. However, too little has been done to provide these professionals with educational opportunities in injury epidemiology and prevention policies. Health care professionals also have the opportunity to work within the system to facilitate treatment not only for the injury itself but for any underlying alcohol and drug problem, which is often the primary cause of the injury.

Trauma care professionals are challenged to work more closely with rehabilitation professionals to facilitate early referral for physical restoration, psychosocial reintegration, and reentry into the work environment. This aspect is a particularly important challenge in view of the growing number of survivors who sustain injuries resulting in significant physical, cognitive, and psychological impairments. Standard protocols for assessing the patients' posttrauma care needs must be developed and applied on a routine basis. Rehabilitation facilities should be designated in a similar way to trauma centers, and standardized transfer protocols to those facilities should be instituted and formalized.

Finally, there is minimal public awareness of the benefits of effective trauma care systems. The public might equate trauma care with ambulances or emergency department care and not see it as a continuum of care from onset of injury through recovery. A lack of understanding by the public could hinder proper development and function of the system. An informed public can dispel myths about trauma care and create community awareness regarding trauma care systems and trauma prevention. An informed public knows that trauma care is part of emergency care and comes to expect the continuity of care provided by trauma care systems (9).

Role of Trauma Care Systems in Primary Prevention and Rehabilitation - Committee Recommendations:

Increase the availability of funding for research on injury control (prevention, acute care, and rehabilitation).

- Work with rehabilitation professionals to facilitate early referral for physical restoration, psychosocial reintegration, and reentry into the work environment.
- Develop and implement standard protocols for assessing the patients' posttrauma care needs.
- Designate rehabilitation facilities according to their level of expertise.

Establish trauma care as a national public health priority.

- Establish and clarify the role of the federal agency that is to provide national leadership to coordinate trauma care system development with other injury prevention and control efforts.
- Educate the public that trauma is preventable.
- Expand injury prevention activities.

Summary of Recommendations

The following recommendations reflect the areas that need to be addressed in order to provide all citizens with access to optimal trauma care, given available resources. Since the concept of inclusive trauma care systems is relatively new, many recommendations are fundamental and not specific with operational details. Before inclusive trauma systems are widely developed and implemented, the American public must be educated that trauma is preventable. In addition, trauma professionals must demonstrate to the public and the federal government the effectiveness and cost-efficiency of trauma care systems. Once these two objectives have been accomplished the public will demand optimal trauma care throughout the country, and the trauma care field will be widely recognized and supported.

1. **Establish trauma care as a national public health priority.**

   - Establish and clarify the role of the federal agency that is to provide national leadership to coordinate trauma care system development with other injury prevention and control efforts.
   - Educate the public that trauma is preventable.
   - Expand injury prevention activities.

2. **Develop, implement, and evaluate an inclusive trauma care system in the United States.**

   - Provide adequate federal funding to implement the Trauma Care Systems Planning and Development Act of 1990 (37). This should include the following:

     — Establish and operate a national clearinghouse on injury surveillance and methods of evaluating trauma system performance.

       - Develop appropriate, modern trauma care systems and EMS systems through sharing information.
       - Collect, compile, and disseminate information on the achievements and problems of providing trauma care and emergency medical services (EMS), especially the unique needs of rural and urban areas.

- Provide technical assistance relating to trauma care and EMS to state and local agencies.
- Sponsor workshops and conferences on trauma care and EMS.

— Develop and implement a national uniform data set for trauma care, including system performance and patient outcome measurements for prehospital, hospital, and rehabilitation services, and establish guidelines for states to collect, analyze, and report these data.

- Establish and maintain national standards for trauma care data systems that facilitate aggregation, analysis, and reporting of standardized data at the local, state, and regional levels.
- Develop and implement inclusive trauma care systems that involve all acute care institutions.

  — Identify and provide incentives to encourage participation in the systems.

- Establish an effective triage scheme and triage criteria.
- Ensure universal access to EMS (911) and a trauma care system (including trauma centers).
- Establish an integrated system of care, including prehospital, hospital, and rehabilitation services (42).
- Initiate rehabilitation services during the acute care treatment of injured persons.
- Designate rehabilitation facilities according to their level of expertise.
- Expand the availability of NHTSA DOTS training in states and communities.

3. Develop, implement, and evaluate a national uniform data set for trauma care. National standards for case criteria and for collecting, analyzing, and reporting trauma care data should be appropriate for use by all acute care institutions.

- Develop and implement national standards for case criteria and data set content for system performance and patient outcome measures relevant to prehospital, hospital, and rehabilitation services.
- Develop national guidelines for standardized methods of collection, analysis, and reporting of trauma data.
- Develop, validate, and implement methods and measures for routinely evaluating trauma system performance.
- Link resource availability and use to patient outcome, with an emphasis on morbidity, mortality, and long-term disability.
- Evaluate the feasibility of aggregating trauma data regionally or statewide to provide basic utilization and outcome information on all injury patients, regardless of where they were injured.

- Evaluate the use of trauma care data for epidemiologic research and as a public health tool for the design, development, and evaluation of intervention and prevention strategies.

4. **Increase the availability of funding for research on injury control (prevention, acute care, and rehabilitation).**

   - Develop and implement prevention programs to decrease the need for trauma care.
   - Develop and implement standard protocols for assessing the patients' posttrauma care needs.
   - Develop methods to facilitate early referral for physical restoration, psychosocial reintegration, and reentry into the work environment.

5. **Study, identify, implement, and evaluate cost-effective measures for trauma care systems.**

   - Improve the cost-effectiveness of trauma care systems.
   - Improve trauma patient transfer criteria within the system.
   - Develop and implement data acquisition and a trauma care data system that monitors and ensures cost-effectiveness.

6. **Conduct a comprehensive evaluation of reimbursement problems and provide financial support for trauma care systems.**

   - Evaluate the cost-effectiveness of trauma care systems.
   - Address the issue of uncompensated and undercompensated care.
   - Expand Medicaid and Medicare coverage for trauma care.
   - Ensure adequate reimbursement for care rendered at accredited trauma centers.
   - Define and implement methods for improving automobile insurers support for care of those injured in motor vehicle crashes, including no-fault insurers.
   - Establish trauma financing pools (such as taxation schemes on alcohol, vehicles, and firearms) specifically to fund trauma care systems.
   - Study and define the unique differences in the economics of rural and urban systems.

7. **Establish programs for training and educating the public and all health professionals in the field of trauma care, including injury prevention, research, and prehospital, hospital, and rehabilitation services.**

   - Establish a "citizens" trauma care education course.
   - Promote careers in trauma care.
   - Broaden education and training for all trauma care professionals.

- Influence schools of prehospital care, medicine, nursing, and allied health to recognize injury as a national health problem and to include curricula to educate health care professionals about the problem.
- Ensure academic recognition and credibility for the field of trauma care — increase grants for trauma system research and trauma education, including fellowships, endowed chairs, and professorships.
- Develop and initiate trauma training programs for rural health care providers.

8. Provide incentives for professionals in the field of trauma care.

- Extend the "good samaritan" law to cover all trauma care.
- Develop methods for fairly compensating trauma care professionals — all payer system and emergency fee schedule.
- Implement compensation for "off" hours, intensity of work, and risk.

9. Identify the problems of providing optimal trauma care to the rural population.

- Identify and establish linkages between all regional trauma care resources.
- Study and implement effective and efficient transfer systems (including mode of transportation) among all levels of regional resources.
- Evaluate the problems of discovery and access to care.
- Develop and initiate trauma care training programs for rural health care providers.
- Define optimal and affordable trauma care resources for each type and size of rural institution.

10. Study and define the problems of urban trauma care — especially systems overload.

- Evaluate the economics of urban trauma care and provide adequate funding for institutional and professional care.
- Study violence and develop solutions to the medical problems associated with it.
- Study and refine triage criteria to increase specificity of use of the trauma center.
- Develop a back-up system for the overload problems of urban university hospitals.

11. Study, evaluate, identify, and implement solutions to problems associated with pediatric trauma care.

- Establish programs for training and educating all health care providers in pediatric trauma care, including prevention, research, and rehabilitation.
- Develop a uniform national data set for pediatric trauma care.

- Develop national standards for pediatric trauma care with special reference to those cases requiring specialty centers and rehabilitation referral.
- Study the long-term effect of pediatric trauma on the individual, family, and society.
- Increase injury prevention efforts with special reference to unintentional injury to children, child abuse, and teen suicide.

12. **Study, evaluate, and identify solutions to problems associated with geriatric trauma care.**

    - Develop and implement ongoing prevention activities for the elderly.
    - Practice aggressive management of the elderly injured patient with the goal of maximum mobility at hospital discharge.
    - Support home health care and continued physical therapy for elderly injured persons.
    - Refine DRGs to reflect the cost of treating elderly injured persons.

13. **Foster collaborative study on the ethical, moral, and legal dilemmas facing trauma care today. Items for study include removal of artificial life-sustaining technology, organ donation and procurement, and further development of criteria for determining death in trauma patients who are potential organ donors.**

    - Educate health care professionals and the public about these issues.

References

1. Majno G. The healing hand: man and wound in the ancient world. Cambridge MA: Harvard Univ. Press, 1975.

2. Homer. The Iliad. (Trans. AT Murray). Cambridge MA: Harvard Univ. Press, 1967.

3. Breasted JH. The Edwin Smith surgical papyrus. Chicago IL: Univ. of Chicago Press, 1930.

4. Cales RH. Concepts. In: Cales RH, Heilig RW Jr, editors. Trauma care systems: a guide to planning, implementation, operation, and evaluation. Rockville MD: Aspen Publishers, 1987:3-18.

5. Hardaway RM. Viet Nam wound analysis. J Trauma 1978;18(9):635.

6. Haacker LP. Time and its effects on casualties in World War II and Vietnam. Arch Surg 1969;98:39.

7. American College of Surgeons Committee on Trauma. Resources for optimal care of the injured patient. Chicago IL: American College of Surgeons, 1990.

8. American College of Emergency Physicians. Guidelines for trauma care systems. Ann Emerg Med 1987;16:459-63.

9. National Highway Traffic Safety Administration. Development of trauma systems (DOTS): a state and community guide. Washington DC: U.S. Department of Transportation, 1989.

10. Allen M. Miami trauma care network founders over unpaid bills and grumbling doctors. Wall Street J 1987 Feb 25: sect. 1:31 (col. 4).

11. Champion HR, Mabee MS. An American crisis in trauma care reimbursement. Washington DC: The Washington Hospital Center, 1990.

12. American Trauma Society. Trauma facts. Baltimore MD: 1987.

13. Ornato JP, Craren EJ, Nelson NM, Kimball KF. Impact of improved emergency medical services and emergency trauma care on the reduction in mortality from trauma. J Trauma 1985;25(7):575-9.

14. Shackford SR, Hollingworth-Fridlund P, Cooper GF, Eastman AB. The effect of regionalization upon quality of trauma care as assessed by concurrent audit before and after institution of a trauma system: a preliminary report. J Trauma 1986;26(9):812.

15. Alexander RH, Pons PT, Krischer J, Hunt P. The effect of advanced life support and sophisticated hospital systems on motor vehicle mortality. J Trauma 1986;24(6):486.

16. Jacobs LM, Sinclair A, Beiser A, D'Agostino RB. Prehospital advanced life support: benefits in trauma. J Trauma 1984;24(1);8.

17. Cales RH. Trauma mortality in Orange County: the effect of implementation of a regional trauma system. Ann Emerg Med 1984;13(1):15.

18. West JG, Cales RH, Cazzaniga AB. Impact of regionalization. Arch Surg 1983;118:740.

19. West JG, Trunkey DD, Lim RL. Systems of trauma care: a study of two counties. Arch Surg 1979;114:460.

20. National Highway Traffic Safety Administration. Emergency medical services program and its relationship to highway safety. U.S. Dept. of Transportation technical report; Publication No. DOT HS 806. Washington DC: U.S. Government Printing Office 1985:832.

21. National Association of State EMS Directors, National EMS Clearinghouse. Survey of all 50 states. Carlsbad CA: 1986.

22. United States General Accounting Office. Report to Congress: health care: states assume leadership role in providing emergency medical services. Washington DC: U.S. General Accounting Office, 1986.

23. Teter H, Dailey J. Trauma center closures: a national assessment. In: Third Annual Injury Control Conference: a guide to the display of topical tables. Atlanta GA: Centers for Disease Control, 1991.

24. Rockefeller JD IV. The Pepper Commission Report on Comprehensive Health Care. N Engl J Med 1990;323(14):1005-7.

25. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress. San Francisco, CA: Institute for Health & Aging, Univ. of California, and Injury Prevention Center, The Johns Hopkins Univ., 1989.

26. Schwab CW, Young G, Civil I, Ross SE, Talucci R, Rosenberg L, et al. DRG reimbursement for trauma: the demise of the trauma center (the use of ISS grouping as an early predictor of total hospital cost). J Trauma 1988;28(7):933-46.

27. Jacobs LM, Schwartz RJ. The impact of prospective reimbursement on trauma centers: an alternative payment plan. Arch Surg 1986;121(4):479-83.

28. Thomas F, Clemmer TP, Larsen KG, Menlove RL, Orme JF Jr., Christiason EA. The economic impact of DRG payment policies on air-evacuated trauma patients. J Trauma 1988;28(4):446-52.

29. Bennett BR, Jacobs LM, Schwartz RJ. Incidence, costs, and patients: a 3-year experience. J Trauma 1989;29(5):556-65.

30. MacKenzie EJ, Morris JA, Smith GS, Fahey M. Acute hospital costs of trauma in the U.S.: implications for regionalized systems of care. J Trauma 1990;30(9):1096-103.

31. MacKenzie EJ, Steinwachs DM, Ramzy AI. Evaluating performance of statewide regionalized systems of trauma care. J Trauma 1990;30(6):681-8.

32. Eastham JN, Steinwachs DM, MacKenzie EJ. Trauma care reimbursement: comparison of DRGs to an injury severity-based payment system. J Trauma 1991;31:210-6.

33. Young JC, Macioce DP, Young WW. Identifying injuries and trauma severity in large databases. J Trauma 1990;30(10):1220.

34. Young W. Measuring the cost of care using patient management categories. HCFA Grant No. 18-P-97063/3. Pittsburgh PA: Blue Cross of Western Pennsylvania, 1985.

35. Young W. Incorporating severity of illness and comorbidity in case mix measurement. Health Care Financing Rev 1984 (Ann Suppl):23-31.

36. West JG, Williams MJ, Trunkey DD, Wolferth CC Jr. Trauma systems: current status — future challenges. JAMA 1988;259(24):3597-600.

37. Trauma Care Systems Planning and Development Act of 1990. United States Public Law 101-590.

38. National Highway Traffic Safety Administration, Abt Associates. Trauma system development: final report. Washington DC: U.S. Department of Transportation, 1988.

39. U.S. Congress, Office of Technology Assessment. Rural emergency medical services special report, OTA-H-445. Washington DC: U.S. Government Printing Office, 1989.

40. Martin GD, Cogbill TH, Landercasper J, Strutt PJ. Prospective analysis of rural interhospital transfer of injured patients to a referral trauma center. J Trauma 1990;30:1014-20.

41. Eastman AB, Lewis FR, Champion HR, Mottox KL. Regional trauma system design: critical concepts. Am J Surg 1987;154:79-87.

42. Public Health Service, Healthy people 2000: national health promotion and disease prevention objectives: full report, with commentary. Washington DC: U.S. Government Printing Office, 1991: DHHS Publication No. (PHS) 91-50212.

43. Baruch M, Mackenzie EJ, Smith GS, Damiano AM. Coding external causes of injury (E-codes) in Maryland hospital discharges, 1979-88: a statewide study to explore the uncoded population. Am J Public Health 1990;10(12):1463-6.

44. Lewis F, Trunkey D. Autopsy of a disaster: the Martinez bus accident. J Trauma 1980;20:861-6.

45. Quarantelli EL. Delivery of emergency medical services in disasters: assumptions and realities. New York NY: Irvington, 1983.

46. Jacobs L, Goody M, Sinclair A. The role of the trauma center in disaster management. J Trauma 1982;23:697-710.

47. Tierney K. Emergency medical preparedness and responses in disasters: the need for interorganizational coordination. Public Admin Rev 1985;45:77-84.

48. DeMaria EJ, Kenney PR, Merriam MA, Casanova LA, Gann DS. Aggressive trauma care benefits for the elderly. J Trauma 1987:1200-6.

49. Champion HR, Sacco WJ, Hunt TK. Trauma severity scoring to predict mortality. World J Surg 1983;7(1):4-11.

50. Baker SP, Whitfield RA, O'Neill B. Geographic variations in mortality from motor vehicle crashes. N Engl J Med 1987;316:1384-7.

51. Baker SP, Whitfield RA, O'Neill B. County mapping of injury mortality. J Trauma 1988;28:741-5.

52. Mueller BA, Rivara FP, Bergman A. Urban-rural location and the risk of dying in a pedestrian-vehicle collision. J Trauma 1988;28:91-4.

53. Krob MJ, Cram AE, Vargish T, Kassell NF, Davis JW, Airola S. Rural trauma care: A study of trauma care in a rural emergency medical services region. Ann Emerg Med 1984;13:891-5.

54. Cales RH. Medical direction. In: Cales RH, Heilig RW Jr, editors. Trauma care systems: a guide to planning, implementation, operation, and evaluation. Rockville MD: Aspen Publishers, 1987:21-35.

55. Cleveland H. Transportation. In: Cales RH, Heilig RW Jr, editors. Trauma care systems: a guide to planning, implementation, operation, and evaluation. Rockville MD: Aspen Publishers, 1987:129-41.

56. Trunkey DD. Trauma. Sci Am 1983;249:28-35.

57. Shackford SR, Hollingsworth-Fridlundk P, McArdle M, Eastman AB. Assuring quality in a trauma system: the Medical Audit Committee: composition, cost, and results. J Trauma 1987;27:866-75.

58. Cooper GF, Murrin P, Sheridan-McArdle M. Advances in quality assurance. Adv Trauma. 1987;2:1-20.

59. Mayer TA, Keaton B. Data sets. Trauma Q 1989;5:22-36.

60. Eastman AB, Rice CL, Bishop GS, Richardson JD. An analysis of the critical problem of trauma center reimbursement. J Trauma 1991; 31:920-60.

61. Charhut M, Lippitt E, Oberman D. Survey results of trauma care systems in 21 U.S. cities: report to Health Commissioner Richard Krieg, City of Chicago, October, 1989.

62. Pollock DA, McClain PW. Trauma registries: current status and future prospects. JAMA 1989;262(16):2280-3.

63. Boyd CR, Tolson MS, Copes WS. Evaluating trauma care: the TRISS methodology. J Trauma 1987;27:866-75.

64. Rhodes M, Sacco W, Smith S, Boorse D. Cost-effectiveness of trauma quality assurance audit filter. J Trauma 1990;30(6):724-7.

65. Centers for Disease Control. Report from the 1988 trauma registry workshop. J Trauma 1989;29:827-34.

66. Trunkey DD. Presidential address: on the nature of things that go bang in the night. Surgery 1982;92(2):123-32.

67. Hsiao WC, Braun P, Yntema B, Becker ER. Estimating physician's work for a resource-based relative-value scale. N Engl J Med 1988;319(13):835-41.

68. Kelen GD, DiGiovanna T, Bisson L, Kalainov D, Sivertson KT, Avinn TC. HIV infection in ED patients: epidemiology, clinical presentations, and risk to health care workers: the Johns Hopkins experience. JAMA 1989;262:516-22.

69. Kelen GD, Fritz SK, Qagish B, Brookmeyer R, Baker JL, Kline RL. Unrecognized HIV infection in ED patients. N Engl J Med 1988;318:1645-50.

70. Soderstrom CA, Furth PA, Glasser D, Dunning RW, Groseclose SL, Cowley RA. HIV infection rate in a trauma center treating predominantly rural blunt trauma patients. J Trauma 1989;29:1526-30.

71. Scalea TM, Simon HM, Duncan AO. Geriatric blunt multiple trauma: improved survival with early invasive monitoring. J Trauma 1990;30(2):129.

72. Youngner SJ, Landefeld CS, Coulton CJ, Juknialis BW, Leary M. "Brain death" and organ retrieval: a cross-sectional survey of knowledge and concepts among health professionals. JAMA 1989;261(15):2205-10.

