

Public health approaches to occupational injury prevention: do they work?

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Occupational injuries represent a considerable part of the injury burden to society, affecting people in the most productive years of their lives. Globally, almost 1000 workers are killed by injuries every day, and about six of every 1000 workers will be fatally injured at work during a 40 year work life span.¹ Non-fatal injuries are an even more pervasive problem. In the United States alone, recent studies estimate that almost 16 000 workers daily are hurt on the job, approximately six million occupational injury cases annually.² The field of public health has made significant contributions to worker safety in the United States in the past century. In fact, one review³ concluded that two of the top 10 leading public health achievements were the decline of workplace injury fatalities from 37 to four fatalities per 100 000 workers between 1933 and 1997,⁴ and the reduction in motor vehicle fatalities (many of which are work related) from 18 per 100 million vehicle miles traveled in 1925 to 1.7 in 1997.⁵ While the above achievements demonstrate considerable progress, the wide variations in reported occupational injury fatality rates between industrialized countries and even within industries in the same country^{1 2} suggest that much more can be done.

This special issue of *Injury Prevention*, and the recent National Occupational Injury Research Symposium (NOIRS) from which it derives, represent milestones in the public health approach to occupational injury research and to occupational injury control. The articles contained herein and my discussion in this commentary, demonstrate the new focus on the comprehensive, multidisciplinary methods of reducing work injuries that we believe will define the field of occupational public health in the new millennium.

Milestones

The occupational injury focus of this special issue is significant for several reasons. First, it is gratifying to see occupational injury research being published in *Injury Prevention*. This broadened focus by the journal was initiated earlier this year with a commentary and several articles on work related injuries and the consequences of work exposures.⁶⁻⁹ All too often studies of occupational injuries have been considered separate from other injury problems, relegated largely to occupational health and safety publications. The fragmentation of injuries into artificial categories such as "intentional", "unintentional", and "occupational" has resulted in an inefficient and sometimes unequal use of the limited resources available to combat the causes and the consequences of this important aspect of health care. This

problem is compounded by the fact that in many countries there are separate organizational entities for workplace injury control programs and those devoted to general community injury control. For example, while the United States National Center for Injury Prevention and Control considers itself to be the federal focus for injury prevention, their mandate includes everything *except* injuries occurring in the workplace.¹⁰ Similarly, an analysis of the content of the World Health Organization (WHO) Violence and Injury Control Program web site found not a single mention of occupational injuries.¹¹ The subdivision of work and non-work injuries is becoming increasingly artificial and ignores the reality that there is often little difference between the mechanisms of injuries occurring on and off the job. Both work and non-work injuries can and should be subject to the public health approach outlined in the article by Nancy Stout found in this issue.¹²

This supplement also celebrates another milestone—namely, the second NOIRS conference that brought together the occupational health and injury prevention communities.¹³ Participants at this and the earlier meeting in 1997¹⁴ included representatives from many different backgrounds, and camaraderie has rapidly developed across disciplines and even nations. Many new friendships and collaborations were fostered. An important realization from these meetings was the breadth of occupational injury research being conducted, ranging from laboratory studies of working at elevation, to an evaluation of school based education to improve farm safety in teenagers. Another insight gained from the NOIRS meetings was the great learning opportunities afforded not just across disciplines but also across nationalities. Many occupational injury problems are similar between countries, yet differences in some injury rates suggest there is much we can learn from each other. Towards this end, NOIRS has become an international conference, drawing participants from at least 14 different countries. We have tried to reflect the diversity of interests and disciplines in this issue.

Public health approach to injury prevention

Beginning in the early 1950s, public health has emphasized a broader approach to injury control, moving beyond educational methods to "accident prevention".¹⁵ The public health approach views prevention from the standpoint of population based risk. It identifies and targets workers in high risk occupations, those underserved by traditional occupational safety

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programs, and areas where wide gaps exist in injury rates and hazards in those doing similar tasks. At the end of the 1990s the National Occupational Research Agenda (NORA) offered a broad strategy for traumatic occupational injury research based on the public health model.¹⁶ The subsequent sections of this commentary discuss how NORA and the articles in this issue fit into the traditional public health approaches to prevention, namely:

- Surveillance—problem identification and prioritization.
- Risk factor identification—analytic injury research.
- Intervention development and evaluation—identification/development of prevention/control strategies.
- Implementation—methods to put into practice and evaluate prevention and control programs.

