

Technical Reports

The data recording instrument

Establishment of a National System for Surveillance of Injuries

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A PROJECT to establish a system of national surveillance on trauma was initiated during the spring of 1968 by the National Center for Urban and Industrial Health (Injury Control Program), Public Health Service. Following the reorganization of the Department of Health, Education, and Welfare in July 1968, part of the responsibility for the establishment of the system was assigned to the Food and Drug Administration (Office of Safety Services).

The project's purpose was to add new and significant epidemiologic knowledge on nontransportation and nonoccupational accidental injuries occurring in the United States; its development has proceeded in three distinct phases. The first phase was concerned with the refinement and specifica-

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tion of the goals of surveillance and the designing and testing of an instrument for recording the data on injuries. The second phase dealt with the application of the data recording instrument and the establishment of a reporting network. The final phase comprises an ongoing evaluation of the reporting system, including the preliminary analysis of the data. I shall describe the development of the initial phase of the surveillance system.

Background

Efforts to control injuries. The morbidity and mortality from injuries has long been of such magnitude as to constitute a national tragedy. Accidental injury is, and for the past several decades has been, the leading cause of death and incapacity for persons between 1 and 35 years of age. In 1900, accidental death was the seventh leading cause of death. By 1970, accidental injuries had become the fourth leading cause. The death rate for all types of accidental injury has been between 50 and 60 per 100,000 population for the past several decades (1). Although complete information on the frequency of morbidity from injuries is lacking, estimates from the National Health Survey (2) indicate that about 300 of every 1,000 men, women, and children in this country suffer an injury every year which requires medical treatment. This rate is equivalent to more than 50 million injuries in the United States annually.

Examination of the data on mortality from injuries available from the National Health Survey (2) and the National Safety Council (3) indicates that efforts to control or eliminate the causes have been less than satisfactory for most types of accidental death.

Despite the tremendous toll of injuries, the circumstances surrounding their etiology still remain clouded. What information there is exists mostly in the form of general or descriptive data on mortality derived from death certificates. There is no information on mortality or morbidity of sufficient detail for epidemiologic study. Descriptions of the agents of injuries, for example, are often lacking or incomplete.

Yet as early as the late 1940's the Federal Government had tried to uncover the causes of injuries. The resources allocated for the study, however, were inadequate; as were those for implementation of control measures. In the Public Health Service, discussion about ways to collect sufficient data to carry out the goals of injury control began in the late 1950's. A few States

Primary Collaborators in Initial Phase

The primary collaborators in the initial phase of the project to establish a system of national surveillance on trauma were all members of the staff of the Injury Control Program, National Center for Urban and Industrial Health, Public Health Service. Their contributions were as follows:

Design of the recording instrument—Emil P. DeJan.

Compilation of list of agents and establishment of reporting network—John H. Morrison and Charles J. Petrillo.

Development of format for read form for optical mark machine, including details of specification and criteria for the design—Norman W. Staehling, David Marchant, and Lee D. McMullen.

Formulation of classifications for injuries and of specifications for recording data—Frederic D. Burg, M.D., Ronald Yeomans, M.D., and John Douglas, M.D.

Testing of the recording instrument and initial implementation of the reporting procedures—Edward Fairchild, Ph.D., James Walters, James Simpson, John Locke, Michael Olvia, and Steve Remais.

were collecting some data on injuries. It was apparent, however, that a national system of reporting the morbidity and mortality from injuries was needed that would reflect the variations in populations and geography in the United States. The initial concepts of an injury reporting system were formulated in the Service's Division of Accident Prevention. Full development of that system became the major focus of the Epidemiology and Surveillance Section of the Public Health Service's Injury Control Program.

Epidemiologic approach. Epidemiologic research offers the same promise for injury control as for infectious disease control. When epidemiologic strategy is applied to disease control, a sequential examination is first undertaken of the distribution of cases according to certain general descriptive factors (mostly demographic). Observations and comparisons are then made from these distributions, and hypotheses explaining the differences in the distributions according to these descriptive factors are formulated and statistically tested. Such epidemiologic principles were first applied to the study of injuries in the 1940's by Gordon (4).

To test hypotheses generated at the descriptive level of epidemiologic analysis, however, additional data are often needed which go beyond the demographic variety. And such data are not being routinely collected or recorded. Nevertheless, information of intermediate depth is essential for the

formulation of the more explicit hypotheses which might explain variations in distributions of deaths and injuries according to such demographic factors as age, sex, race, income, and so forth. Intermediate data may also provide clues to methods of control when completely definitive etiological information is nonexistent or not available. Many epidemiologic studies have promoted disease control without having explicit details concerning the cause of the disease. It seems reasonable to believe that injury control could also be instituted on the same basis.

