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Surveillance for Nonfatal Work-Related Injuries in Alaska, 1991–1995

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Historically, Alaska has had an occupational fatality rate five times greater than that for the United States. This article reports recent surveillance results for hospitalized nonfatal work-related injuries in Alaska, using the population-based Alaska Trauma Registry (ATR) from 1991 through 1995. The fishing, construction, and logging industries led with the highest number of reported cases in the ATR. Workers in the logging, water transportation, and wood product manufacturing industries had the highest injury rates. Cause, severity, type, and body region of injury were examined for each target industry. For industries with the highest numbers and rates of injuries, in most cases, falls were identified as a common cause of injuries. A fractured bone was the most common type of injury, and the extremities were the most common body region affected. The ATR has proved to be a reliable tool for work-related injury surveillance and will be helpful in planning research priorities and targeting injury prevention efforts. Am. J. Ind. Med. 34:493–498, 1998. *© 1998 Wiley-Liss, Inc.*

KEY WORDS: occupational injury; occupational safety; occupational epidemiology; injury surveillance; injuries; accidents

INTRODUCTION

From 1980 to 1989, Alaska had the highest rate of any state for occupational fatalities, with 34.8 deaths per 100,000 workers in all industries, five times higher than the U.S. average of 7 deaths per 100,000 workers for the same time period [Centers for Disease Control and Prevention, 1993b].

In 1991 the National Institute for Occupational Safety and Health (NIOSH) established an office in Anchorage, to focus on work-related fatalities in Alaska. Detailed information from fatal injury investigations in Alaska were gathered and entered into the Alaska Occupational Injury Surveillance system. The highest incident rates of occupational fatalities were found in the fishing, logging, and aviation industries [Helmkamp et al., 1992; Centers for Disease Control and Prevention, 1993a, 1993b, 1994, 1997a, 1997b]. These data have been instrumental in surveillance and prevention of worker deaths in Alaskan workers.

This article reports recent surveillance results for nonfatal work-related injuries in Alaska, using the Alaska Trauma Registry (ATR) for the five year period beginning January 1991 through 1995. Hospitalized nonfatal injuries come with a high cost, suffering, lost work, and potential permanent disability that have an impact on workers and employers in Alaska. We feel this is an important area to focus on injury surveillance and prevention. Our intent is to examine the industries listed in the ATR and identify those industries with the highest nonfatal injury incidence rates, then further examine the injuries to workers in those industries for injury prevention planning purposes.

METHODS

The ATR is a population-based trauma registry that collects information from all 24 acute care hospitals in Alaska. The database consists of seriously injured patients

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admitted to any Alaskan acute care hospital. The ATR is maintained by the Alaska Department of Health and Social Services, Division of Public Health, Community Health and Emergency Medical Services Section. One of the strengths of the ATR is the ability to use population data to calculate incidence rates. The ATR is one of the first statewide population-based trauma registries in the United States.

With 151 data elements, the ATR has been designed for and is extensively used as a quality assurance and assessment tool for prehospital and hospital patient care. The ATR is also used for injury surveillance and prevention, with approximately 69 data elements that have previously been used for this purpose [Johnson et al., 1992; Kilkenny et al., 1992; Warren et al., 1995].

Criteria for a case to be entered into the ATR include patients who have sustained injuries described by the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis code of 800.00–995.89 (traumatic injuries, poisoning, environmental effects), and who are either admitted to a hospital in Alaska, transferred to a hospital with a higher level of care, or declared dead in the emergency department (ED). Patients who are excluded from the ATR include those who have not been treated within 30 days following injury, those admitted for observation only, and those with preexisting chronic injuries who are entered into the ATR once and not for subsequent admissions.

Trauma registry cases are identified and information abstracted either concurrently or retrospectively (after patient discharge) by nursing or medical records personnel in each hospital. Data are recorded either on a data abstraction work sheet or into a proprietary computerized trauma registry program [Cales, 1986b]. The data worksheets, or computer diskettes, are then sent to the Alaska Department of Health and Social Services for entry into the ATR. The data are then cleaned and coded in preparation for analysis using a proprietary trauma registry computer program [Cales, 1986a]. In addition, the ATR data are sent to the National Institute for Occupational Safety and Health, Division of Safety Research, Alaska Field Station where the work-related surveillance data undergo additional cleaning, coding, analysis, and linkage to data obtained from other sources.

