



EVALUATION OF NEW JERSEY'S HOSPITAL DISCHARGE DATABASE FOR OCCUPATIONAL
INJURY SURVEILLANCE

FINAL PERFORMANCE REPORT

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16. Abstract (Limit: 200 words) The utility of New Jersey's hospital discharge database for surveillance of five selected injuries that occurred at work during 1985 or 1986 was evaluated. The five injuries included: finger amputation, thumb amputation, crush injury of the lower limb, chemical poisoning due to heavy metals, and eye burns. Hospital records for 289 patients with one of the five injuries were compared with data collected by telephone interview of the patients. About 60% of the selected injuries were work related by self report. The authors conclude that the New Jersey hospital discharge database can be used for surveillance of occupational injuries. Finger amputations and crush injuries of the lower limb may be chosen as specific injury types to be targeted for occupational injury surveillance. Available external cause of injury data were too limited on the databases to be useful for targeting specific prevention activities. The database can be used to describe the demographic characteristics of hospitalized individuals due to occupational injuries. For finger amputations, rates of hospitalizations were higher for males than females, and for Hispanics and blacks as compared to whites. Interview of injured persons were required to ascertain occupation and industry information and injury circumstances for further epidemiologic study.				
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SUMMARY OF SIGNIFICANT FINDINGS

The summary of the significant findings from this study are in two parts: (1) an evaluation of the hospital discharge database for occupational injury surveillance and (2) use of the hospital discharge database for epidemiologic study of occupational injuries.

A. Database Evaluation for Occupational Injury Surveillance

1. New Jersey's hospital discharge database can be used for surveillance of occupational injuries. Workers' compensation codes in the primary payer field are good to excellent proxy indicators of the work-relatedness of these injuries. Thus, counting occupational injuries that result in hospitalization is possible using New Jersey's hospital discharge database.
2. About 60 percent of the selected injuries (finger amputation, crush injury of the lower limbs, chemical poisoning due to heavy metals and eye burns) were work-related by self-report.
3. Finger amputations and crush injuries of the lower limb may be chosen as specific injury types to be targeted for occupational injury surveillance. The numbers of interviewed cases with occupational chemical poisoning and eye burns were too small to reach conclusions concerning their surveillance potential using hospital discharge data.

4. Available external cause of injury data (E-code) are too limited (present for 11% of records) on the database to be useful for targeting specific prevention activities. E-codes are valuable for identifying potential causative factors of injuries and every attempt should be made to include them on the database for cases of hospitalized injuries.

B. Database Use for Epidemiologic Study

1. The database can be used to describe the demographic characteristics (age, race and gender) of hospitalized individuals due to occupational injuries.
2. For finger amputations, rates of hospitalizations were higher for males than females, and for Hispanics and blacks as compared to whites.
3. Interviews of injured persons were required to ascertain occupation and industry information and injury circumstances for further epidemiologic study. Provided personal identifying information is available, hospital discharge data provide a basis for in-depth epidemiologic study of specific injuries.

AN EVALUATION OF NEW JERSEY'S HOSPITAL DISCHARGE DATABASE
FOR SURVEILLANCE OF SEVERE OCCUPATIONAL INJURIES

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This paper is scheduled for presentation at the annual meeting of the Society for Epidemiologic Research, June 12, 1991, Buffalo, NY.

ABSTRACT

An Evaluation of New Jersey's Hospital Discharge Database for Surveillance of Severe Work-Related Injuries. G. Sorock, E. Smith, N. Hall
(New Jersey State Department of Health, Trenton, NJ)

Computerized population-based hospital discharge data in New Jersey offer new opportunities for surveillance of serious work-related injuries. This database was evaluated for its potential in identifying selected injuries that occurred at work during 1985 and 1986. Hospital discharge data were compared with data collected by telephone interview of discharged patients. A total of 1,575 unique hospital discharge records included: finger amputation (1,041), thumb amputation (209), crush injury of the lower limb (208), toxic effects of heavy metals (69) and eye burns (48). Of 809 potential study subjects, 445 (55%) could be contacted, and 289 (36%) were interviewed for the study. Sixty-one percent (175) said their injury was work-related. A comparison was made between self-reported injury at work and the presence of workers' compensation payer codes on the discharge database. The agreement beyond chance (Kappa) was 0.78 (95% CI=0.67,0.89). The sensitivity of this indicator of work-relatedness was 83%; specificity was 98%. These data suggest that workers' compensation payment on the hospital discharge database may be a good to excellent proxy indicator of the work-relatedness of these injuries.

INTRODUCTION

Nonfatal work-related injuries are a major cause of work-related illness and may require immediate medical care, lost work days, hospitalization and result in permanent disability. The National Institute for Occupational Safety and Health estimates that at least 10 million injuries occur on the job each year⁽¹⁾, about three million of which are severe enough to be treated in hospital emergency rooms⁽²⁾. The National Safety Council estimates about 1,700,000 work-related injuries result in temporary or permanent disability beyond the day of the injury⁽³⁾. If progress toward the Year 2000 objectives⁽⁴⁾ of reducing severe work-related injuries by 20% is to be achieved, adequate surveillance mechanisms⁽⁵⁾ must be in place to assess changes in the frequency of severe on-the-job injuries.

An injury surveillance system is useful if it generates data that can lead to the prevention and control of injuries or if it leads to research about injury prevention and control⁽⁵⁾. For example, the presence of external cause of injury information (E-code) on a database, such as injury caused by metal working machine (E919.3), would be useful for targeting prevention activities. Statewide hospital discharge data are increasingly being used for injury surveillance^(6,7) and are potentially useful for surveillance of work-related injuries that result in hospitalization. These databases are not, however, designed for the purpose of surveillance and the extent to which they can be used for work-related injury surveillance is largely unexamined. These databases are currently maintained by 28 states⁽⁸⁾.