Injury surveillance. One method of obtaining data for epidemiologic research is by surveillance. Surveillance is generally defined as a system of continuous monitoring or observation of specific events over an extended period. The concept has been used to great advantage in the study and control of infectious disease. Moreover, surveillance of the incidence of mortality and morbidity can add another dimension to basic information on etiology and control programs. Application of this concept in the area of environmental health had been advocated in 1967 in the Linton report (5). One of the principal recommendations that the Task Force on Environmental Health and Related Problems made in this report was that a systems approach of continuous surveillance be established to identify those elements in the environment which are harmful to the public. Another recommendation was that, in its sampling network, the surveillance process should reflect broad geographic and social representation.

It seems likely that a large majority of the persons suffering a serious injury are treated initially in hospital emergency rooms. At hospitals, information about injuries can be obtained directly from witnesses or the injured person and immediately after the injury, whereas other systems of data collection rely on the patient's recall days, months, or even years after the injury has occurred. In many cities and counties, even when persons sustain injuries resulting in death, their bodies are generally routed through the emergency room before being removed to a morgue. Persons with less serious injuries are also often examined and initially treated in the emergency room before being released. Thus, the hospital emergency room seems the most logical place to begin collecting data for etiological studies of injuries.

Nevertheless, it should be pointed out that, while the majority of injured persons are treated initially in hospital emergency rooms, many of the

injured are also seen in the offices of private physicians, the bodies of many of the fatally injured are examined in coroners' offices, and patients are occasionally admitted directly to hospitals as inpatients.

Data collected by surveillance are considered to be intermediate in depth as compared with vital statistics, which are considered superficial, and as compared with data based on case investigation, which are exacting and precise. As would be expected, the cost per injury case recorded varies according to the nature and depth of the data sought. Surveillance data are slightly more expensive to obtain than vital statistics but far less expensive than data based upon the case investigation.

Under a national injury surveillance system, epidemiologic data can be collected that will provide a broad base of descriptive information, and this information can be used to characterize the national mortality and morbidity from injuries. Through surveillance, information can also be collected that is in sufficient and meaningful enough detail to allow presentation of a profile of the injuries occurring in communities, States, and regions and to permit the establishment of priorities and directions for research on injury control. Through surveillance, the patterns of injury incidence over time, the populations with high incidence, and hazardous factors in the environment can be identified.

Methods and Procedures

The overall design of the injury surveillance system entailed the following procedures:

1. Selection of the epidemiologic factors to be recorded.
2. Designing and testing the instrument for recording injuries.
3. Identification and selection of the sources for reporting injuries.
4. Implementation of the reporting records and sources and quality audit of same.
5. Analysis, interpretation, and dissemination of data.

This paper is limited to a discussion (a) of the selection of the epidemiologic data to be recorded and (b) of the design and testing of the surveillance instrument.

Selection of epidemiologic data. From a list of almost 50 potential epidemiologic factors which were considered related to injuries, the final recording instrument was limited because of space

INJURY SURVEILLANCE RECORD

FORM APPROVED
BUDGET BUREAU NO. 000001
RECORD No. 000001

AGE IN YEARS IF 2 YEARS OR OLDER									
0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9
AGE IN MONTHS IF UNDER 2 YEARS									
0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9

M	F	SEX	NS	UNK
00	00		00	00

COLOR/RACE						NS	UNK
WHITE	NONWHITE						
SPAN	OTH	NEG	ORI	AMER	OTH		
00	00	00	00	00	00	00	00

MARITAL STATUS				NS	UNK
SGL	MAR	SEP	DIV	WID	
00	00	00	00	00	00

MONTH OF INJURY								
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
00	00	00	00	00	00	00	00	00
OCT	NOV	DEC						UNK
00	00	00						00

DATE OF INJURY									
0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9
NS UNK									

YEAR OF INJURY									
0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9
NS UNK									

DAY OF WEEK INJURY OCCURRED									
MON	TUE	WED	THUR	FRI	SAT	SUN	NS	UNK	
00	00	00	00	00	00	00	00	00	

TIME OF INJURY	
MIDNIGHT - 5:59 AM	00
6:00 AM - 8:59 AM	00
9:00 AM - 11:59 AM	00
NOON - 2:59 PM	00
3:00 PM - 5:59 PM	00
6:00 PM - 8:59 PM	00
9:00 PM - 11:59 PM	00
NOT STATED	00
UNKNOWN	00

