Hospitalized Nonfatal Injuries in the Alaskan Construction Industry

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Background *Construction industry workers are exposed to many hazards leading to fatal and nonfatal injuries. Information for nonfatal work-related injury surveillance may be vague and come from a variety of sources.*
Methods *The Alaska Trauma Registry (ATR) is used as an injury surveillance tool to focus on hospitalized nonfatal injuries in the Alaskan construction industry.*
Results *During 1991–1999, 717 workers in the Alaskan construction industry were hospitalized due to occupational injuries, with an average annual injury rate of 0.39 injuries/100 workers. Leading causes of injury included falls (48%) and machinery (15%). Thirty-four percent of the falls were from a building or structure, followed by falls from a ladder (24%). A fractured bone was the most common type of injury (57%).*
Conclusions *Information on hospitalized patients from the ATR focuses on the more severe and debilitating injuries, and provides valuable information for prioritizing injury prevention efforts in Alaska.* Am. J. Ind. Med. 47:428–433, 2005. *© 2005 Wiley-Liss, Inc.*

KEY WORDS: epidemiology; injuries; construction safety; injury prevention; safety; nonfatal injuries

INTRODUCTION

The construction industry has many inherent hazards. Heavy machinery, power tools, motor vehicles, work at heights, heavy loads, exposure to the changing outdoor environment, collapsing structures and trenches, and electrical energy all have potential to cause harm to a construction worker. As a result of these hazards, workers in the US construction industry suffered over 400,000 injuries and illnesses as defined by the Occupational Safety and Health Administration (OSHA) in 2002. Approximately 226,000 of these involved days away from work [Bureau of Labor Statistics, 2003a]. The rate of all nonfatal injuries and illnesses for the construction industry in 2002 was 7.1 cases per 100 workers (full-time equivalent), higher than the rate for all workers of 5.3 cases per 100 workers [Bureau of Labor Statistics, 2003b].

Unfortunately, the true rate of all nonfatal injuries and illnesses is probably much higher than that reported through the Bureau of Labor Statistics (BLS) Annual Survey of OSHA records, the only national source of occupational injury and illness data. Workplace injuries and illnesses are often under-reported [Oleinick et al., 1995; Glazner et al., 1998; Pransky et al., 1999] or cases are lost at one of the many levels of documentation necessary for a worker's injury to be recorded in the OSHA system [Azaroff et al., 2002]. Regional studies of nonfatal injury in the construction industry have focused on information from workers' compensation [Cattledge et al., 1996; Alexander et al., 1999; Horwitz and McCall, 2004] or hospital emergency departments (EDs) [Hunting et al., 1994; Zwerling et al., 1996; Hunting et al., 1999]. Case definitions for each data source differ:

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- OSHA recordable injuries require more than basic first aid and include time away from work or restricted work duties.
- Workers' compensation requires a minimum number of days away from work.
- EDs have different definitions of basic first aid than OSHA and no lost work requirements.

A comparison of OSHA logs with local ED patient records for a large construction site in Washington DC found that only 27% of ED-treated worker injuries were classified as OSHA recordable and that the pattern of injuries varied depending upon the data source [Welch and Hunting, 2003].

In order to plan and initiate appropriate injury prevention measures, with limited resources, critical workplace injury trends and patterns need to be assessed. Hospital medical record data provide a unique source of information, especially record systems that collect information sufficient for use in surveillance. The objective of the study reported here is to use the Alaska Trauma Registry (ATR) as a statewide surveillance tool for hospitalized nonfatal injuries in the Alaska construction industry. By focusing our surveillance on cause and nature of injury, the data can be used for further work-site investigations and injury prevention.