The purpose of this paper is to evaluate the utility of New Jersey's hospital discharge database for surveillance of five selected injuries that occurred at work during 1985 or 1986. The five injuries and their International Classification of Disease - 9th Coding Manual (ICD-9CM) nature of injury codes (N-codes) are: finger amputation (886.0-886.1), thumb amputation (885.0-885.1), crush injury of the lower limb (928.0-928.9), chemical poisoning due to heavy metals (985.0-985.9), and eye burns (940.0-940.9). The five specific injuries were chosen based on the expectation that a high proportion of four would be work-related (finger and thumb amputation, crushing injury of the lower limb, and eye burns) and because one was already reportable by regulation⁽⁹⁾ to the New Jersey Department of Health (NJDOH) (chemical poisoning due to heavy metals).

Two main questions were addressed by this study: First, was there sufficient information on the hospital discharge database to identify work-related injuries? This is an essential first step to counting these injuries as part of an occupational injury surveillance system. Second, was there external cause of injury information on the discharge database, e.g., metal working machine, coded as E-codes? In addition, was there sufficient external cause of injury information on the original medical records (admission sheet and discharge summary) to assign E-codes to the medical record? This information is necessary for suggesting where to target prevention activities.

METHODS

Hospital Discharge Database

Beginning in 1976, the 105 acute-care (non-federal) hospitals in New Jersey were required to computerize information on patient characteristics, diagnoses, procedures and method of payment for each discharge. Starting in 1981, this database was used to create a uniform bill-patient summary so that diagnoses could be aggregated into diagnostic-related groups and used by the NJDOH for rate-setting purposes. Computerized records with patient name and address are sent first to a data processing company for editing. Then the records are sent to the NJDOH without personal identifying information in order to maintain confidentiality.

A subfile of the database held by the NJDOH was requested for years 1985 and 1986 for all records with a primary diagnosis of any of the five selected injuries. The subfile included the medical record number, patient number, hospital code, the primary ICD9-CM diagnosis, up to eight ICD9-CM secondary diagnoses, up to eight procedure codes, hospital admission date, sex, birth date, primary payer, zip code of patient's residence, municipality and county of patient's residence, and attending physician code. Discharge coding rules specify that the primary diagnosis code must be a nature of injury code (N-code) rather than an E-code. The secondary diagnosis fields may contain an external cause of injury code (E-code) on a voluntary basis. The primary

payer may be private health insurance, workers' compensation, self-pay or uninsured. The primary payer is the expected source of payment asked at the time of hospital admission.

Composition of Study Population

A merged file for both years, 1985 and 1986, was created containing 1,601 records. Repeat admissions of the same individual were eliminated from this merged file. This was performed by deleting all discharges (n=26) except the first for any discharge(s) that matched on all of the following fields: primary diagnosis, month and year of birth, sex, race, and zip code of patient's residence. There was a total of 1,575 individual admissions for the five selected types of injuries during 1985-1986 (Table 1). The number of incident admissions for thumb amputations (209) was a small percentage (17%) of the total finger and thumb amputations (1250).

A total of 1,575 records were sent to 97 hospital medical records directors for the addition of personal patient identifying information. Eighty-two percent (1,293 records) were returned from 83 hospitals with completely identified records including name, address and phone number. Twelve hospital medical records directors did not respond to repeated requests for information; two directors refused for confidentiality concerns.

A list of all personally identified patients was sent to the attending physicians as identified by the attending physician code on the discharge database. Physicians were asked to notify us if their patients should not be

contacted about their injuries. Four physicians objected to including their patients as potential study subjects so no attempt was made to contact them (4 patients).

There were 1,086 amputations with personal identifiers. Of these, 926 were for fingers. A simple random sample of 496 finger amputation cases was chosen (about 50%) by selecting random days of the month (1-31) and then selecting records with those days of hospital discharge. The sample was chosen to reduce the number of finger amputations for study relative to the other injury types (Table 1).

In addition to the random exclusion of 430 finger amputation records, which reduced the total number of potential study subjects from 1,293 to 863, the number was reduced further by 54 to 809 for the following reasons: suspected coding errors among persons admitted with a primary diagnosis of heavy metal poisoning and secondary psychiatric diagnoses, such as depression and suicide attempts (n=29); persons who participated in the pilot study of the telephone questionnaire were ineligible for the main study (n=21); and physicians who declined on behalf of their patients (n=4).

Subject Interviews

A letter of introduction, consent form, and a form giving us permission to request a copy of the patient's medical records were mailed to each potential study subject with a return self-addressed stamped envelope. A telephone call was made two to three days after the mailing to attempt to

interview the study subject. The work-relatedness of the injury was based on the subject's response (yes/no) to the question: "Were you at work or at your job or at your place of business when the injury occurred?" For instances in which the injury was work-related, additional questions regarding the employer and occupation at the time of the injury, the circumstances of the injury including the external source of injury, worker training and actions taken to prevent similar injuries were asked. For work-related cases in which a social security number was provided, a workers' compensation claim was searched for in the workers' compensation office of the New Jersey Department of Labor. Interviews of subjects who were injured at work lasted approximately 15 minutes. Interviews of subjects who were not injured at work lasted about five minutes. After the interview, the subject was asked to send the consent form and the form giving permission to request a copy of their discharge summary and admission sheet back to the NJDOH. The study interviews were conducted between October 1989 and October 1990, which were three to five years following hospitalization.

A total of 809 letters were mailed to potential subjects. Of 364 persons unable to be contacted, 265 (73%) moved, 73 (20%) had an unpublished telephone number, and 26 (7%) could not be contacted for other reasons. Of 445 people contacted, 302 (68%) were successfully interviewed, 143 (32%) refused, and 289 (65%) persons 16 years of age or older were included in for the study. The 55% contact rate (445/809) was achieved after at least two mailings for persons who moved to another address, and searching the Department of Motor Vehicle records for current addresses of persons who did move. The 68% (302/445) interview rate was achieved after up to five telephone callbacks. The response rate for completed eligible interviews was 36% (289/809).