Glossary of Terms

Glossary of Terms

abbreviated injury scale (AIS) - a consensus-derived, anatomically based system that classifies individual injuries by body region on a 6-point ordinal severity scale ranging from AIS 1 (minor) to AIS 5 (currently untreatable). The AIS does not assess the combined effects of multiple injuries.

acute care - surgical and medical treatment to arrest and reverse the rapid deterioration or loss of vital signs or body functions resulting from an injury or medical emergency that poses the threat of imminent loss of life, limb, or important bodily function

acute care institution - a hospital that provides diagnostic and therapeutic services for patients whose medical conditions require emergency or urgent care

by-pass - transport of an EMS patient past a normally used EMS receiving facility to a designated medical facility for the purpose of accessing more readily available or appropriate medical care

citizen access - the act of requesting emergency assistance for a specific event

communications system - a collection of individual communication networks, a transmission system, relay stations, and control and base stations capable of interconnection and interoperation that are designed to form an integral whole. The individual components must serve a common purpose, be technically compatible, employ common procedures, respond to control, and operate in unison.

diagnostic related group (DRG) - a reimbursement method based on a prospective set rate that is a fixed allocation without consideration for individual hospital services

disaster - any occurrence that causes damage, ecological destruction, loss of human lives, or deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected community area

dispatch - the act of sending emergency resources in response to a specific event

field categorization (classification) - a medical emergency classification procedure that is applicable under conditions encountered at the site of a medical emergency. An example is the procedure used for classification of injuries incident to motor vehicle crashes (dead, disabling, nondisabling, possible, or none).

inclusive trauma care system - a trauma care system that addresses the needs of all injured patients and provides a continuum of services, including prevention, prehospital care, acute care, and rehabilitation

injury - the result of an act that damages, harms, or hurts

injury prevention - efforts to forestall or prevent events that might result in injuries

injury rate - a statistical measure describing the number of injuries expected to occur in a defined number of people (usually 100,000) within a defined period (usually 1 year). An expression of the relative risk of different injuries or groups.

injury severity score (ISS) - a quantitative summary of the severity level of one or more injuries sustained by an individual; it is calculated by the sum of the squares of the highest severity score of injuries in up to three body regions

living will - specific written directives regarding the right to refuse artificial life-sustaining procedures when the patient is incompetent to refuse such procedures directly

major trauma - that subset of injuries that encompasses the most severe or critical types of injury and therefore requires a systems approach (i.e., a trauma care system) in order to save life or limb

mechanism of injury - the source of forces that produce mechanical (e.g., elastic, viscous, or inertial) deformations and physiologic responses that cause an anatomic lesion or functional change in humans

medical command - an order given to a provider of emergency medical services by an authorized physician who meets qualifications prescribed by the Department of Health

medical control - guarantees physician direction over prehospital activities. Dedicated medical control should ensure efficient and proficient trauma triage, transportation, and care, as well as ongoing quality assurance.

medical direction - when a physician is identified to develop, implement, and evaluate all medical aspects of an EMS system

morbidity - the relative incidence of disease

mortality - the proportion of deaths to population

off-line medical direction - the establishment and monitoring of all medical components of an EMS system, including protocols, standing orders, education programs, and the quality and delivery of on-line control

on-line medical direction - immediate medical direction to prehospital providers in remote locations (also known as direct medical control) provided by a physician or an authorized communications resource person under the direction of a physician

overtriage - directing patients to trauma centers when they do not need such specialized care. Overtriage occurs because of incorrect identification of patients as having severe injuries when retrospective analysis indicates minor injuries.

patient assessment - the systematic identification of a patient's real or perceived problem(s) by means of documentation and evaluation of data based on site surveys, examination of the patient for evidence of emergency medical conditions, and pertinent information available from the patient

patient mix - the statistical distribution by type, cause, and severity of medical emergency, of patients received and treated at a medical facility over time

primary assessment - the identification of a patient's real or perceived problem(s) by means of the accumulation and evaluation of data from an initial rapid survey of the conditions at the scene, a rapid survey of the patient for life-threatening conditions, and pertinent information available from the patient

protocols - standards for EMS practice in a variety of situations within the EMS system

quality assurance - the process by which patient care, patient outcome, and structural aspects of the organization that impact patient care are systematically evaluated according to predetermined standards. The purpose is to ensure that the highest possible measure of quality is achieved.

response time - the date and time when an emergency response unit arrived at the scene of the emergency

rural - those areas not designated as metropolitan statistical areas (MSAs)

service area - that geographic area defined by the local EMS agency in its trauma care system plan as the area served by a designated trauma center

trauma - a term derived from the Greek for "wound"; it refers to any bodily injury

trauma care system - an organized approach to treating patients with acute injuries; it provides personnel, facilities, and equipment for effective and coordinated trauma care in an appropriate geographical region at all times

Trauma Care Systems Planning and Development Act of 1990 - the bill resulting from the conference between the House and the Senate on H.R. 1602, the Trauma Care Systems Planning and Development Act of 1989, and a Senate amendment that included the text of S. 15, the Emergency Medical Services and Trauma Care Improvement Act of 1989. The purpose of the legislation is to assist state governments in developing, implementing, and improving regional systems of trauma care. By providing incentives to states and localities to establish well-coordinated regionalized systems of trauma care, severely injured individuals can receive specialized, high-quality care as rapidly as possible following their injury.

trauma center - a facility that is designated by a duly authorized entity to provide comprehensive medical and nursing services to severely injured patients

trauma physician - a physician with experience in the initial resuscitation, treatment, and diagnostic work-up of the injured patient and who participates in the systematic approach to delivering trauma care. Emergency physicians, anesthesiologists, and surgeons constitute the bulk of these physicians, but they may include other physicians with special interest in trauma care.

trauma registry - a collection of data on patients who receive hospital care for certain types of injuries (e.g., blunt or penetrating trauma). Such data are primarily designed to ensure quality trauma care and outcomes in individual institutions and trauma systems but have the secondary purpose of providing useful data for the surveillance of injury morbidity and mortality.

trauma surgeon - a physician who (a) has completed a surgical residency approved by the Accreditation Council for Graduate Medical Education and the course in Advance Trauma Life Support given by the American College of Surgeons (ACS), (b) has clinical experience in caring for injured persons, and (c) is board-certified in accordance with American College of Surgeons provisions for surgeons who treat trauma patients

trauma team - the multidisciplinary group of professionals who have been designated to collectively render care for trauma patients at a designated trauma center

triage - the process of sorting injured patients on the basis of the actual or perceived degree of injury and assigning them to the most effective and efficient regional care resources, in order to insure optimal care and the best chance of survival

triage criteria - measures or methods of assessing the severity of a person's injuries that are used for patient evaluation, especially in the prehospital setting, and that use anatomic and physiologic considerations and mechanism of injury

uncompensated care - care for which no reimbursement is made

undertriage - directing fewer patients to trauma centers than is warranted because of incorrect identification of patients as having minor injuries when retrospective analysis indicates severe injuries

urban area - anywhere within 20 miles of a population of 30,000 or more

911 - a three-digit telephone number to facilitate the reporting of an incident or situation requiring response by a public safety agency

enhanced 911 - a telephone system that includes automatic number identification, automatic location identification, and (optimally) selective routing, to facilitate appropriate public safety response

Acute Care Treatment

Acute Care Treatment
— Contributors—

Frank R. Lewis, M.D.,* Cochairperson, San Francisco General Hospital, San Francisco, CA

Thomas A. Gennarelli, M.D., Cochairperson, Hospital of the University of Pennsylvania, Philadelphia, PA

Daniel A. Pollock, M.D., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Denise Johnson, Assistant Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

Robert H. Demling, M.D., Harvard Medical School, Boston, MA

Frank Ehrlich, M.D., The Graduate Hospital, Philadelphia, PA

Martin R. Eichelberger, M.D., Children's National Medical Center, Washington, DC

Arthur W. Fleming, M.D., King-Drew Medical Center, Los Angeles, CA

John H. Ferguson, M.D., National Institutes of Health, Bethesda, MD

Kenneth W. Kizer, M.D., M.P.H., California Department of Health Services, Sacramento, CA (Present address: School of Medicine, University of California, Davis, CA)

Raj K. Narayan, M.D., Baylor College of Medicine, Houston, TX

Grace Rozycki, M.D., The Washington Hospital Center, Washington, DC

G. Thomas Shires, M.D., Cornell University Medical Center, New York, NY

Peter G. Trafton, M.D., Rhode Island Hospital, Providence, RI

Donald D. Trunkey, M.D., Oregon Health Sciences University, Portland, OR

John Weigelt, M.D., University of Texas Health Science Center, Dallas, TX

Nancy Burton, M.P.H., Macro International, Inc., Atlanta, GA

Acknowledgment: The panel thanks Robert Morris, M.D., and C. Douglas Witherspoon, M.D., University of Alabama at Birmingham; Louis D. Pizzarello, M.D., Southampton Hospital, Southampton, NY; and James P. Ganley, M.D., Dr.P.H., Louisiana State University Medical Center, Shreveport, LA, for their contributions to the section on ocular trauma. The panel thanks Ricardo Martinez, M.D., Stanford University Hospital, Stanford, CA, for his contributions to the section on prehospital care and emergency department care.

* Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Where We Are

This position paper on acute care treatment deals with the prehospital and in-hospital phases of medical care following traumatic injury. Systems issues related to the design of regional trauma care systems, the number of trauma cases to be expected in a given population, the methods of determining the need for and designation of trauma centers, and the triage of major trauma patients to specific trauma centers are all addressed in the position paper on trauma care systems. Although planning for rehabilitation and the earliest stages of the rehabilitation process must begin during the acute treatment phase of the initial hospitalization, these issues are examined in the position paper on rehabilitation.

Trauma care has evolved as a separate area of specialty interest over the last three decades, and optimal treatment for many injuries has been examined in detail and is generally well defined. We will not attempt to address here the areas in which there is good agreement about appropriate treatment, but will instead focus on research objectives for controversial areas or areas for which our present efforts are inadequate to control or reverse the mortality and morbidity after major trauma. These research objectives were formulated after extensive discussion in the total committee, but were drafted by a specific committee member with special expertise in that area. The objectives are in areas, identified by the committee, in which advances in care are most needed, although the committee did not attempt to place any relative priority or any cost/benefit ratios on the specific goals.

Although all medical specialties may be involved in the care of complex trauma patients, generally only a few surgical specialties are directly involved. The initial assessment and resuscitation of the trauma patient in most hospitals is done by the emergency medicine specialist. On the basis of patient needs, the appropriate surgical specialist is contacted for in-hospital care, and the patient is transferred to that surgeon's care when leaving the emergency department. In trauma centers, the trauma surgeon, who is a general surgeon with special interest and training in trauma care, may assume direct management of the patient during emergency department resuscitation and diagnostic workup, although the emergency medicine specialist remains integrally involved. The trauma surgeon should lead the team caring for the patient during his or her hospitalization and should consult other surgical specialists as needed for injuries involving particular organ systems. Statistically, the orthopedist and neurosurgeon are the specialists most commonly needed and are closely involved with the patient's management, from presentation in the emergency department through hospitalization.

The material in the next chapter of this position paper is organized in the sequence of care that an incoming patient would receive: prehospital and emergency department care, definitive care, intensive care, and care for complications and morbidity. Five specific areas of trauma care require focused attention: pediatric trauma, neurotrauma, burn injury,

musculoskeletal injury, and ocular trauma care. Although these specific areas and the more general topics often overlap, we have tried to keep the issues as separate as possible. Each section begins with an introduction intended to place that section within the overall perspective of the acute care position paper. However, the majority of the material focuses on specific topics that need further investigation. Each research topic is followed by a brief discussion of the issues involved.

Where We Want To Be

Prehospital Care/Emergency Department Care

Introduction

Most trauma care professionals recognize the importance of high-calibre prehospital care in trauma management, especially the need for optimal resuscitation, immobilization, triage, and transportation (1). Future research in the area of prehospital therapy should focus on those areas most likely to contribute to improved patient outcome (2).

Deaths secondary to trauma follow a trimodal distribution. Early deaths, occurring immediately or during the first few minutes, are usually due to severe injury to the central nervous system, large blood vessels, or heart. Even optimal treatment has little effect on this group of injuries, and only improved injury prevention will significantly reduce the number of early trauma deaths (3).

The second mortality peak occurs within the first few hours after injury; nearly all the injuries causing these deaths are treatable, making time a key factor. The time interval between injury and definitive care bears a direct relationship to survival, with hemorrhage and central nervous system (CNS) injury being the principal causes of mortality in this period. The tradeoffs between potential improvements in outcome as a result of prehospital interventions versus the time taken for these interventions have yet to be well defined, yet a precise determination of these tradeoffs is crucial for the design and operation of prehospital systems (4, 5). Although many resuscitation modalities are used in the prehospital phase of treatment, these modalities are not uniformly implemented because medical direction, training, education, and skill maintenance vary. Improved methods must be found for teaching and monitoring the quality of effective, presently available treatments, and for disseminating improvements as they become available. These areas should be the highest priority for those designing clinical studies of prehospital care in the next few years.

Care for the injured patient begins at the scene of the injury. Ideally the patient is then delivered to an appropriate facility in accordance with regional trauma system guidelines. Emergency department care for the trauma patient, the initial in-hospital phase of treatment, focuses on resuscitation and diagnosis. The next phase is definitive in-hospital care. Optimal trauma care is a continuum of treatment that begins with the prehospital provider, as an extension of the hospital's trauma care team, and continues through the patient's discharge and rehabilitation. For emergency department care to be completely effective, there must be an integrated team effort involving trauma physicians, nurses, and other support personnel, all of whom must have received adequate training in the care of trauma patients. Trauma team leaders must understand the priorities and methodology of

resuscitating the severely injured patient and of initiating the diagnostic protocols of the institution. Surgery is the in-hospital definitive care of the severely traumatized patient, and essential physician specialists such as anesthesiologists, trauma surgeons, orthopedic surgeons, and neurosurgeons must be available as soon as possible. A surgeon experienced with trauma care should be immediately available in the emergency department to direct the complex care of patients with multisystem trauma and to coordinate the care given by other essential trauma physicians. Nurses experienced in caring for severely injured patients should be involved throughout the patient's stay in the emergency department, operating room, and intensive care unit. Numerous support personnel are also essential, including laboratory, blood bank, and radiology technicians. In hospitals without the resources and staff necessary for further care of severely injured patients, the trauma team leader must coordinate communications and arrange the patients' transfer to definitive care facilities. To reverse or prevent further cellular damage and organ injury to trauma patients, the trauma team must provide expedient treatment and diagnosis during the emergency department phase.

Specific Objectives

Neurologic Dysfunction

The most common cause of death among trauma patients is head injury. Enhanced prehospital care would give many head-injured patients a chance to survive.

Research into the prehospital phase of treatment of patients with traumatic brain injuries must focus on preventing further injury to neuronal tissue and enhancing its repair. Early noninvasive monitoring of intracranial pressure (ICP), objective indicators of the need for and degree of hyperventilation, and newer pharmaceutical agents such as the lazaroids need to be studied and, if found effective, introduced into the prehospital phase of treatment. The results of recent studies suggest that degrees of hypoxia or hypotension that normally would be well tolerated have exaggerated adverse effects in the presence of even mild brain injury, but further studies of these effects are needed (2). Improved noninvasive monitoring techniques are needed, particularly for assessing cerebral perfusion, oxygenation, and function. Infrared spectroscopy for cerebral perfusion should be evaluated for emergency department use, as should means of noninvasive ICP monitoring. We must better understand the central nervous system cellular response to injury if we are to alter the morbidity and mortality of patients with head injuries.

Research also needs to be done on the effects of various nursing interventions on ICP, and this information needs to be incorporated into nursing practice.

Respiratory Dysfunction

The single most important cause of preventable morbidity and mortality in the prehospital setting is the lack of adequate oxygenation. Despite the emphasis that airway management and ventilation have been given in the teaching of resuscitation, patients still die of

respiratory compromise. More precise and objective guidelines for early intubation of patients are needed for both the prehospital and emergency department phases of care. Standardized methods are needed for training prehospital personnel, and improved non-human intubation models also are needed.

Improved techniques for emergency intubation are needed, as are better neuromuscular blocking agents to facilitate intubation. We also need to develop new noninvasive portable technologies to objectively monitor CO_2 production, ventilation, oxygenation, and tissue perfusion and damage.

Circulation and Perfusion (Fluid Resuscitation)

Circulatory support has long been emphasized in the resuscitation of patients in hypovolemic shock. Nevertheless, unrecognized or inadequately treated hypovolemia continues to be a principal cause of preventable trauma mortality. To save lives, improved methods of monitoring blood pressure, circulatory volume, and tissue perfusion or damage are needed, particularly as indicators of the effectiveness of resuscitation and ventilation.

Alternative methods of vascular access and fluid delivery need to be devised. Although intraosseous infusion has the potential to benefit patients of all ages, improved practical devices are needed for field use.

Isotonic salt solutions are the standard resuscitative fluid for prehospital use, but physiologic principles suggest that combinations of hypertonic salt solutions and synthetic colloids may be more effective for rapid volume expansion. Although agents for volume replacement are available, they are not necessarily optimal. We need careful clinical studies of the benefits-to-costs ratio of using hypertonic saline and colloids in trauma resuscitation.

Oxygen-carrying fluids based either on hemoglobins or fluorocarbons would be of enormous value in both prehospital and hospital care. Data also are needed about the use of blood products, both in terms of the optimal use of different types of products and the risk of adverse sequelae following their use (for example, AIDS).

The value of using fluid resuscitation to treat hypotension before definitively controlling bleeding has recently been questioned and should be studied further (6).

Methods of blood conservation and autotransfusion need further study. The use of packed or washed red cells theoretically engenders clotting abnormalities sooner than the use of whole blood; we must better evaluate the effect that the use of packed or washed cells have on the morbidity and mortality of trauma patients. The exact etiologies of bleeding disorders, disseminated intravascular coagulation, and other coagulopathies are often poorly defined, and efficacious treatment for most of them has not been developed.

We also need to develop more compact and effective high-pressure volume infusors that would allow delivery of about 500 ml/minute, and we need to evaluate the clinical outcomes of patients treated with such large volumes per minute.

Diagnostic (Imaging) Studies

We need improved imaging studies of traumatized patients that combine the techniques of computerized tomography, angiography, and magnetic resonance imaging. The goal should be to correlate metabolic, anatomic, and functional definitions of internal organs. Ideally, organ blood flow, parenchymal bleeding, and the metabolic state of the organ should be defined without the use of invasive monitoring techniques. In addition, more sophisticated and less invasive methods are needed for evaluating cardiac function and for vascular imaging.

Pharmacotherapy

Although numerous pharmacologic interventions are available for cardiac victims, few are available for trauma victims. Improved agents — osmotic or otherwise — to reduce cerebral swelling are urgently needed. We must better understand the central nervous system's cellular response to injury if we are to alter the morbidity and mortality of patients with head injuries.

Neuromuscular blocking agents are being studied as adjuncts for airway and ICP control and safe patient transport. The efficacy and safety of these agents need to be evaluated among different patient populations. Studies also are needed to find suitable pharmacologic agents, such as free radical scavengers, that reduce or eliminate cellular and organ injury associated with shock and reperfusion. Improved understanding of the early cellular effects of trauma and inflammation may make it possible to administer agents (such as steroids to patients with spinal cord injuries) that will reduce or prevent later organ failure. As such drugs become available, they should be studied in carefully designed prospective trials.

Underdosing of antibiotics because of fluid shifts has been demonstrated. The adjustment of dosages given to acutely injured patients must be better defined (7).

Temperature

Noninvasive methods of determining, monitoring, and maintaining a core temperature are needed, especially in the prehospital and transport environment; these methods should be suitable for patients of all ages. Rapid intravenous infusers capable of heating fluids should be developed, as should methods of maintaining body temperature or correcting hypothermia in a traumatized patient.

Anesthesia/Analgesia

Newer agents with minimal cardiovascular, respiratory, and other side effects are needed for anesthesia and analgesia of the traumatized patient during the prehospital and emergency department phases of treatment. Agents that effect prostaglandin synthesis may modulate both pain and the immune system and need further study.

Immobilization Techniques

Orthotic devices and immobilization techniques are acceptable in many instances, but in others, design improvement is needed. We need to develop compact, light-weight, safe, and cost-effective equipment that is capable of providing immediate access to the patient's airway, neck, and chest. Little data exist for comparing the efficacy of many competing devices and techniques, particularly those used for cervical spine immobilization. Performance standards must be better defined, and standardized testing procedures must be implemented.

Components/Timing

Although traumatic injury occurs in an instant, the ultimate outcome is determined by a complex chain of events. The benefit of many interventions versus the risk of delaying definitive care is controversial. Careful clinical studies are needed to determine the optimal organization of prehospital and hospital resources, including the optimal use of trauma physicians (8).

We need to identify the interventions and modes of transport that are useful or essential, and those that have no bearing on the patients' outcomes. We also need to identify the skills and interventions that are beneficial in the initial hospital phase of resuscitation so that educational efforts can focus on these components of care.

Studies relating outcome to timing of intervention are needed, as are improved triage criteria for identifying patients who require early operative care. Improved triage guidelines will enable prehospital personnel to properly identify patients needing trauma center care, while reducing overtriage (i.e., misclassification of the severity of trauma patients' injuries, resulting in overuse of trauma center hospitals).

Trauma centers are expensive to operate. The value of the separate components must be assessed so that optimal resource utilization can be identified, especially for designing rural trauma systems and for identifying those patients who would benefit by transfer to a tertiary trauma center.

The delayed effects of actions occurring during the early phases of the treatment of traumatic injury need to be clarified. For example, sepsis may result from the bacterial

translocation from the intestine or bacterial contamination introduced during the resuscitative phase of trauma care. A better understanding of the effects of early treatment of patients with severe injuries is necessary to develop improved interventions.

Research

A variety of methods are available for collecting data on trauma patients, scoring injury severity, and predicting clinical outcomes following injury. However, methods of severity scoring and outcome prediction do not control for the time elapsed between the injury event and the clinical interventions. Methods with which to better compare data from various sources also need to be developed. Reproducible methods of comparing injury variables to the various outcome variables need further study.

Definitive Care

Introduction

Definitive care of injured patients begins in the emergency department with resuscitation, assessment, and definitive diagnosis, and extends to the operating room, intensive care unit (ICU), or ward, as appropriate. With the development of Guidelines for Optimum Care of the Injured Patient approximately 15 years ago by the American College of Surgeons, standards for equipment and availability of surgical and medical personnel were established and have been validated by extensive experience.

Caring for injured patients during this phase is principally the responsibility of the trauma surgeon, with the frequent involvement of appropriate surgical subspecialists. The value of a separately organized trauma service for managing patients and for coordinating input from multiple physicians and paramedical personnel has been clearly demonstrated.

The management of the most common traumatic injuries is well defined and not subject to major controversy, though there are exceptions. In the material to follow, we will attempt to highlight those areas where controversy exists or improved care is needed.

Specific Objectives

Physiologic Monitoring of Volume Assessment and Tissue Perfusion

Objective methods are needed for quantifying blood loss and tissue perfusion early in the definitive care of injured patients. The clinical tools for evaluating these parameters are qualitative and often misinterpreted. Blood pressure, for example, is used as a substitute for volume measurement; what is needed is an accurate, simple test that would give changes in volume on a real-time basis.

Another area to be investigated is the possible protective value of hypotension before bleeding is definitively controlled. The question has recently been raised as to whether fluid resuscitation in selected hypotensive patients should be limited or withheld until the patient is in the operating room and surgeons gain operative control over further internal bleeding. It is hypothesized that aggressive resuscitation prior to this may aggravate bleeding.

Maxillofacial Injuries

Surgeons treating severe maxillofacial injuries need improved imaging methods that provide a three-dimensional view of the injury process and allow them to define the effects of reconstruction. Methods of reconstruction have advanced significantly in the last few years with the use of miniaturized internal fixation devices, but these methods are still not widely used: knowledge of the techniques involved should be further disseminated. Because the late results of midface fractures are still often suboptimal, additional research is needed into improved methods of fracture reduction and fixation.

Thoracic Injuries

Although management of most pulmonary injuries is not considered controversial, studies to determine optimal treatment methods are needed in several areas.

Flail chest occurs among 3% to 5% of the people with major thoracic injuries. In the recent past, long-term ventilatory support was needed in over 50% of the cases. This has been reduced with better pain management, and current pain management is best provided by epidural catheterization. The development of pain control techniques with fewer side effects is desirable.

Although air embolism occurs in less than 1% of all patients with major torso trauma, 80% to 90% of affected patients die. Diagnosis is difficult, and no methods of routine screening have been developed. Effective treatment is similarly lacking.

Pulmonary contusion remains the second most common injury among thoracic trauma patients, and by itself pulmonary contusion is lethal among about 15% of patients with the injury. Improved early prognostic indicators are needed, and newer methods of treatment should be evaluated. The issue of colloid versus crystalloid resuscitation continues to be controversial, and no definitive studies have been done on patients with pulmonary contusion.

For thoracic trauma patients at highest risk of death from acute, potentially reversible, pulmonary compromise, a trial of extracorporeal oxygenation appears to be warranted now that surface coatings for the perfusion circuit are available that do not require anticoagulation for cardiopulmonary bypass.