Currently three fields in the ATR contain information on work-related cases. These fields include: if the injury is ''work-related'' (yes/no/unknown), a brief ''occupation description'' in narrative form, and a two digit industry code for 11 previously identified target industries in Alaska. The target industries listed in the ATR include air transportation, construction, commercial fishing, land transportation, logging, military, mining, oil/gas, seafood processing, water transportation, and wood product manufacturing. To qualify as a work-related case, the injury has to comply with the Operational Guidelines for Determination of Injury at Work criteria used by the National Institute for Occupational Safety and Health [Centers for Disease Control and Prevention, 1993b]. These guidelines include all injuries that occur on employers' premises except if the worker is engaged in recreational activities for personal enjoyment or if the person is a visitor for nonwork purposes. Injuries that occur off employer premises are not included unless the person is working for pay or compensation (including at home), working as a volunteer (EMS, firefighter, law enforcement), working in a family business (including family farm), traveling on business, or engaged in work activity where the vehicle is considered the work environment.

For our analysis, cause of injury is taken from the ICD-9-CM ''E Code'' field in the ATR. The ''cause of injury'' category can be useful in assessing the environment around the worker when the injury occurred (e.g., if the worker was using a machine or struck by an object). In the ATR, the E Code is complemented by an additional data field, the injury description narrative, to further reveal information on events surrounding the injury. Information for both type of injury and body region were taken from the ICD-9-CM, N Code (discharge medical diagnosis) field in the ATR.

The 1985 revision of the Abbreviated Injury Scale (AIS) [Association for the Advancement of Automotive Medicine, 1985] is used to classify injury severity in the ATR. The AIS scoring system ranges from one to six, with a score of one corresponding to a minor injury and a score of six being a virtually unsurvivable injury. A computerized automatic mapping system built into the ATR system software [Cales, 1986a] converts ICD-9-CM N Codes into an AIS score. The maximum AIS score for the most severe injury (by N Code) the patient sustained is used for our analysis. We considered those injuries having an AIS score of three or greater (high risk for permanent physical impairment or death) as being severe.

By examining the type, body region, and severity of injury we can prioritize areas for injury prevention planning. The type of injury category can be used to assess the severity of injury for prioritization purposes (i.e., open wound vs. amputation). The ''body region'' category identifies the target of the injury-producing force. This information can be used to prioritize prevention measures and to identify areas to guard machines or parts of the body that may need additional protection. The body regions used are head/neck/spine, chest/abdomen/pelvis, upper extremities, and lower extremities. The head, neck, and spine areas have been combined to provide a focus on actual or potential central nervous system injuries. Severe injuries are an area of focus because they are likely to result in the most suffering and disability.

Denominator data for industries were collected from various sources. Fishing industry workforce estimates were

calculated by NIOSH to be approximately 17,400 full-time equivalent workers each year [Centers for Disease Control and Prevention, 1993a]. Fishermen in Alaskan waters often are from out of state, and this incursion was taken into account in our worker population estimate. Alaska military population estimates were provided by the Alaska Department of Labor [Williams, 1996]. The seafood processing industry worker estimates, comprising Standard Industrial Classification codes 2091 and 2092, were provided from unpublished data by the Alaska Department of Labor, Research and Analysis Section. The remainder of the industry population estimates were supplied by the Alaska State Department of Labor Annual Employment and Earnings Summary Report [Alaska Department of Labor, 1991, 1992, 1993, 1994, 1995]. These estimates are given as annual average monthly employment estimates. The annual estimates are then totaled for the five-year study period for each industry and used as our denominator. All rates are expressed as an average annual rate per 100 workers.

There are known limitations to the ATR data and the denominator information. The industry categories in the ATR are limited to the industries initially targeted when ATR data collection began. Beginning in January 1997, the ATR work-related fields have been expanded to include comprehensive industry and occupation categories correlating with those of the U.S. Department of Commerce, 1990, Bureau of the Census industry and occupation codes.

Except for the military and commercial fishing industry, the available denominator information does not include self-employed workers. This could lead to an overestimation of the incidence rates, particularly in the Alaskan construction and logging industries. However, the ability to employ population-based injury rates is a strength of this statewide surveillance system.

Currently, the only worker population estimate available for the Alaska commercial fishing industry is measured in full-time equivalent (FTE) workers. The estimates for all other industries are the total number of workers employed in that industry. We were unable to gather additional information to adjust FTE workers to employed workers or vice versa. Because of this difference, when looking at industry injury rates in our analysis, we were not able to compare the commercial fishing injury rate with the other industries.

RESULTS

From January 1991 through December 1995, the ATR contains information for 20,842 injuries. Of these injuries, 2,421 (12%) were classified as ''work-related'' and 97 were entered as being of ''unknown'' work status. The unknown entries were not considered in our evaluation.

Of the ATR cases, 37 workers died as a result of their injuries, with 28 expiring in the ED, 6 in an intensive care unit, and 3 in a hospital operating room. These victims are excluded from the remainder of this analysis, leaving 2,384 hospitalized nonfatal work-related injuries.