No one under 16 had an occupationally-related injury. Thirteen subjects who were interviewed and who were under age 16 at the time of their injury were excluded. Thus, there was a total of 289 completed interviews of persons 16 years of age or older.

Medical Record Review

The medical records (discharge summary and admission sheet) were requested from the respective hospital where the hospitalization occurred. The medical record data were abstracted for primary diagnosis (N-code), admitting diagnosis, occupation and industry and external cause of injury information. E-codes were then assigned to each case based on the medical record data available, and later independently based on the telephone interview.

Statistical Analysis

Agreement between work-relatedness of injury by self-report and presence of workers compensation codes in the primary payer field in the hospital discharge database was assessed by using an agreement statistic (Kappa) and 95% confidence intervals.⁽¹⁰⁾

The chi-square test was used to assess the statistical significance of the difference in proportions of people interviewed from people not interviewed by selected variables on the database.

RESULTS

A comparison of selected demographic variables of persons interviewed with persons unable to be interviewed was made (Table 2). For this comparison, the total number of hospital discharge records for persons 16 years of age or older were used (n=1414). Younger persons, especially those 25 to 34 were less likely to be interviewed than older persons, especially those 55 to 64. Similarly, blacks and Hispanics were less likely to be interviewed than whites. Persons interviewed were more likely to have a thumb amputation than a finger amputation. No difference by gender was seen, however, in likelihood of a completed interview. In addition, persons who were interviewed were just as likely to have a workers' compensation primary payer code on their discharge database as those who were not interviewed.

Work-relatedness of Injuries

The total proportion of 289 interviewed cases who said their injury was work-related was 60.6% or 175/289. The proportion of subjects who said their injury was work-related by injury type was: finger/thumb amputation (58.8%, 134/228); lower limb crush injury (70.2%, 33/47); chemical poisoning (60%, 3/5) and eye burns (50%, 2/4).

The only indicator of the potential work-relatedness of these injuries on the hospital discharge database was the presence of workers' compensation payer codes in the primary payer field. The agreement between self-reported injury at work for an amputation and the presence of workers' compensation

codes in the primary payer field on the database is presented in Table 3. The reliability measure (Kappa) is 0.76 and is interpreted as excellent agreement beyond chance⁽¹⁰⁾. Furthermore, assuming the true classification is by interview, the specificity was higher than the sensitivity. The proportion of false negatives (19%) (i.e., no workers' compensation code but self-reported injury at work) is higher than false positives (2%) (i.e., there is a workers' compensation code but the self-report of injury was not work-related). Of the 25 false negatives, 13 were self-employed and thus would not be covered by workers' compensation. Twelve were employed by others, of whom 8 had a workers' compensation claim on file in the New Jersey Department of Labor. The agreement for crush injury of the lower limb was 91%, Kappa = 0.84 (95% CI = 0.61-1.07); the false negative number and percent were 4 and 12%, respectively.

Of the 289 persons interviewed 115 (40%) gave permission to request their medical records. We retrieved 100% of these records. We asked for only the admission sheet and the discharge summary, but we frequently got more than these records. All of the 115 records we received confirmed the nature of injury by self-report by examining the primary discharge diagnosis (N-code) and the written admitting diagnosis on the admission sheet of the medical record.

We also examined work-relatedness information on medical records. Of 115 medical records reviewed, including the admission sheet and discharge summary only 59 (51%) had any mention of whether the injury occurred at work or not. Of 68 persons with work-related injuries and whose medical records were reviewed, 43 (63%) records indicated the injury occurred at work, 25 (37%) had no information about the work-relatedness of injury.

External Cause of Injury Codes (E-Code)

The second objective of this evaluation was to determine the frequency of occurrence of E-codes on the hospital discharge database. In addition, medical records were requested to assign E-codes independently of the database and to verify the injuries.

The frequency of E-code occurrence on the hospital discharge database by injury type and the frequency of E-codes that we assigned based on the available medical records are presented in Table 4. For the discharge data, only 151 of 1,414 (11 percent) records of persons 16 years of age or older had at least one E-code in one of eight secondary diagnosis fields. Only one of the 151 records with E-codes had more than one E-code. E-codes were less likely to be present on the hospital discharge database if the injury was at work (7%) than if it was not (15%).

Of 115 medical records, 89 (77%) were assigned an E-code based on information in the admission sheet or discharge summary. External cause information was less common on medical records of persons injured at work (74%) than not (83%). We were unable to assign an E-code, based on the admission sheet and discharge summary, to 26% of the medical records of persons injured at work.

Based on the interview data, we were able to assign an E-code to 100% of the cases interviewed (n=68) for which we had medical record data and whose injury occurred at work. E-codes assigned to medical records were the same as

E-codes assigned to the interview 90% (45/50) of the time E-codes were available from both the medical record and the interview. The most frequent external causes of the 68 injuries in descending order were: Other and unspecified machinery (E919.8 and E919.9, n=19), caught accidentally in or between objects (E918, n=8), lifting machines and appliances (E919.2, n=7), woodworking and forming machines (E919.4, n=6), metal working machines (E919.3, n=5), struck accidentally by falling object (E916, n=5), accidents caused by machinery (E919, n=4), and 14 with other less common E-codes.

Of 68 medical records from persons with work-related injuries, 59 (87%) had name of employer; eight of the remaining nine were not self-employed but their employer's name was not in the medical record. Only 32 (47%) records included the occupation of the patient. The percent agreement between employer and occupation information on the medical records and the interview, when information from both sources were present, was 97% and 88%, respectively.

DISCUSSION

The major findings of this study are two-fold: First, the New Jersey hospital discharge database can be used for surveillance of hospitalized severe occupational injuries. Second, the database has major limitations with respect to understanding why these injuries occur.