MATERIALS AND METHODS

The ATR is a comprehensive population-based injury surveillance system which has been in place, statewide in Alaska, since 1991. It includes information on all patients with sufficiently severe injuries to require hospitalization in any of the 24 acute-care hospitals in Alaska. The ATR is maintained by the Alaska Department of Health and Social Services, Division of Public Health, Community Health and Emergency Medical Services Section, in Juneau, Alaska, with technical support and partial funding from the National Institute for Occupational Safety and Health (NIOSH). Criteria for a case to be included in the ATR include people with injuries that are identified by the *International Classification of Diseases*, 9th Revision, Clinical Modification (ICD-9-CM), discharge diagnosis code of 800.00-995.89 (e.g., traumatic injuries, poisoning, environmental effects) and who are admitted to a hospital in Alaska or transferred to a hospital with a higher level of care. Patients whose data are excluded from the ATR include those who have not been treated within 30 days following injury. All injuries that resulted in fatalities were excluded from this study. For patients who were seen in a hospital ED, or who were admitted to a hospital and then transferred to another facility for admission, our analysis includes only information gathered on the first hospital visit (primary hospital ED or hospital admission).

Occupational status of the injury is determined during data abstraction from the hospital medical record. To be included as a work-related case, the collected information must fit the criteria published by NIOSH, which include guidelines for including or excluding consideration for injury at work both on and off employer-owned premises [Centers for Disease Control and Prevention, 2001a]. For cases that are work-related, a two-digit industry code is assigned for one of 11 previously identified target industries (which includes the construction industry) or assigned as 'other.' Cases involving individuals less than 15 years of age were excluded from the analysis.

Information on cause of injury was taken from ICD-9-CM, E-codes (external cause of injury). For this study, the E-codes were grouped into categories similar to those used in the National Traumatic Occupational Fatality surveillance system [Centers for Disease Control and Prevention, 2001b].

The ICD-9-CM, N-code (medical diagnosis) was used to record nature and body region of injury. Some injuries may have multiple N codes; when this is the case, the N-code that corresponds to the most serious injury is used for our analysis. Body regions have been divided into four categories which include head/neck/spine, chest/abdomen/pelvis, upper extremities, and lower extremities. The nature of injury classification reflects the primary medical diagnosis resulting from the injury. Examples of such characteristics can include fractured bone, burn, or amputation.

The ATR also includes an ''injury description'' free text field in which the data abstractor can enter additional information, including details of the injury event. The narrative in this field was used for additional information about the circumstances surrounding the injury.

Severity is rated using the Abbreviated Injury Scale (AIS), 1985 version scoring guidelines [Association for the Advancement of Automotive Medicine, 1985]. An AIS score of ''one'' corresponds to a minor injury, while an injury with a score of ''six'' represents a virtually unsurvivable injury. AIS scores are not given to unspecified injuries, hypothermia, toxic effects, or poisonings. Each primary ICD-9-CM N-code is linked to a corresponding AIS value. For our study, an AIS score of ''three'' or greater was considered a ''severe'' injury.

Construction industry employment information from the Current Population Survey was used for the denominator in rate calculations (Data acquired from the U.S. Bureau of Labor Statistics in 2000). Other information was available for denominator estimates (Alaska Department of Labor Employment and Earnings estimates, and Alaska Department of Labor Current Employment Statistics); however, these data did not provide the flexibility to stratify for variables used in our analysis. Annual employment was estimated as the yearly average of the monthly number of employees whose primary industry listed was construction.

These denominator estimates were not able to be adjusted for hours worked, so a person whose primary job is part-time was treated equally with a person whose primary job is full-time.

RESULTS

From January 1991 to December 1999, the ATR contained information for 717 hospitalized nonfatal injuries in the construction industry which met the case definition. This represents an average annual injury rate of 0.39 injuries/100 workers (Table I). The annual injury rate for construction was rather steady during the 1990s with 1992 as an outlier with 0.56 injury cases per 100 workers. The higher rate in 1992 was due to a 10% decrease from 1991 to 1992 in the population of workers as estimated by CPS data. Estimates of construction industry workers from the Alaska Department of Labor Current Employment Statistics and Employment and Earnings also demonstrated a decline from 1991 to 1992, although to a lesser extent (1% and 3% decline respectively). We have not been able to find other information explaining this decrease in workers for this time period.