The lung appears to be an early target for microemboli or in situ thrombosis in the pulmonary vasculature. The vascular occlusive process is one of the earliest changes among people with adult respiratory distress syndrome (ARDS) and may be responsible for initiating most of the subsequent events. The use of newer thrombolytic agents such as tissue plasminogen activator should be evaluated in the early treatment of acute respiratory failure.

Further research also is needed on the effects of nursing interventions such as patient positioning, turning, frequent suctioning, and other components of aggressive pulmonary toilet.

Cardiac Injuries

Cardiac contusion remains a diagnostic and therapeutic enigma. Some authors have reported that cardiac contusion occurs among 60% of patients following severe anterior chest trauma, but the sensitivity, specificity, and accuracy of current diagnostic tests is inadequate. Therapeutic interventions are poorly defined and apparently are needed in only a few cases. Diagnoses could in theory be aided by the use of magnetic resonance spectroscopy or a similar technique capable of detecting a metabolic abnormality in a bruised or ischemic myocardium. Therapeutic intervention would only be required for pump failure, incipient transmural rupture, or demonstrated injuries to anatomic structures such as papillary muscles, valves, and chordae tendineae. The diagnosis of these injuries is crude at best.

Abdominal Injuries

Although more sophisticated than past methodologies, current imaging studies still are suboptimal. Injuries to the bowel, pancreas, duodenum, and other retroperitoneal structures are often misdiagnosed. Some solid parenchymal organ injuries could be managed nonoperatively if the clinician could determine that bleeding was primarily venous. Current diagnostic techniques do not allow the clinician to differentiate the source of the bleeding. A combination of computed tomography (CT) scan and digital subtraction angiogram (DSA) would provide a precise definition of the sources of bleeding.

The capability of noninvasively assessing ischemia or nonperfusion of abdominal organs by a precise imaging system like computerized tomography would be of major benefit. The management of the patient during the resuscitation and perioperative period could also be aided by a real-time measurement of key blood chemistries (blood gases and certain electrolytes). An intravascular, ion-selective, field-effective transistor (ISFET) has been developed but not mass produced.

The role of percutaneous surgery in elective cholecystectomy has caught the imagination of many clinicians. Percutaneous or transcutaneous surgery may also have a role in the

management of certain traumatic injuries; however, little research has been conducted in this area — including the development of animal models.

Liver Injuries

The liver injuries of some patients can be managed, without operating, through the use of more accurate imaging and diagnosis. Estimates of the percentage of patients who can be managed nonoperatively vary from 6% to 30%. The treatment of bleeding from a massive liver injury is still problematic, although techniques such as veno-veno bypass, which has been perfected in transplant surgery, may have a role. We also need better hemostatic agents that can be applied to parenchymal lacerations.

Spleen Injuries

In a recent multiinstitutional trial, 14% of all spleen injuries were managed nonoperatively. Although the nonoperative approach appears to be a safe alternative to mandatory exploration, we need to conduct 5- to 10-year follow-up studies of the outcomes of the alternative approaches, particularly the frequency of infectious complications due to additional blood transfusion associated with nonoperative management.

To improve the treatment of patients with spleen injuries, we need to (a) develop improved methods of splenic salvage and improved topical hemostatic agents, (b) provide additional training for many surgeons in techniques of splenic salvage, (c) define the interrelationship between T-cell function and macrophage function, and (d) further investigate the frequency of late postsplenectomy sepsis (6 weeks to 2 years postoperatively) among adults.

Colon Injuries

Recently there has been increasing interest in the primary repair of colon injuries, except for injuries to the rectum. Most of the current reports are retrospective; no one has conducted a prospective, multiinstitutional, randomized clinical trial of the various recommended therapeutic modalities. Additional research is needed to better define how the use of routine enteral feeding, commencing immediately after operative repair, might contribute to the protection of the enterocyte, and to determine whether or not other protective measures are needed to prevent atrophy of the enterocyte.

Pelvic Injuries

In many ways pelvic injuries are still the most difficult type of injury to treat. Hemorrhage, abnormal clotting, and postinjury sepsis are still common complications among patients with pelvic fracture. No randomized, prospective studies have been conducted on the relative advantage of rapid external fixation, angiography, and other techniques to control bleeding.

Extremity Injuries

The treatment of extremity injuries remains controversial, particularly in regard to the type of prosthetic devices to be placed in injured arteries. Degloving and crush injuries remain vexing problems, particularly as they relate to the development of compartment syndromes and remote organ damage due to myoglobin or hemoglobin pigment. The treatment of pigment injuries is empiric at best. Skin substitutes and the timing of reconstructive procedures have not been subjected to randomized trials. The effects of reperfusion injury on tissues in the extremities are just beginning to be defined, and effective therapies to prevent adverse consequences of reperfusion are not available. This entire problem needs detailed study.

Nutritional Support

Most experts now recommend that nutritional support of severely injured patients begin 48 hours after the injury. Newer methodologies would allow either enteral or parenteral nutrition to be started almost simultaneously with resuscitation. The workings of the intermediary metabolic pathways during the acute resuscitation and definitive surgery phases are not well understood, and the role of specialized diets or amino acids needs investigation.

Anesthesia/Analgesia

The ideal anesthetic and analgesic techniques for acutely injured patients have not been developed. A particular problem is the ventilatory management of patients during the definitive surgery immediately following injury. After prolonged procedures, patients often have severe shunts or hypothermia; the mechanisms causing these problems at a basic physiologic level are not understood.

Several important questions remain in the treatment of severely traumatized patients: Is there a role for sophisticated ventilators in the operating room, and would these prevent some of the oxygen desaturation that frequently occurs? Would the capability to rapidly measure oxygen consumption and delivery during the acute resuscitative phase alter treatment and outcome? Would better analgesics minimize the catecholamine response in the immediate resuscitative and postinjury period, thus reducing some of the undesirable effects of the inflammatory cascade that follows severe injury?

Autotransfusion/Blood Conservation

The availability of blood is critical for trauma management. Methods of blood conservation and autotransfusion used in the treatment of trauma patients have not been studied thoroughly. The use of packed cells or recovered washed red cells theoretically engenders clotting abnormalities sooner than the traditional use of whole blood. Whether this has a significant impact on the survival of trauma patients has not been evaluated.

Intensive Care

Introduction

The intensive care unit (ICU) has evolved from an area dedicated to mechanical support of respiration to specialized areas dedicated to providing life support systems for all bodily functions. Although only 10% to 15% of trauma patients require admission to an ICU, their outcome would be worse without access to this level of care. Specific examples of patients who benefit include those with head injuries, those with chest trauma requiring ventilation, those with multiple organ injuries, and those in severe hypovolemic shock. Careful attention to these patients' organ systems allows correction of early derangements and may prevent the multiple organ failure syndromes. Unfortunately, the cost of ICU care is increasing, and we need to find better ways of providing this sophisticated level of treatment to people who need it (9).

Organization of Intensive Care Units

Develop and Test Valid Admission Criteria

The continuing increase in the cost of ICU care, already the most expensive care in the health care system, underscores the need for a better definition of who should receive such care. Admission criteria should reflect the availability of local resources, the patient's need for acute life support, and the potential for ICU care to prevent complications. The criteria for ICU admission and the criteria by which patient outcomes are evaluated should be independent.

Develop and Test Outcome Predictors

Valid predictors of patient outcome are needed for multiple purposes, including predicting the likelihood of a patient's survival and evaluating quality of care. These indices should aid a clinician in making a decision regarding the benefits of ICU care for an individual patient (10). Current tools have been inadequately validated in the young injured population (11).

Develop Alternatives to ICU Care

Current access to ICU beds is limited, and bed rationing is occurring (12). The development of intensive care units has diminished the level of ward care. This trend could be reversed by using new technology or by improving ward nursing care so that some of our patients who are now admitted to an intermediate care or ICU area could be managed in a ward setting (13).

Redefine Roles of Various Personnel Required for Intensive Care

Critical care nurses are in high demand. Are there alternatives to critical care nurses in the ICU? Can a nursing team made up of a critical care nurse supervising less-trained personnel provide adequate ICU care? What is the role of respiratory therapists in the intensive care

unit? Do robotics have a place in the ICU? With the apparent nursing shortage in the ICU, we need to learn how to retain successful ICU nurses and increase their job satisfaction and status.

Standards of nursing care and practice must better define which personnel and which setting (ICU, intermediate, or general care) will best meet the patient's needs and lead to improved outcomes and cost-effective treatment.

Computerized management of data for bedside monitoring and other patient care data should decrease the nurses' clerical time and improve their efficacy (14). Current nursing standards, particularly documentation requirements, have been developed with little awareness of their cost/benefit ratio and without demonstrated effectiveness in improving patient care. Studies in this area are urgently needed.

Improve the Instruction in ICU Technology

Teaching the skills required to become proficient in managing critically ill patients remains a dilemma for those who conduct training programs. As technology advances, computer simulators should be developed to help the clinician gain and retain the skills needed to manage such patients (15).

Monitoring Physiologic Functions

Tissue Perfusion and Metabolism

The inadequacy of standard physiologic monitoring for assessing tissue perfusion is becoming increasingly evident. The results of many recent studies have shown that critically ill trauma patients have an ongoing oxygen deficit, which implies that injured and noninjured cells are not receiving sufficient oxygen for normal metabolism (16, 17). This state of chronic, subtle shock may be largely responsible for patients' failing to recover from the initial trauma or for their subsequently developing organ failure with its high mortality rate.

Standard hemodynamic parameters do not appear to be sufficiently sensitive to detect tissue ischemia (18). Biochemical parameters, such as lactate levels, also are late markers. More sensitive and specific markers need to be developed, preferably noninvasive ones. Techniques such as nuclear magnetic resonance (MR) spectroscopy appear promising. Methods to quantitate oxygen consumption and carbon dioxide production must be improved or developed (19). Metabolic carts are used to measure carbon dioxide production, but with current technology they are inaccurate when used on critically ill patients (20-23). Oxygen consumption is usually calculated from data obtained by invasive monitors. Tissue monitors are needed to measure on-line oxygen consumption and carbon dioxide production (24).

Hemodynamic Monitoring

Hemodynamic monitoring must not be forgotten in the search for safer noninvasive monitors. Invasive hemodynamic monitors are still the best available technology at the bedside, but noninvasive methods must not be ignored (25). More effort is needed to correlate hemodynamic monitoring with clinical events. Additionally, computer-assisted interpretation of hemodynamic monitoring needs to be available on line (26).

Tissue Monitors

Cellular monitors such as ISFET should also be a priority. Patients could be better managed during the resuscitative and perioperative period if real-time measurements of key blood chemistries, including blood gases and certain electrolytes, were available. An intravascular ISFET has been developed but not mass produced. The mass production of cellular monitors such as ISFET appears feasible with current technology, but further development and testing is necessary (27).

Tissue monitors may enable clinicians to identify better endpoints for resuscitation, and bedside monitors of all types of physiologic parameters must also be investigated. Rapid, simple laboratory determinations at the bedside should be incorporated into advances in clinical care (28).

Specific Treatment Issues

Ventilatory Techniques

Studies should be conducted to assess whether ventilatory techniques can make a difference in patient outcome. Which ventilator technique should be used for which type of pulmonary pathology? Are current safeguards adequate?

Nosocomial Infections

The epidemiology of nosocomial infections in intensive care units needs to be evaluated along with approaches to decreasing the risk of these infectious complications. Research subjects for investigation include bacterial translocation, modulation of gastric pH, catheter sepsis, postoperative infections, and pneumonia.

Cardiac Support

What is the best inotropic agent to be used for cardiac support in various types of low-output states? Is cardiac support in high-output states needed? Are there better ways to manage and monitor cardiac function after acute injury?

Deep Venous Thrombosis (DVT)

Can DVT be prevented in the intensive care unit? What is the best method of prevention? Can the findings of the NIH consensus report be applied to ICU patients (29)? Further study is needed to determine the effectiveness of nursing interventions such as passive and active range of motion exercises, pneumatic stockings, and elastic support hose for reducing the incidence of DVT and pulmonary emboli.

Immune Function

How can the immune function be stimulated in critically ill patients? Is stimulation of the immune system good for critically ill patients? Which stimulants can be useful?

Psychosocial Needs

The psychosocial needs of patients and families have been largely ignored in the ICU and need to be investigated. The types of psychosocial support that patients and their families are likely to need can be classified as general support, injury-specific support, and population-specific support.

General Support

The immediate psychosocial support requires in-hospital support groups and services. Families and patients can access these groups and services for general knowledge of how to get through the acute phase. These groups and services can also help patients and their families cut through the red tape associated with unanticipated hospitalization.

Injury-Specific Support

Specialized psychosocial groups and services might include those specifically for patients with head injuries, spinal cord injuries, multiple injuries, or ocular injuries. These groups could help guide the patient throughout the total trauma care process.

Population-Specific Support

Population-specific services target population groups with similar characteristics and needs. Patients with psychiatric problems, patients with similar occupations, adolescent patients, pediatric patients, and children hospitalized because of child abuse are examples of population-specific groups in need of unique psychosocial support. This type of support would be especially important in helping the patient and family interface with other agencies. Disaster support groups would also fall into this category.

We also need an organized means for referring people to appropriate agencies for alcohol and substance abuse counseling and rehabilitation.

Complications/Morbidity

Introduction

The objective of definitive care and intensive care is not only to treat immediate life-threatening processes but also to prevent these processes from producing cellular and organ damage that result in later multiple organ failure and infection. The improved early management of previously fatal injuries has led to the survival of an increasingly sicker patient population that suffers more severe complications.

Despite what would be considered optimum care, complications do occur, leading to significant morbidity and mortality. These complications can be divided into two categories: those caused by the progression of critical illness after traumatic injury and those resulting from the therapeutic interventions themselves.

Trauma also occurs among older patients who have chronic diseases that predispose them to frequent complications. This predisposition might be a factor in the higher rate of morbidity among older trauma patients compared with that among younger patients with similar injuries.

Specific Objectives

Minimize Infectious Complications of Monitoring Devices

The intravascular and intracranial pressure monitors that are used to detect complications also can be sources of complications, particularly infectious complications due to the transfer of micro-organisms to patients who are being monitored. Unfortunately, the risk of infectious complications versus the benefits of monitoring remain undefined, and well-defined protocols to minimize infectious complications of invasive monitors have yet to be developed and implemented. Even reasonably straightforward issues, such as how frequently to change intravascular catheters or how to diagnose vascular catheter infection, have yet to be resolved. The CDC guidelines for prevention of vascular catheter infections have not been adopted universally because of the perception that contradictory data exist in the literature. With all this uncertainty in the field, research into the use of invasive monitoring devices should have a high priority.

Develop Methods to Better Define Infection and the Infecting Organisms and to Distinguish Infection from a Noninfectious Inflammatory Response to Major Trauma

Extensive antibiotic use is a characteristic of ICU treatment, and antibiotics are often used to treat suspected infection. However, the symptoms of infection are difficult to distinguish from the inflammatory response to tissue injury. Empiric antibiotic administration often is used because, with our current techniques, bacterial colonization is difficult to distinguish from actual tissue infection, particularly in the lung. Antibiotics are not only extremely expensive, but can lead to many complications, such as renal failure and ototoxicity, and can

produce increasingly resistant organisms. More precise methods need to be developed for determining the presence of infection in lungs, in wounds, and in the peritoneal cavity.

Develop Agents to Modify the Inflammatory Response of Tissue to Injury and Infection

It is becoming increasingly clear that the progression of critical illness after traumatic injury is due largely to the progression of an acute destructive inflammation, initiated in response to the tissue trauma. In essence, the body's response to the trauma or infection goes out of control and produces significant morbidity and mortality. The traumatic insult, as well as any secondary infection, results in the release of many potentially harmful products from tissues, particularly inflammatory cells. When some of the key early products, known as cytokines, are released, they activate a series of other cascades of inflammation and coagulation which in turn result in abnormal bleeding, immune suppression, and ongoing tissue damage. Modifying the inflammatory response of tissue is an extremely complex area, and further research is needed, especially since biochemical modifiers of the inflammatory process can now be developed for clinical use via genetic engineering.

Improve Our Knowledge and Treatment of Adult Respiratory Distress Syndrome (ARDS) and Resulting Pulmonary Fibrosis

Respiratory failure remains a leading cause of death among ICU patients. The cause and treatment of progressive lung failure, leading eventually to lung fibrosis, are poorly understood. Methods of modulating the fibrotic response to injury need to be developed, as do specific inhibitors of the inflammatory mediators initiating and perpetuating the process.

Improve Our Ability to Define and Correct the Immune Depression Seen Among Critically Ill Patients

The trauma patient is at high risk for infection due to (a) open and often contaminated wounds, (b) management techniques that require invasion of the normal local immune defenses, and (c) a profound trauma-induced immunosuppressive state. The immunosuppression is largely due to immunosuppressive factors produced in response to the traumatic injury. Inhibitors of the immunosuppressive factors and augmenters of both systemic and local host defenses need to be developed. No agents have been demonstrated clinically to block the immune dysfunction, although there are several promising agents, particularly several lymphokines and prostanoid inhibitors. These agents need to be studied clinically as soon as possible.

Improve Our Knowledge of Impaired Healing Capability Among Critically Ill Patients and Improve Our Ability to Modulate this Process

The body's impaired healing capability is a result of systemic organ failure, infection, or simply a slowing of the wound healing process, which is a common problem among severely traumatized patients. Current technology allows us to manufacture the human growth

factors necessary to increase the rate of healing. However, before these agents can be used, we must better define the mechanism of wound healing, the interaction of the multiple growth factors, and the appropriate growth factors to be administered.

Pediatric Trauma

Introduction

Injury continues to be the leading cause of death for children between the ages of 1 and 14. (Though opinion varies about the definition of a "child," the focus of this section is on children less than 14 years of age, with a mean age of 7 years.) Efforts to improve outcome from injury are focused on early treatment by effective resuscitation and definitive care. The magnitude of the annual cost for such care, approximately $14 billion, suggests the need for new approaches to control injuries among children (30). Childhood injury control depends upon society's commitment to the continuum of care, encompassing prevention, acute care, and rehabilitation. When prevention fails, children sustain injuries most commonly from motor vehicle crashes, burns, submersions, falls, ingestion of poisonous substances, choking, and violence. These types of injuries result in variable physiologic derangements, including hypoxia, hypovolemic shock, immunologic dysfunction, and malnutrition (31, 32).

Specific Objectives

Improve the Outcome Assessment of Treatment Methods

Quantitative methods to evaluate patient outcomes from injury are available (33-35). However, if these methods are to yield clinically meaningful findings, then the methods must be applied to specific injury patterns, and they must be used to document improvements in quality of care. Also important are objective comparisons between the outcomes of child and adult trauma patients; the TRISS model does provide a consistent method for useful comparison (33). Unfortunately, objective measures of disability from childhood injury are especially deficient; data that correlate acute injury, care, and disability are scarce.

Evaluate Specific Treatment Methods for Children with Head Injuries

Brain injury during childhood is a leading cause of death and disability (32). Analyses of the effectiveness of prehospital intubation, of intracranial blood evacuation, of current treatments for intracranial pressure management, and of the mediator response to injury are essential. Severe traumatic brain injury (TBI) results in compelling disability; nevertheless, to determine the likely outcomes of mild TBI in the developing brain, we must establish objective parameters. Current treatment focuses on protecting the brain from further (secondary) insults, which may have an age-dependent impact upon outcome. Methods of describing brain injury must be improved, since the Glasgow coma score does not account for physiologic derangement and associated injury. Consequently, children may be found

to have the same outcome as adults once a valid comparison of similar injury patterns to the brain is possible. The accuracy of the Injury Severity Score (ISS) could be similarly improved by a more specific definition of the injuries of the central nervous system.

Analyze the Acute Organ System Response to Injury

The treatment of children's injuries has historically been based on methods proven effective for adult patients. Child-specific analysis is required if we are to understand their unique humoral and cellular responses to injury. By focusing on the pediatric neuroendocrine, metabolic, immunologic, and inflammatory responses, we will be able to establish age-specific data. Multisystem organ failure is uncommon among injured children, which suggests that their injury response is intrinsically different from that of adults (32).

Analyze the Therapeutic Needs of Children with Burns

To better treat children with burn injuries, we need to analyze the following: their metabolic and cellular response, the relative advantages of tissue culture epidermis versus autologous skin graft, their nutritional support needs, and their infection potential. Also essential are analyses of rehabilitation and family needs.

Assess the Methods Used to Treat Torso Injury

Chest trauma results in a high mortality rate among children. To prevent deaths, we need to evaluate the treatment given children with pulmonary contusion, lung laceration, and ARDS (31, 36). The role of extracorporeal membrane oxygenation (ECMO) among infants has been demonstrated, but we need to investigate its efficacy in treating pediatric patients with lung injuries. We also need to analyze the relative advantages of operative versus nonoperative management of spleen and liver injuries (37, 38). The use of blood products with each approach should be assessed to determine the transmission frequency of hepatitis and of HIV.

Analyze the Significance of Musculoskeletal Injury Among Children

Most children's fractures heal satisfactorily with closed reduction and cast immobilization. The role of surgical stabilization (with either internal or external fixation) needs better definition, especially for the treatment of children with severe injuries, children with head and other combined injuries, and children nearing skeletal maturity. The management of the injured immature spine, with its increased risk of late deformity, also deserves study, as does the prevention and correction of growth abnormalities that result from some fractures.

Analyze the Management of Maxillofacial Injury Among Children

Maxillofacial injury to the developing bone of the child is a common injury that can result in severe deformity and abnormal function. We need to determine the best timing for surgery, facial reconstruction, and the application of internal fixation.

Develop Methods to Prevent Amblyopia Among Children with Ocular Injuries

Ocular trauma that occurs during the first 6 years of life frequently is associated with permanent amblyopia due to visual deprivation experienced by children with their still-developing visual system. Evaluation of a child's ocular injuries is difficult, and particular care is required to avoid further damage to the eye during its examination. Improved methods of evaluating and treating ocular trauma among children are needed.

Improve the Home Care of Injured Children with Chronic Disabilities

Acute treatment of children continues once disability occurs. We must improve the management of chronic problems such as speech impairment, swallowing dysfunction, malnutrition, urinary tract infection, bowel dysfunction, immobility, depression, and family dysfunction.

Analyze the Impact of Injury on Psychosocial Family Needs

Injuries to children disrupt the entire family. We need to determine the effect of family support on the rehabilitation of injured children as well as the impact of the injury on the integrity and functioning of the family unit.

Neurotrauma

Introduction

Every 15 seconds, someone suffers a head injury in the United States. Every 5 minutes, one of those people dies and another becomes permanently disabled. Each year, head injuries claim the lives of 75,000 Americans. Of those who survive, 70,000-90,000 suffer life-long disability, 5,000 develop epilepsy, and 2,000 remain in a vegetative state. Primarily a disability of the young, traumatic brain injury takes a tremendous toll on our society. The economic costs alone approach $25 billion annually, but paradoxically, research into the control and treatment of brain injury receives less than one penny of every federal dollar spent on medical research (39).