The positive aspects of using the database for occupational injury surveillance are: 1) workers' compensation codes may be used as an excellent proxy indicator of the work-relatedness of these injuries, thus, injury incidence and trend analysis are feasible; 2) basic demographic variables on the database permit the calculation of incidence rates by age, race and sex (provided population data are available); 3) occupational injuries are reported reliably by workers as confirmed by medical records; and 4) at least in New Jersey, hospitals will provide personal identifying information so that further epidemiologic study of the injured workers can be conducted.

The limitations of using the database for surveillance and epidemiologic study include: 1) the absence of personal identifying information for contacting injured individuals about the circumstances of their injuries; 2) the paucity of E-code information on the database; 3) the database only captures the most severe cases, that is, it may represent only about 20% of all occupational finger amputations treated in New Jersey hospital emergency rooms (11); 4) the less frequently occurring injuries, including lower limb crush injuries, eye burns and chemical poisonings, are not suited for epidemiologic study unless larger databases are used, however, they may still be targeted for surveillance and prevention activities. A specific limitation of this study was the time lag between discharge and interview. This reduced the response rate and probably the recall of the injury circumstances.

In this study, E-codes were added to 50 of 68 (74%) medical records that described work-related injuries in enough detail to permit E-coding. This percentage is much higher than the percentage of records on the hospital

discharge database with an E-code: eleven percent. Clearly more E-coding of medical records is feasible. E-codes on the discharge database were less often present for work-related rather than non work-related cases. It may be that external causes of injuries are asked of non-work related cases more thoroughly.

There are barriers to the use of E-codes on medical records. In New Jersey, E-codes do not influence hospital reimbursement rates, so the extra coding work is not of financial benefit to the hospital. Use of E-codes would also require some initial training that adds to the cost. In addition, there may not be enough diagnostic fields on the database to add an E-code, depending on the severity of the injuries and the number of co-morbid conditions of the injured person. The presence of E-codes on Maryland's hospital discharge database has been found to vary inversely with the age of the injured person and the severity of the injury (7).

E-codes are useful for understanding the mechanism of injuries, for suggesting how to prevent them and thus they should be added to hospital discharge databases (6-8, 12). In a study of injuries to about 59,000 children in external causes of injuries are asked of non-work related cases more thoroughly. Massachusetts (12), almost all medical records were assigned an E-code, whether the case resulted in hospitalization or emergency room treatment. The combination of nature of injury (N-code) data and cause of injury (E-code) data indicated a high proportion of head injuries to children in motor vehicle crashes. This suggests improving child restraint devices and possibly changing state laws regarding their use. Similarly, in a companion

paper (13), finger amputations at work in New Jersey were associated with work on saws and slicing machines, suggesting improved guarding devices or safety practices.

Another problem with E-codes is their lack of detail in some instances. For example, in this study, non-specific E-codes were assigned in 36 of 68 (53%) persons who were injured at work. E-codes should be expanded to include more detailed categories including many types of machinery. We look forward to the next revision of the ICD-10 that will expand E-coding options (12).

In spite of these barriers, six states have mandated the use of E-codes for injuries recorded on their hospital discharge databases: New York, Rhode Island, Vermont, Wisconsin, Washington and California (6,7). Suggested strategies for mandating use of E-codes include: 1) meeting with hospital administrators and medical records personnel to discuss the issue of mandating the use of E-codes for injuries; 2) encouraging health professionals to ask about external causes of injuries at time of treatment or admission and documenting causes in the medical record; 3) adding an additional field(s) on the discharge database exclusively for E-code(s); 4) providing training for medical record personnel in the use of E-codes; and 5) monitoring accuracy and trends in E-code usage by hospital and patient characteristics.

Occupational injury surveillance should be part of a comprehensive occupational illness and injury surveillance system. Hospital discharge databases can provide a valuable mechanism for identifying health conditions

and for suggesting where public health interventions should be targeted (14, 15). To be more effective, however, medical and public health professionals must work together to ensure that necessary information on external causes and industry and occupation information is collected and recorded for future use.

RECOMMENDATIONS

To use hospital discharge database:

1. In New Jersey, the database can be used for counting cases with workers' compensation codes as a proxy indicator of work-relatedness. The caveat being the number will be an underestimate and will miss primarily self-employed injured workers.

To improve use of hospital discharge databases for occupational injury surveillance:

1. Other states should conduct similar analyses to verify these findings.
2. Databases would be more efficient for surveillance including follow-up activities such as interviewing patients, if personal identifying information were readily available, providing strict adherence to confidentiality is maintained.
3. E-coding should be mandated for medical records and inclusion on the hospital discharge database.

4. The name of the employer and occupation should be added to the database as agreement between both these variables on the medical records and interview was 97% and 87%, respectively, when they were available on both data sources.

5. Inspections of worksites identified by this surveillance mechanism could be conducted to determine the feasibility of adding a public health response component to prevent similar non-fatal injuries.

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TABLE 1: Overview of Persons Selected from the Hospital Discharge Database and Subjects Interviewed by Injury Type, New Jersey, 1985-1986.

Subject Selection Process From Database	Finger/Thumb Amputations		Crush Injury Lower Limb		Chemical Poisoning		Eye Burns		Total	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Admissions	1250	(100)	208	(100)	69	(100)	48	(100)	1575	(100)
Identified by Hospital	1086	(87)	130	(63)	52	(75)	25	(52)	1293	(82)
Subjects Selected	637	(51)	126	(61)	21	(30)	25	(52)	809	(51)
Subjects Interviewed ¹										
Contacted	355	(56)	71	(56)	9	(43)	10	(40)	445	(55)
Not Contactable	282	(44)	55	(44)	12	(57)	15	(60)	364	(45)
Interviewed	241	(38)	48	(38)	5	(24)	8	(32)	302	(37)

¹ Percentages are based on the total numbers of subjects selected for each injury type.

