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Risk assessment of occupational injuries using Accident Severity Grade

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ABSTRACT

Problem: In spite of recent efforts to improve occupational health and safety, many occupational accidents result in serious injury and death every year. Continued efforts are therefore necessary to improve current safety initiatives and reduce the frequency and severity of these incidents. To identify workplace hazards, many safety surveillance techniques have been used, including severity metrics to determine the significance of an accident. These techniques involve risk assessment to identify potential hazards and the expected severity of injuries which may result from these hazards, usually based on the severity of similar past injuries. However, these severity metrics do not consider important employee and workplace risk factors, such as age, gender, and weather, which may have significant impacts on accident severity.
Method: A new severity scoring system is introduced which considers multiple injury severity factors, and is used as part of a novel three-dimensional risk assessment matrix which includes an incident's severity, frequency, and preventability. A case study using the proposed methodology with real data is presented.
Discussion: The consideration of additional severity factors improves risk assessment and the estimation of injury severity. A three dimensional risk assessment matrix allows for the analysis of an incident's degree of preventability, frequency, and severity all at once.
Practical Applications: This study demonstrates that organizations, industries, and regulatory bodies can improve workplace safety surveillance tools by incorporating this new severity metric in a three-dimensional risk assessment matrix.

1. Introduction

Occupational accidents are responsible for many fatal and nonfatal injuries in the United States. The Bureau of Labor Statistics reports that about 3 million nonfatal workplace injuries and illnesses occurred in 2012 (Bureau of Labor Statistics, 2011), while fatal injuries in the same period were reported to have a rate of 3.2 cases out of every 100,000 full-time workers (Bureau of Labor Statistics, 2012). The National Institute for Occupational Safety and Health (NIOSH) states that one of its main missions is to reduce work-related injuries, illnesses, and death through periodic surveillance (Centers for Diesease Control and Prevention, 2013), in an effort to increase the utility of information gathered from different stakeholders regarding injuries and hazards in the workplace.

1.1. Severity as a surveillance metric

The relative severity of an accident is a common surveillance metric that is used to determine the magnitude of an incident (Safety and Administration, 1999). An accident's severity is often defined based on the number of lost or restricted workdays resulting from the incident (Safety and Administration, 1999; OSHA). According to the dictionary of scientific and technical terms, an accident severity rate is defined as "the number of worker days lost due to a disabling accident per thousand worker-hours of exposure" (Terms, 2003). Similarly, the Occupational Safety and Health Administration (OSHA) defines the Severity Rate (SR) of an incident as (Safety and Administration, 1999):

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$$SR = \frac{(\text{Total number of lost or restricted workdays in the past 12 months}) * 200,000}{\text{Number of work hours during the past 12 months}} \quad (1)$$

The numerator in Eq. (1) represents the number of lost or restricted workdays in specific department in a 12-month period, multiplied by 200,000 to normalize the number of observed workers to a standard form of 100 employees working 50 weeks per year. SR is a generic metric that can be used in different industries and work environments to quantify injury severity.

Prevention and control of occupational injuries require information about the leading causes of incidents or risk factors. Literature has shown the causal role of work and environmental conditions in the occurrence of occupational accidents (Gauchard and et al., 2001). Further, employee factors such as age and gender may have effect on accident occurrence (Laflamme and Menckel, 1995). Notably, any correlation between the SR and employee factors such as age and gender is not considered in Eq. (1). Other commonly used severity metrics such as odds ratios (Kines, 2001) and the Injury Severity Score (Gillen and et al., 1997) do not include these factors either. Including the impact of these predictors as part of a regular injury surveillance can eventually help safety managers identify potential safety hazards before they lead to severe injuries (Schuh et al., 2013). For example, the most common finding in the literature associated with age is that accident severity tends to increase with age. In terms of gender, comparisons between male and female workers suggest that men tend to have a comparable average days away from work per injury to women, but higher rates of permanent disabilities and fatalities were observed (Laflamme and Menckel, 1995). Furthermore, it has been noted that the rate of serious injuries increases with age, however, the total number of injuries decreases for older ages (Kines, 2001; Root, 1981; Jenkins and Kisner, 1980; Goldberg et al., 1989); in recognizing this, it is clear that instituting age-specific injury prevention interventions may help reduce both the rates of serious injuries in older employees and the number of serious injuries in younger employees. Likewise, gender-specific practices and data collection has been shown to improve safety processes in workplaces (Messing and et al., 2003), which may result in less injuries and fatalities.