Surveillance

IMPROVING DATA SYSTEMS

Key to the public health approach to injury prevention is the development of good data systems needed to identify problem areas, prioritize the issues, and evaluate the effectiveness of prevention strategies. The earliest continuously reported data for the United States are from the National Safety Council, who began regular reporting of estimated numbers and rates of work related fatalities nationwide in 1933.¹⁷ However, the great variability in occupational fatality data resulted in little understanding of the true magnitude of the nation's occupational injury burden. For example, in 1990 official estimates of work related fatal injury ranged from 2900 to 10 100.^{17 18} Data systems improved dramatically in the early 1990s, starting with the National Traumatic Occupational Fatality (NTOF) system built on uncoded death certificate information from 1980.^{19 20} Subsequently, the more comprehensive Census of Fatal Occupational Injuries (CFOI) was developed that provided extensive case level data on all workplace fatalities beginning with 1992 data.¹⁹ The effect of moving to individual case based counting from estimating procedures based on ICD codes resulted in National Safety Council estimates falling from 9800 fatalities in 1991 to 4968 in 1992 (6026 in 1998), the year they started using CFOI.¹⁷ The improved data from NTOF and CFOI have led to many changes in public attitudes and policy such as the attention given to workplace violence prevention in the United States.^{21 22} Occupational homicides have declined 34% from 1994 to 1998,²³ compared to only a 25% decline in community homicide rates.²⁴ Similar advances in improving and using workplace fatality data have been made in other countries.⁷ Several papers in this issue demonstrate the next generation in occupational injury surveillance technology that should result in even greater accuracy and specificity of work related morbidity and mortality.^{25 26}

IMPROVING THE USE OF DATA THROUGH FREE TEXT ANALYSIS

It is important to make full use of all available data. One area of information mining that is gaining increasing attention is the use of free text data.^{20 26-29} The available text data on death certificates in the United States, although limited, can provide invaluable information on injury circumstances and location by allowing searches for specific words.^{20 30} In other countries, such as New Zealand, free text has been entered on the vital statistics file for many years and has proven an invaluable source of data for injury research.³¹ The addition of free text data to any injury database can greatly improve the value of the original data source as a case finding tool.

Williamson *et al* takes free text analysis beyond its use as a case finding tool and explores how text information can be computer coded to overcome incompatibility in injury mechanism coding between countries.²⁶ One of the major limitations of doing international comparisons of work related injuries is comparability of data coding and definitions.⁷ The free text data available in the records from Australia, New Zealand and the United States, however, allowed computer coding of cause of injury information across national classification systems, making comparison of occupational injury statistics feasible. While Williamson's paper demonstrates the feasibility of coding by computer, the difficulty of achieving exact coding of complex cases using free text data makes it doubtful that machine coding could completely replace manual coding. Despite these caveats, if specificity was set high such that few cases were incorrectly coded and the remaining cases were hand coded, we believe that the savings from machine coding in terms of cost and manpower would be substantial and may even result in more consistent coding.

An important barrier to more widespread use of free text data is the lack of standardization regarding how information is recorded. Some descriptions may be very informative while others may be very limited. Interactive computer prompts with branching questions provide an opportunity to record more detailed and systematic information on injury causes, such as is being used in the new United States National Health Interview Survey.³² These prompts also allow a more structured approach to the collection of free text and the potential to incorporate software to recognize certain words that prompt for more detail. The benefits of this approach will include decreased abstraction time and improved machine coding of narrative text. Other new developments in free text mining include advanced software that uses multiple word combinations and recognizes the context in which a word is used. Such software has already been used by national security agencies and has been adapted for the analysis of aviation mishaps (Dodd R, personal communication, 1 June 2001).