The importance of neurological injury in determining the mortality and morbidity associated with trauma is well recognized by professionals in the field. However, as with trauma in general, the extent and impact of neurotrauma is grossly underestimated by other professionals and by the public.

In the last two decades, certain important developments have occurred in the treatment of neurotrauma. Most clinicians who treat patients with neurotrauma recognize that intensive care protocols (which include early intubation, early evacuation of mass lesions, and intracranial pressure monitoring) can improve patient outcomes. The morphological basis

of head injury at the cellular level is beginning to be better understood, as is the role of secondary insults in compounding the damage sustained at the moment of impact. Much of the current research is aimed at limiting the deleterious effect of these secondary processes.

With spinal cord injury, considerable excitement has been generated by the second phase of the National Acute Spinal Cord Injury Study (NASCIS II), which demonstrated that high-dose steroids used early after spinal cord injury result in significant improvement in outcome. Although steroids are certainly not a magical cure for spinal injury, the study is important in that it has stimulated the initiation of similar studies.

Peripheral nerve injuries remain a neglected area in neurotrauma. While surgical techniques and intraoperative neurophysiological monitoring are being developed, basic scientific studies of neurotrauma have been limited.

The greatest progress will occur when teams of basic scientists work in collaboration with experienced clinicians dedicated to clinical research in head injury. This concept has been supported in theory by the National Institutes of Health, in the form of program projects. However, only three program projects devoted to head injury research are currently funded in the entire Nation. We believe that the program project concept is sound and that it generally helps attract high-quality basic scientists into what is otherwise considered a "clinical" field. The problem of head injury was considered to be so important that in February 1989, the Interagency Head Injury Task Force which had been assembled in response to a Congressional request, advocated a national strategy for dealing with traumatic brain injury. The task force recommended a broad approach to head injury that transcends the issues of acute care treatment. The task force emphasized the need to elucidate the biomechanics of brain injury, improve public health surveillance of this condition, develop and implement prevention programs, and enlarge the capacity of postacute clinical care and rehabilitation facilities. Here, we identify areas of acute care of neurotrauma that are most likely to be productive in the next decade; the remainder of this section is divided into three segments, dealing with head, spinal, and peripheral nerve injuries.

Specific Objectives — Head Injury

Facilitate Drug Trials

After two decades of primarily epidemiological and descriptive studies, the field of head injury has entered an exciting phase in which the results of laboratory studies have been used to identify several potentially useful drugs for clinical testing. These include free-radical scavengers, steroid analogs, calcium channel-blockers, and various receptor agonists and antagonists. Since most drugs work better when given soon after the injury, we need to develop and support a national consensus on deferred consent for the treatment of such devastating conditions as severe head injury. To facilitate rapid testing of new drugs, we need to develop a network of centers that treat a high volume of patients with head injuries

and that have investigators dedicated to neurotrauma research. Since at least 3-5 years are needed for the initiation and completion of a multicenter phase III drug study, the simultaneous testing of different agents by different groups should be encouraged so as to rapidly bring various therapies into clinical use. Given the multiple pathogenic mechanisms involved in head injury, no single drug is likely to be the panacea for this condition, and the treatment of patients with head injuries will require a combination of several agents, each directed at a different pathological process.

Improve Methods of Reducing Brain Swelling

The pathophysiology of brain swelling is beginning to be better understood, but its biomechanics and causation are not. We now recognize that all brain swelling is not secondary to edema and that cerebral hyperemia is a substantial cause of the problem in many patients. The improved treatment of brain swelling depends on a better understanding of the mechanisms involved and on the development of drugs and interventions specifically aimed at these etiologies. The agents now available for treating brain swelling are very limited and not fully successful. Developing better agents that reduce brain swelling and intracranial pressure should be a high priority during the next decade.

Study the Effects of Cerebrovascular Abnormalities

There is increasing recognition that cerebrovascular abnormalities are a major contributor to the pathophysiology of traumatic brain injury. Researchers and clinicians have long recognized that the regulation of cerebral blood vessels is paralyzed among patients with head injuries. This can result in malignant brain swelling, increased intracranial pressure, reduced perfusion, and consequent ischemic brain damage. There also is evidence that head injury results in abnormalities of the blood brain barrier, with increased brain edema. The effect of vasospasm among patients with head injuries has also been recognized in recent years. We need to conduct studies aimed at clarifying these problems and to institute therapies intended to correct them. The development of measures of vascular reactivity also should be encouraged. However, the more immediate emphasis should be on studies of ways to tailor therapies for patients with head injuries on the basis of blood flow abnormalities present in a given patient.

Improve Intracranial Pressure (ICP) Monitoring Techniques

During the last decade, the use of intracranial pressure (ICP) monitoring in the management of severe head injury has become widely accepted. Most major head injury centers now use the technology routinely. Issues that need to be further defined include the criteria used to select patients for monitoring; the development of better monitoring techniques (including noninvasive methods) need to be developed, as do waveform analyses with which to determine the state of intracranial pressure compensation.

Conduct Metabolic Studies

Although researchers and clinicians have long recognized the existence of significant abnormalities in brain metabolism following CNS trauma, the technology available for effective study of this problem has been limited. In recent years, techniques such as positron emission tomography (PET) scanning, single photon emission computed tomography (SPECT) scanning, magnetic resonance spectroscopy, and various biochemical assays for cerebral metabolites have become available. These techniques are unlikely to be widely used because of their cost and the level of technical sophistication required. However, they could be valuable tools in physiological interventions and could provide the basis for larger clinical studies.

Study the Effects of Brain Nutrition

High glucose levels can have a deleterious effect on the recovery of patients with brain injuries. The roles of normal glucose protocols and alternative nutritional substrates such as amino acids and free fatty acids need to be further examined.

Study Methods of Detecting Morphological Abnormalities

Computed tomography (CT) scanning remains the basic means of evaluating patients with head injuries. Although magnetic resonance imaging (MRI) has been used in later stages of assessment and has been shown to be very sensitive in detecting morphological abnormalities in the brain, its application has not been fully exploited. With further refinements, MRI probably can provide greater insight into cerebral blood flow and metabolism. Furthermore, MR angiography will be a useful screening method for vasospasm, carotid dissections, and other vascular abnormalities that can worsen the outcome of patients with head injuries.

Determine the Best Methods of Managing Contusions

The management of cerebral contusions remains problematic despite their high frequency. Patients with contusions clearly demonstrate both morphological and clinical deterioration for several days following the initial injury. Interventions that can limit or reverse this progression as well as prevent delayed traumatic intracerebral hemorrhages would benefit many patients.

Develop Treatments for Cranial Nerve Injuries

Several types of cranial nerve injury may occur among patients with head injuries. These include optic nerve contusions, third, fourth, and sixth nerve palsies, facial palsies, and eighth nerve or inner ear injuries resulting in dizziness. Therapies aimed at treating these problems need to be developed.

Determine the Effects of Central Nervous System Stimulants

Although a few reports indicate that certain stimulant drugs (such as methylphenidate and amphetamines) can stimulate recovery from coma or augment certain cognitive functions such as memory, the medications have not been subjected to rigorous testing. Research is necessary for determining treatments that will prevent long-term sequelae of brain dysfunction, especially when the treatments are given during the acute management phase of health care.

Study General Management Issues

Numerous general patient management issues relating to head injury have never been subjected to rigorous scientific examination. Some of these — such as guidelines for admitting patients with minor head injury to the hospital — are not so much scientific questions as economic or legal ones. Similar issues include defining brain death and determining the effects of alcohol and drugs on the neurologic examination. Other, more scientific issues include the basis for immunologic suppression among patients with head injuries who require long-term care, coagulopathies resulting from or associated with head trauma, the effect of head position on intracranial pressure, and fluid and electrolyte management of patients with head injuries. Other supportive therapies, such as kinetic therapy (use of an automatic turning bed that ensures frequent change of patient position), also need to be studied further.

Increase the Level of Basic Research

Basic research in neurotrauma needs to be emphasized. Only from the further understanding of basic pathogenic mechanisms can new therapies become available. The pathologic conditions seen in humans must be produced in more realistic animate models by more realistic mechanical methods than are currently available. Basic and clinical scientists must communicate and interact with each other, which would be possible in a program project format.

Specific Objectives — Spinal Cord Injury

Conduct Drug Trials

The recent NASCIS II results demonstrated that high doses of methylprednisolone given within the first 8 hours after spinal cord injury result in a significant improvement in neurological function. Although these results created a great deal of excitement in the lay press and among professionals in the field, the effect of this drug was actually relatively small. While not discounting its value, we must stress that the NASCIS study was just a beginning to the process of finding an effective treatment for spinal cord injury. Although spinal cords that have been completely severed are probably nonsalvageable, most cord injuries are contusions that worsen during the first several hours after the injury. Patients with such contusions are most likely to benefit from drug therapies. The establishment of collaborative centers where newly available drugs can be tested deserves a high priority.

Study Spine Stabilization Techniques

Because the indications for surgical spine stabilization remain controversial, the relative advantages of spinal fusion versus external immobilization with devices such as the halo must be studied. Furthermore, the risks and benefits of the various spinal fusion systems need to be ascertained.

Study Methods of Ventilatory Support Among Patients with Spinal Cord Injuries

This is a major issue, especially with high quadriplegics. With better prehospital care now available in most major communities, the high cervical quadriplegic patient is more likely to survive the initial injury and make it into a hospital. Since such a person seldom recovers spontaneous respiratory function, life-long ventilatory support usually is required. Currently available alternatives to life-long ventilatory dependence, such as diaphragmatic pacing, are expensive, unreliable, and applicable only to a fraction of such patients. Improved methods of ventilatory support for such patients would be a valuable advance.

Study Intrathecal Therapies

The use of effective intrathecal agents to reduce spasticity among patients with spinal cord injury who have failed all other therapies has been an exciting development and should be pursued.

Study Therapies for Syringomyelia

Posttraumatic syringomyelia is a relatively common sequela of spinal cord injury. The pathophysiology of this condition is poorly understood, and there is lack of consensus on its optimal treatment. Newer surgical and medical therapies for this problem need to be considered.

Specific Objectives — Peripheral Nerve Injuries

Develop Guidelines for the Indications and Timing of Surgery

The treatment of peripheral nerve injuries has remained an area of considerable controversy. Because such injuries are relatively uncommon among civilians, they have received much less attention than head and spinal cord injuries. Further studies are needed to more clearly define if and when surgery is needed and what type of surgery is needed.

Develop and Test Drug Therapies

We need to develop nerve growth factors that stimulate nerve regeneration and repair. Once such factors become available, their testing should be encouraged.

Provide More Patients with Better Means of Intraoperative Stimulation

Very few centers are set up to perform intraoperative stimulation of nerves as an adjunct to peripheral nerve surgery. More centers of this type are needed.

Burn Injury

Introduction

About two million burn injuries occur in the United States each year. Over 100,000 are severe enough to require hospitalization and about 7,500 deaths each year can be directly attributed to burn- and fire-related causes (40).

Burn injury is a complex and devastating body insult, and treating patients with burn injuries consumes immense medical and financial resources. Mortality and morbidity rates are high for patients with massive burns and for those with burns combined with smoke inhalation injury, especially among the pediatric and geriatric patient populations. Morbidity rates, however, are high even for those with small burns, with many of these patients suffering temporary disability, as well as long-term dysfunction caused by scarring.

With current treatment approaches, huge resources are required to minimize mortality and improve the function of patients with burn injuries. These approaches focus on aggressively supporting the body functions of the patient while rapidly removing the burned tissue. The burned person's response to the skin or lung burn (i.e., inflammation) appears to be largely responsible for early cardiorespiratory problems, sepsis and organ failure, and later scar formation and musculoskeletal dysfunction. The entire body reacts intensely to the local skin burn. In the near future, we expect marked improvements in treatment in several key areas. We anticipate the availability of treatments that will substantially modify the body's reaction to the burn and improve the function of the skin replacing the burned skin.

Specific Objectives

Improve Our Knowledge of the Pathophysiology, Diagnosis, and Treatment of Lung Injury from Smoke Inhalation

Respiratory failure is now the leading cause of death among burn patients. Shortcomings in our understanding of the pathophysiology of lung injury among burn patients impede the development of early interventions that would prevent progression of the disease process. Current treatment is purely supportive. The need for and timing of positive pressure ventilation and methods to diminish the degree of lung inflammation merit further study.

Improve the Initial Fluid Resuscitation to Minimize Tissue Damage at the Local Burn Wound and the Distant, Nonburned Organs

Because our current monitors for resuscitation end points are not sensitive enough, impairment in the perfusion of nonburned organs can occur, despite fluid resuscitation that is adequate on the basis of information from available hemodynamic monitors. Since the early insult sets the stage for later organ failure and increases the depth of the initial burn injury, information on early care is essential if we are to prevent major complications.

Define the Role of Inflammatory Mediators in the Burn Tissue and in Distant Organs

It is becoming increasingly clear that the body's generalized inflammatory response to the skin burn increases the degree of injury. Modulators and blockers of inflammation are now becoming available for clinical use. We need basic information on the specific mediators involved and their time course, so that we can select the appropriate treatment agents and begin the necessary clinical trials.

Define the Immunologic Abnormalities That Make the Burn Patient Prone to Infection

The underlying mechanism of immune depression among burn patients is extremely complex, and continued research is needed to define it. Research in this area is particularly relevant since agents to correct or at least improve deficiencies in immune response can now be developed for clinical use.

Provide Better Pain Control to the Burn Patient

Uncontrolled pain is a major unsolved clinical problem. To solve it, we need a reliable tool for quantifying pain and more clinical research into pain control. At present, clinical assessment is subjective, and the most common method of pain management, the administration of narcotics, results in significant morbidity due to suppression of respiratory drive.

Define the Mechanism of Hypermetabolism Among Burn Patients and the Appropriate Nutritional Support Regimens

The pathophysiologic mechanism of the inflammation-induced hypermetabolic state needs to be defined more precisely, since this process leads to rapid weight loss and high risk of infection. Appropriate nutritional support depends on our improved knowledge of nutrient requirements and utilization. We need to define the role that agents such as growth hormone and glutamine play in the nutritional support of burn patients.

Define the Mechanism of Wound Healing, Including Scar Formation and its Modification

Much of the management of burn wounds focuses on initial healing, followed by the control of scarring with compression dressing and reconstruction. Wound-healing factors to increase the healing rate are now available, but the specific indications and the optimal method of delivery to the wound have yet to be determined. In addition, scarring is the

major cosmetic defect and the cause of the most serious functional defects after healing. A nonsurgical approach to scar control will only be developed through extensive basic research.

Develop Better Skin Substitutes

Wound closure with temporary skin covers has been a major advance, but further improvements are necessary. The use of permanent skin substitutes remains limited because of problems in skin quality, quality control, and production.

Musculoskeletal Injuries

Introduction

Musculoskeletal injuries are very common. Although most are minor, recovery may be prolonged, and many such injuries result in permanent disability. Rarely fatal by themselves, fractures and dislocations increase the mortality rate of patients with multiple injuries and contribute enormous costs (estimated to be more than $30 billion per year). As much as 43% of the total direct cost of care delivered in trauma centers is incurred by patients whose principal injury involves an extremity (41). The outcome of skeletal injuries may not be clear for some time, since recovery often requires a year or more; posttraumatic arthritis, a frequent sequela of severe joint injuries, may take years to appear. The lengthy delay before results are established makes evaluating the efficacy of acute care for musculoskeletal injuries difficult, though results from recent studies have shown that immediate surgical fracture fixation decreases overall morbidity and mortality and results in remarkable functional recovery.

Specific Objectives

Improve the Diagnostic Classification System for Fractures

The multiplicity of skeletal injuries and the severity span represented by a single *International Classification of Diseases, Ninth Revision* (ICD9) diagnosis interfere with communication and comprehension. A fracture of the tibia may be so trivial that it only briefly interrupts work or school, or it may be so severe that amputation is the best treatment (42). The lack of a standard severity scale for most musculoskeletal injuries, particularly one that incorporates the severity of associated soft tissue damage, impedes research into those injuries.

Improve Outcome Scales for Functional and Anatomic Results of Skeletal Injury

Most studies of musculoskeletal injuries have focused on a few aspects: fracture union, radiographic appearance, or avoidance of certain well-defined complications. Comparatively little attention has been paid to the patient's pain, economic loss, sense of well-being, quality of life, ability to return to prior activity, and overall satisfaction with treatment (43).

Define the Outcome for Specific Skeletal Injuries

Although several accepted treatments exist for most skeletal injuries, ranging from nonoperative techniques to open reduction and internal fixation, we need to study alternative protocols for managing significant injuries. We need to define comprehensive management strategies for patients with multiple injuries, and we need to conduct fundamental research into the interrelationships between skeletal injuries and injuries of other systems (44, 45).

Define Optimal Management of Spinal Fractures

Fractures and dislocations of the spine create major disability, due not only to spinal cord injury, but also to instability, pain, and deformity. The need for centralized treatment, the optimal timing for spine stabilization, and the relative indications for most surgical techniques remain to be established.

Determine Optimal Management of Pelvic Ring Fractures

Pelvic fractures are life-threatening and pose long-term disability risks. To better treat patients with pelvic fractures, we need to conduct multicenter prospective studies of the optimal method of controlling acute bleeding and stabilizing the patient. The relative advantages of centralized versus decentralized care for acetabular and other relatively rare and complex fractures should also be studied.

Define the Process of Joint Healing to Discover Ways to Reduce Posttraumatic Arthritis

Patients with major joint injuries risk disability because of changes in joint structure and function. Studies of pathophysiology and treatment are essential. Outcome studies must continue for many years, since posttraumatic arthritis often develops slowly.

Improve the Treatment of Peripheral Nerve and Muscle-Tendon Injuries

Injuries of peripheral nerves and muscle-tendon units may be significantly and permanently disabling. Wound-healing modulation, advances in nerve repair biology, and alternative techniques to restore function deserve prospective comparative trials, as well as further basic science studies.

Develop Methods to Prevent Atrophy of Unused Muscles and Fibrosis of Joints During Immobilization

Atrophy and fibrosis are common, disabling complications. Drug therapies to prevent and treat such "fracture diseases" are needed.

Clarify the Potential Role of Growth Factors and Other Inflammatory Mediators in Fracture Healing

Encouraging prospects exist for the use of biologic mediators to reduce inflammatory responses and for the use of growth factors to stimulate the healing of musculoskeletal

tissues. Most fractures heal uneventfully, but each year thousands of patients with fractures develop disabling nonunions. Basic fracture-healing mechanisms and the means for stimulating bone union (growth factors and electrical or mechanical stimulation) need further study. We also need well-designed clinical studies of the efficacy and indications for particular treatments.

Improved Bone Grafting Techniques

Autogenous bone grafts are commonly used to replace lost bone or to stimulate healing. Cadaver allografts are a less satisfactory alternative. Further studies are needed in the following areas: the indications and timing of bone grafting, biological and nonbiological substitutes for autogenous bone grafts, the use of autologous bone marrow, and the role of growth factors.

Define the Role of Traction Osteogenesis

Traction osteogenesis (the Ilizarov technique) results in new bone and is clinically effective in correcting bone defects and deformity (46). This phenomenon needs further basic and clinical study.

Develop and Improve Methods for Preventing and Treating Osteoporosis

Osteoporosis, common in older women, predisposes them to fractures that are often difficult to treat. The prevention or reversal of osteoporosis would eliminate thousands of fractures each year. The optimal management of osteoporotic hip fractures must be defined, since they account for more than 50% of the days that patients spend in the hospital with any kind of fracture, and the frequency of such hip fractures continues to increase.

Ocular Trauma

Introduction

Each year, ocular injuries in the United States cause at least 500,000 years of lost eyesight, and people less than 30 years of age are at the highest risk of eye injury (United States Eye Injury Registry, unpublished data, 1991). An estimated 2.4 million Americans sustain eye injuries annually, and nearly 1 million Americans currently have permanent visual loss as a result of ocular trauma (47). Eye injury is the leading cause of monocular blindness in the United States and is second only to cataracts as the most common cause of visual impairment (48).

Penetrating ocular injuries and globe ruptures secondary to blunt trauma remain the most severe types of conditions to manage because of the gravity of the intraocular damage.

Although operative techniques have improved, in many cases such severely damaged eyes cannot be saved. Research is needed to further improve the functional outcome of severely traumatized eyes.

Eyes with chemical or thermal burns require proper and immediate care to prevent serious permanent damage. Emergency department personnel must recognize the severity of the eye injury and be able to render the care necessary to reduce the permanent sequelae. If possible, they should provide emergency eye care in conjunction with an ophthalmologist.

Specific Objectives

Improve the Triage of Multiply Injured Patients with Eye Injuries

The trauma team is, of course, most concerned with stabilization and definitive treatment of life-threatening injuries. However, delays or inappropriate care of ocular trauma can lead to intraocular tissue extrusion, tissue traction, infection, iatrogenic injury, or other complications that can cause permanent visual disability. Timely integration of the ophthalmologist into the trauma team and the education of nonophthalmic personnel will improve eye injury triage of the multiply-injured patient.

Develop an Ocular Trauma Scoring System

An ocular trauma scoring system is needed for rapid clinical assessment and characterization of the severity and prognosis of ocular injuries. Such a system also would facilitate studies of the efficacy and optimal timing of medical and surgical interventions used in the treatment of ocular trauma.

Determine the Optimal Timing and Techniques for Ocular Reconstruction

By using "closed globe" techniques, ophthalmologists can begin reconstructing injured intraocular tissue at any time after closing the primary wound. For some intraocular injuries, the extent to which reconstructive surgery should be performed at the time of initial wound closure remains undefined. Research also is needed to define the optimal timing and technique of secondary "closed globe" interventions.

Determine the Optimal Use of Early Vitrectomy

The use of vitrectomy as an early intervention in severe ocular trauma has shown great promise in repairing retinal damage (49). Additional study of early vitrectomy is needed to determine the most appropriate timing for the use of vitrectomy as an intervention.

Evaluate the Role of the Temporary Keratoprosthesis in Reconstructing Combined Anterior-Posterior Segment Eye Injury

Temporary keratoprosthesis (TKP) is a device that may be used to provide temporary surgical visualization of the posterior segment of the injured eye, supplementing indirect

diagnostic testing and external examination. The use of TKP takes on great therapeutic importance when coupled with recently developed techniques to reattach the retina even after severe damage to the anterior segment of the eye. Underutilization of TKP in the management of these injuries may lead to irreversible scarring or to otherwise avoidable enucleation (Witherspoon CD, Morris R, Phillips RL. Temporary keratoprosthesis vitrectomy in severe ocular trauma. Presentation at American Academy of Ophthalmology Annual Meeting, Las Vegas, Nevada, 1988). Studies are needed to define the criteria for referring patients with combined anterior-posterior segment eye injuries to specialized centers that have the capability to use TKP.