Table 2: Comparison of Selected Variables from Hospital Discharge Database for Interviewed (n = 289) and Non-interviewed (n = 1125) Persons New Jersey, 1985-1986.

<u>Age Category</u>	<u>Interviewed</u>		<u>Non-Interviewed</u>	
	<u>n</u>	<u>(%)</u>	<u>n</u>	<u>(%)</u>
16 - 24	64	(22)	249	(22)
25 - 34	52	(18)	317	(28)
35 - 44	52	(18)	208	(19)
45 - 54	40	(14)	150	(13)
55 - 64	52	(18)	122	(11)
65+	29	(10)	79	(7)

<u>Race/Ethnicity</u>	<u>n</u>	<u>(%)</u>	<u>n</u>	<u>(%)</u>
White (non-Hispanic)	232	(80)	714	(64)
Black (non-Hispanic)	30	(10)	191	(17)
Hispanic	19	(7)	183	(16)
Other	3	(1)	25	(2)
Unknown	5	(2)	12	(1)

<u>Injury Type¹</u>	<u>n</u>	<u>(%)</u>	<u>n</u>	<u>(%)</u>
Finger Amputation	162	(56)	774	(69)
Thumb Amputation	67	(23)	129	(12)
Crush Injury Lower Limb	47	(16)	131	(12)
Eye Burn	8	(3)	28	(3)
Chemical Poisoning	5	(2)	63	(6)

¹ Includes one person who had a finger amputation according to the hospital discharge data but who refused to identify the type of injury during the telephone interview.

Differences in proportions of above characteristics between interviewed and non-interviewed persons were statistically significant (p < 0.001).

TABLE 3: Agreement Between Injury at work by Interview and Presence of Workers' Compensation Payer Codes on the Discharge Database: Finger and Thumb Amputations, New Jersey, 1985-1986 (n = 228)

		Workers' Compensation Codes on the Discharge Database		
		<u>Yes</u>	<u>No</u>	<u>Total</u>
Injury at Work by Interview	Yes	109	25	134
	No	2	92	94
	Total	111	117	228

Reliability Measures: Percent Agreement = 89%
 Agreement beyond chance (Kappa) = 0.76
 95% confidence interval for Kappa = (0.67-0.89)

Validity Measures: Sensitivity = 81% False negative proportion = 19%
 Specificity = 98% False positive proportion = 2%

TABLE 4: Number of Records with External Cause of Injury Codes (E-Code) on the Hospital Discharge Database and the Number of Available Medical Records Assigned an E-Code by Injury Type, New Jersey 1985-1986.

	Hospital Discharge Records ¹		Medical Records	
	No. With E-code (%)	Total Records	No. With E-code (%)	Total Records
Finger/Thumb Amputation	97 (9)	1132	73 (78)	94
Lower Limb Crush Injury	15 (7)	178	12 (75)	16
Chemical Poisoning	36 (53)	68	--	--
Eye Burns	3 (8)	36	4 (80)	5
Total	151 (11)	1414	89 (77)	115

¹ Discharge records of persons 16 years of age or older.

HOSPITALIZED OCCUPATIONAL FINGER AMPUTATIONS

NEW JERSEY, 1985-1986

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ABSTRACT

About 19,000 finger amputations occur at work each year. Twenty percent of these injuries are severe enough to require hospitalization. Hospital discharge data from New Jersey (1985-1986) were used to describe the demographic characteristics of persons with such injuries and to identify potential subjects for telephone interview. A total of 637 persons hospitalized for finger amputations were sent letters asking for their participation. Of 637 persons, 355 (56%) were contacted and 228 (36%) were interviewed of whom 134 (59%) said their injury occurred at work. The annual rate of finger amputations at work was 9.3 per 100,000 employed persons. The rate was higher for males (14.7) than females (1.9). The age-adjusted rates were higher for Hispanic (52.8) and black (28.9) males than for white males (9.5). Persons working with machines, or maintaining them, in the manufacturing industry were at highest risk. Unjamming or repairing machinery (e.g., presses, saws or slicers) while in operation was particularly hazardous. These data can be used to target occupations and industries for specific worksite intervention to prevent finger amputations. One limitation of this study, however, is that hospitalized occupational finger amputations may not be representative of all finger amputations, the majority of which are less severe and do not require hospitalization.

INTRODUCTION

The number of annual work-related finger amputations in the United States in 1977 has been estimated to be 19,000 based on Bureau of Labor Statistics data⁽¹⁾. A similar annual number, 18,900, was estimated by the Consumer Product Safety Commission (CPSC)⁽²⁾ that sampled hospital emergency room encounters from 1985-1986. The CPSC survey indicated, however, that only 3,600 (19 percent) of the 18,900 persons seen in hospital emergency rooms for occupationally-related finger amputations were severe enough to be hospitalized. Besides lost work-time and large medical expenses, severe finger amputations may also impact on future employment. In a study of 130 patients with severe workplace finger amputations, 22 percent had a permanent change in their jobs after the injuries⁽³⁾. The prevention of occupational finger injuries must be based on an understanding of the determinants of these injuries. Use of injury surveillance data can identify preventive strategies to reduce the frequency of finger amputations⁽⁴⁾.

This report is based upon data of an evaluation study⁽⁵⁾ of hospital discharge data for surveillance of occupational non-fatal injuries, including finger amputations. In the evaluation study, the hospital discharge database was found to reliably identify work-related severe injuries, including finger amputations. Two hundred twenty-eight finger amputation cases were interviewed for the evaluation study. For finger amputations, the agreement between self-reported injury at work and workers' compensation as the primary payer was good to excellent, with sensitivity of 81% and specificity of 98%.