IDENTIFICATION OF WORK RELATEDNESS

The complete and accurate estimation of non-fatal occupational injuries is frequently hampered by the limitations of currently available surveillance systems, which separate data for work related injuries from information about all injuries in the population. Neither system is complete because the latter seldom includes indications of work relatedness and the former often excludes certain sectors of the workforce and/or suffers from underreporting of occupational injuries.^{33 34} For example, the proportion of injury hospitalizations related to work is unknown in the United States (and most countries) because external cause codes do not separately identify "injuries at work". Workers' compensation as the expected source of payment on hospital discharge data may be useful to identify some, but not all "at work" injuries.³⁵ Just as "cause of injury" coding is now mandated on many statewide hospital databases, so should "injury at work: yes/no" be a required field included on all hospital discharge and other databases containing injury data.

The identification of non-hospitalized occupational injuries has improved considerably in recent years, as demonstrated by Jackson's paper which discusses efforts to improve the detection of occupational injuries presenting to emergency departments through the National Electronic Injury Surveillance System (NEISS).²⁵ Originally developed to track only injuries related to consumer products, NEISS was first used to gather information on selected occupational injuries in 1981, and since 1996 they have collected data on all occupational injuries. NEISS has recently expanded to include all injuries (work and non-work) in two thirds of the sample hospitals, but because of limited resources specific E codes are not assigned.³⁶ Most National Center for Health Statistics surveys also now include details on injury causes and work relatedness.^{25 32 37}

Emergency department data are important but may not be representative of all medically treated injuries. Attendance may vary by injury severity, insurance status, local referral practices (especially after hours) and the existence of other clinics, particularly those in the workplace.³⁸ NEISS and other record based surveys also rely on the accurate reporting of work relatedness in the original medical record. The addition of specific questions on "injury at work" in the recent redesign of the National Health Interview Survey is a major advance in achieving a more complete population based estimate of all non-fatal occupational injuries.³² The development of integrated company-wide surveillance activities such as that implemented by Ford Motor Company,²⁹ by the Army,³⁹ or through linkage of insurance claims with outcome data,⁴⁰ represents the future of improved surveillance and provides invaluable information to develop, and evaluate prevention programs. An important aspect of these systems is the ability to link data from different sources for more in-depth studies.

USE OF CASE BASED SURVEILLANCE

INVESTIGATIONS FOR PREVENTION

Not all injury problems require detailed population based surveillance data or etiological studies of risk factors to develop prevention programs. Often a single, well done case investigation (an important component of traditional safety investigations) can lead to important prevention strategies. The Fatality Assessment and Control Evaluation (FACE) Program described by Higgins *et al* is an example of a systematic public health approach to case investigations.⁴¹ FACE uses the classic model of agent, host, and environment to examine factors that present during the pre-event, event, and post-event phases of injury occurrence.⁴² Preventive action was taken based on a single case investigation of an electrocution from a faulty water pump in a public swimming pool. It is gratifying to see that 73% of respondents who received the initial hazard alert had their pools inspected, especially since 37% of those reported finding electrical problems. The more lasting effects of this work, however, was its translation into state legislation mandating regular inspection and certification of electrical equipment in public pools.

The identification of a newly emerging hazard created by the construction of cell phone towers is another example of the value of case investigations, and how they can inform prevention practitioners at other agencies.⁴¹ Case reports from FACE are available on the internet and encompass both topic and state specific investigations, allowing for early identification of new occupational injury risks by making all the isolated reports accessible in a single location. For example, a review of FACE investigations from Minnesota covers reports ranging from attacks by a bull, or being engulfed by corn in a grain bin, to being struck by a falling 400lb zoo cage.⁴³ The widespread dissemination of study findings and prevention recommendations from FACE has been an important component of its success.

The report of serious burns from portable oxygen systems (see in issue) also provides very compelling evidence for the utility of specific cause investigations for identifying and rectifying specific hazards, namely the fire risk when portable oxygen cylinders are tested.⁴⁴ The strength of this study is that it also proposed practical solutions to observed hazards, such as using brass regulators rather than those made from the more combustible aluminum. The study also illustrates the way such investigations can inform the standards setting process, in this case the development of a national standard and testing system for oxygen regulators.

