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Surveillance for work-related skull fractures in Michigan

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ABSTRACT

Objectives: The objective was to develop a multisource surveillance system for work-related skull fractures. *Methods*: Records on work-related skull fractures were obtained from Michigan's 134 hospitals, Michigan's Workers' Compensation Agency and death certificates. Cases from the three sources were matched to eliminate duplicates from more than one source. Workplaces where the most severe injuries occurred were referred to OSHA for an enforcement inspection. *Results*: There were 318 work related skull fractures, not including facial fractures, between 2010 and 2012. In 2012, after the inclusion of facial fractures, 316 fractures were identified of which 218 (69%) were facial fractures. The Bureau of Labor Statistic's (BLS) 2012 estimate of skull fractures in Michigan, which includes facial fractures, was 170, which was 53.8% of those identified from our review of medical records. The inclusion of facial fractures in the surveillance system increased the percentage of women identified from 15.4% to 31.2%, decreased severity (hospitalization went from 48.7% to 10.6% and loss of consciousness went from 56.5% to 17.8%), decreased falls from 48.2% to 27.6%, and increased assaults from 5.0% to 20.2%, shifted the most common industry from construction (13.3%) to health care and social assistance (15.0%) and the highest incidence rate from males 65+ (6.8 per 100,000) to young men, 20–24 years (9.6 per 100,000). Workplace inspections resulted in 45 violations and $62,750 in penalties. *Conclusions*: The Michigan multisource surveillance system of workplace injuries had two major advantages over the existing national system: (a) workplace investigations were initiated hazards identified and safety changes implemented at the facilities where the injuries occurred; and (b) a more accurate count was derived, with 86% more work-related skull fractures identified than BLS's employer based estimate. *Practical Applications*: A more comprehensive system to identify and target interventions for workplace injuries was implemented using hospital and emergency department medical records.

1. Introduction

Traumatic brain injury (TBI) is an important cause of morbidity and mortality, with injury severity ranging from mild to death. Approximately 1.7 million people each year in the United States have a TBI; 52,000 die, 275,000 are hospitalized, and 1.365 million are treated in an emergency department (Centers for Disease Control and Prevention, 2010, 2011). Recovery from TBI can be prolonged and cause long lasting impairment (Centers for Disease Control and prevention, 2011). Work-related injuries have been estimated to be the cause of 4–7% of TBIs (Hwan, Colantino, & Chipman, 2006; Wei, Roesler, & Kinde, 2012). The magnitude and characteristics of work-related TBI are not routinely reported from population-based data. The Centers for Disease Control and Prevention (CDC), which has been conducting TBI surveillance in partnership with the states since 1988 has not published data on work-related TBI. The Bureau of Labor Statistics (BLS), which collects data on work-related injuries and illness in the United States, does not specifically address TBI.

Michigan has been conducting population-based public health surveillance for a variety of work-related injuries and illnesses since 1988 (http://www.oem.msu.edu/). Recently, the feasibility of putting work-related TBI under surveillance in Michigan was explored, based on the CDC case definition for TBI that includes skull (but not facial) fractures, concussions, and a variety of other head injuries (Centers for Disease Control and Prevention, 2012). Because of limited resources, Michigan initiated surveillance in 2010 for work-related skull fractures only; approximately 20% of TBI cases requiring hospitalization have a skull fracture (Thomas W. Largo, personal communication, February 3, 2014). Skull fractures were selected as they were considered likely to be among the most severe TBIs. In keeping with the CDC definition for TBI, facial fractures were excluded. Like Michigan's other work-related surveillance systems, work-related skull fracture surveillance included collection of case data from multiple sources and was linked to interventions to prevent additional injuries in workplaces. This article describes Michigan's work-related multisource skull fracture surveillance system, summarizes the characteristics of work-related skull

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fractures that occurred between 2010 and 2012, and provides two case studies that demonstrate the usefulness of using the reported cases to initiate worksite inspections.

Although Michigan data were useful for interventions, the data could not be compared to the data from the national occupational health surveillance system maintained by the BLS because BLS data are limited to a category for all fractures of the head, including facial fractures, which in the BLS estimates are not separated from other skull fractures. Therefore, in 2012, Michigan added facial fractures to the surveillance system. Accordingly this article also summarizes the skull fracture data, comparing the impacts of including facial fracture in 2012 and comparing overall results with BLS data on work-related skull fractures in Michigan.

2. Methods

2.1. Surveillance Population

The population consisted of individuals working in the state of Michigan who: (a) had a work-related skull fracture, including out-of-state residents, and who received inpatient, emergency or outpatient medical treatment in one of Michigan's 134 hospitals; (b) were in the Michigan Workers' Compensation Agency (WCA) computerized database as having received wage replacement for a skull fracture; or (c) died from a work-related skull fracture that occurred in Michigan.