Develop Methods to Prevent Postsurgical Scarring (Proliferative Vitreoretinopathy)

The formation of proliferative scar tissue (proliferative vitreoretinopathy) is a major postsurgical complication that can lead to traction retinal detachment. Pharmacologic and surgical techniques are needed to control or reduce this destructive cellular proliferation within the eye.

Improve Anterior Segment Reconstruction

Ocular injuries often are confined to the anterior segment of the eye. Improved methods of reconstructing the anterior segment by using alternative wound closure techniques should be developed, particularly for injuries involving pseudophakic or previous kerato-refractive surgery.

General Recommendations

- Develop a broader constituency for injury control and seek to develop public support for the effort.
- Promote a "think tank" type of study by professionals from diverse disciplines to evaluate reasons why injury control has not developed wider public support and suggest ways in which this support can be generated.
- Increase the awareness of groups that are disproportionately affected by trauma, such as the pediatric and geriatric populations.
- Implement trauma systems in all states so that known therapeutic interventions can be applied effectively to the whole population.
- Develop broadly based studies of the impact of trauma care systems in reducing the impact of injury, and document the cost-effectiveness of trauma care systems.
- Devote increased educational time to the problems of injury in training programs for all types of health-care professionals.
- Attempt to develop peer group pressures related to avoiding high-risk behaviors.
- Prioritize the research objectives outlined in this document on the basis of the number of people affected, the mortality and morbidity caused, and the likelihood of success in reducing or avoiding mortality and morbidity.
- Develop more target-oriented research objectives in order to apply the limited funding in the most effective way.
- Standardize the training of prehospital personnel in all states so that they learn the best known techniques of resuscitation and treatment.
- Accelerate basic science investigations into the inflammatory, immunologic, metabolic, and hemodynamic responses to traumatic injury.
- Identify improved methods of injury severity scoring and clinical outcome prediction, including methods that are applicable to pediatric trauma care, neurotrauma care, burn care, orthopedic care, and ocular trauma care.
- Test and implement techniques for diagnosis and monitoring that provide real-time assessment of tissue perfusion and oxygenation.
- Conduct studies to further define the role of resuscitative measures in the prehospital phase of acute care.
- Formulate more precise and objective trauma treatment guidelines for use in the emergency department phase of care, including guidelines for early intubation and ventilation of patients.

- Conduct clinical trials of pharmacologic agents used to treat acute sequelae of traumatic injury, including agents to block deleterious inflammatory mediators.
- Evaluate new and emerging treatment modalities, such as initiating nutritional support of patients within 48 hours of their traumatic injuries.
- Establish alternative methods of providing intensive care services to trauma patients, such as regionalizing special care units in selected hospitals.
- Further study and develop interventions that address the psychosocial impact of traumatic injury on patients and their families.

Specific Recommendations

Prehospital Care/Emergency Department Care

- Conduct studies to identify improved methods of monitoring trauma patients' respiratory function and other physiologic parameters during the prehospital phase.
- Further evaluate the tradeoffs between potential improvements in patient outcome as a result of prehospital interventions (such as volume infusion by conventional means) versus the time required for these interventions to be implemented prior to the patient's arrival at the hospital.
- Develop safer and more effective methods of stabilizing trauma patients' vital functions, including improved methods of establishing or maintaining an airway for patients with unstable cervical spine fractures.
- Identify improved techniques for monitoring trauma patients in the emergency department, focusing on tissue perfusion and oxygenation of the brain and other vital organs.
- Formulate more precise and objective trauma treatment guidelines, such as guidelines for early intubation and ventilation of patients in the emergency department.
- Conduct studies to determine the optimal fluid(s) and delivery system(s) for initial trauma care resuscitation.

Definitive Care

- Develop methods for quantifying postinjury blood loss that provide more timely and accurate data than conventional clinical tools such as blood pressure measurement.
- Evaluate new and emerging treatment modalities, such as minimizing preoperative fluid resuscitation among selected trauma patients, initiating nutritional support of patients within 48 hours of their injuries, and using newer thrombolytic agents for posttraumatic respiratory failure.

- Identify improved methods and pharmacologic agents to control bleeding following traumatic injuries, including hemorrhage that results from liver or spleen injuries or pelvic fractures.
- Conduct basic and applied research of physiologic derangements, such as hypothermia, that complicate definitive care.

Intensive Care

- Investigate objective methods to identify which trauma patients need intensive care and to predict outcomes of intensive care.
- Establish alternative methods of providing intensive care services for trauma patients, such as intermediate care units and regionalized special care units in selected hospitals.
- Develop improved invasive and noninvasive monitoring devices to track physiological parameters affected by traumatic injury, including metabolic function at the cellular level.
- Conduct research and develop programs that address the psychosocial needs of trauma patients in intensive care units and their families.

Complications/Morbidity

- Identify more sensitive and specific markers of alterations in cellular metabolic function that precede posttraumatic organ failure.
- Further clarify the risks and benefits of the invasive monitoring of critically ill trauma patients.
- Study the mechanism, means of detection, and modification of adverse inflammatory responses and immunosuppression that follow traumatic injury.

Pediatric Trauma Care

- Analyze childhood-specific neuroendocrine, metabolic, immunologic, and inflammatory responses to injury.
- Conduct research to determine the optimal methods of treating children who have sustained major traumatic injuries, including brain injury, burns, chest and abdominal organ injuries, long bone fractures, and eye injuries.
- Study the psychosocial impact of traumatic injury on pediatric patients and their families, and identify interventions that ease the burden of chronic disabilities.

Neurotrauma

- Emphasize basic research in neurotrauma, such as studies to clarify the role of altered cerebral blood flow and metabolism in patients with brain injuries.
- Develop better diagnostic and monitoring techniques, including noninvasive methods, for use in neurotrauma care.

- Conduct multicenter clinical trials of pharmacologic agents used to treat the acute sequelae of head and spinal cord trauma.
- Identify optimal therapeutic approaches to neurotraumatic injuries for which management remains controversial or unclear, including cerebral contusions, unstable cervical spine fractures, and peripheral nerve injuries.

Burn Injury

- Continue to investigate the respiratory, hemodynamic, metabolic, inflammatory, and immunologic response to smoke inhalation and burn injury.
- Develop improved methods for monitoring the resuscitation of patients with burn injuries, including methods to optimize initial fluid management.
- Conduct basic and clinical research into wound healing, factors to promote healing, and artificial skin substitutes.

Musculoskeletal Injuries

- Develop improved systems with which to rate the severity of musculoskeletal injuries and the functional and anatomic results of therapy.
- Conduct basic and applied research into fracture healing and techniques to improve outcomes, such as traction osteogenesis.
- Conduct clinical studies to define the optimal management of spinal injuries, pelvic ring fractures, and other significant musculoskeletal injuries for which alternative treatment protocols exist.

Ocular Trauma Care

- Develop improved triage of multiply injured patients with eye injuries to avoid preventable sight loss due to delayed or inappropriate eye care.
- Develop an ocular trauma scoring system to improve prognostication and communication of the severity of eye injury as well as to guide the employment and timing of optimal treatment.
- Develop new surgical and pharmacological interventions to reduce the risk of postoperative proliferative vitroretinopathy and to improve the functional outcome of reconstructive procedures.

References

1. Jacobs LM, Sinclair A, Beiser A, D'Agostino RB. Prehospital advanced life support: benefits in trauma. J Trauma 1984;24(1):8-13.

2. MacLeod BA, Seaberg DC, Paris PM. Prehospital therapy past, present, and future. Emerg Med Clin North Am 1990;80:57-74.

3. Trunkey DD. Trauma. Sci Am 1983; 249(2):28-35.

4. Gold CR. Prehospital advanced life support vs. "scoop and run" in trauma management. Ann Emerg Med 1987;16(7):797-801.

5. Kaweski SM, Sise MJ, Virgilio RW. The effect of prehospital fluids on survival in trauma patients. J Trauma 1990;30(10):1215-9.

6. Bickell WH, Shaftan GW, Mattox KL. Intravenous fluid administration and uncontrolled hemorrhage. J Trauma 1989;29(3):L409.

7. Ericcson CD, Fisscher RP, Rowlands BJ, Hunt C, Miller-Crotchett P, Reed L. Prophylactic antibiotics in trauma: the hazards of underdosing. J Trauma 1989;29(10):1356.

8. Anderson IWR, Black RJ, Ledingham IMA, Little K, Robertson LE, Urquhart JD. Early emergency care study: the potential and benefits of advanced prehospital care. BMJ 1987;294:228-31.

9. Birnbaum ML. Cost-containment in critical care. Crit Care Med 1986; 14(12):1068-77.

10. Madoff RD, Sharpe SM, Fath JJ, Simmons RL, Cerra FB. Prolonged surgical intensive care. Arch Surg 1985; 120:698-702.

11. Demling RH. Surgical patients in the ICU: administrative issues. In: Wilmore DW, Brennan MF, Harken AH, Holcroft JW, Meakins JL, editors, American College of Surgeons Care of the Surgical Patient, Volume 2, X-Organizational Issues. New York: Scientific American, Inc., 1990: 1-13.

12. Strauss MJ, LoGerfo JP, Yeltatzie JA, Temkin N, Hudson LD. Rationing of intensive care unit services. JAMA 1986; 255(9):1143-6.

13. Singer DE, Carr PL, Mulley AG, Thibault GE. Rationing intensive care — physician responses to a resource shortage. N Engl J Med 1983; 309(19):1155-9.

14. Civetta JM, Hudson-Civetta JA. Maintaining quality of care while reducing charges in the ICU: ten ways. Ann Surg 1985; 202(4):524-32.

15. Saliterman SS. A computerized simulator for critical-care training: new technology for medical education. Mayo Clin Proc 1990; 65:968-78.

16. Gann DS, Carlson DE, Byrnes GJ, Pirkle JC, Allen-Rowlands CF. Impaired restitution of blood volume after large hemorrhage. J Trauma 1981;21(8):598-603.

17. Edwards JD. Practical application of oxygen transport principles. Crit Care Med 1990;18(1):S45-8.

18. Corbally MT, Brennan MF. Noninvasive measurement of regional blood flow in man. Am J Surg 1990;160:313-21.

19. Piantadosi CA, Hemstreet TM, Jobsis-Vandervliet FF. Near-infrared spectrophotometric monitoring of oxygen distribution to intact brain and skeletal muscle tissues. Crit Care Med 1986;14(8):698-706.

20. Mann S, Westenskow DR, Houtchens BA. Measured and predicted caloric expenditure in the acutely ill. Crit Care Med 1985;13(3):173-7.

21. Damask MC, Askanazi J, Weissman C, Elwyn DH, Kinney JM. Artifacts in measurement of resting energy expenditure. Crit Care Med 1983;11(9):750-2.

22. Makita K, Nunn JF, Royson B. Evaluation of metabolic measuring instruments for use in critically ill patients. Crit Care Med 1990;18(6):638-44.

23. Nelson LD, Anderson HB, Garcia H. Clinical validation of a new metabolic monitor suitable for use in critcally ill patients. Crit Care Med 1987;15(10):951-7.

24. Shapiro BA, Cane RD. Blood gas monitoring: yesterday, today, and tomorrow. Crit Care Med 1989; 17(6):573-81.

25. Donovan KD, Dobb GJ, Woods WPD, Hockings BE. Comparison of transthoracic electrical impedance and thermodilution methods for measuring cardiac output. Crit Care Med 1986;14(12):1038-44.

26. Sramek BB. The impact on diagnosis and therapy of computerized integration, processing and display of noninvasive hemodynamic and cardiodynamic parameters. Intensive Care World 1989;6(4):205-11.

27. Eberhart RC, Weigelt JA. New chemical sensing techniques for critical care medicine. In: Shoemaker WC, Ayres S, Grenvik A, Holbrook PR, Thompson WL eds., Textbook of Critical Care. Philadelphia: WB Saunders, 1989;223-30.

28. Chernow B. The bedside laboratory: a critical step forward in ICU care. Chest (Suppl) 1990; 97(5)183S-4S.

29. Office of Medical Applications of Research, National Institutes of Health. Prevention of venous thrombosis and pulmonary embolism, consensus conference. JAMA 1986;256:744-9.

30. Rice DP, MacKenzie EJ and Associates. Cost of injury in the United States. San Francisco, CA: Institute for Health and Aging, University of California and Injury Prevention Center, The Johns Hopkins University, 1989.

31. Pecklet MH, Newman KD, Eichelberger MR, Gotschall CS, Garcia VF, Bowman LM. Thoracic trauma — an indicator of increased mortality in children. J Pediatr Surg 1990; 25:961-6, 1990.

32. Pecklet MH, Newman KD, Eichelberger MR, Gotschall CS, Guzzetta PC, Anderson KD et al. Patterns of injury in children. J Pediatr Surg 1990; 25:85-91.

33. Eichelberger MR, Mangubat EH, Sacco WS, Bowman LM, Lowenstein AD. Outcome analysis of blunt trauma in children. J Trauma 1988; 28:1109-17.

34. Tepas JJ, Ramenofksy MI, Molitt DL, Gans BM, DiScala C. The pediatric trauma score as a predictor of injury severity: an objective assessment. J Trauma 1988; 28:425-9.

35. Pollack MM, Ruttimann UE, Getson PR. Pediatric risk of mortality (PRISM) score. Crit Care Med 1988;16:1110-6.

36. Sivit CJ, Taylor GA, Eichelberger MR. Chest injury in children with blunt trauma: evaluation with CT. Radiology 1989; 171:815-8.

37. Taylor GH, Fallet ME, Potter BM, Eichelberger MR. The role of computed tomography in blunt abdominal trauma in children. J Trauma 1988; 28:1660-4.

38. Brick SH, Taylor GA, Potter BM, Eichelberger MR. Hepatic and splenic injury in children: role of CT in the decision for laparotomy. Radiology 1987; 165:643-6.

39. National Institute of Neurological Disorders and Stroke. Interagency Head Injury Task Force Report. Bethesda, MD; National Institute of Health, 1989.

40. Demling RH, LaLonde C. Burn trauma. New York, NY: Thieme Medical Publishers, 1989.

41. MacKenzie EJ, Shapiro S, Siegel JH. The economic impact of traumatic injuries: one-year treatment-related expenditures. JAMA 1988;260:3290-6.

42. Hansen ST, Jr. The type IIIC tibial fracture: salvage or amputation [editorial]. J Bone Joint Surg [Am] 1987;69:799-800.

43. Gartland JJ. Orthopaedic clinical research: deficiencies in experimental design and dissemination of outcome. J Bone Joint Surg [Am] 1988;70:1357-64.

44. Border JR, Algower M, Hansen ST, Jr., Ruedi TP. Blunt multiple trauma. Comprehensive pathophysiology and care. New York and Basel, Switzerland: Marcel Dekker, Inc., 1990.

45. Phillips TF, Contreras DM. Timing of operative treatment of fractures in patients who have multiple injuries. J Bone Joint Surg [Am] 1990;72:784-8.

46. Paley D, Catagni MA, Argnani F, Villa A, Benedetti GB, Cattaneo R. Ilizarov treatment of tibial nonunions with bone loss. Clin Orthop 1989;241:146-65.

47. Glynn RJ, Seddon JM, Berlin BM. The incidence of eye injuries in New England adults. Arch Ophthalmol 1988;106:785-9.

48. Karlson TA, Klein BE. The incidence of acute hospital-treated eye injuries. Arch Ophthalmol 1986;104:1473-6.

49. Sternberg P, Amberg TM. The persistent challenge of ocular trauma. Am J Ophthalmol 1989;107:421-3.

Glossary of Terms

Glossary of Terms

acetabular fracture - fracture of the hip socket

adult respiratory distress syndrome (ARDS) - a life-threatening pulmonary complication of trauma, burns, and critical illness characterized by severe shortness of breath, low levels of oxygen in the blood, decreased elasticity of lung tissue, and accumulation of fluid, protein, and cells in the air sacs of the lungs

air embolism - a bubble of air that travels through the bloodstream and eventually lodges in a blood vessel, obstructing blood flow and leading to tissue damage

amblyopia - visual impairment of one or both eyes, without detectable organic disease, often caused by visual deprivation in early childhood

angiography - an x-ray technique for visualizing blood vessels that is usually used for diagnostic purposes but is sometimes used in therapeutic interventions to control internal bleeding

anterior segment - anatomic front third of the eyeball, including the cornea, anterior chamber, iris, and lens

autogenous bone graft - a bone graft obtained from the patient's own bone, often the pelvis

autotransfusion - the collection and reinfusion of a patient's own blood obtained from an active bleeding site

bacterial translocation - the movement of bacteria from within the gastrointestinal tract to the bloodstream, leading to widespread, bloodborne infection that often complicates the care of a multiply traumatized or burned patient

blood brain barrier - a selective mechanism opposing the passage of most ions and large-molecular compounds from the bloodstream to the brain

calcium channel blocker - a drug that inhibits the flow of calcium ions across cell membranes, causing a variety of effects including dilatation of cerebral arteries and arterioles and increased cerebral blood flow

cardiac contusion - a focal heart injury, occurring after blunt chest trauma, that can cause potentially lethal cardiac rhythm disturbances

catecholamine response - a physiologic reaction to stress in which key neurologic chemicals are released, leading to a wide variety of cardiovascular, metabolic, endocrinologic, and immunologic effects

cerebral contusion - a focal brain injury, often associated with a serious concussion, that may lead to secondary or delayed neurologic deterioration

cerebral swelling - a complication of head injury in which blood vessels in the brain increase in size, resulting in increased blood volume in the brain and placing the patient with head injuries at risk for further neurologic deterioration

coagulopathy - any disorder of blood coagulation

compartment syndrome - a condition, occurring most commonly after trauma to a limb, in which bleeding or swelling in a confined anatomic area obstructs blood flow to the area, jeopardizing healthy tissue

computed tomography (CT) - an x-ray technique in which anatomic information is gathered from a cross-sectional plane of the body and processed by computer for display

crystalloid - a substance that dissolves in solution and passes readily through cell membranes

cytokine - a general term for soluble products released by one cell that can alter the activity of other cells

deep vein thrombosis - a potentially life-threatening disorder in which a clot forms within a blood vessel

degloving injury - a tearing away of all or part of a hand or finger

digital subtraction angiography (DSA) - an x-ray technique in which data about the anatomy and function of blood vessels is obtained through computer subtraction of unnecessary background information and intensification of the image of the vessels

disseminated intravascular coagulation (DIC) - a type of life-threatening coagulopathy that can complicate severe injury or disease

enteral alimentation - administration of nutrients to a patient through a tube that has been inserted into the gastrointestinal tract

enterocyte - the type of cell that lines the inner wall of the gastrointestinal tract

epidural catheterization - introduction of an instrument for withdrawing fluids from or introducing fluids into the space outside the membranes covering the brain and spinal cord

external fixation - a method of holding together the fragments of a fractured bone by placing pins through the fragments and attaching an external frame to the pins outside the skin surface

extracorporeal membrane oxygenation (ECMO) - the use of an artificial membrane outside the body that provides oxygen to a patient's blood as it is filtered through the membrane

flail chest - a condition in which multiple rib fractures cause instability in part of the chest wall, disrupting the normal pattern of breathing

free radical scavenger - a drug that removes a type of toxin, known as a free radical, that is released following tissue injury

growth factor - a general term for a type of cytokine that affects the development and function of bone and other tissues

hemodynamic monitoring - ongoing measurement of cardiac activity, vascular pressures, blood flow, and the adequacy of tissue perfusion and oxygenation

hemostatic agent - a substance used to stop blood loss at a bleeding site

hypermetabolic state - an increase in metabolic rate as a consequence of burns or severe injury, characterized by increases in oxygen consumption, heat production, body temperature, and protein breakdown

hypertonic salt solution - a type of salt solution that, following intravenous administration to a patient, causes a net flow of water out of the cells bathed by the solution

Ilizarov technique - a method of treating traumatic and other bony deformities that combines external fixation, traction osteogenesis, and other interventions

immobilization - rendering an injured body part incapable of being moved for purposes of preventing further injury or treating a diagnosed injury

immunosuppression - interference with the body's capacity to mount an immunologic response to normally immunogenic stimuli

inflammatory response - the reaction of tissue to local injury, mediated by a variety of complex chemical and cellular actions that can also damage healthy tissue, thereby perpetuating and extending the inflammatory reaction

Injury Severity Score (ISS) - a widely used numerical descriptor of the overall severity of injury in persons who have sustained multiple injuries

internal fixation - an operative method of holding together fragments of fractured bone by directly attaching the fragments to one another with surgical wires, screws, pins, plates, or an adhesive substance

inotropic agent - a drug that increases the force of heart muscle contractions

intracranial pressure (ICP) - the pressure of the fluid that is present in the space between the skull and the brain

intraosseous infusion - administration of fluids or drugs to a patient through a needle that has been inserted into the bone marrow cavity of one of the patient's long bones, often the tibia (shin bone)

intrathecal agent - a drug injected into the fluid-filled space surrounding the brain and spinal cord

isotonic salt solution - a type of salt solution which, following intravenous administration to a patient, does not cause a net flow of water in or out of the cells bathed by the solution

ion-selective field-effective transistor (ISFET) - a chemical-sensing technology, suitable for use in devices that are placed temporarily in a patient's bloodstream to measure pH and other blood chemistries on an ongoing basis

kerato-refractive surgery - surgical procedure performed on the cornea (the transparent front wall of the eye that provides most of the eye's optical power) to improve optical function of the eye

lung fibrosis - a scarring of lung tissue that may occur following direct injury

lymphokine - a general term for mediators of the body's immune response that are not antibodies or complement components

macrophage - a carrier or scavenger cell capable of ingesting bacteria, foreign particles, and other cells

magnetic resonance imaging (MRI) - a diagnostic modality in which an external magnetic field is applied to the body and the resultant signals from hydrogen ions in body tissues are processed by computer to produce an image of soft tissue structures

maxillofacial injury - an injury to part or all of the jaws and face

microemboli - a microscopic blood clot that travels from one blood vessel to a smaller one, where the clot obstructs blood flow

multiple organ failure syndrome - a cumulative sequence of organ failures, most often initiated by adult respiratory distress syndrome (ARDS), that frequently complicates the care of severely traumatized or burned patients