Risk factor identification

A wide variety of factors contribute to workplace injury risk, including hazardous environmental conditions, individual worker characteristics, economic issues, social, and other workplace organizational factors.^{16 45 46} Well designed scientific studies are needed to identify, quantify, and prioritize modifiable risk

factors that can be used to develop occupational injury prevention strategies. The multifactorial nature of occupational injuries necessitates research incorporating the skills and methods from a variety of disciplines. This is the reason that, perhaps more than any other field, injury science as a whole is multidisciplinary, embodying diverse fields such as epidemiology, biomechanics, physics, ergonomics, mechanical engineering, law, and the political, behavioral and medical sciences.¹⁵⁻⁴⁷ The field of occupational injury science is no different. The articles in this issue represent some of the methodological skills needed to find solutions to the dangers encountered in the workplace.

EPIDEMIOLOGIC STUDY DESIGNS: CASE-CROSSOVER STUDIES

Many epidemiological study designs have been used to study occupational injuries including hybrid study designs, which can include using alternative control groups such as examining characteristics of sites with and without injuries.⁴⁸⁻⁵⁰ The case-crossover paper by Sorock *et al* (see this issue) describes one area where new epidemiological methods are being developed to study injuries at work.⁵¹ This paper represents the collective wisdom of participants in a workshop on this topic at NOIRS. The case-crossover method is a novel approach to overcoming some of the problems in conducting case-control studies in the workplace. This innovative method addresses the question “what is different about the time period just before a person had their injury compared to other times when the person was not injured on the job?”. Subjects are both cases and controls: they are controls when they are not injured; becoming cases at the time the injury occurs. The approach is attractive for a number of reasons, particularly as it obviates the expense and difficulty involved in selecting and interviewing control subjects. Even more important, this design eliminates between subjects confounding as a source of bias. Some aspects of the case-crossover methodology however need further investigation, especially the impact of differential recall of factors at the time of the injury compared to other times. Additionally, risk estimates derived from case-crossover studies may vary from those derived from traditional case-control designs, as the designs often answer slightly different questions.⁵¹

EXPERIMENTAL LABORATORY STUDIES

Experimental laboratory studies often provide important information to guide the development of intervention strategies. The study on balance control by Simeonov is an example of issues that are difficult to study at the worksite due to ethical or practical concerns but can be done safely in the laboratory setting, without loss of generalizability to the actual workplace.⁵² Ergonomic and biomechanical studies utilizing new investigative methods to simulate the circumstances of injury, such as the studies presented at the special sessions at NOIRS related to slips, trips and falls, and on the use of

virtual reality to simulate hazardous environments,¹³ can provide valuable insights into injury etiology and prevention of injuries. While Simeonov *et al*'s study does not directly prove that increasing the presence of solid visual reference points for example will reduce the risk of falls, this research and others like it can provide the evidence needed to implement effective prevention programs, especially since randomized controlled trials of injury prevention interventions (often considered the gold standard),⁴⁹ are difficult if not impossible to conduct under such situations.

Intervention development and evaluation

Strategies to prevent workplace injuries vary widely and include engineering controls, protective equipment, education/training, and regulatory and management practices (including those that encourage safe behavior and practices). We have come a long way from relying on safety posters and brochures to educate workers, as illustrated by the spectrum of interventions discussed in this issue. However, as noted in the special feature by Barry Pless,⁵³ the relative paucity of studies evaluating interventions, both in the literature and at NOIRS, is a reflection in part of the relative “newness” of the field compared to many other areas. The design and implementation of interventions should be based upon a solid understanding of effective prevention methods. However, in many areas this is not the case. To address this issue, good etiological research, both epidemiological and experimental, is needed to identify and addresses modifiable risk factors. Without good science to back up interventions, prevention efforts may fail or even do harm. Many workplace interventions are being promoted (including training programs)⁵⁴ that have not been scientifically evaluated, or, as in the recent case of back belts, are ineffective.⁵⁵

DESIGN OF ENGINEERING SOLUTIONS

Redesign of the job or engineering solutions to make it safer are still two of the most effective prevention strategies available. The paper by Powers *et al* on the performance of the automated rollover protective structure (Auto-ROPS) is an example of an effective engineering solution to reduce tractor injuries, and is a fitting tribute to the memory of the late Dr Karl Snyder who championed this work at NIOSH.⁵⁶ One of the major difficulties in implementing ROPS has been the use of permanent structures in low clearance areas such as barns and fruit orchards. The practical solution outlined in this paper goes a long way to overcome these barriers.