TABLE I. Alaska Trauma Registry, Nonfatal Work-Related Injuries by Age Groups, 1991–1995

Age group	Number of injuries	%
0–9	2	0.08
10–19	89	3.73
20–29	704	29.53
30–39	736	30.87
40–49	520	21.81
50–59	242	10.15
60–69	81	3.40
70–79	9	0.38
≥80	1	0.04
Total	2,384	99.99

Patient Demographics

Males accounted for 90% (2,153) of the work-related injuries. The mean age of workers injured in the ATR was 36 years. Age distribution is displayed in Table I. An analysis of race distribution reveals that 1,794 (75%) of those injured were white, 269 (11%) Alaska Native, 88 (4%) Asian/Pacific Islander, 63 (3%) Black, and 170 (7%) were categorized as unknown. Two cases appeared in the youngest, 0–9-year age group. One of these injuries occurred in the commercial fishing industry, in which a child fell into the hold of a fishing vessel and received a concussion. The other injury involved a child falling from a moving tractor at a dairy farm and receiving abdominal injuries. Both of these incidents involved industries that are often owned and operated as a family business in Alaska.

The annual number of work-related cases has decreased each year from 540 cases in 1991 to 374 in 1995. At this time we are uncertain of the cause of this trend. Possibilities include an actual decrease in the number of work-related nonfatal injuries, the recent shift of hospitals to treat more patients on an outpatient basis for nonsevere injuries, and an ATR data collection problem.

Industry Analysis

Commercial fishing leads all industries, with the highest number of reported work-related ATR injury cases (390), followed by construction (365) and logging (215). When incidence rates were calculated using currently available industry data, the industry rank order change considerably, with logging, water transportation, and wood product manufacturing industries having the highest rates (Table II).

TABLE II. Alaska Trauma Registry, Number of Injuries and Injury Rate by Industry Category

Industry	1991–1995 ATR injuries	Average annual injury rate/100 workers
Logging	215	2.50
Water transportation	118	1.33
Wood product manufacturing	30	0.94
Construction	365	0.63
Mining	30	0.54
Fishing	390	0.45[a]
Land transportation	84	0.37
Seafood processing	136	0.26
Oil and gas	99	0.21
Air transportation	69	0.19
Military	202	0.18

[a]Denominator measured in full-time equivalent workers.

Cause, Body Region, and Severity of Injury

Table III shows work-related injuries by industry and cause. The industries included in this table are those with the highest incidence rates and/or number of injuries. Highlights include the high number of falls in construction, machinery and falls in the fishing industry, and being struck by an object while logging. Severe work-related injuries by industry and cause are also shown in Table III. The same highlights mentioned above continue to stand out for the severe injuries.

With the high number of fall injuries in the construction industry, we examined the severe injuries and which body region was injured. Falls caused 18 injuries to the head, neck, or spine followed by 15 to the chest, abdomen, or pelvis, 13 to the lower extremity and six to the upper extremity.

DISCUSSION

Our priority industries for nonfatal injury prevention planning are those recognized in our analysis with the highest injury incidence rates: logging, water transportation, and wood product manufacturing, as well as fishing and construction, which resulted in the largest number of injuries.

In the Alaskan logging industry, the majority of the injuries were caused by being struck by an object followed by falls (Table III). The objects most commonly striking workers were trees, logs, or limbs. Other causes responsible for injury included machinery or cables used to transport logs. The most common type of injury was a fractured bone and the body region most commonly injured was the lower extremities. Fractured bones themselves can be serious (especially to the femur, pelvis, or vertebrae) and long-term disabling injuries or accompanying additional injuries (e.g., brain trauma, skull fractures) would give them a high priority for injury prevention efforts. Further research and recommendations could focus on the use of highly mechanized harvest methods where the operator sits in an enclosed cab while a large arm grasps, cuts, and lays the tree horizontally on the ground. Integrated head, ear, and eye protection as used in the Nordic nations [Väyrynen, 1993] should also be considered and evaluated for use in Alaska.

In the water transportation industry, falls were the cause of the majority of injuries in the ATR. The injury narrative field revealed that falling while on stairs or ladder, or into the hold of a vessel, were frequent causes of injury. High seas and ice were also mentioned frequently in the injury narratives. A fractured bone was the most common type of injury and the lower extremities were the most common body region mentioned. Using this information, further investigations will be focused on injury prevention strategies for falls while onboard vessels.

The majority of injuries in the wood products industry were caused by machinery and falls. Saws were the most common device associated with injury. Fractured bones and amputations to/of the upper extremities were the most common types of injuries. Further research could examine injury prevention strategies for working with machinery in this industry.