NATURE OF ACTIVITY	
OCCUPATIONAL	00
RECREATIONAL/LEISURE	00
HOUSEHOLD ACTIVITY	00
NOT STATED	00
UNKNOWN	00
OTHER	00
IF "OTHER" PLEASE SPECIFY	
01	

ACCIDENT LOCATION	
HOME-INDOORS	00
HOME-OUTDOORS	00
HOME-NS OR UNK	00
FARM HOME-INDOORS	00
FARM PREMISES-INCL OCCUPATIONAL	00
FARM-NS OR UNK	00
OCCUPATIONAL LOCATION (NONFARM) (NONHOME)	00
SCHOOL FACILITY	00
RESIDENT INSTITUTION	00
PUBLIC BUILDING OR FACILITY	00
RECREATIONAL AREA	00
NONMOTOR VEHICLE TRANSPORTATION	00
HIGHWAY OR STREET	00
NOT STATED	00
UNKNOWN	00
OTHER	00
IF "OTHER" PLEASE SPECIFY	
02	

RECORD NUMBER									
0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9
DO NOT MARK IN THIS AREA									

HOSPITAL NUMBER									
0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9
UNIT CODE NUMBER									
0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9

NATURE OF ACCIDENT	
AUTOMOBILE	FIRE/FLAME
MOTORCYCLE	EXPLOSION
PEDAL CYCLE	HOT SUBSTANCES/SURFACES
BUS/TRAIN	ELECTRIC CURRENT
AIRCRAFT	CORROSIVES
WATERCRAFT	MACHINERY/TOOLS
PEDESTRIAN	APPLIANCES
OTHER MOTOR VEHICLE	CUTTING/PIERCING INST OR OBJECTS
NONMOTORIZED VEHICLE	SUBMERSION (INCL DROWNING)
INHALATION (GAS)	MECH SUFFOCATION
INGESTION	FOREIGN BODY
CONTACT TOXIN	IMPACT
OVEREXERTION	RADIATION
FALLS	NOT STATED
FIREARMS	UNKNOWN
MISC PROJECTILES	OTHER
IF "OTHER" PLEASE SPECIFY	
03	

PATIENT DISPOSITION	
EXPIRED (DOA)	00
EXPIRED IN HOSPITAL	00
EMERGENCY ADM TO HOSPITAL	00
TREATED & ADM TO HOSPITAL	00
TREATED & TRANSFERRED TO OTHER MEDICAL FACILITY	00
TREATED & REFERRED TO PRIVATE PHYSICIAN OR OUTPATIENT DEPARTMENT	00
TREATED & RELEASED	00
LEFT WITHOUT TREATMENT OR NO TREATMENT REQUIRED	00
NOT STATED	00
UNKNOWN	00
OTHER	00
IF "OTHER" PLEASE SPECIFY	
04	

PLEASE READ INSTRUCTION SHEET AND CODING GUIDE BEFORE MARKING FORM.

RECORD NO. 000001

NAME (Victim) _____ LAST _____ FIRST _____ INITIAL _____ PATIENT FILE NUMBER _____ COMPLETED BY _____ RECORD NO. 000001
 LOCAL ADDRESS _____ NUMBER _____ STREET _____ CITY _____ STATE _____ ZIP _____ PHONE _____ DATE _____

NATURE OF INJURY		NOT	APP
(A) PHYSIOLOGIC INSULT (only one response)			
ASPIRATION	POISONING INGESTION		
ASPHYXIATION	POISONING CONTACT		
STRANGULATION	EFFECTS OF TEMP/PRESSURE		
SUFFOCATION	RADIATION		
ELECTROCUTION/ELECTRIC SHOCK	NOT STATED		
DROWNING	UNKNOWN		
POISONING GAS/VAPOR/SMOKE	OTHER		
05 IF "OTHER" PLEASE SPECIFY _____			

DO NOT MARK IN THIS AREA

RECORD NUMBER

IF "OTHER" ON PART "B" PLEASE SPECIFY

06 _____

	(B) TRAUMA (mark as many as applicable)						NOT	APP
	BURN	BURN WITH COMP	AMPUTATION	AVULSION	CONCUSSION	CRUSHING	FRACTURE	
HEAD/SKULL								
FACE								
EAR/EYE								
NECK								
UPPER ARM/SHOULDER								
LOWER ARM/ELBOW								
HAND/WRIST								
FINGERS								
BACK								
CHEST								
ABDOMEN								
PELVIS								
BUTTOCKS/PERINEUM								
UPPER LEG/HIP								
LOWER LEG/KNEE								
FOOT/ANKLE								
TOES								
NOT STATED								
UNKNOWN								