PERSONAL PROTECTIVE EQUIPMENT

Many hazards in the workplace are difficult to completely eliminate. However, much can be done to reduce risk such as the use of protective clothing or by improving chances of survival once injured. The study by Prezant *et al* is an excellent example of how improved protective clothing can provide a major reduction in burn injury risk to firefighters.⁵⁷ Burns

to the head from serious fires were reduced by 46%, and burns to the upper extremities by 86%. The second part of the study is also interesting in that it demonstrates that a more comfortable uniform under the improved outer layer does not reduce its protection effectiveness.

EDUCATIONAL INTERVENTIONS

Farming is a particularly hazardous occupation and represents a group of workers difficult to reach by traditional safety programs or legislation. The study by Reed *et al* is a good example of an educationally based intervention to reduce injuries to children and teens on farms.⁵⁸ The study is well grounded in modern behavioral change theory, and while not examining a direct effect on reducing injuries; significant improvements were made in safety attitudes and readiness to change. The real test in educational evaluations is to demonstrate the relationship of attitude change to reductions in injury rates. Such studies are however difficult to conduct and often very expensive.⁵⁹ Long term follow up of farming injury incidence rates within this population are warranted.

Other issues in developing workplace injury prevention interventions

While the papers in this issue treat a variety of important topics in the area of occupational injury prevention, several important issues are not represented. It is hoped that future volumes of this journal will include reports on other approaches such as community based interventions, international comparisons that document differences in prevention strategies, and injury prevention methods directed at all phases of injury occurrence or mitigation.⁴⁷

COMMUNITY INJURY PREVENTION IN THE WORKPLACE

Traditional occupational injury prevention has focused on individual workplaces that employ many workers, and tended to ignore small workplaces, despite the fact they often have some of the highest injury rates.⁶⁰ In many environments, both in market economies and in developing countries, there is also little separation of activities between home and work.⁴⁷ Many of these non-traditional workplaces are excluded from health and safety regulations. A potential solution to this problem is to focus on community-wide efforts at prevention.⁶¹

There is much that occupational injury practitioners can learn from the rest of the injury field with regard to serving community groups, such as in the expanded community based efforts to reduce injuries to farm children.⁶² Pless's call to establish contacts between researchers and consumers may help ensure that research will be of use to those who it was designed to help.⁵³ Some non-occupational health funding agencies now included consumers (such as breast cancer survivors) as peer reviewers for their grants programs.^{63 64}

Pless also noted that there are some important differences between workplace and other injuries, especially with regard to the implementation of prevention strategies.⁵³ These differences may actually present some unique opportunities to the non-occupational injury prevention community to develop, implement, and evaluate prevention efforts. Many injuries have similar causes no matter where they occur. The workplace can be a valuable laboratory to implement and evaluate community prevention efforts directed at both on-the-job and off-the-job injuries, as demonstrated by the many workplace programs designed to increase seat belt use.^{65 66} Often there are regulations or laws in the workplace that may make it easier to enact or enforce rules than in the outside community. The worksite also provides a captive population to deliver prevention programs, including those directed at lifestyle choices. Finally, some companies, especially those that self insure their employees, have good data systems for capturing information not just on work related injuries, but also about all worker health problems.²⁹ As the trend toward company self insurance continues to grow, the opportunities to monitor and improve total worker health within the organizational setting will also grow. These can facilitate intervention evaluation and provide opportunities to evaluate the costs and benefits of the intervention.

INTERNATIONAL COMPARATIVE STUDIES

The wide variation in injury rates between countries^{1 7 47} suggests that there may actually be natural experiments of intervention implementation already in place, if we can recognize them. Higher fatality rates have been identified in fishermen in New Zealand compared to Australia and the United States. Similarly, electrocution fatality rates were higher in Australia compared to New Zealand, a country with the same voltage (240 volts).⁷ Whether this is due to different exposures or safety practices between countries has yet to be determined, but more in-depth analyses of causes such as begun by Williamson *et al*²⁶ or of workplace policies (such as use of ground fault circuit interrupters)⁶⁷ may reveal differences that could lead to important reductions in fatalities. The recent addition of occupational injuries to the studies included under the International Collaborative Effort of Injury Statistics is an important step in this direction.⁶⁸