At the time of injury, workers' ages ranged from 17 to 71 years, with an average age of 38.5 years (Table II). Those injured were predominantly male (98%) and between the ages of 30 and 49 (62%). Race was available for 94% of those injured. Most injuries were to white workers (575), followed by Alaska Native/American Indian (85). Rates of injury for these subpopulations indicated one high-risk group. Known Alaska Native and American Indian workers comprised only 12% of total injured workers, but their injury rate of 0.54 injury cases per 100 workers was higher than the overall average of 0.39/100 workers. Construction workers between the ages of 20–29 had the highest injury rate of all age classes (0.44/100 workers), although younger workers in general did not have higher rates than older workers. In fact, the youngest workers in this sample, age 15–19, had the lowest rate of injury (0.31/100 workers).

The length of hospital stay ranged from one to 41 days, with approximately 60% of the patients having hospital stays of one to three days. Nearly one-third of the injuries occurred in the Anchorage area (31%), 18% in Southeast Alaska, 9% in the Matanuska-Susitna Borough, and 8% each in Fairbanks and on the Kenai Peninsula. This corresponds roughly with the population centers of the state, with 42% of the population residing in the Anchorage municipality (U.S. Census Bureau, 2000 Census of Population & Housing, Summary File 3). Sixty-three percent of injuries occurred in the six-month period from June to November.

TABLE I. Alaska Trauma Registry Annual Hospitalized Nonfatal Injuries, Construction Industry, Alaska, 1991–1999

Year	Number of injury cases	Average annual injury rate/100 workers
1991	70	0.43
1992	82	0.56
1993	83	0.44
1994	66	0.32
1995	67	0.31
1996	83	0.38
1997	91	0.41
1998	85	0.32
1999	90	0.39

TABLE II. Demographic Information, Hospitalized Nonfatal Construction Injuries, Alaska, 1991–1999

Variable	N	Rate/100
Total cases	717	0.39
Age		
15–19	21	0.31
20–29	133	0.44
30–39	244	0.42
40–49	202	0.34
50–59	89	0.36
60–69	27	0.40
$\geq$70	1	0.09
Race		
White	575	0.34
Alaska Native/American Indian	85	0.54
Black	10	0.28
Asian/Pacific Islander	5	0.34
Unknown	42	
Gender		
Male	702	0.43
Female	15	0.06

The main cause of hospitalized nonfatal injury was falls, accounting for almost half of the cases (Table III). The next most common cause was machines, accounting for 15% of all injuries. About one-third of all hospitalized nonfatal injuries (31%) were to the lower extremities (legs, feet, and toes), with slightly fewer occurring to the upper extremities (arms, hands, fingers). A fractured bone was the most common nature of injury (57%) requiring hospitalization. Most fractures occurred in a lower extremity (171, 42%), followed by head/neck/spine (105, 26%), and then by an upper extremity (101, 25%).

One hundred ninety-one (27%) of the injuries were considered severe (AIS score $\geq$3). The head/neck/spine were the location of the largest number of severe injuries (68), followed by injuries to the lower extremities (50), chest/abdomen/pelvis (48), and upper extremities (26). The leading causes for severe injuries were falls (112), machinery-related injuries (26), and being struck by a falling object (17), which parallels closely with the cause of injury ranking for all ATR construction industry injuries. Permanent disability was recorded for 10 workers with injuries to the head, neck, or

TABLE III. Injury Characteristics, Hospitalized Nonfatal Construction Injuries, Alaska, 1991–1999

Variable	N	Percent
Total cases	717	
Cause		
Falls	347	48
Machines	109	15
Cutting/piercing instruments	63	9
Falling objects	56	8
Other	142	20
Area of body		
Lower extremities	223	31
Upper extremities	205	29
Head/neck/spine	164	23
Chest/abdomen/pelvis	88	12
Other/unspecified	37	5
Nature of injury		
Fractured bone	409	57
Open wounds	107	15
Sprain/strain	40	6
Other	161	22

spine. Five injuries were to the spine, two injuries were directly to the brain, two were skull fractures, and one injury was to the eye.