IS THIS A PRODUCT RELATED INJURY		YES	NO
07	MANUFACTURER (BRAND) NAME		
08	MODEL		
09	SERIAL NUMBER		
10	MANUFACTURER (BRAND) NAME		
11	MODEL		
12	SERIAL NUMBER		
13	MANUFACTURER (BRAND) NAME		
14	MODEL		
15	SERIAL NUMBER		

16 REMARKS (INCLUDING ACCIDENT SEQUENCE)

and time to the demographic or descriptive questions about age, sex, color or race, marital status, month, date, day, and time of injury. These factors were considered basic in terms of epidemiologic characterization. Certain other epidemiologic variables, however, were also considered of critical importance, including accident location, nature of the accident, disposition of the victim, nature of the injury, body part(s) involved, and the agent of the injury. At present, no system exists in the country for the systematic collection and recording of data on these latter types of epidemiologic variables.

Criteria for data recording instrument. Before the data recording instrument was designed, three major criteria were considered. These criteria included the person who was to complete the form, the person who was to supply the data to be recorded, and the number of forms to be collected. The person who would most often fill in the data on the form would be the hospital emergency clerk. Answers to questions on the form would be obtained by interviewing the injured person or witnesses or by abstracting data from existing emergency room records. The data recording instrument would have to accommodate both of these contingencies. The anticipated volume of completed forms during a year was about 100,000. A system to automatically process, code, and analyze these forms would have to be established. The system that seemed to afford the quickest and easiest management of raw forms was that of an optical scan, card punch, and magnetic tape sequence.

Recording instruments used in other research projects were examined to see if they could be used. Unfortunately, none of them met the objectives of the planned surveillance and, consequently, had to be rejected. The format of the recording instrument was determined on the basis of the ease of automatic transfer of data from the raw form to magnetic tape.

In optical scan, a system of light reflection results in electronic impulses, which are registered for certain specified areas of the form. Each area of the form corresponds to a question. A series of rows numbered from 0 to 9 are found on the left and right portions of the first page (see form). The scan traces these rows and records the marks that the person filling out the form has made in the spaces.

Many problems were identified while designing the questions, including stray pencil marks on the

form, erasures, cross-over marks, forms marked in ink, and so forth. Nevertheless, the advantages of automatic transfer of the data from the raw form to magnetic tape were found to outweigh the potential difficulties. An International Business Machine publication describes the optical scanning system of data transfer (6).

Design of questions. Most questions appeared to be relatively straightforward, and responses seemed to be mutually exclusive and exhaustive. Because of incomplete recording of information and the absence of similar questions on existing hospital emergency room forms, two specific standard responses were designed. The first standard response was "unknown," that is, the question was answered with a "do not know" response or was left blank (no response given). The second standard response was "not stated," that is, the information was not requested on the existing hospital form and therefore was not recorded. Other responses to questions and explanations were supplied in the Injury Surveillance Coding Guide. (A copy of the guide can be obtained from the author; see author identification.)

Questions about the location of the accident, nature of the accident, and disposition of the patient were designed, whenever possible, so as to correlate with classifications of information in existing systems of data collection. For example, the question "nature of accident" corresponds fairly closely to the general classification of the external cause of injury in the eighth revision of the International Classification of Diseases and Accidents (7).

Questions about the disposition of the patient have routinely been asked in surveys of injuries. The responses, however, have been so broadly grouped as to be of little value. This question was therefore completely redesigned (see form) to overcome this difficulty.

In all existing survey records of injuries, both injuries due to physical trauma and injuries due to physiological insult have been grouped together. In the injury surveillance record, however, these two classes are separated. Also, injuries of multiple types and injuries to multiple parts of the body have traditionally presented difficulties in designing forms. A matrix which could be scanned optically for the type of trauma and for the body part affected and which, furthermore, allowed for multiple responses (see form) was considered an innovation in the recording of data about injuries.

The agent of injury. The concept of an

"agent" in the causation of injury has been documented previously. Gordon (4) and Haddon (8) have discussed this concept in detail. For all types of trauma or physiological insult, the basic agent of injury is energy, either in mechanical, electrical, chemical, radiological, or thermal form. For most injury types, the "agent" has been difficult to delineate and therefore, traditionally, it has not been coded or recorded by reporting sources. "Agent" as used here means the item, substance, material, and so forth that transfers the energy form from a reservoir to the host. The concepts of "contact agent," "source agent," and "vehicle or vector of agent" were introduced (see form) to help distinguish the object or item that inflicts the injury from other associated factors.