DECREASING INJURY SEVERITY AND POST-EVENT INTERVENTIONS

The early pioneers in injury control realized the need for a broader approach to injury prevention at a time "when educational approaches to 'accident prevention' were the most popular".¹⁵ Many workplace programs still continue to emphasize only the pre-event phase. Some of the more effective general injury prevention strategies have been directed at reducing both the severity and likelihood of an injury during an event, or improving recovery from an injury. The efforts to increase

automobile safety through better vehicle crash-worthiness and highway barriers are examples of effective interventions directed at the event phase.⁴⁷ Similarly, the dramatic reduction in fishing fatalities seen in a study in Alaska were primarily due to increasing survival in the post-event phase and had little effect on reducing boating mishaps.^{69–70} Rather than thinking of minor injuries or near misses as indicators of the potential for more serious injuries, it may be more productive—and accurate—to view such incidents as indications of what was done right rather than as failures in prevention. Rehabilitation programs that speed recovery and return to work are also an important part of any comprehensive injury prevention program,⁴⁹ but are beyond the scope of this paper. In developing new intervention strategies, it is essential to consider the whole spectrum of approaches to reduce the burden of injuries and not just consider strategies directed at the pre-event phase.

Implementation and dissemination of existing knowledge

While more needs to be done to develop and evaluate new intervention strategies, there is also much we already know that works. An important area of investigation is how to eliminate those injuries that could be prevented if we applied what we already know. While effective communication of knowledge and transfer of technology to those who can use it are important, other barriers still exist.

MANAGEMENT AND ORGANIZATIONAL ISSUES

The paper by Becker *et al* provides one example of how to overcome institutional barriers to implementation and get proven interventions out to diverse and difficult to reach worksites, such as construction.⁷¹ Management attitudes to safety and organizational factors are important determinants of injury risk,⁴⁶ and Becker *et al*'s study provides an organizational framework to facilitate management commitment to fall safety programs. A key program ingredient was accountability and labor management involvement. While the study found that safety practices improved, there is also a need to demonstrate if these result in actual injury reductions. Control contractors without the intervention also improved in their safety practices, which illustrates the importance of including control populations when evaluating interventions.⁵⁹ The “Maine 200” initiative, conducted as part of efforts to “reinvent worker safety and health” at the Occupational Safety and Health Administration, is an example of applying targeted management approaches towards prevention activities by government.⁷²

COST

Another implementation barrier is cost. Many of the intervention strategies discussed in this volume, and in a recent review of effective workplace injury interventions⁷³ are expensive. However, the direct costs are often less or no greater than those used to fix the problem once it has occurred, and the indirect costs in the

prevention of worker pain and suffering, lost income and lost opportunities probably render many of these technologies even more cost effective. For example, the major barrier to ROPS use has been the high cost of retrofitting existing tractors, estimated to be at \$937 per tractor in 1993 or \$825 000 per life saved.⁵⁶ While this may seem high, it is about the median cost of lifesaving interventions currently being implemented in society (assuming that about 20 life years are saved per case by ROPS).⁷⁴ Cost effectiveness analyses have found that for the range of interventions studied, injury prevention interventions have very favorable cost: benefit ratios. In addition, when the cost per life year saved is compared, those directed at issues such as cancer reduction are usually much more expensive than those for injuries.^{74–75} There is a need to include more cost effectiveness studies when conducting injury intervention studies.