National Acute Spinal Cord Injury Study (NASCIS) - a multicenter clinical trial that showed that patients with acute spinal cord injuries who are treated with a high dose of methylprednisolone have improved neurologic function

neuromuscular blocking agent - a drug that temporarily paralyzes skeletal muscle, often used to facilitate insertion of an artificial breathing device or to relax muscles before surgery

nosocomial infection - an infection, acquired by a patient during hospitalization, that was neither present nor incubating prior to the patient's hospital admission

orthotic device - an orthopedic appliance or apparatus used to support or align a moveable body part or to prevent or correct deformities that interfere with the function of a moveable body part

osmotic agent - a type of diuretic drug, widely used in treatment of severe brain injury, that shrinks the brain and lowers intracranial pressure

parenchymal - the functional tissue of an organ, as distinguished from the organ's supporting or connective tissue

Pediatric Risk of Mortality Score (PRISM) - a quantitative method of estimating mortality risk for pediatric patients admitted to intensive care units

Pediatric Trauma Score (PTS) - a triage tool for pediatric trauma patients consisting of the sum of six component scores

peritoneal cavity - the body space that contains the abdominal and pelvic organs

positive pressure ventilation - any technique in respiratory therapy in which compressed air or gas is delivered to respiratory passages at greater than ambient pressure

positron emission tomography (PET) - a tomographic imaging of local metabolic and physiologic functions in tissues, the image being formed by computer synthesis of data transmitted by positron-emitting radionuclides administered to the patient

posterior segment - anatomic rear two-thirds of the eyeball, including structures located behind the lens (vitreous gel, retina, and optic nerve)

prostanoid inhibitor - a drug that impedes synthesis of prostaglandins, naturally occurring chemicals that mediate some of the adverse inflammatory reactions to injury

pseudophakic - the condition of an eye from which the crystalline lens has been removed and replaced with a prosthetic intraocular lens

pulmonary contusion - a focal lung injury resulting from blunt chest trauma that disrupts lung tissue and severely compromises respiratory function

real-time monitoring - display of anatomic images or physiologic data simultaneous with the occurrence of the phenomena under observation

resuscitation - the process of restoring or stabilizing the vital functions of a person who has sustained a life-threatening injury

retroperitoneum - the body space containing the aorta, kidneys, and other structures that lie posterior to the abdominal-pelvic (peritoneal) cavity

sepsis - a life-threatening condition resulting from the spread of bacteria or their toxins through the blood stream or other body tissues

single photon emission computed tomography (SPECT) - tomographic imaging of local metabolic and physiologic function in tissues, the image being formed by computer synthesis of data transmitted by single gamma photons administered to the patient

synthetic colloid - an intravenous fluid consisting of a dextran, gelatin, or starch in solution, used to increase plasma volume

syringomyelia - a slowly progressive condition in which cavitation occurs in the central segments of the spinal cord causing neurologic deterioration

T-cell - a circulating cell that has several functions, but primarily mediates cellular immune responses

thrombolytic agent - a drug that dissolves clots in blood vessels

tissue ischemia - a deficiency of blood supply to a body organ or part

tissue oxygenation - the physiologic process of maintaining sufficient oxygen in cells

tissue perfusion - the physiologic process whereby the cardiovascular system delivers oxygen to the cells

traction osteogenesis - a technique of stimulating new bone formation to correct bone loss defects by surgically dividing one of the bone ends and applying an external pulling force to the existing skeletal structures

Trauma Score and Injury Severity Score (TRISS) - a quantitative method of estimating a trauma patients likelihood of survival on the basis of physiologic measurements (revised Trauma Score), an assessment of injury severity (Injury Severity Score), the mechanism of injury (blunt or penetrating), and the patient's age

veno-veno bypass - a procedure, used in liver transplantations and other surgical operations, in which blood is temporarily mechanically pumped from one vein to another, thus circumventing an organ, such as the liver, through which blood would normally flow

vitrectomy - an intraocular surgical procedure performed to remove opacified vitreous gel to restore intraocular clarity or to allow treatment of retinal pathology

Rehabilitation of Persons with Injuries

Rehabilitation of Persons with Injuries
— Contributors—

Theodore M. Cole, M.D., Chairperson, Department of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, MI

Frederick M. Maynard, M.D.,* Department of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, MI

Philip L. Graitcer, D.M.D., M.P.H., Executive Secretary, Division of Injury Control, National Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA

David F. Apple, Jr., M.D., Shepherd Spinal Center, Atlanta, GA

Kathleen H. Acree, M.D., California Department of Health Services, Sacramento, CA

James R. Boen, Ph.D., University of Minnesota School of Public Health, Minneapolis, MN

Catherine F. Bontke, M.D., Baylor College of Medicine, Houston, TX

John F. DiTunno, Jr., M.D., Thomas Jefferson University Hospital, Philadelphia, PA

Douglas A. Fenderson, Ph.D., Department of Family Practice and Community Health, University of Minnesota School of Public Health, Minneapolis, MN

Lawrence J. Fine, M.D., National Institute of Occupational Safety and Health, Centers for Disease Control, Cincinnati, OH

Philip R. Fine, Ph.D., University of Alabama, Birmingham, AL

Marcus J. Fuhrer, Ph.D., Baylor College of Medicine, Houston, TX

Dorothea D. Glass, M.D., Rehabilitation Medicine, Department of Veterans Affairs Medical Center, Miami, FL

William Graves, Ed.D., National Institute of Disability and Rehabilitation Research, Washington, DC

Phala A. Helm, M.D., University of Texas Southwestern Medical Center, Dallas, TX

Kenneth M. Jaffe, M.D., University of Washington School of Medicine, Seattle, WA

Allen Jette, P.T., Ph.D., New England Research Institute, Watertown, MA

*Author of the background paper that was used to stimulate discussion among contributors; the paper was not published.

Ellen J. MacKenzie, Ph.D., Health Services Research and Development Center, The Johns Hopkins University, Baltimore, MD

Jay Moskowitz, Ph.D., National Institutes of Health, Bethesda, MD

Jacqueline Perry, M.D., Rancho Los Amigos Medical Center, Downey, CA

Roberta B. Trieschmann, Ph.D., Scottsdale, AZ

Kent Waldrep, Kent Waldrep National Paralysis Foundation, Dallas, TX

T. Franklin Williams, M.D., National Institute on Aging, National Institutes of Health, Bethesda, MD

Katie Baer, M.P.H., Macro International, Inc., Atlanta, GA

Where We Are

Introduction

Statement of the Problem

Rehabilitation involves restoring an injured person's altered physiologic, psychologic, and social functioning as closely as possible to its original state. The ultimate goal of rehabilitation for persons with disabling injuries is to achieve optimal health and personal autonomy so they can live an independent and noninstitutional lifestyle.

In recent years, improvements in injury prevention, emergency medical services, trauma systems, and medical and surgical management of persons with injuries have resulted in more people surviving all injuries and more people surviving severe injuries.

These improvements in prevention and medical care have increased the demands on rehabilitative systems of care. Each year more than 200,000 people require extensive rehabilitation services as a result of spinal cord injuries (SCIs), traumatic brain injuries (TBIs), and burns. Limb and extremity injuries, injuries to the face and eyes, and polytrauma add considerably to demands for rehabilitative services.

Unfortunately, rehabilitation services are not available to all who need them for two primary reasons. First, comprehensive rehabilitation services are not available in all regions of the country. Although some areas have excellent systems of rehabilitative care for severe injuries that result from burns, SCI, or TBI, only about 20% of people with spinal cord injuries are actually treated in a comprehensive system of care. The second problem is cost. Some injured persons are unable to pay for comprehensive rehabilitation services. In addition, third party payers (private insurance carriers, Medicaid and Medicare, and workers' compensation insurers) tend to support therapies on the basis of cost and expediency rather than efficacy.

Our panel made a major effort to develop an agenda for rehabilitation services, research, and policy for the next decade. We believe that our agenda — combined with concurrent and parallel efforts by the National Institutes of Health, the National Council on Disability, the National Institute for Disability and Rehabilitation Research, and the Institute of Medicine — will significantly advance the availability and quality of comprehensive rehabilitation services for those with a disabling injury.

We are encouraged that progress toward improved rehabilitation is already under way. The recent passage of the Americans with Disabilities Act (ADA) recognizes — for the first time

— the rights of a person with a disability to have access to full employment and to therapies that will make them independent. The ADA will have a significant impact on employers, educational institutions, persons with disabilities, and our Nation. We urge prompt and vigorous implementation of the provisions of the ADA.

We are also encouraged by the recent publication of *Disability in America* by the Institute of Medicine. This report documents the impact of disability in America and presents an extremely useful framework for understanding the disabling process better and for developing strategies to intervene in this process. We urge careful reading of this report.

The recommendations expressed in this paper are based on the following three principles:

- To integrate rehabilitation successfully into injury control programs, policymakers and the general public must understand that rehabilitation services represent one phase in a continuum of care that begins when the injury occurs and may continue for life.
- To deliver comprehensive rehabilitation services, a coordinated team of rehabilitation specialists must work in concert with the persons who have disabling injuries and with their families.
- To achieve optimal health, personal autonomy, and independence for seriously injured people, we need to establish by the end of this decade, a cost-effective system of rehabilitation care.

Our goal is ambitious. It will require substantial financial commitment, innovative thinking, and cooperation among specialists. It will require reorganizing health services delivery, developing new systems of health care financing, conducting new basic science and clinical research, and establishing new methods to critically evaluate rehabilitation services. The cost of reaching our goal will be great, but we believe that the financing can be found. Our goal can be met only through a collaborative and collegial effort among researchers, clinicians, consumers, families, communities, and public and private agencies.

Key Terms and Definitions

Associated injury: An injury that occurs when the primary injury occurs.

Comprehensive medical rehabilitation: Coordinated multidisciplinary rehabilitation services provided in an inpatient or outpatient setting under the direction of a qualified physician. These services are designed to obtain for the patient the highest attainable levels of personal independence, health, and productivity.

Condition: A person's medically diagnosed physical or psychological situation.

Disability: Inability or limitation in performing the socially defined activities and roles expected of people in a social and physical environment.

Functional limitation: Restriction or inability, which results from impairment, to perform an action or activity in the manner or within the range considered normal.

Impairment: All mental, emotional, physiological, or anatomical losses or abnormalities, including pain and those not attributable to an active pathologic condition.

Limb and extremity injury: Traumatic injury to the limbs, which could involve muscles, bones, joints, soft tissues or peripheral nerves.

Pathologic condition: Interruption or interference in normal bodily processes or structures.

Polytrauma: Potentially life-threatening or disability-producing injury to more than one major body region or organ system.

Primary injury: The injury with the greatest consequence to the person, within a particular context of care. For example, when a polytrauma patient is first injured, the primary injury could be a cardiac contusion; after acute medical care is complete, the primary injury could be a spinal cord injury.

Public health surveillance: The ongoing systematic collection, analysis, and interpretation of health data needed for planning, implementing, and evaluating public health programs.

Rehabilitation services: Care and treatment provided by professionals from the disciplines of medicine, physical therapy, occupational therapy, speech and language pathology, rehabilitation nursing, orthotics and prosthetics, rehabilitation engineering, psychology, social work, recreational therapy, and vocational counseling.

Secondary condition: Any pathologic condition that begins as a result of a previous condition. (In this document, the first condition is always understood to be an injury.)

Spinal cord injury (SCI): Injury to neurologic structures contained in the spinal cord that may cause motor or sensory impairment, or bowel or bladder dysfunction.

Standard of care: A health care practice that is expected in defined circumstances.

Traumatic brain injury (TBI): An insult to the brain (not of a degenerative or congenital nature) that may produce a diminished or altered state of consciousness and that results in temporarily or permanently impaired cognitive or perceptual abilities or physical function.

Spinal Cord Injury

Dimensions of the Problem

Recent estimates of the prevalence of spinal cord injury (SCI) range from 177,000 to 200,000 people. As recently as World War II, practically all those who sustained a spinal cord injury died; today, life expectancy for all but the most catastrophically injured can approach normal. Advances in the management of cardiorespiratory complications (the leading cause of death among children and adults with SCI) are expected to increase the number of people with SCI who survive. Each year, 10,000 to 20,000 persons in the United States receive a spinal cord injury, resulting in 30 to 35 additional persons per million population who need rehabilitation services for SCI.

More than 80% of people with new SCIs are men, and about 60% of these men are from 16 to 30 years of age when the injury occurs (1). Among young men, motor vehicle crashes, often involving alcohol use, account for more than half of the SCIs. Among people older than 60 years of age, more than half of the SCIs result from falls.

About 75% to 80% of people with acute traumatic SCI experience some degree of permanent impairment despite optimal medical and rehabilitation management. Neurologic impairment is more often incomplete among older people. Among older persons, impairment and disability may be greater because of preinjury conditions that interfere with the person's physiologic and psychologic ability to adapt to spinal paralysis. Most people with SCI have disabilities that interfere with major life activities such as walking, bowel and bladder control, and employment, disabilities that result in a life-long need for assistance with daily activities. Regretfully, the postinjury vocational outcome of SCI patients is less than desirable, as evidenced by data showing that as long as 5 years after injury, only 20% of patients who received comprehensive care in model SCI care systems are employed. Little is known about the relationship between rehabilitation outcomes and injury etiology, alcohol use, or other behavioral risk factors related to cause of injury. The effects of age, gender, and psychosocial factors on rehabilitation outcomes have not been well described (2).

The average annual direct costs of initial medical and rehabilitation care in a model SCI system during 1988-1989 ranged from $71,980 for a patient with incomplete paraplegia to $153,312 for a patient with complete quadriplegia. Lifetime direct costs for a single case of complete quadriplegia are now estimated at $571,584, and lost earnings are estimated at more than $308,054 (3). The total annual economic burden for SCI patients in the United States has been estimated at about $6.2 billion (3).

In 1988, the Council of State and Territorial Epidemiologists selected SCI as the first injury to be included in public health surveillance by state departments of public health. Because states faced multiple financial, organizational, and methodological barriers to obtaining accurate surveillance data on SCIs, only a few states have begun surveillance efforts.

Complete case ascertainment, the need for monitoring mandatory reporting, and unreliable and undetailed medical records are some of the problems preventing effective implementation of SCI surveillance in states. New strategies are being developed and tested.

Pathophysiology

Currently, our understanding of the determinants of clinical recovery from acute SCI is rudimentary. Clinical prognosis is best determined by the degree to which motor and sensory function is preserved or improves during the days immediately following injury. Severe mechanical forces applied to the spinal cord are followed by microcellular and neurochemical changes, creating a microenvironment in the damaged area of the spinal cord that inhibits or prevents regrowth of nerve axons. Intensive basic science research is being conducted to understand the neurophysiologic changes that follow sudden mechanical forces being applied to the spinal cord. Some believe that early removal of any structures such as bone or foreign bodies that cause continued mechanical compression on the spinal cord, particularly after reduction of an associated spinal fracture, improves recovery (4), although no controlled-series studies on the efficacy of this treatment strategy exist. Results of one recent study showed that the early administration of high doses of steroid is associated with a significant rate of improvement in semiobjective clinical measures of motor and sensory function (5). Further contributions to clinical recovery that result from basic science research on nerve regeneration will be incremental, and use of these new findings will need to be combined with currently known medical and rehabilitative techniques to enhance functional recovery.

The impact of the psychological and pathophysiologic aspects of aging on people with SCI has not been adequately studied. A person's age when SCI occurs and the duration of an SCI may synergistically affect the rate of degenerative changes in different organ systems and may affect a person's life-long functional performance.

Rehabilitation Interventions and Outcomes

Since 1971, the National Institute of Disability and Rehabilitation Research (NIDRR), Department of Education, has supported the Model SCI Systems Program, which has collected extensive descriptive data about people with SCI, treatment, and SCI outcomes during and following the injured person's participation in specially designed model systems of care. A 1989 national consensus conference provided SCI experts an opportunity to examine various research results documenting the efficacy of this model care system (3). Results of one study (3) showed that patients treated in model SCI systems had shorter hospital stays and were more often discharged to community living situations than a comparison group of persons treated in nonmodel SCI system hospitals. Patients with neurologically complete quadriplegia treated in model SCI systems gained significant functional independence sooner after injury, a result that reduces costs. Researchers compared two groups of SCI patients for secondary complications that developed during initial hospitalization. They found that the group of SCI patients admitted immediately to model SCI systems had a significantly lower prevalence of contractures, heterotopic

ossification, atelectasis, urosepsis, and pressure sores than SCI patients admitted 2 to 60 days after injury.

Little is known about the epidemiology of secondary conditions that develop during the lives of people with SCI. Only recently have more than a few persons with SCI begun surviving more than 30 years (3), and the impact of effective rehabilitation on the occurrence of secondary conditions during a lifetime has not been fully evaluated. Recent clinical reports have described the onset and treatment of many secondary conditions such as pressure sores and urinary tract infections. Other common problems are infertility among many male SCI patients, intractable pain, contractures, and fractures due to osteoporosis. Clinical depression is probably increased, and suicide may be five times more prevalent as a cause of death in the spinal-injured population than in able-bodied populations. Although effective treatment for many of these conditions is available, more knowledge is needed about preventive interventions, including the timing, intensity, and mix of interventions. The delivery of rehabilitation services as soon as possible is also important. Delayed or ineffective treatment results in additional disability that affects the quality of life and functional independence of people with SCI. We believe that, ideally, rehabilitation should not only begin as soon as possible after the acute injury, but should continue throughout the injured person's lifetime.

Service Delivery Issues

Not enough comprehensive clinical rehabilitation programs can fully apply the rehabilitation methods developed and demonstrated in the Model SCI Systems Program. Although, in certain regions, these programs have a high capture rate of patients with acute traumatic SCI, overall less than 20% of all people with SCI are treated in these systems. Furthermore, only about half of all persons with SCI are treated at some time by physicians who are members of the American Spinal Cord Injury Association, a multispecialty physician organization devoted to improved care and treatment for people with SCI. The number of experienced rehabilitation professionals in allied health fields is also inadequate to meet the needs of persons with SCI.

Helping people achieve an independent lifestyle following injury is a major objective of rehabilitation. Since SCI patients typically are cognitively intact young people, they are an ideal group in which to demonstrate methods for achieving independent living. Independent living centers, various state vocational agencies, and other independent organizations offer attractive models for providing cost-effective services to people with SCI. We must evaluate the effectiveness and costs of training injured people to live independently at centers. A key to effective rehabilitation is to involve the family of an injured person in the support and delivery of services. Another key element in rehabilitation is to provide training to help persons with SCI get full employment.

Funding Issues

Many people have inadequate or no third-party medical insurance (private insurance, Medicare or Medicaid, or workers' compensation). Universal and more uniform insurance coverage for rehabilitation services can help increase the availability of specialized care for people with SCI throughout the country. Treatments, outcomes, and cost-benefit analyses of various mixes of inpatient, outpatient, and home care services need to be examined. At present, the mix of the level and location of rehabilitative services is strongly driven by reimbursement mechanisms rather than by effectiveness or cost-benefit analyses. For example, one objective of the Model SCI System Program has been to begin rehabilitation services immediately after injury, blending acute medical care with early rehabilitation care in specialized SCI units or programs. Although data support this method as cost-efficient, the current reimbursement system makes achieving these objectives difficult. The most effective mix of acute care and rehabilitative services during the acute phase of SCI needs to be determined. Standards of care should be developed to balance cost, effectiveness, and various treatment modalities. Acute and rehabilitative care settings and systems that most cost-effectively lead to optimal outcomes must be characterized. Incentives are needed to improve coordination between acute-medical and rehabilitative services to people with SCI, both during initial hospitalization and during follow-up.

Advances in adaptive equipment technology have greatly expanded opportunities for people with extensive paralysis to increase their productivity and independence. The cost of this technology, however, often makes it inaccessible to people who need it, and obtaining funding for adaptive equipment is difficult. In addition, information about the availability and benefit of new equipment is inadequately disseminated among professional, payer, and consumer groups. Financial constraints also can limit the availability of affordable barrier-free housing and transportation systems, optimal public school services, and personal care attendants.

Traumatic Brain Injury

Dimensions of the Problem

The true annual incidence of traumatic brain injury (TBI) in the United States is unknown because no reliable systems of surveillance are established in any state. In addition, coding problems are significant because ICD-9 coding does not have a specific code for TBI. The results of a 1985 survey of central nervous system injuries found 225 TBIs per 100,000 population, of which 5% to 10% (20 per 100,000) were fatal (6). About 20% to 40% of the people with nonfatal TBIs did not seek medical care. Of those who received medical care, only 40% to 60% were hospitalized.

Each year in the United States, about 70,000 head injuries are classified as moderate to severe. Persons with moderate to severe TBI will live the rest of their lives with a combina-

tion of cognitive, physical, behavioral, and emotional deficits and will require long-term rehabilitation services. Almost no data are available on so-called mild TBI or on the impact of mild TBI on a person's capacity to function normally. The peak incidence of TBI occurs among adolescents and young adults [from 15 to 24 years old (6)]. TBI is two to three times more common among men than women. Patients with TBIs often are single and in lower socioeconomic groups. Many persons with TBI have a history of alcohol or drug use and may have undergone psychiatric care before their head injuries occurred (7). Motor vehicle crashes and falls are leading causes of TBI. Clearly, the most effective way to prevent disability is to prevent TBI from occurring in the first place. Mandatory seat-belt and motorcycle-helmet laws, air-bags, and bicycle-helmet usage are examples of primary prevention strategies.

Pathophysiology

The pathophysiologic changes to the brain that result from TBI begin at impact. Contusions are a type of focal brain injury that can occur beneath sites of impact or skull fracture. They also occur as a result of the brain gliding over the irregular surfaces of the base of the skull, especially at the frontal and temporal regions. Other focal brain injuries occur as a result of laceration of blood vessels, which then bleed into surrounding tissue to cause epidural, subdural, or intracerebral hematomas. Rotational acceleration can cause movement between different components of the brain tissue itself; such movement results in concussion and shear injury or diffuse axonal injury. In the latter type of injury, delayed degeneration of injured brain cells occurs.

As contusions and hematomas enlarge, intracranial pressure rises. This rise, in turn, causes brain displacement, potential tissue necrosis, and obstruction of venous blood flow. These events further increase the pressure, compromise cerebral blood flow, and promote an ischemic condition that worsens the original injury and can lead to cerebral infarction. The ischemia can be aggravated by extracranial factors, such as hypoxia due to respiratory failure or hypotension due to blood loss.

Intracranial pressure is managed by such advanced assessment techniques as magnetic resonance imaging, computerized axial tomography, and intracranial pressure monitors. In addition, acute neurosurgical treatment includes techniques such as positioning, hyperventilation, sedation, diuretics, ventricular drainage, and paralyzation. Aggressive early surgical decompression of mass lesions and surgical treatment of hydrocephalus have resulted in decreased damage due to the effects of increased intracranial pressures. Basic research on delayed cellular damage and the development of medications to diminish cell death are needed to minimize the neurological dysfunction after TBI.