In addition, it may be desirable to consider workplace factors such as the weather, job location, and the condition of work environment. For instance, cold weather has been shown to increase injury severity in the US Army (DeGroot et al., 2003). Moreover, climate may also affect the slip and fall injuries among construction workers, and rainy weather has a significant effect on workplace fatalities in this industry (Liao and Perng, 2008; Leamon and Murphy, 1995). Hot weather during summer can increase the risk of electrocution in various industries (Taylor et al., 2002).

The location of the worksite is another important factor that can affect an employee's injury risk in various jobs such as underground mining (Maiti and Bhattacherjee, 1999). More severe injuries might be experienced if an emergency team cannot help an injured person in a timely manner due to limitations of the location or accessibility issues.

The condition of the work environment may also be of interest. Several studies have investigated the effect of surface conditions on occupational accidents (Chang, 1999; Strandberg, 1985; Simeonov and Hsiao, 2001). Slippery surfaces often result in falls, which cause workplace injuries among construction and mining workers. Thus, the effect of surface condition on occupational accidents should be studied as a potential risk factor, especially in these industries.

Moreover, occupational tasks can influence an employee's risk for workplace injuries. For instance, several studies have found a positive correlation between repetitive motion tasks and occupational injuries such as musculoskeletal disorders (Silverstein et al., 1986; Yassi, 1997).

The condition of equipment is another factor that can affect the risk of occupational injuries. One study showed that the risk of hand injuries was increased by using tools and equipment that are not working properly (Sorock and et al., 2004).

Therefore, identifying the potential risk factors similar to the ones that are discussed in this section can improve the risk assessment processes. Clearly, many factors can influence the severity of an occupational injury and should therefore be considered in injury surveillance metrics. The new surveillance metric is flexible and can be adjusted for different industries, accounting for unique sets of risk factors.

1.2. Severity in risk assessment

Once collected, all of this employee and workplace data can be used for health risk assessment purposes and surveillance. Several scoring systems have been developed to assign relative impact scores to healthcare incidents for the purpose of improved surveillance. Patient scores in healthcare, such as the Parsonnet score, Cleveland Clinic score, French score, Euro score, and Ontario Province risk scores, were introduced to monitor medical outcomes (e.g., mortality rate) following surgery (Steiner and Jones, 2010; Wynne-Jones et al., 2000; Nashef et al., 1999; Lawrence et al., 2000). Studies have shown that the development of these distinct scoring systems can enhance the quality of patient care (Geissler et al., 2000; Kawachi et al., 2001). However, there are very few risk assessment scoring systems for occupational injuries. The fishing industry and the Alaska Marine Safety Education Association have generated a risk assessment score sheet to reduce the accidents in fishing vessels (Dzugan). Numerical risk values can be assigned to influential factors based on the assessment criteria for each factor. Darby et al. (2009), used five different fleet driver assessment scores (i.e., exposure to risk score, attitude to safe driving score, behavioral score, knowledge of the rules of the road score, and hazard perception score) to identify, target, and reduce occupational road safety risks. These methods identify high risk factors so that injury prevention strategies can be prioritized.

1.3. Aim

Occupational injury risk scores that include employee and workplace risk predictors are necessary for the improvement of current risk assessment tools. Because the current methods for determining accident severity do not include several important factors such as age, weather, and gender, a new severity scoring system is introduced which will be incorporated into a risk assessment tool. This scoring system can be utilized by a variety of industries to quantify injury severity since the method is generic, and can be modified according to the specific risk factors in the work environment. The proposed severity scores will then be used to create an occupational injury risk scoring system that includes an