Suppose, for example, a burn is caused by direct contact with the stove burner. The contact agent would be the burner. In this case, the identification of the stove burner as the source of the heat which caused the burn provides information beyond that usually found in reports of injuries. Another example would be of a child who ignited his clothing and consequently suffered extensive burns. The contact agent, of course, was the burning clothing. The kind of report which only indicates burns from flaming clothing is generally useless in that the source of ignition of the clothing is not identified. Suppose the child had spilled gasoline near the pilot light of a furnace as well as on his clothing. The injury surveillance system, which identifies the gasoline as the vehicle of the agent, the furnace pilot light as the source agent, and the clothing as the contact agent, thus depicts the sequence of events that was responsible for the injury. An explicit description and exact identification of the agent were viewed as critical in the collection of data on injuries. (An Explanatory Definition of Agent can be obtained from the author upon request. See author identification.)

"Agent of accident" and "agent of injury" are terms that have been used to help conceptualize the sequence of events leading to an injury. During the field trial of the prototype injury surveillance form, however, the persons filling it out were unable to differentiate adequately between the agent of the accident and the agent of the injury and thus filled in the wrong code numbers for these agents. Also, some injuries are a consequence of a series of events or circumstances which cannot be defined in terms of the accident or agent of the injury. Expansion and redefinition of the terms "agent of accident" and "agent of

injury" were therefore considered necessary. The concept of a vehicle or a vector of the agent was therefore introduced to compensate for the shortcomings observed and to provide an additional explanatory dimension to the conceptualization of the agent in injuries.

The question on the form about the agent of injury was left open ended rather than in a multiple-choice style requiring selection of code numbers for the agents. From the remarks and descriptions that the persons filling out the forms provided in answering the open ended question, the agent or agents could be coded. The classification and listing of agents was deemed essential if there was to be a rational system of identifying agents on the recording instrument. No such classification or list was available. Therefore major classes and subclasses of agents had to be formulated. Subsequently, these were modified extensively many times before a reasonably exhaustive list was achieved. This listing of agents (see author identification) was made available as a reference or reminder for those who would ultimately complete the surveillance record in the emergency room. It also served as the basis for the categorization of agents and products by the National Commission on Product Safety. The listing is not to be considered exhaustive.

Field testing. After extensive intramural study, a prototype injury surveillance form was tested in the field to determine its validity, the ease of response, and potential difficulties. (The difficulty that persons filling out the forms had in determining the appropriate code number for the agent of injuries has already been mentioned.) In the field test, personnel of injury study teams in Boston, Mass., Denver, Colo., and Cincinnati, Ohio, used the prototype to record data taken from hospital injury records. Modifications were subsequently made in the form to accommodate the difficulties identified, mostly by clarifying and extending the responses and expanding the coding guide. In a second, shorter field trial the revised prototype was tested. No additional significant problems were encountered.

The Bureau of the Budget gave preliminary clearance so that copies of the surveillance record form could be printed for the first year's operation of the national injury surveillance system. The critical aspect of the layout and printing of the form was whether the optical scanning equipment would be able to "read" the completed forms. Because of the contingencies of recording, the

multiple handling of the form, the necessary editing, and so forth, a heavy-weight paper was used for the printing as well as for a carbon copy to be retained by the data reporting source. Before the printing, also, the arrangement, wording, and spacing of the questions were given intensive study. The questions on the form were designed to conform with existing hospital forms that had been used in the field trial. Almost 1 year from the time that the design of the recording instrument began, the national injury surveillance system was ready to go into operation.

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A project aimed at establishing a national system for surveillance of injuries was begun in 1968 by the National Center for Urban and Industrial Health (Injury Control Program), Public Health Service. Later in 1968, part of the responsibility for establishing this surveillance system was assigned to the Food and Drug Administration (Office of Safety Services). During the first phase of the project, the goals of surveillance were specified and re-

fined and an instrument for recording data on injuries was designed and tested.

The need for generating nationally, in a standard manner, epidemiologically sound data of intermediate depth on injuries became obvious as the concept of a national injury surveillance system was explored. And for such data, the hospital emergency room was clearly a primary resource. It was therefore decided to collect data from this source

for the surveillance system. The data were to be recorded on a standard instrument from which responses could be automatically "read" and fed into a computer.

After field tests were conducted of this instrument, revisions were made to overcome the difficulties observed. Approximately 1 year from the time work began on designing the recording instrument, a national system for injury surveillance was ready for operation.