Rehabilitation Interventions and Outcomes

Rehabilitation for people with TBI differs from general rehabilitation because of the longer recovery course after severe head injury and because of different stages of recovery associated with different profiles of physical and cognitive impairments. The optimal

approach to rehabilitation for people with TBI is to adapt treatment as each major stage of impairment occurs and to prepare patients and families for the next stage of recovery. Physical problems often include extracranial injuries (both soft tissue and skeletal fractures) and motor impairment; later, spasticity and heterotopic ossification often develop. In the early phases of recovery, aggressive rehabilitation efforts that prevent contractures will frequently minimize later disability. Patients who engage in passive range-of-motion exercises twice a day have fewer contractures (8). Aggressive, nonpharmacologic management of spasticity with the use of inhibitive casts and nerve blocks also will decrease the likelihood of contracture formation (9).

Cognitive rehabilitation is a specialized type of rehabilitation for patients who are disabled primarily as a result of impairments in memory, judgment, and other cognitive functions. In the past few years, cognitive rehabilitation has become increasingly controversial because of the proliferation of costly, time-consuming, and unproven treatments. Results demonstrating the effectiveness of cognitive rehabilitation are, at best, preliminary. There is clear evidence, however, that patients can improve function through compensatory strategies, and many can be retrained to return to work or school (10-12). The patient's level of cognitive and behavioral functioning is usually the major factor in outcome and can be used to determine realistic goals for the patient (13). Family intervention with adequate information and support is important to the patient's recovery and should start as soon as possible (14).

Service Delivery Issues

The usual course of treatment in comprehensive rehabilitation begins with the rehabilitation team evaluating the patient's strengths and deficits, establishing overall rehabilitation goals, and estimating the expected length of stay. Treating cognitive impairments is an interdisciplinary process. Since rehabilitating people with TBI is likely to extend beyond acute care hospitalization, it is important that team members and potential community service providers, including school personnel in the case of children with TBI, be identified and invited to participate in any discussions about long-range goals and treatments. This comprehensive approach is especially important in rehabilitating children with TBI whose developmental, educational, and social needs are especially sensitive.

Controlled efficacy studies of specialized rehabilitation programs are needed. Uncontrolled study results have shown that large improvements in function can occur during initial rehabilitation (15), but the evaluation of treatment effects is confounded by rapid spontaneous recovery following traumatic brain injury. The National Institute for Disability and Rehabilitation Research (NIDRR) is presently supporting the development of five model systems of care for people with TBI. Unique to these systems is a common standardized method of collecting data that should facilitate comparisons of treatment efficacy among various rehabilitation facilities.

Funding Issues

To provide the best possible outcome for patients with TBI, we must (a) develop a national network of Level I trauma care systems with well integrated rehabilitation programs and (b) fund rehabilitation services and acute care services. Funding for custodial and long-term care is often needed for people with TBI, since they have often incurred those injuries in their teens or early twenties, have near-normal life spans, and often survive the death of the family member who was the primary care giver. Additional funding is needed to train health professionals, special education teachers, and personal care givers.

Burns

Dimensions of the Problem

Each year, about 1% of the population of the United States receives a burn injury. About half of these injuries will require medical attention or be severe enough to restrict daily activities in the home, school, or workplace. One-fourth of these injuries require confinement in bed. Hospital admissions for burns are estimated to be between 70,000 and 108,000 a year; about 20% of those admitted are children. On the basis of data for 1965 to 1979 from the National Burn Information Exchange (NBIE), 18% of 37,442 patients were older than 50 years and 10% were older than 60 years.

Each year between 6,500 and 12,000 people die from burns. The most common groups burned are children (ages 2 to 4 years), young adults (ages 17 to 25 years), and males of any age.

The United States now has 198 burn units with 2,243 specialized burn-care beds. About one-third of all patients who are hospitalized for burns are treated in these centers. In general, burn centers are directed by plastic or general surgeons. Only at a few burn centers do physicians with specialty training in physical medicine and rehabilitation (physiatrists) work closely with the burn team and follow up with burned patients after their hospital discharge. During their formal education, physiatrists and allied health professionals are usually not trained in the treatment of burns or rehabilitation of burned patients. Most of their education about burn rehabilitation must occur on the job and during professional seminars.

Most data collected about burns are on mortality and morbidity. No data exist on rehabilitation outcomes, long-term sequelae to burn injuries that affect quality of life, the cost of care for inpatient or outpatient rehabilitation, or (except for a few reports) rehabilitation complications during acute care or at hospital discharge.

Outpatient rehabilitation programs are not always available in burn centers. Of centers with fewer than 81 admissions each year, 33% do not have outpatient rehabilitation programs. Of burn centers with 81 to 120 admissions each year, 20% do not have such programs, and of those with more than 121 admissions, 12% do not. Accurate information is needed on the cost of rehabilitative care, including ways to lower those costs, such as increasing productivity by distributing the peak service demand for services over 24 hours, using part-time employees, and diversifying.

Pathophysiology

Hypertrophic scarring: Hypertrophic scarring creates a major cosmetic problem, can cause severe contractures, and may be the most challenging aspect of rehabilitating a burn patient. The lack of adequate animal models on which to test the various therapeutic modalities has limited study of burn scar development.

Contractures: A burn wound will shorten until it meets an opposing force. Often, the shortening force can be so severe that it dislocates joints. A variety of treatment techniques is needed to manage burned-skin contractures because they differ from other types of contractures. For example, since burns may cover an entire limb, contractures may affect more than one joint. No studies have compared the effectiveness of various treatment methods.

Peripheral and central nervous system: Few investigations have assessed the implications of peripheral and central nervous system involvement in the burn-injured patient. Neurological problems in burn patients can result from various etiologies, many of which are preventable with proper precautions. Peripheral neuropathy is a common neurological problem that occurs in 15% to 29% of patients with burns on more than 20% of their total body surface (16); however, its etiology is unknown. Electrical burns produce many neurological complications and sequelae. The pathophysiological mechanism of burns on the central nervous system needs to be described.

Musculoskeletal changes: Bone and joint changes have been reported in 2% to 5% of severely burned patients. These musculoskeletal changes are particularly devastating when they occur among children, for whom they can cause bone-growth disturbances, kyphotic deformities, scoliotic deformities, heterotopic ossification, and joint dislocation.

Rehabilitation Interventions and Outcomes

Few clinical studies have compared treatment techniques to determine what protocols are best. In addition, little information about successful therapies is available, and no universally accepted measurement of functional recovery exists.

Although burn care is mostly centered around inpatient burn units and centers, outpatient care is growing in importance. Use of alternative care locations, such as intermediate care

facilities and the patient's home, may permit earlier discharge than the use of hospitals alone. Innovative patterns of ambulatory care by which various specialists of the burn team can deliver patient care need to be developed. In all rehabilitation models, caregivers must address the psychosocial needs of children and adults with burns as well as the needs of their families. Burn patients also need to use existing rehabilitation facilities more frequently. A review of discharge diagnoses on 46,667 patients in 119 rehabilitation facilities showed that only 0.8% of the diagnoses were burn injuries.

We need longitudinal research to document the problems that burn patients face after recovery. Such research should involve many burn centers, each using the same protocol so that an adequate number of patients can be studied to obtain valuable information for planning a burn patient's future and for predicting costs of care.

Service Delivery Issues

Training: A major problem for burn rehabilitation is the lack of trained personnel, particularly physiatrists. Generally, physiatry residents do not study burn care. The shortage of allied health personnel trained in burn rehabilitation is also acute.

Public awareness: The public's failure to understand the social, emotional, and occupational problems that face burn patients after healing is especially critical in the workplace and for children and adolescents returning to school.

Standards of care: Members of the American Burn Association agree that a comprehensive model of standards or guidelines for treating and rehabilitating burn patients should be developed and outcome criteria identified. Such a model is needed (a) to assure the delivery of quality burn rehabilitation services and (b) to aid third-party payers in supporting appropriate therapies.

Other issues: Very few burn patients receive Social Security benefits. On a national basis, the percentage of disability claims paid to burn patients by Social Security from 1981 to 1983 was less than 1%. A universal approach is needed for retraining persons whose burns do not permit them to return to their previous type of employment. Burn patients often are forced to seek employment that does not require their full capabilities and does not provide sufficient income to support themselves or their families. These people need social security and vocational rehabilitation services.

Limb Injuries

Dimensions of the Problem

Each year an estimated 986,000 people are admitted to a hospital for treatment of an injury to a limb; they account for nearly half of all hospital trauma admissions. Costs associated with initial hospital treatment alone amount to $5.1 billion (1985 dollars). Injuries to lower limbs account for most admissions (696,000 per year or 70% of all admissions for limb injuries). People 65 years and older are at particularly high risk of being hospitalized for treatment of a lower limb injury; they account for a disproportionate share (40%) of all hospitalizations for lower limb injuries (17).

Although current data on limb injuries do not specify etiology, severity, place of occurrence, or treatment, we know that significant causes of limb injury are sports, leisure, and home activities and trauma resulting from motor vehicle crashes. As the population ages, falls among the elderly that result in injury will become an increasing problem. The sequelae of massive limb trauma, which may be amputation, also need further study.

Pathophysiology

The pathophysiology of bone healing is not well understood. The relationship between weight-bearing and internal fixation is unclear, and more research is also needed to help clarify the value of adjunctive therapies, such as electrical stimulation, in improving bone healing. Surgery to repair blood vessels is highly effective, but research into improving peripheral nerve repair has not received much attention in the past 10 years. The ability to move skin and soft tissue to enhance tissue coverage has improved, but repair techniques for ligaments are still evolving. Immobilization as a treatment for limb injury is not ideal, because muscle weakness, fibrous tissue contractures, and cardiopulmonary deconditioning are all inevitable complications. The patient's loss of energy is the cost of accommodating an immobilized limb. Walking with crutches to avoid putting weight on a limb raises the heart rate 25%. Using a fracture brace instead of the traditional cast minimizes the loss of energy and periarticular fibrosis.

Rehabilitation

Rehabilitation has not played a major role in the management of limb fractures, except when the limb is amputated. The traditional model for managing limb injuries involves primary care by an orthopedist, with occasional assistance from vascular and plastic surgeons. Follow-up is provided on an outpatient basis, which allows the patient to set the rehabilitation pace. Care is focused on healing the primary pathologic condition, and little attention is given to traditional concerns of rehabilitation such as employment problems and social reintegration.

The trend toward increasing the number of trauma centers provides an opportunity for early involvement of the rehabilitation team in acute care settings. Although many

rehabilitation therapy protocols need to be evaluated, information about factors that influence a patient's return to work following hospitalization for limb injury is emerging. In one study of outcomes following limb injuries, results showed that of patients with Abbreviated Injury Scores (AISs) of 1 or 2, 44% were back at work 6 months after injury, and 65% 1 year after injury (18). Of the patients with more severe limb injuries (AISs of 3 or more), 28% were back at work 6 months after injury, and 54% 12 months after injury. Especially striking is the high percentage of less severely injured workers who were not working after 1 year. Factors that correlated positively with patients returning to work were quantity and quality of vocational rehabilitation, preinjury personality traits, and involvement of the family in the recovery program. Negatively correlated factors were low income and low education, which may reflect limited resources for rehabilitation care.

Service Delivery Issues

One major problem in limb injury rehabilitation is clinical care providers' lack of awareness that rehabilitation can improve limb injury outcome. Another problem involves deciding when is the best time to begin rehabilitation. Including rehabilitation as an element in trauma centers is advantageous. For example, psychologists and other counseling professionals can help patients return to work early, and these professionals can also contribute to more efficient coordination of community services. Patients who can return to work, even though they do not work full time, may have improved recoveries. There is evidence that if a person fails to return to work by 6 months postinjury, the likelihood of that person ever returning to work is reduced (18).

Funding Issues

For work-related injuries, most phases of treatment are funded satisfactorily. For injuries occurring during a leisure activity, treatment is generally reimbursed through third-party payers who may not adequately cover a patient's rehabilitation needs. Assistive medical equipment, other than such simple items as crutches, may not be covered by health insurance and therefore unavailable to some injured persons.

Back Injuries

Dimension of the Problem

Musculoskeletal injury to the spinal column is also an important source of impairment and disability, especially among workers. Although exact figures on the numbers of back injuries that occur each year are not available, one can estimate the problem by determining the number of people who complain about low back pain and the number of workers' compensation claims filed for back injuries.

About 5.2 million Americans are disabled by low back pain; half of them are chronically disabled (19). The annual costs of compensable low back pain have been estimated at $11 billion (in 1986 dollars). Low back pain is the most common cause of work disability among adults less than 45 years of age and the third most important cause of disability among those 45 years or older (19). The rate of disabling low back pain increased 14-fold from 1970 to 1981 (20). Each year about 5% of the population complains of low back pain. Because of the difficulty in making a differential diagnosis, it is unknown to what extent reported symptoms of back pain are due to an acute sudden injury, to cumulative trauma to the spine as a result of repeated heavy physical work, or to congenital anomalies and chronic medical conditions. In general, an exact diagnosis is made for only 10% to 15% of all patients with low back complaints (20).

Work-related back injuries account for about one-fifth of all workers' compensation claims (21). The annual incidence rate of compensable back injuries among all industrial workers has been estimated to be 2%, although these rates vary considerably by industry and occupation, with highest rates reported among machine operators, truck drivers, and nurses (21). Estimates of the back injury problem that are based on workers' compensation claims are generally low since many workers who experience a back injury do not file a claim or are not covered under state programs. Claims data do, however, provide important information on the incidence of serious back injury and can be used to design and target prevention programs.

Three-quarters of all claims for back injury are filed by men. The average age of the back injury claimant is 35 to 40 years (21).

Overexertion, including lifting, pulling, and throwing, is the most common cause of back injury. In many cases, however, back pain is not associated with a sudden injury; rather, it is the result of cumulative spinal damage due to heavy physical work. This is especially true if workers lift more than their capacity.

Treatment

The treatment for back injury, and low back pain generally, is not standardized and ranges from conservative therapies to surgery (22). In general, little scientific evidence supports the choice of a particular clinical strategy (23). Published reports of clinical studies are few because of the lack of appropriate controls and random assignment of patients to alternative therapies, reliance on short-term follow-up evaluations, and poor standardization of both treatments and evaluation. In addition, many studies lack clear and precise criteria for particular patients; the result is that study populations are heterogeneous with regard both to etiology of low back pain and to sociodemographic factors (24). The lack of scientific evidence to support alternative therapies has led to wide variations in treatment practices for both acute and chronic low back pain.

It is important to distinguish between acute and chronic back pain. Acute back pain is generally defined as lasting less than 12 weeks, and chronic low back pain as lasting more than 12 weeks.

The prognosis for acute low back pain is generally favorable. About 90% of all cases of acute low back pain are resolved within 6 to 12 weeks (22). Although bed rest, often in combination with analgesic medication, is regarded as the principal therapy for acute low back pain, little scientific evidence supports the efficacy of this approach. Prolonged bed rest can be harmful and may promote chronic pain and disability (25). One study found that patients who were prescribed 2 rather than 7 days of bed rest did equally well in terms of functional, physiologic, and perceived outcomes. Further, the group for whom only 2 days of rest were prescribed missed 45% fewer days of work (26). The role of various types of exercise and physical therapy in treating acute lower back pain is even more controversial. Evidence is growing, however, to indicate that activity is not harmful for acute back pain patients and that an active rehabilitation program and early return to work can improve function and reduce pain (22). Surgery is rarely indicated for relief of acute low back pain except for a small percentage of patients with unrelenting sciatica.

Although only 5% of all cases of low back pain are chronic, these cases account for approximately 85% of the costs associated with low back pain (27, 28). The available statistics on long-term recovery from chronic back pain are discouraging. In general, 40% of patients who have been disabled because of lower back pain for 6 months eventually recover; this figure drops to only 20% if the disability persists for up to 1 year (29-31). Most patients with low back pain are managed conservatively with anti-inflammatory medication and an exercise program. The indications for surgical treatment are vague and imprecise. Many experts would agree that back surgery in this country is performed too frequently, with poor, or at best, equivocal, results.

Interventions

Recent studies have emphasized the potential benefits of functional restoration programs that emphasize physical reconditioning and pain relief. In these programs, patients are educated and counseled in order to enhance their motivation to work and to teach them ways to deal with their impairment and avoid further injury. One study found that 87% of persons enrolled in a multidisciplinary functional restoration program were actively working after 2 years, compared with only 41% of comparable patients not enrolled in the program. The comparison group, moreover, made physician visits at a rate five times higher than the treatment group, and twice as many in the comparison group had additional spine surgery (32). These results are promising; further evaluation of the costs and benefits of similar programs should be given high priority.

The role of back schools in relieving symptoms and preventing recurrent episodes among workers with low back pain needs to be further evaluated. These schools, originally developed in Sweden, combine an exercise program with education and counseling on

ergonomics (33). Although the effectiveness of back schools has been questioned, one study demonstrated that a program at one such school was effective for workers with severe chronic pain (34, 35).

Training

To improve the medical treatment of back injury, health professionals who routinely see patients with complaints of low back pain must have appropriate training in the assessment and management of pain behavior (36). Health professionals must be able to integrate and coordinate different modalities of care, such as medication, exercise, and surgery. Too often, the first physician to evaluate a back patient has had little training or education in pain management. Typically, orthopedic surgeons and neurosurgeons are consulted, even though surgery is indicated in only 1% to 2% of all cases. Physiatrists, given their training in the management of musculoskeletal disorders and pain, should be more broadly involved in the treatment of back pain.

Other factors besides medical treatment play important roles in a patient's recovery from back injury (20). Among the factors shown to affect the outcome (including the extent and rate of return to productive work) are the patient's educational background and vocational resources, other personal and psychosocial factors, and the type and security of the job the patient held when injured. Some researchers believe that the type and amount of compensation received influence a patient's return to work, although the few studies that have addressed these issues report conflicting results. The role of income replacement programs as work disincentives is complex and depends on numerous factors, including type of job and salary, job satisfaction, program rules and procedures, and the willingness of an employer to hire persons with disabilities. Workers' compensation programs and laws should be reviewed to determine whether they inhibit successful rehabilitation of injured workers. More study is needed to determine how multiple factors interact to impede a timely return to work after back injury. The Americans with Disabilities Act, which becomes effective in July 1992, should help to eliminate employment discrimination for people with disabilities.

Medicine and the allied health professions that focus on occupational rehabilitation are fragmented in their approach to service delivery. Occupational or industrial medicine has existed for several decades as a recognized medical specialty, but the discipline has not grown sufficiently to meet demands for services. Similarly, occupational medicine has not been well-integrated with physical medicine, rehabilitation, or orthopedic surgery.

Facial and Eye Injuries and Polytrauma

Significant disability and the need for rehabilitation services are associated with injuries other than those in the major categories of SCI, TBI, limb injury, back injury, and burns. Most notably, these include injuries to the face and eye.

Facial and Eye Injuries

Although injuries to the face and eye are rarely life-threatening, they can result in significant temporary or permanent impairment. Each year an estimated 85,000 people are hospitalized for treatment of a significant injury to the face or eye (37). Eye injury is the primary diagnosis in 33,000 hospitalizations (38). An additional 9 million injuries occur that result in treatment on an outpatient basis or result in one or more days of restricted activity (Ellen MacKenzie, The Johns Hopkins University, unpublished data, 1990). Impairments resulting from these injuries include disfigurement (scars, deformities of the face and jaw, missing or maloccluded teeth), visual impairment and blindness, chronic obstructed nasal lacermal passages or chronic sinusitis, anosmia (loss of sense of smell), and impairments such as difficulty chewing or temporal mandibular joint arthritis.

Of particular importance in terms of long-term impairment and disability are ocular injuries, an important cause of blindness and vision loss in the United States. Although good information about the consequences of these injuries is unavailable, estimates of the number of people visually impaired as a result of ocular trauma are as high as one million, nearly 80% of whom are blind in one eye. Eye injury is the leading cause of monocular blindness in the United States and is second only to cataracts as the most common cause of visual impairment (39). Although no segment of society escapes the risk of eye injury, eye injuries are especially frequent among young adults, with 64% of all ocular trauma occurring to persons younger than 30 years of age (U.S. Eye Injury Registry, Birmingham, AL, unpublished data).

There is much controversy about the leading causes of ocular injuries. Some studies focus on injuries in the home, during sports, at work, or resulting from motor vehicle crashes; other studies point out that assault accounts for a significant proportion of eye trauma (38, 39).

Little is known about the long-term functional consequences of eye trauma. Severe visual impairment often affects ability to read, drive, walk, pursue hobbies and sports, and interact socially because of their difficulty in recognizing and acknowledging friends and because of their concerns about their appearance.

Although significant strides have been made in developing aids and devices to assist people with visual impairments, programs and policies must ensure that this technology is financially accessible to all who need it. Research is needed to further evaluate artificial vision devices for the blind. Rehabilitation services for the visually impaired must emphasize the importance of creative job placement — that is, taking advantage of individual skills and

talents as opposed to placing people in stereotypic jobs for blind and visually impaired people. We need to give special attention to equipping the person with visual impairment with the skills necessary to undertake activities of daily living such as working and driving, to providing adequate services for families of injured patients, to developing creative rehabilitation programs, and to researching the prevention of ocular injuries.

Polytrauma

Many injured persons are best categorized as polytrauma patients, (i.e., patients who sustain injuries to more than one body system). Because combinations of injuries among polytrauma patients vary, the rehabilitation strategies required are varied and complex.

Multiple injuries occur most frequently as the result of motor vehicle crashes. Approximately half of all people injured as the result of police-reported crashes had multiple injuries. The average number of injuries is 2.5 per injured person.

For polytrauma patients, physicians often have difficulty deciding which is the primary injury. For example, which specialized services are most appropriate for SCI or TBI if a person has both? Recent studies suggest that more than 80% of patients with severe TBI also sustain injuries to other body systems (6). The frequency of problems associated with managing selected conditions in polytrauma patients has not been adequately determined. Polytrauma injuries often associated with TBI include fractures to the spine and extremities, soft tissue injuries to the chest and abdomen, and peripheral nerve injuries (1). About 10% of all SCI patients have an associated TBI. Associated injuries in TBI patients, especially skeletal fractures, complicate recovery and result in greater disability.

One organizational problem occurs when people with severe primary injuries in an organ system and relatively minor TBIs or SCIs are not referred for rehabilitation services by trauma specialists who are intent on managing the primary injury. Recent evidence has suggested that up to half of patients with SCI may also sustain a mild head injury. Patients need to have these mild head injuries diagnosed and rehabilitation therapy set up to ensure optimal recovery and quality of life.

Little is known about the effects of general debilitation and associated cardiovascular and neuromuscular deconditioning that can occur in multiple trauma patients with severe injuries to the abdomen and thorax. Although advances have been made in techniques for nutritional support of patients who have severe abdominal injuries, objective measurements are needed to assess the relative importance of maintaining optimal nutrition and its effect on rehabilitation goals.