Most injuries caused by a fall were from a building or structure, usually a roof (119, 34%; from ATR narrative injury description text field). Other fall-related injuries involved falling on or from a ladder (82, 24%), falling on or from scaffolding (63, 18%), falling from one level to another (57, 16%), and falls on same level slip/trip/stumble (21, 6%). The narrative injury description mentions ''ice'' or ''snow'' as a contributing factor to a fall in only 12 cases.

Injuries in the machinery category involve various machines ranging from earthmovers to circular saws. By E-code groupings, machines in the woodworking/forming machines category (38) were associated with the highest number of injuries, followed by earthmoving/scraping/excavating category (32), and lifting machines (17). The ATR narrative injury description field provided additional information on circumstances surrounding these machinery-related injuries. In the earthmoving/scraping/excavating category, commonly mentioned details include having an extremity ''run over'' by the machine or being ''hit'' by a moving part of the machine. All recorded injuries with woodworking machines were caused by saws. The type of saws mentioned most commonly were table and circular hand saws, and the most common type of injury was cut hands or fingers. In eight cases, machinery that the worker was in (loaders, tractors, or cranes) tipped or rolled over. Twenty (32%) of the 63 cutting and piercing injuries involved the use of nail or staple guns.

DISCUSSION

Comparisons to Other Research

This study identified common causes and types of injuries that led to hospitalization among workers in the Alaska construction industry. Direct comparison of our results with data from other sources can be complicated by differences in coding schemes and case definitions. Our study, along with those using other medical data sources such as ED data, classify injury events based on the ICD-9 external cause code, while the OSHA record data utilized by the BLS employ the occupational injury and illness classification system (OIICS). A worker who is injured when struck by the bucket of an excavator provides a good example of differences between coding systems. The ICD-9 category for being struck by the bucket of an excavator is ''machine,'' while the OIICS category is ''Struck By Object.'' In spite of these differences, comparisons can provide insight into both the risk of injury to Alaska's construction workers, and the patterns of injuries presented by different data sources.

The rates of hospitalized nonfatal injury in the Alaska construction industry are similar to those in comparable data from Washington state. Alexander et al. [1999] found that building construction workers in Washington state had 0.15 and 0.29 cases per 100 full-time equivalent (FTE) for less and more severe hospitalized nonfatal injuries respectively during 1991–1995 compared to 0.39 cases/100 workers for all construction workers in Alaska. Roofing, metal siding and gutter work, bridge construction, and overhead lines construction had the highest rates of severe hospitalized nonfatal injuries ranging from 0.40 to 0.52 cases/100 FTE. Leading causes of injury within the construction industry were similar between Alaska and Washington. For wood frame building, building, and road construction the most common cause of injury was a fall. This corresponds to the findings from this study that falls continued to present the leading risk to workers in the construction industry for hospitalized injuries.

Hospitalization data provides a different aspect of injury than other sources. Emergency Department (ED) data from Washington DC during 1990–1997 [Hunting et al., 1999] showed that the majority of injury cases for construction workers were lacerations (37%), followed by sprains/strains (22%), while fractures, which were the majority of injuries in the ATR, accounted for under 9% of all cases. EDs discharge more patients with less serious injuries than they admit. They also treat a higher volume of cases overall than those accounted for in hospital discharge or hospitalized record data. In the ATR, the most common circumstances which led to these injuries were cutting or piercing objects (27%), followed by falls (17%). Injury prevention efforts based on these data may miss the overwhelming effect that falls play in causing serious, costly, and potentially debilitating injury. Injury reports based upon workers' compensation claims include only those injuries in which there was a minimum time away from work, often two to three days. Claims from 15 states for construction industry workers give another pattern of injury [Kisner and Fosbroke, 1994]. The majority of injuries were either sprains or strains (34%), cuts or punctures (17%), or fractures (11%). The most common circumstances which led to nonfatal injuries were overexertion (24%) followed by struck by an object (22%), with falls accounting for only 19% of the cases. This is similar to workers' compensation claims data from Oregon [Horwitz and McCall, 2004]. The Survey of Occupational Injuries and Illnesses nonfatal injury data based upon OSHA reportable incidents are available nationally. The most common circumstances leading to these injuries were contact with objects and equipment (35%) followed by overexertion (21%) and falls (21%). Workers' compensation and OSHA records include injuries seen by a primary physician or other health professional, but that did not require either hospitalization or an emergency room visit. One example is back injuries, which have been shown to be the most frequent body part injured in a workers' compensation claim [Kisner and Fosbroke, 1994; Courtney et al., 2002; Horwitz and McCall, 2004], are usually not life threatening, and often meet the requirements of an OSHA reportable injury. Again, the data source determines the types of injuries which are included and determines the focus of any resulting prevention efforts.