2.2. Data Collection Time Period

Work-related skull fractures were identified for the three year time period from January 1, 2010, to December 31, 2012.

2.3. Data Sources

2.3.1. Hospital/Emergency Department

All 134 acute care hospitals, including Veterans' Administration Hospitals in Michigan, are required by the state regulation to report and submit medical records for individuals treated as an inpatient, in the emergency department (ED) or in an outpatient clinic with a work-related skull fractures (Michigan Administrative Code, 1979). Hospitals reported individuals aged 16 years or older for whom a skull fracture-related diagnosis code was assigned as one of the patient's diagnostic codes (the *International Classification of Diseases, 9th Revision* [ICD-9] (Public Health Services and Health Care Financing Administration, 1980) codes for skull fractures):

- 800.0–.9 (fracture of vault of skull),
- 801.0–.9 (fracture of base of skull),
- 802.0–.9 (fracture of face bones)*.

*Beginning in 2012, Hospitals/EDs were required to report ICD-9 code 802.0–.9:

- 803.0–.9 (other and unqualified skull fractures), and
- 804.0–.9 (multiple fractures involving skull or face with other bones).

2.3.2. Workers' Compensation Agency

The WCA provided access to a database of all claims for wage replacement that occurred between January 1, 2010 and December 31, 2012. Individuals were eligible for wage replacement when they have had at least 7 consecutive days away from work (five work days and two weekend days). Cases identified using Michigan's Workers' Compensation system were defined as an individual who was in the wage replacement database with an accepted claim for a fracture ("nature of injury" code) for one of the following "parts of body:" brain; concussion; multiple parts including face; forehead; head, multiple; head, unspecified; scalp; sinus; or skull.

2.3.3. Michigan Fatality Assessment Control and Evaluation Program

The Michigan Fatality Assessment Control and Evaluation (MIFACE; Michigan State University Occupational and Environmental Medicine) program uses death certificates, police reports, medical examiner reports, and newspaper clippings to identify acute traumatic fatalities in Michigan. All deaths where a skull fracture was the underlying cause of death on the death certificate were included. The following ICD-10 codes were used to identify work-related skull fractures (World Health Organization, 1992):

- S01 (open wound of head),
- S02 (fracture of skull and facial bones),
- S07 (crushing injury of head),
- T02 (fracture involving head with neck)
- T04 (crushing injuries involving head with neck).

Additional fatalities where the underlying cause of death was not a skull fracture were identified in the MIFACE database when skull fracture cases identified from the hospitals were later identified to have died from their injuries.

2.4. Record Review, Data Abstraction, and Removal of Duplicates

The discharge summary diagnosis for hospital admissions, and the history and physical for emergency department and outpatient visits were reviewed to determine whether the skull fracture was work-related and to obtain the following information: type of medical care (hospital, ED, outpatient), hospital name, type of visit, date of admission and discharge, patient demographics, city and county of residence, source of payment, employer information (name, address, with North American Industry Classification Code [NAICS]) (U.S. Office of Management and Budget and Executive Office of the President, 2002) assigned by the abstractor, injury date, cause of injury, type of fracture, and loss of consciousness. For the MIFACE records death certificates, police reports, and medical examiner reports were reviewed to obtain the following information: patient demographics, city and county of residence, employer information, fatality date, type of fracture, cause of injury, and whether the individual lost consciousness due to the injury to their head.

Cause of injury was classified as fall, struck by, motor vehicle accident (MVA), assault, medical condition (syncope or fainting), and others. Type of skull fracture was classified as depressed, displaced, linear, or compound. Hospital/ED and MIFACE data were entered into a Microsoft Access database. Records were manually linked on an annual basis to all wage replacement claims in the Workers' Compensation database. Matches were identified using the individual's first and last name, date of birth, date of injury, and employer information. WCA cases meeting the work-related skull fracture case definition that did not match with individuals in the two other data sources were identified. Matched cases and new cases from the Workers' Compensation database were added to the database of all work-related skull fractures. Duplicates identified by more than one reporting source were eliminated.

2.5. Analyses

2.5.1. I and III. Descriptive Analyses 2010–2012

Work-related skull fracture rates by age, gender, and industry were calculated as the total number of skull fractures in a calendar year divided by the estimated number of workers during that calendar year and expressed as the number of skull fractures per 100,000 workers per year. The U.S. Census/Department of Labor's Current Population Survey was used to determine denominators of total workers and workers by industry and occupation (U.S. Census Bureau & U.S. Department of Commerce, 2014). Data analysis was performed using queries conducted in Microsoft Access. Data for 2010–2012 were combined, excluding