A secondary goal of the evaluation study was to assess the utility of the hospital discharge database for epidemiologic study of occupational injuries, including finger amputations. Previous epidemiologic research(1,6-8) has suggested that employment in the manufacturing industry, work with machinery, male gender and young age (below 25 years) are risk factors for finger amputations at work. The focus of this report is restricted to describing potential risk factors for work-related finger amputations requiring hospitalization in New Jersey.

METHODS

The data for this study come from two sources. The first is from two years (1985-1986) of state-wide hospital discharge data submitted by each of 105 acute care hospitals to the New Jersey State Department of Health for setting reimbursement rates. The second source is data from telephone interviews of a subset of persons identified from the above hospital discharge data set with a finger or thumb amputation at work. Finger and thumb amputations are combined for these analyses.

The hospital discharge database includes information on patient demographic characteristics, diagnoses, and method of payment for each discharge. For this study, only ICD9-CM primary discharge diagnoses of finger amputation (886.0 or 886.1) or thumb amputation (885.0 or 885.1) were used. The specific fields used from this subfile included: age, race, sex and primary payer.

The presence of workers' compensation codes in the primary payer field of the hospital discharge database was used as a proxy indicator of injury work-relatedness. The number and rate of hospitalized finger amputations at work, during 1985 and 1986, were estimated by age, sex, race/ethnicity with the caveat that the numerator would be underestimated by about 19%. Denominators for rates of finger amputations by age, sex, race/ethnicity come from the 1980 Census of the civilian employed population in New Jersey.(9)

The second data source is the subset of persons identified from the hospital discharge database who were interviewed. A total of 1,250 individuals with a primary diagnosis of finger amputation was identified on the hospital discharge database. Hospital medical records personnel provided personal identifiers for 1,086 (87%) of these records for the purpose of this study. A random sample of finger amputations was selected and the final number of persons mailed letters to request their participation in the telephone interview was 637. Of these, 355 (56%) were contacted, 228 (36%) were interviewed, and 134 (59%) said their finger amputations occurred at work. All interviewed subjects who had a finger amputation at work were 16 years of age or older. The telephone interviews occurred three to five years after hospital discharge.

During the interview, the 134 persons with work-related finger amputations were asked about: education, race/ethnicity, occupation and industry at the time of injury, source of injury, a description of how the injury occurred and what steps were taken to prevent a recurrence of the

injury. Fifty-three subjects gave consent to review the medical records (admission sheet and discharge summary) from their hospitalization. The agreement between self-reported injury information and the medical record was evaluated.

All questionnaire data were computer entered and verified with the original questionnaire. Occupation was coded as standard occupation code (SOC)(10), industry as standard industrial code (SIC)(11) and source of injury was categorized using American National Standards Institute ANSI(12) codes. Frequency distributions of selected variables were calculated. A statistically significant trend in injury rates was assessed using the chi-square test for trend(13). Injury rate differences were tested for statistical significance using an approximation of the random variation of the rates(14).

RESULTS

Six hundred nine of 1,250 (49%) incident hospital discharge records for finger amputation had a workers' compensation code in the primary payer field over the two year period, 1985-1986. The estimated annual incidence rate of hospitalized occupational finger amputations in New Jersey was 9.3 per 100,000 employed civilian workers.

Table 1 presents the numbers and incidence rates of finger amputations by age and race stratified by gender. The male rate was 7.7 times greater than

the female rate. With respect to age, the rates for males were highest at the youngest age group (16-24) and then showed a downward trend with increasing age ($p < 0.001$). The rates for females were more uniform with age but were limited by the small numbers of cases after age 44.

Compared to whites, blacks and Hispanics had significantly ($p < 0.05$) elevated age-adjusted rates of finger amputations at work, regardless of gender. Compared to white males, the rate ratios for Hispanic males and black males were 5.6 and 3.0, respectively. Compared to white females, the rate ratios for Hispanic females and black females were 6.2 and 2.9, respectively.

All 134 amputation cases were confirmed by medical records. That is, the primary discharge diagnosis or the admitting diagnosis on the admission sheet was a finger amputation.

Table 2 shows the distribution of interviewed cases by occupation at the time of injury and the percent of New Jersey work force in those occupations based on 1980 Census data⁽¹⁵⁾. The most frequent categories were machine operators and tenders and precision production occupations. The percent of the workforce in listed occupations is also included. Machinery maintenance occupations are over-represented among the interviewed cases in comparison with their proportion in the work force, i.e., 6.7%/0.02% or 335 times more involved than expected. Other occupational categories were also over-represented among the interviewed subjects, but to a lesser extent.

The distribution of cases by industry is shown in Table 3. For comparison purposes, the percent of the total non-farm wage and salary employment by industry based on New Jersey Department of Labor data for 1986(16) is also included. Manufacturing and construction are two industries that are overrepresented with respect to finger amputations. Injuries occurred among service industry employees less often than expected.

The sources of injury of the finger amputations are displayed in Table 4. ANSI categories were used to group machines where possible. A total of 76 amputations (57%) were machinery related.

The nature of the event preceding the finger amputations is shown in Table 5. This information is based on subjects' own account of what events led to the injury. The most frequent preceding event was a hand being caught between moving parts. The second most common preceding event was repairing/maintaining a machine while it was running. Furthermore, in 18.7% of the cases, a hand was caught and pulled into a more hazardous area, for example, by a fan belt pulling a finger into a sprocket, or by a gloved hand being pulled by a machine part into a point of contact, or a piece of wood being held was drawn quickly into the blade of a saw. Thirty-three percent (25/76) of amputations that were machinery related occurred while the subject was cleaning, unjamming or repairing the machine. The most frequent preceding event for specific machines was: hand pulled into saws (6/17); presses and slicers in operation while being repaired (5/14 and 5/15, respectively).