Few trauma programs routinely include rehabilitative services, except for patients with specific injuries such as TBIs and SCIs. Several organizational problems within the health care system contribute to the lack of routine referrals for rehabilitation services for patients with polytrauma injuries, although many of these patients will have long-term disability and could benefit from comprehensive medical rehabilitation.

Where We Want To Be

Introduction

Rehabilitation after injury can greatly improve a patient's chance of achieving optimal health, personal autonomy, and reemployment; rehabilitation techniques mitigate impairments, reduce residual disabilities, and help the patient maintain function. Unfortunately, rehabilitative services are not available throughout the country, nor are all services accessible financially to all who need them. Some clinical rehabilitation therapies have been inadequately evaluated, and others are determined by the cost to third-party payers rather than efficacy. Although great progress has been made in developing and delivering rehabilitative services, many improvements are still needed. Everyone, especially children and the elderly, must benefit from currently available rehabilitation techniques; and research, both basic and applied, must be financially supported. **Our goal is to establish, by the year 2000, a cost-effective system of rehabilitation care that will permit an injured person with a disabling injury to achieve optimal health, personal autonomy, and an independent, noninstitutional lifestyle. A cost-effective system of rehabilitative care will help achieve an important objective of *Healthy People 2000*, namely the reduction of secondary disabilities as a result of head and spinal cord injuries.**

To develop this ideal system of rehabilitation care, we have recommendations in six major areas: basic science research, injury and rehabilitation surveillance, information dissemination and technology transfer, rehabilitation services capacity, health services research models, and training. Financial support for implementing these recommendations must come from public, philanthropic, and corporate sources. These recommendations should be addressed through a collaborative and interdisciplinary effort by clinicians, researchers, public health practitioners, patients and their families, policymakers, and the public.

Basic Research

The knowledge base on which injury rehabilitation rests is too small. Support of research in the basic mechanisms of tissue function and dysfunction is essential to provide a basis for understanding and applying rehabilitation therapies. Recently, the National Institutes of Health (NIH) convened a group of more than 100 experts in rehabilitation medicine, behavioral and social sciences, allied health, nursing, and health services research to help determine what research is needed to build a strong foundation for rehabilitation services. The resulting task force report recommended that a solid program of basic science research and outcome research needed to be developed. In addition, research must be undertaken to validate outcomes associated with new and old forms of treatment. Recently, the National Center for Medical Rehabilitation Research was established within the NIH to

develop a program of basic research in rehabilitation. **We strongly endorse the recommendations of the NIH task force report and the establishment of the National Center for Medical Rehabilitation Research and recommend establishing a cohesive research program in all areas of injury, ranging from basic science to ways that persons with injuries can function in the community.**

Injury and Rehabilitation Surveillance

To develop an effective system of rehabilitative care, we need objective evaluation of preventive strategies and clinical management. Sound decisions about clinical care strategies, preventive interventions, and cost and treatment options depend on developing measurement systems that generate a population-based, patient-oriented data base that contains information on etiology, risk factors, treatment, and outcome. The field of rehabilitation has been hampered by lack of objective tools with which to measure outcomes. **We recommend developing a clinical care data base from the records of all injured people. The data base would include epidemiologic information on etiology, risk factors, treatment, outcomes, and costs.** Developing this data base will require (a) innovative approaches to collecting data from health departments, hospitals, trauma centers, private care providers, and patients, and (b) improved cause-of-injury codes in patient records. Specialized registries; mandatory reporting; and evaluation of insurance, medical examiner, and coroner data will be needed. Issues such as confidentiality, participation, and data linkage also need to be addressed. Despite the difficulty in collecting these data, we must make every effort to do so, because they are necessary to evaluate the effectiveness of various therapies, to establish the direction for research aimed at prevention, and to reduce secondary complications.

Information Dissemination and Technology Transfer

For rehabilitation programs to be successful, up-to-date knowledge must be available to the providers of rehabilitation services, to persons with disabling injuries, to families of injured persons, and to the community, We believe strongly that the transfer of information from the researcher to clinical and public health programs and to the general public is critical to the development of our proposed model system. In addition, information about gaps in knowledge, effective and ineffective strategies, and new and emerging problems must be made known to the researcher. Information about successful patient- and community-based prevention and care strategies must be shared with injured persons, their families, and their medical providers. **We recommend that high priority be given to information dissemination and technology transfer among researchers, clinicians, health providers, injured persons and their families, and the community.**

Increased Capacity for Rehabilitation Services Delivery

At virtually every level, rehabilitation services are insufficient to meet the needs of injured Americans. This problem has two aspects: geographical distribution of services and their affordability. The development of Model Spinal Cord Injury (SCI) Care Systems during the past two decades demonstrates that effective systems of care can be provided by using existing clinical and prevention knowledge. In these model systems, cooperative, integrated systems of care have made rehabilitative medical services more readily available. **We propose that systems of care be developed for people with any injury that produces significant limitations in function and that the effectiveness of these systems be evaluated.** Groups using innovative approaches to delivering rehabilitative care, such as home care agencies, public school systems, independent living centers, and state agencies for vocational rehabilitation, should be encouraged and their effectiveness in delivering rehabilitation services should be objectively evaluated. Guidelines for clinical rehabilitation of injured patients will be developed from these models and can serve as the basis for intervention at all treatment facilities.

Research on Clinical and Health Services

Many interventions outside the medical model play vital roles in the outcomes and quality of life of people with disabilities. **We recommend that health systems research models, incorporating a variety of innovative and traditional approaches, be used to address issues such as access to and payment for services, the cost-benefit analysis of rehabilitation services, reemployment training and back-to-work incentives, and combinations of traditional and nontraditional rehabilitation services and therapeutic methods.**

Training

There are shortages of trained medical, allied health, and nonmedical personnel in medical rehabilitation. **We strongly believe that more trained personnel are needed in all areas of rehabilitation (including research, clinical care, and personal services) to ensure the development of model systems of rehabilitative care.** This training should be at the medical-student, resident, and fellow levels. Nursing, behavioral science, and allied health programs should include general and specialized training in injury rehabilitation, and continuing education in rehabilitation should be provided to medical practitioners. Attracting and training nonprofessional staff members is also important. A specific critical need is the development of formal methods to train, support, and certify personal care attendants and other nonprofessional care providers who are vitally important to the continuing success of rehabilitative efforts for persons who can never achieve physical independence in daily living activities. Special training for family members of injured persons also needs to be addressed.

By strengthening these six areas, our goal of creating a cost-effective system of rehabilitative care can be achieved in this decade. Achieving that goal, however, will be difficult and costly, but we strongly believe that a cooperative and well-planned approach can achieve much and ultimately be worth the cost.

How We Get There

Introduction

Three issues relating to evaluation impede the development of model systems of rehabilitation care: (a) the absence of objective methods for measuring functional recovery, (b) the lack of suitable comparison groups, and (c) the sheer complexity of clinical care evaluation studies.

There are few objective measurements of functional recovery. Such measurements have many uses for researchers studying cost-effectiveness, designing optimum mixes of inpatient and outpatient rehabilitation services, or measuring the effectiveness of various interventions. Measurements of functional recovery should be on three levels:

- **Motor, cognitive, and sensory impairment.** The rehabilitation field needs practical clinical measures of motor, cognitive, and sensory impairments that are sufficiently sensitive to changes and that produce results with practical meaning for clinicians and patients.
- **Functional capacity.** Functional capacity relates to a patient's general health (including cardiopulmonary fitness, cognitive ability, and pain) and to neuromuscular impairments of strength, joint mobility, and control.
- **Functional performance.** Functional performance involves the injured person's activities and is related to the severity of impairment and functional capacity. It is also influenced by environmental, cognitive, and emotional factors.

To build functional capacity, many rehabilitative services use physical restoration techniques, skill training, and education. In comprehensive medical rehabilitation programs, however, an interdisciplinary approach is used to address all aspects of physical health and environmental, psychological, and sociocultural factors that build functional performance.

Semiobjective measures of functional performance, such as ordinal scales for scoring a patient's ability to complete common activities of daily living, were first developed more than 20 years ago. Recently, however, the Functional Independence Measure (FIM) has been developed (40), and it may prove capable of measuring the effectiveness of many rehabilitation strategies. FIM's validity, reliability, and usefulness in cost-effectiveness studies have yet to be fully determined. Ways to assess the functional demands of a task and an individual's capacity with regard to that task need to be developed. Measuring the functional capacity of children is particularly challenging, since their functional capacity changes with development.

Another constraint to conducting and interpreting the results of outcome studies is the dearth of suitable comparison groups. Acquiring comparison data on a sufficient number of patients who received fragmented or potentially inadequate rehabilitation services has not been possible. One way to obtain sufficient comparison data would be to mandate a national surveillance system whereby all cases would be reported to a governmental or research organization not concerned with clinical service. Such a system may also resolve similar problems with longitudinal follow-up of populations with injury-related disabilities over their lifetime.

Three other problems encountered in studies to measure the effectiveness of various forms of rehabilitative care involve the sheer complexity of such studies. The first problem is the difficulty, already noted, of establishing a comparison group. Referral of patients to specialized or general centers involves many factors, such as the patient's ability to pay and the accessibility to such centers. Those factors can influence the numbers and types of patients in treatment and the makeup of the comparison groups. Second, because of existing payment systems, patients may receive care in a variety of settings that range from optimum to minimum standards of care. Finally, the evaluation of rehabilitation outcomes may require long-term follow-up studies of up to 10 to 20 years of continuous observation. These studies are costly and logistically complicated.

Specific Recommendations

Several federal agencies currently have programs concerned with rehabilitation services and research. Among them are the National Institutes of Health, the National Council on Disability, the National Institute of Disability and Rehabilitation Research, the Centers for Disease Control, the Agency for Health Care Policy and Research, the Department of Veterans Affairs, the Food and Drug Administration, and the Health Care Financing Administration. Other public organizations such as the Institute of Medicine, the National Head Injury Foundation, and the American Spinal Cord Injury Association are intensely involved in issues related to care, research, and policy on rehabilitation. Although this list does not include all groups involved in rehabilitation, it demonstrates that there is indeed a broad national interest in rehabilitation.

In making the following recommendations, the panel believes that some may be ideally carried out by one, several, or all of the agencies listed previously. Recommending which organization(s) should undertake these activities is, however, beyond the scope of this panel. We suggest that consideration be given to developing an intergovernmental committee to coordinate the implementation of these recommendations.

Basic Research

- Address and appropriately support research on injury conditions that require rehabilitation.
- Consider increases in research budgets of federal agencies to support significant, long-term, basic research studies of rehabilitation issues such as central nervous system regeneration, mechanisms of both normal and injured tissue function, and the impact of pharmacological agents on healing, pain, and bone biology.

Injury and Rehabilitation Surveillance

- Establish a longitudinal population-based surveillance system to determine the incidence, prevalence, etiology, and risk factors for specified impairments, functional limitations, and disabilities resulting from injury. This surveillance system should be designed as a partnership of federal and state public health and research practitioners, clinical research facilities, and rehabilitation agencies.
- Draft model legislation to mandate state-based public health surveillance of injuries that result in disabilities. Link this system to existing trauma registries and include relevant information on rehabilitation. Give special consideration to models for surveillance that can be supported by revenues generated from special-use taxes, such as those on cigarettes or alcohol.
- Develop a burn surveillance system to link causal and short- and long-term outcome information. This system would require the close cooperation of health departments, burn centers, and rehabilitation facilities.
- Conduct a national survey of persons with disabilities to collect more detailed information on injury-related disabilities.

Information Dissemination and Technology Transfer

- Develop and fund a cooperative effort to transfer research information among government agencies and private agencies involved in rehabilitation. Focus on collecting current and pertinent basic, applied, and clinical research findings and disseminating them to clinicians and other health care providers.
- Develop a coordinated approach to educate third-party payers about the complex rehabilitation needs of injured patients.
- Develop and implement a strategy to improve the quality of published rehabilitation research reports. Various professional associations concerned with rehabilitation services should work to improve the peer-review process, evaluate research protocols, and provide support for collecting rehabilitation information.
- Develop resource and information guides for persons with injuries so that those who need rehabilitation and their families can have a better understanding of the latest research and services provided by comprehensive rehabilitation.

- Hold consensus conferences supported by various professional associations to develop minimum clinical treatment guidelines for each major area in injury-related rehabilitation. Make these guidelines available to persons with disabilities, the clinical care community, and the general public.

Increased Capacity for Rehabilitation Services Delivery

- Support nontraditional models for providing rehabilitation services such as independent living centers, improve training and referral systems, and provide more personal care attendants.

- Develop model burn injury centers similar to model SCI and TBI centers.

- Develop a system for the uniform delivery of personal assistance services. This system should, at a minimum, serve all people of any age, regardless of income, include respite and emergency assistance care, not create disincentives to employment, and have a training component for consumers, personal care attendants, payers, and administrators.

- Consider increasing the funds for model SCI and TBI systems of care to demonstrate that rehabilitation care for specific disabilities can be made universally available throughout the United States.

- Establish disability and injury prevention programs in each state health department.

Research on Clinical and Health Services

- Increase support for clinical research and clinical trials on improved approaches to comprehensive rehabilitation. This research should focus on injured persons of all ages and should include an examination of early rehabilitative interventions and the contributions made by all rehabilitation-related professions such as physiatry, physical therapy, clinical psychology, social work, and dentistry.

- Conduct population-based and longitudinal studies to better establish the prognoses and medical rehabilitation needs of patients with traumatic brain injury, spinal cord injury, and burns.

- Develop an inventory of all rehabilitation facilities to determine their location, the population served, and disease categories dealt with. Consider ways to upgrade facilities with the goal of making them model treatment centers.

- Fund research and demonstration projects that focus on strategies to enhance living with the long-term consequences of disability. Include important psychosocial components such as stress management, psychosocial integration into the community, vocational guidance and training, and independent living services (e.g., personal care attendants, peer counseling, and transportation).

- Support research to assess the strengths and weaknesses of various service delivery models for providing designated services to persons disabled because of injury.
- Initiate research on alternate models of health care and rehabilitation services that could complement traditional medical models.
- Identify new research paradigms and statistical methods to assess the complex interactions among multiple impairments, functional limitations, and disabilities.
- Support research of secondary conditions that develop after the acute phase of rehabilitation and throughout the lives of people with residual disabilities. Such studies are needed to understand the long-term sequelae of injury, the outcomes of rehabilitative services, and what new services (such as health promotion), if any, are needed to enhance the health, productivity, and quality of life of persons with disabilities.
- Develop a strategy to evaluate national health care funding mechanisms for rehabilitative services, especially with respect to the needs of persons who are disabled because of injury. Consider developing guidelines or single points of access that would meet the lifelong needs of these people.
- Induce third-party payers such as workers' compensation programs, insurance providers, and Medicare and Medicaid programs to support service demonstration programs that permit people with disabilities to maintain eligibility for Social Security and Supplemental Security Income after they return to work.
- Adopt the nomenclature recommended by the Institute of Medicine in its report, *Disability in America: Toward a National Agenda for Prevention*. The report describes a model with four related but distinct concepts: pathology, impairment, functional limitation, and disability.

Training

- Add courses on caring for people with disabling injuries to the curriculums of nursing, physical therapy, and occupational therapy schools.
- Include the principles and practices of rehabilitation in the training of physicians, especially of physicians involved with people requiring acute care for burn or extremity injuries.
- Increase support for predoctoral and postdoctoral training for people who wish to specialize in the clinical and research aspects of rehabilitation services.

References

1. Stover SL, Fine PR, editors. Spinal cord injury: the facts and figures. Birmingham AL: University of Alabama at Birmingham, 1986.

2. Graitcer PL, Maynard FM, editors. Proceedings of the First Colloquium on Preventing Secondary Disabilities Among People with Spinal Cord Injuries. Atlanta GA: Centers for Disease Control, 1991.

3. Apple D, Hudson L, editors. Spinal cord injury: the model. Atlanta GA: The Georgia Regional Spinal Cord Injury Care System, Shepherd Center for Treatment of Spinal Injuries, 1990.

4. Ducker TB, Bellegarrique R, Salcman M, Walleck C. Timing of operative care in cervical spinal cord injury. Spine 1984;9:525-31.

5. Bracken MB, Shepard MJ, Collins WF, Holford TR, Young W, Baskin DS. A randomized, controlled trial of methyl-prednisone or naloxone in the treatment of acute spinal cord injury: results of the Second National Acute Spinal Cord Injury Study. N Engl J Med 1990;322:1405-11.

6. Frankowski RF, Annegers JF, Whitman S. The descriptive epidemiology of head injury in the United States. In: Becker DP, Povlichock JT, editors. Central nervous system research status report, 1985.

7. Kraus JF, Black MA, Hessol N, Ley P, Rokaw W, Sullivan C. The incidence of acute brain injury and serious impairment in a defined population. Am J Epidemiol 1984; 119:186-201.

8. Kottke, FJ. Therapeutic exercise to maintain mobility. In: Kottke FJ, Stillwell GK, Lehmann JF, editors. Krusen's handbook of physical medicine and rehabilitation, 3rd ed. Philadelphia: WB Saunders, 1982:389-402.

9. Lehmkuhl LD, Thoi LL, Baize C, Kelley CJ, Krawczyk L, Bontke CF. Multimodality treatment of joint contractures in patients with severe brain injury: cost, effectiveness, and integration of therapies in the application of serial/inhibitive casts. J Head Trauma Rehabil 1990;5:4.

10. Ben-Yishay Y, Silver SM, Piasetsky E, Rattok J. Relationship between employability and vocational outcome after intensive holistic cognitive rehabilitation. J Head Trauma Rehabil 1987;2(2):35-48.

11. Prigatano GP, Fordyce DJ, Zeiner HK, Roueche JR, Pepping M, Wood BC. Neuropsychological rehabilitation after closed head injury in young adults. J Neurol Neurosurg Psychiatry 1984;47:505-13.

12. Wehman P, Kreutzer J, West M, Sherron P, Diambra J, Fry R. Employment outcomes of persons following traumatic brain injury: pre-injury, post-injury, and supported employment. Brain Inj 1989;3:397-412.

13. Fryer LJ, Haffey WJ. Cognitive rehabilitation and community readaptation: outcomes from two program models. J Head Trauma Rehabil 1987;2(3):51-63.

14. Sandel ME. Rehabilitation management in the acute care setting. In: Horn LJ, Cope DN, editors. State of the art review: traumatic brain injury. Philadelphia: Hanley and Belfus, 1989;3:27-42.

15. Carey RG, Seibert JH, Posavac EJ. Who makes the most progress in inpatient rehabilitation? An analysis of functional gain. Arch Phys Med Rehabil 1988;69:337-43.

16. Helm PA, Johnson ER, Carlton AM. Peripheral neurological problems in the acute burn patient. Burns 1977;3:123-5.

17. MacKenzie EJ, Morris JA, Smith G, Fahey M. Acute hospital costs in the United States: implications for regionalized systems of care. J Trauma, In press.

18. MacKenzie EJ, Shapiro S, Smith RT, Siegel JH, Moody M, Piti A. Factors influencing return to work following hospitalization for traumatic injury. Am J Public Health, 1987;77:329-34.

19. Kelsey JL. Epidemiology of muscoloskeletal disorders. New York: Oxford University Press, 1982.

20. Frymoyer JW. Epidemiology. In: Frymoyer JW, Gordon SL, editors. New perspectives on low back pain. Park Ridge IL: American Academy of Orthopaedic Surgeons, 1988:19-33.

21. Klein BP, Jensen RC, Sanderson LM. Assessment of workers' compensation claims for back strains/sprains. J Occup Med 1984;26:443-8.

22. Waddell G. A new clinical model for the treatment of low back pain. In: Goel VK, Weinstein JN, editors. Biomechanics of the spine: clinical and surgical perspective. Boca Raton FL: CRC Press, 1990.

23. Quebec Task Force on Spinal Disorders. Scientific approach to the assessment and management of activity-related spinal disorders. Spine 1987;12(7S):S1-60.

24. Ohnmeiss DD, Stith WJ, Gilbert P, Rashbaum RF. Treatment of acute low back pain. Spine 1989;3:69-81.

25. Waddell G, Main CJ, Morris EW, DiPaola M, Gray ICM. Chronic low back pain, psychological distress and illness behavior. Spine 1984;9:209-13.

26. Deyo RA, Diehl AK, Rosethal M. How many days of bed rest for acute low back pain? N Engl J Med 1986;315:1064-70.

27. Frymoyer JW, Pope MH, Clements JH, Wilder DG, MacPherson B, Ashikaga T. Risk factors in low back pain: an epidemiological survey. J Bone Joint Surg 1983;65-A:213-8.

28. Snook SH. Low back pain in industry. In: American Academy of Orthopedic Surgeons' Symposium on Idiopathic Low Back Pain. St. Louis: CV Mosby, 1982:23-38.

29. Beals RK, Hickman NW. Industrial injuries of the back and extremities: comprehensive evaluation — an aid in prognosis and management: a study of 180 patients. J Bone Joint Surg [Am] 1972;54-A:1593-611.

30. Million R, Hall W, Nilsen KH, Baker RD, Jayson MIV. Assessment of the progress of the back-pain patient: Spine 1982;7:204-12.

31. Blumer D, Heilbronn M. Chronic pain as a variant of depressive disease: the pain-prone disorder. J Nerv Ment Dis 1982;170:381-406.

32. Mayer TG, Gatchel RJ, Mayer H, Kishino ND, Keeley J, Mooney V. A prospective two-year study of functional restoration in industrial low back injury: an objective assessment procedure. JAMA 1987;258:1763-7.

33. Forssell MZ. The back school. Spine 1981;6:104.

34. Weinstein SM, Herring SA, Shelton JL. The injured worker: assessment and treatment. Phys Med Rehabil. 1990;4:361-76.

35. Klaber-Moffett JA, Chase SM, Portek I, Ennis JR. A controlled prospective study to evaluate the effectiveness of a back school in the relief of chronic low back pain. Spine 1986;11:120-2.

36. Herring SA. The physiatrist as the primary spine care specialist. Phys Med Rehabil Clin 1991;2(1):1-5.

37. Rice DP, MacKenzie EJ, and Associates. Cost of injury in the United States: a report to Congress. San Francisco CA: Institute for Health & Aging, University of California and Injury Prevention Center, The Johns Hopkins Univ., 1989.

38. Tielsch JM, Parver L, Chanker B. Time trends in the incidence of hospitalized ocular trauma. Arch Ophthalmol 1989;107:519-23.

39. Karlson TA, Klein BE. The incidence of acute hospital-treated eye injuries. Arch Ophthalmol 1986;104:1473-6.

40. Hamilton BB, Granger CV, Sherwin FS, Zielezny M, Tashman JS. A uniform national data system for medical rehabilitation. In: Fuhrer MJ, editor. Rehabilitation outcomes: analysis and measurement. Baltimore: Paul H. Brookes, 1987.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1992-634-666