Limitations

Information in the ATR portrays severe nonfatal injuries. Only some of the injuries which occur during work require professional medical attention, and only a fraction of those seen at a hospital result in hospitalization. Jackson reports that only 2% of workers with nonfatal work-related injuries treated in hospital EDs were admitted to the hospital [Jackson, 2001]. In a study of construction laborers who were seen in a ED, only 6% were admitted to a hospital [Welch et al., 2000]. The injuries requiring admission are the most severe and often dominated by injuries from falls [Welch et al., 2000; Layne et al., 2001]. Medical costs are a large portion of workers' compensation in construction [Horwitz and McCall, 2004], and thus hospitalized injuries represent many of the most expensive injury cases.

Historically, the ATR has had limited information on both industry and occupation which makes trade-specific analysis impracticable [Hunting et al., 1999]; however, these specifics are useful when developing injury prevention programs. Since 1997, comprehensive information on industry and occupation has been collected, although it was not available for our entire study period. Another potential limitation is whether occupational status was accurately documented in the medical record, and discovered by the data abstractor. Additional training of health care providers and ATR abstractors was initiated in 1996 to increase the validity and reliability of this information. As there was not a noticeable change in the annual rates of hospitalized injury relative to this training, it is not believed that there was a serious lack of documentation prior to 1996.

Estimates of construction industry workers used in calculating rates may have biased the results. Only employees whose primary industry was construction were included in the estimates and all workers were treated as full-time (not weighted based upon hours worked). Thus part-time workers whose primary industry was construction were counted as full-time workers, and part-time workers whose primary industry was not construction were not included at all. It is unclear what effect this may have had on the calculated rates, but it is more likely that the estimated population numbers are an underestimate of the true population size, and thus the resulting rates may be biased slightly higher than the true rates.

Utility of Trauma Registry Data

Trauma registries offer a unique source of work-related injury surveillance data because they focus on hospitalized injuries—injuries that are the most serious, costly, and debilitating.

A major strength of the ATR as a surveillance system is that it is a statewide population-based information source. Unlike other medical data sources such as ED data or hospital discharge data, the population at risk is identifiable. These data can be paired with state-based worker estimates to calculate rates by industry or occupation.

Currently, information from the ATR is used to identify and prioritize injuries and recommend areas to focus prevention efforts in the Alaskan construction industry through the Alaska Interagency Working Group for the Prevention of Occupational Injuries. It has also been used to identify critical risk areas for training, including proactive fall protection, scaffolding safety, and rigging and hoisting loads. Over 400 workers, safety personnel, and others have been trained during sessions at the Alaska Governor's Safety and Health Conference. The Alaska Injury Prevention Center has used ATR data to examine the risks posed by falls in the construction industry, and focus on preventing injuries among specific worker subpopulations susceptible to certain types of falls. This has led to collaboration with construction industry associations where ATR data has been used to similarly identify topics for safety training.

The ATR has proven to be a valuable tool in studying work-related injuries in Alaska. Using injury surveillance information from the ATR, such as that presented here, safety and injury prevention specialists are able to tailor injury research and prevention efforts toward the needs of workers in the Alaska construction industry. Other regions may also be able to utilize trauma registries for nonfatal injury surveillance and prevention.

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