Somewhat surprisingly, falls were the leading cause of nonfatal injuries in the commercial fishing industry (Table III). Falls most often occurred into holds, through open hatchways, and as a result of slipping on ladders and gangways. Machinery ranked a close second as a cause of nonfatal injuries. ''Crab pots'' (baited cages weighing up to 700 lb) and a ''crab pot launcher'' were listed as being involved in a number of injuries. A crab pot launcher is a hydraulic lift that raises and tilts the pot over the top of the gunwale, to be slid into the water. Fishing nets, lines, and winches were also repeatedly mentioned. The upper extremity was the body region afflicted most often. Severe injuries in the fishing industry were more likely to have been caused by falls and machinery. Causes of nonfatal injuries in the commercial fishing industry differ greatly from the vessel stability and person overboard risk factors causing the majority of fatal injuries.

The insights provided by the nonfatal injury data provided by the ATR for the Alaska fishing industry are striking. While work-related fatalities in this industry are almost entirely attributable to hypothermia and cold-water drowning [Centers for Disease Control and Prevention, 1993a, 1997b], the role of machinery and falls will be very important to address for reducing nonfatal injuries. One important area of overlap in the etiology of fatal and nonfatal

TABLE III. Work-Related Injuries and Severe Injuries (AIS ≥ 3) by Industry and Cause, Alaska, 1991–1995

	Cause of all injuries (cause of severe injuries)				
Industry	**Fall**	**Machinery**	**Struck by**	**Cut/Pierce**	**Overexertion**
Construction	179 (52)	63 (21)	40 (12)	13 (1)	5 (1)
Logging	27 (7)	14 (1)	54 (17)	14 (1)	3 (0)
Fishing	94 (23)	92 (32)	14 (1)	16 (1)	4 (0)
Wood products	10 (3)	10 (3)	0 (0)	1 (0)	3 (0)
Water transportation	56 (17)	18 (6)	3 (2)	0 (0)	1 (1)

injuries in fishing is ensnarement of an extremity in lines, which caused 9 (29%) of the 31 man-overboard deaths in Alaskan commercial fishing during 1991–1996 [Centers for Disease Control and Prevention, 1997b], and to which are attributed many of the serious nonfatal injuries sustained by this workforce. Our future research will focus on protecting the worker from nets, lines, and onboard machinery in the fishing industry.

Construction-related injuries were most frequently attributable to falls, followed by machinery and being struck by objects (Table III). ATR narrative fields reveal a repetitive pattern of falls from ladders, scaffolding, and roofs leading to these injuries. Machinery-related injuries were attributable to a much broader range of machines, ranging from crush injuries by heavy earthmoving equipment to lacerations and amputations by handheld power tools. The lower extremities were the most frequent body region injured, with the upper extremities following closely behind. In the construction industry, 38% of all injuries were to the head, neck, spine, chest, abdomen, and pelvis, while among severe injuries, a much higher 59% were to these body regions. The frequency with which falls from heights are implicated in construction injuries supports much greater attention being paid to fall protection for Alaska's workers in the construction trades. Additional attention should also be paid to Alaska-specific risk factors (e.g., lack of daylight in winter along with persistent snow and ice) pertaining to falls.

Surveillance studies for nonfatal work-related injuries can acquire data from many sources, including hospital records, workers compensation records, and the Bureau of Labor Statistics. These studies can also have various case definitions that could include any workers seen at a medical clinic to only those who have been admitted to a hospital. Given the different data sources and case definitions used, we were not able to compare our results to other published nonfatal work-related studies. We chose to focus on hospitalized patients as a priority area for injury prevention. Many state health departments have existing trauma registries that can be used similarly, in work-related injury surveillance. We look forward to seeing more of these trauma registries used for work-related injury surveillance and injury prevention. We also look forward to seeing other data published in other states and compared to our study.

The Alaska Trauma Registry is continually evolving into a high-quality injury surveillance tool, useful for injury prevention planning. In addition to the improvements mentioned above, recent changes include formalized data abstractor training and data entry directly into computer (rather than a paper worksheet) for all hospitals. These recommendations and changes will facilitate higher sensitivity and quality of the data.

Concerted efforts are now being made to prevent work-related injuries in Alaska. In 1991, NIOSH cofounded the Alaska Interagency Working Group for the Prevention of Occupational Injuries, which includes the Alaska Department of Labor, the Alaska Department of Health and Social Services, the National Transportation Safety Board, the U.S. Coast Guard, the Federal Aviation Administration, the U.S. Forest Service, the National Institute for Occupational Safety and Health, and the Occupational Safety and Health Administration. The working group currently has four committees focusing on preventing deaths and injuries in aviation, commercial fishing (particularly crabbing), commercial diving (vessel repair and dive fisheries), and the construction industry.

Current data from the ATR are useful for estimating injury rates and trends in Alaskan workers. Our analysis has identified specific high-risk industries, causes, and types of injury. This information will assist us to design controls and training to decrease the number of traumatic injuries in these industries.

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