IMPLEMENTING THE PUBLIC HEALTH MODEL

A major challenge to public health is how to implement the public health approach to occupational injury prevention in the field. The suggestion by Pless that health departments get more involved in occupational injury prevention is an important part of implementing this approach.⁵³ Health departments are in a unique position to reach the groups not well served by traditional occupational health and safety agencies, and to coordinate efforts across different jurisdictions. One successful implementation of the public health model at the state level is Alaska's occupational injury prevention program. Surveillance data identified Alaska as the state with the highest occupational fatality rate in the United States, almost five times the United States average and about 10 times that of Norway with a similar industrial make-up.⁶⁹ A multiagency collaborative prevention effort was then developed based on the public health approach of (A) establishing surveillance; (B) building multiagency collaborations; (C) prioritizing prevention efforts based on surveillance data; and (D) planning appropriate prevention strategies tailored to local conditions. From 1991 to 1998, overall occupational injury fatalities decreased 46% (49% from 1990–99, see updated data in fig 1) with the largest improvements occurring in fishing and logging (particularly helicopter logging), two areas identified as priority areas for intervention. An important part of this process was the application of prevention strategies at multiple phases of the Haddon matrix. For example, in logging the biggest improvements came from pre-event strategies, while in fishing the survival rate of each incident improved dramatically, due in part to requiring new safety equipment such as immersion suits, life rafts, and radio beacons to increase the chances of finding vessels.

While not all localities have the benefit of collaboration with a local office of NIOSH, the Alaska example provides an important lesson for what can be achieved at a state level. However, the capacity of state (and local) health

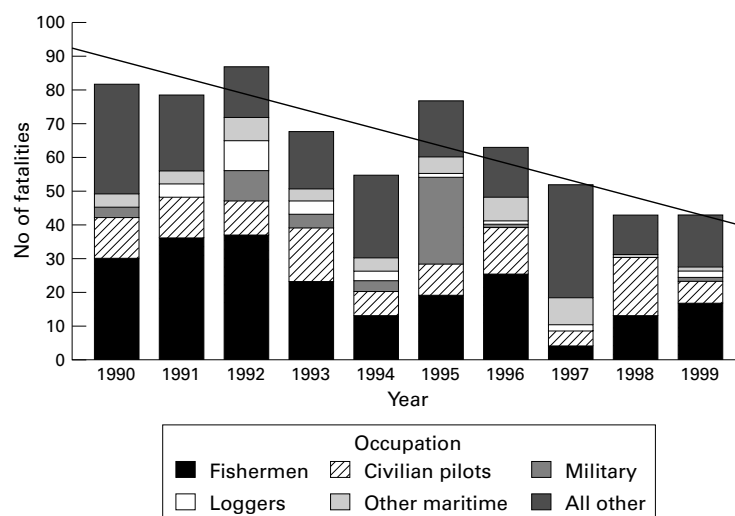


Figure 1 Decline in occupational injury fatalities in Alaska by occupational group and year, 1990–1999 ($n=648$). Source: Alaska Occupational Injury Surveillance System, updated data from Conway et al, 1999.⁶⁹ Trend line shows total fatality decline.

departments to address occupational health problems (including injuries) varies widely and has been identified as an important area for development.⁷⁶ New Jersey is one state with a well-developed program.⁷⁷ Given the often well established state based activities in non-occupational injury prevention,⁷⁸ it would make sense to coordinate their activities with any expansion of occupational injury prevention efforts.

Conclusions

The articles in this issue, and other reviews of occupational injury interventions, demonstrate that we have made considerable advances in our understanding of injury causes and the means of reducing injuries. To achieve significant injury reductions will require a much more focused effort of many different groups, and a societal commitment that any occupational injury is unacceptable. It will also require the development of a skilled scientific workforce to conduct the necessary injury research and train investigators and practitioners alike. Unlike other areas of science, funding for occupational injury research training has not kept up with needs, and a recent report by the National Academy of Sciences Institute of Medicine identified a critical shortage of doctoral level graduates in occupational injury prevention.⁷⁹ Many of the new advances in injury prevention will also come about through the integration of laboratory/experimental studies with other public health disciplines. Often experimental articles, such as the studies in this issue, tend to be rather technical in nature and less comprehensive in relating their findings to prior epidemiologic studies. Similarly, the more traditional public health studies in this journal make little reference to experimental laboratory studies or use experimental data to guide their research. There needs to be more dialogue across disciplines in order to overcome some of the institutional barriers to increasing multidisciplinary work, and accessing each other's literature.⁸⁰

While much is already known regarding effective prevention strategies, there is often a

large gap between what we know works and what is implemented. More research is needed to define the barriers to intervention implementation and technology transfer from the laboratory to the workplace. Hopefully, this supplement will stimulate further interest in occupational injuries within the broader injury prevention community.

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