Subjects were asked what steps were taken to prevent another similar injury (Table 6). Nearly 60% of subjects said either no steps were taken or they did not know or could not recall what steps were taken to prevent another injury. In a small number of cases, safety guards (n = 12) were added or unsafe machines (n = 12) were removed.

DISCUSSION

The results of this study tend to confirm other epidemiologic studies^(1,6-8) which suggest a higher risk of occupational finger amputation for males than females, for persons working with machines in the manufacturing industry and for workers exposed to unguarded hazardous machine parts while operating, unjamming or repairing machinery.

This study was limited to work-related finger amputations that resulted in hospitalization in New Jersey. It only represents the most severe finger amputation injuries that occur at work. One estimate is that 19% of occupational finger amputations are hospitalized after reaching the hospital emergency room⁽²⁾. Severe finger amputations may be treated on an outpatient basis and not hospitalized. Differences have been found between hospitalized and non-hospitalized injury cases in type of activity prior to injury. This may bias epidemiologic studies that attempt to generalize results to specific injuries treated outside of the hospital⁽¹⁷⁾.

Our evaluation study⁽⁵⁾ which compared interviewed subjects with persons not interviewed found that the interviewed subjects were not representative of the age and race/ethnicity composition of the hospitalized population. Therefore, certain selection biases precluded estimating numerators for rates of finger amputations based on the interview data only. In addition, the telephone interviews occurred three to five years after the injury occurred, so some details about the injury circumstances may have been forgotten.

The finding regarding higher amputation rates for Hispanics and blacks compared to whites has not been shown previously. One hypothesis for these differences might be that Hispanics and blacks are exposed to more hazardous jobs or machinery than whites. Differential risks of occupational injuries and illnesses by race and ethnicity have been found in California⁽¹⁸⁾ using workers' compensation data. Risks were generally lower in that study after adjustments were made for educational level and potential work experience which may explain part of the race/ethnic differences. For Hispanic and black men relative to the white non-Hispanics, the adjusted relative risks were 1.3 and 1.2, respectively. Similar relative risks were seen for Hispanic and black women. In our study, the number and proportion of persons employed in the manufacturing industry (a high-risk industry) at the time of their injury were: white (46,47%), black (15,71%) and Hispanic (9,69%).

In this study machine operators and tenders was the most frequent occupation of worker at the time of injury (18%). Also, machinery maintenance occupations were at highest risk of a finger amputation especially if working on a machine while it was running. Using BLS data for the state of New Jersey (19), machinists and operators were found to have significantly elevated standardized morbidity ratios for amputations adjusted for age and sex.

The percentage of amputations of industry was found to be highest in manufacturing (53). This was also the most frequent industry in BLS data (62%)(7) and in Minnesota (43%)(6). Retail trade was the second most frequent industry among these cases (13%) followed by construction (11%).

The most common source of injury was by machine (57%) which in other studies was: BLS (65%)(7), Minnesota (55%)(6). Saws were the most frequent machine in this study (13%), as it was in the BLS data (16%)(7).

The event preceding the injury indicated what the subject could recall about his or her hand movements just prior to the injury. Two phenomena were reported to be occurring. The first is that in 19% of the cases (n = 26) the machine was running while it was being repaired and the subject appeared to try to "beat" the machine by quickly entering the hazardous zone of machine operation and was caught or cut by moving parts. Subjects may have misjudged how fast they could move their hands relative to the speed of a hazardous machinery part. In the second scenario, 18% (n = 25) of the subjects said their hand was pulled by part of the machine into a more hazardous region of the machine's operation.

The speed of the operators' hands can contribute to an amputation. Printing presses can be operated at speeds that increase the likelihood of an inadvertent machine actuation error by altering the speed of the operators' hands governing the controls⁽²⁰⁾. More human factors research on the relationships between machine speed, machine operators' hand placement and speed and self-perceived ability to move hands in and out of hazardous areas is needed. Certainly, improved machine guarding that is acceptable to the employee operating the machinery is needed.

These data and others from Minnesota⁽⁶⁾ suggest that less than half of the amputations are followed by the institution of a control measure of some sort. Training regarding machinery and hand speeds is needed. Passive engineering controls, including safety guards and improved automatic designs to stop a machine when it jams or when it is being serviced, are also needed. Machine operators with an interest in machine safety should work with engineers in this regard.

The following recommendations can be made for further research and for strategies to prevent finger amputations:

1. A more detailed on-site investigation of circumstances leading to finger amputations should be conducted. Selected occupations and industry for these targeted investigations should be machine operators and machinery maintenance occupations in the manufacturing industry. Attention should be focused on presses, saws and slicers.

2. Further work should be done to both redesign new machines and to retrofit old machinery with improved guarding devices.
3. The risk factors associated with race and ethnic differences in occupational non-fatal injury rates should be identified.
4. These data demonstrate that hospital discharge data can be used for epidemiologic study of occupational non-fatal injuries, provided cases can be ascertained quickly and interviews conducted to supplement the minimal occupation-related information on the hospital discharge database.

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Table 1: Number and Rate¹ of Work-Related Hospitalized Finger Amputations by Selected Demographic Variables, New Jersey, 1985 and 1986.

<u>Age</u>	<u>Gender</u>			
	<u>Male</u>		<u>Female</u>	
	<u>n</u>	<u>Rate</u>	<u>n</u>	<u>Rate</u>
16-24	119	18.9	11	1.8
25-34	173	18.0	12	1.7
35-44	100	12.9	17	3.1
45-54	95	13.4	7	1.4
54-64	60	10.6	5	1.3
65+	9	6.6	1	1.2
TOTAL	556	14.7	53	1.9

<u>Race/Ethnicity²</u>	<u>Male</u>		<u>Female</u>	
	<u>n</u>	<u>Rate³</u>	<u>n</u>	<u>Rate</u>
White	316	9.5	28	1.2
Black	99	28.9	11	3.5
Hispanic	120	52.8	13	7.4

¹ Rate per 100,000 employees: Numerator Source: NJ Hospital Discharge Data for records with workers' compensation as the primary payer. Denominator Source: 1980 Census of the Population, Tables 221 and 228, U.S. Department of Commerce.

² Race was unknown (n=8), Asian (n=6) and other (n=8) for 22 persons excluded from these race-specific analyses.

³ Race-specific rates were age-adjusted using the age distribution of total employed civilian labor force in 1980 (9).

Table 2: Distribution of Occupation of Persons with Work-related Finger Amputations (n = 134), New Jersey, 1985-1986.

<u>SOC</u>	<u>Occupation</u>	<u>n</u>	<u>%</u>	<u>% Workforce</u> ¹
75-76 (764)	Machine Operators and Tenders (Printing machine operators)	24 (10)	17.9 -	6.5
68 (687)	Precision Production Occupations (Precision food production occupations)	18 (9)	13.4 -	4.3
521	Food and Beverage Preparation and Services	9	6.7	3.8
614	Machinery Maintenance Occupations	9	6.7	0.02
82	Transportation Occupations	9	6.7	3.3
64	Construction Trades	8	6.0	3.2
63	Construction Supervisors	6	4.5	0.6
86	Helpers	5	3.7	4.6
56	Other Agricultural Occupations	5	3.7	0.4
611	Vehicle and Mobile Equipment Mechanics, Repairers	4	3.0	1.4
731-2	Metal Working and Plastic Working Machine Set-up Operators	4	3.0	0.4
55	Farm Operators and Managers	3	2.2	0.2
83	Material Moving Occupations	3	2.2	1.0
	Other ²	26	19.4	
	Unknown	1	0.9	
<hr/>				
	Total	134	100.0	

¹ Source: 1980 Census of the Population, New Jersey, Table 218, U.S. Department of Commerce

² The "other" occupation consisted of small sized categories, two or fewer.

Table 3: Number of Finger Amputations by Industry of 134 Persons Interviewed in New Jersey, 1985 and 1986, with a Comparison of Proportion of Workforce by Industry in 1986.

<u>SIC</u>	<u>Industry</u>	<u>Cases</u>	<u>%</u>	<u>% of Total Workforce¹</u>
20-39	Manufacturing	71	52.9	19.9
	Food and Kindred Products	(11)		
	Chemicals and Allied Products	(10)		
	Printing and Publishing	(9)		
	Rubber and Misc. Plastic Products	(7)		
	Misc. Manufacturing Industries	(16)		
	Other Mfg. Industries	(8)		
52-59	Retail Trade	18	13.4	16.6
15-17	Construction	15	11.2	4.4
40-49	Trans. Public Util.	9	6.7	6.6
70-89,07	Services	7	5.2	22.5
	Other ²	9	6.7	
	Unknown	<u>5</u>	<u>3.7</u>	
	Total	134	99.8	

¹ New Jersey Department of Labor, Employment Projections Volume I Industry Outlook for New Jersey and Selected Areas 1986-2000.

² Other industries consisted of small numbers of persons.

Table 4: Source of Injury¹ of Finger Amputation at Work of 134 Persons Interviewed, New Jersey, 1985-1986.

<u>Source (ANSI Categories*)</u>	<u>n</u>	<u>%</u>
1. Electric Saws, planers, shapers	17	12.7
2. Slicers, mixers, graters	15	11.2
3. Presses (printing & non-printing)	14	10.4
4. Miscellaneous machines*	14	10.4
5. Vehicles, cars, truck & accessory parts*	10	7.5
6. Cutting machines	7	5.2
7. Building structures (ramps, stairs,* doors, windows)	6	4.5
8. Forklift trucks*	5	3.7
9. Lathes and milling machines	5	3.7
10. Hoists, cranes	4	3.0
11. Conveyor belts, brakes and accessories	4	3.0
12. Agricultural machines*	4	3.0
13. Other Source ²	25	18.7
14. Can not recall	<u>4</u>	<u>3.0</u>
Total	134	100.0

¹ Items number 1,2,3,4,6,9,12 above were considered machines.

² The "Other Source" consisted of small-sized categories, two or three cases per injury source.

* These categories correspond to ANSI categories: machines not elsewhere classified, automobile parts, buildings and structures, plant or industrial vehicles and agricultural machines. (American National Standards Institute Z16.2-1962).

Table 5: Distribution of Amputation by Nature of the Event Preceding the Injury of 134 Persons Interviewed, New Jersey, 1985-1986.

	<u>Preceding Event</u>	<u>n</u>	<u>%</u>
1.	Hand caught between moving parts/objects	32	23.9
2.	Machine running while being repaired	26	19.4
3.	Hand pulled into hazard by moving machine part	25	18.7
4.	Cut by moving blade	21	15.7
5.	Hit by falling (flying) object	13	0.7
6.	Closing/turning doors	5	3.7
7.	Other	5	3.7
8.	Unknown	<u>7</u>	<u>5.2</u>
	TOTAL	134	100.0

Table 6: Controls Implemented to Prevent Recurrence of Finger Amputations, of 134 Persons Interviewed, New Jersey, 1985-1986.

<u>Controls</u>	<u>n</u>	<u>%</u>
None	44	32.8
Unknown	33	24.6
Safety guards used	12	8.9
Removal of unsafe machines	12	9.0
Workplace procedures changed	7	5.2
Safety features added to machine	7	5.2
Elimination of personnel involved	5	3.7
Worker to be more cautious	3	2.2
Other	<u>11</u>	<u>8.2</u>
Total	134	99.8

FUTURE PUBLICATIONS

The following publications based on this study are planned:

1. A descriptive study of 33 occupational crush injuries of the lower limbs.
2. The hospital costs associated with occupational injuries and the influence of E-codes and procedures on costs.
3. The relationship between handedness and occupational finger amputations.