National Safety Council | MSD Solutions Lab
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The Importance of Musculoskeletal Disorder and Related Injury Surveillance: An Organizational Approach

Contents

Executive Summary

Workplace injuries are a major issue, costing U.S. organizations billions of dollars with 2.6 million illness and injury cases being reported in 2023 according to the U.S. Bureau of Labor Statistics (2024). The human impact is also significant when considering personal suffering and the resulting impact on the injured employee. Yet, reliable data and surveillance systems that properly reflect the nature and extent of injuries are widely missing across organizations. This is especially salient for non-fatal injuries, including musculoskeletal disorders (MSDs). Without reliable collection and record keeping of data, organizations challenged with preventing injuries are inadequately prepared and may not know where to allocate resources or how to begin developing mitigation and hazard reduction strategies. This paper highlights common ways to categorize and consider ergonomic injuries, injury surveillance methods, and provides examples of injury cases and ways to categorize and record such injuries. The Appendix contains example data dashboards and injury record keeping forms from which organizations can draw inspiration when developing or refining their own injury surveillance methods.

While organizations may conceptualize and record MSDs and ergonomic injuries differently or have different parameters in place to determine if an injury event gets categorized as ergonomics-related or not, the goal is to have a consistent definition of what an ergonomic injury is across the organization. Identifying underlying causes is vital for implementing preventive measures to avoid future injuries. This distinction also helps to ensure an accurate record of MSDs and ergonomic injuries, providing accurate information to decision makers regarding investing in risk mitigation.

Additionally, organizations should focus on developing systems that work for them. For some organizations, this may be recording injuries on spreadsheets. Other organizations may utilize sophisticated software or automated technology to assist in categorization. Either way, a good surveillance system is one that is easily used and understood by the employees interacting with it.

Lastly, proper training in using an injury surveillance system is essential. The employees expected to interact with the system need training on how to use it and how to interpret workplace injuries. The exercise provided in this resource helps employees practice and better understand ergonomic injury classification.

A smart surveillance system powered by emerging technologies is also proposed but needs further evaluation to assess its practicality as not all organizations can apply all proposed aspects suggested. For example, smaller organizations may face challenges in scaling artificial intelligence (AI) models or using Internet of Things (IoT) sensors to develop data-driven interventions. Resource limitations may also hinder advanced system integration and data management. Organizations should evaluate and selectively adopt technological elements that fit their operational capacity to create an effective system.

Introduction

Surveillance refers to the continuous and systematic gathering, analysis, interpretation, and sharing of information related to MSDs and hazards (National Institute of Occupational Safety and Health [NIOSH], 2001). The purpose of injury surveillance is to detect patterns, devise MSD prevention methods, and assess these strategies' successes. Injury surveillance can help to produce data about patterns and characteristics of incidents and risk factors for these incidents, thus making it easier to spot injury trends. These data can help organizations design and apply appropriate interventions and monitor results to assess the impacts of interventions.

Preventing MSDs requires both injury surveillance and risk assessments. Proper prevention begins with identifying and mitigating risk factors, while aggregated surveillance data provides precise insights into these risks.

While it is well understood that workplace injuries, any wound or damage to the body resulting from an event in the work environment (U.S. Bureau of Labor Statistics [BLS], 2023), are a major issue, reliable data systems that properly reflect the breadth of injuries are widely missing across the world. This is especially salient for the category of non-fatal injuries, into which MSDs fall. Without reliable data, those organizations challenged with preventing injuries are inadequately prepared and may not know where to allocate resources or how to begin developing mitigation and hazard reduction strategies.

The National Academies also recognizes that there are longstanding barriers to information sharing between employers and employees, often due to a lack of trust. Still, robust occupational safety and health surveillance systems are needed at the organizational level to ensure organizations can effectively capture injury data, understand their nature, and categorize them to determine how to best prevent them from happening in the future. A smart injury surveillance system would reduce the underreporting of occupational injuries by strategically utilizing data while optimizing the application of advanced technologies.

Injury surveillance at the organization level is an important topic deserving of more attention within the safety space, particularly as it relates to MSDs. It is easier to understand how to solve the issue of ergonomic injuries in the workplace if data about these injuries are adequately captured. Having a cohesive and standardized definition of MSDs will also help when categorizing those injuries. Ergonomics is about fitting the work to the capability of the worker, and understanding ergonomic injuries helps organizations to better understand the mismatches between work and worker.

This paper is divided into four main sections: 1) an introduction to injury classification, inclusive of parameters for classifying MSDs, and injury causation factors, 2) a deep dive into issues with injury reporting, 3) an overview of what injury surveillance is and injury surveillance systems, and 4) a self-guided exercise with vignettes, example injury reporting procedures, and exercises to help safety and health professionals better understand accuracy in categorization and surveillance. The resource concludes with a discussion of emerging technologies for injury surveillance and introduces a smart injury surveillance system given organizational technology readiness.

Part I: Classification of Injury Data

The accurate categorization of injuries is vital for a well-developed workplace injury surveillance system. This section describes what injuries are, specific to ergonomic and MSD injuries, and beneficial practices for tracking and recording MSDs.

MSDs and Ergonomic-related injuries

Ergonomics helps reduce or eliminate work-related MSDs and ergonomic injuries, and improves safety by better matching work completed to the worker. Many organizations term injuries associated with physical risk factors as **ergonomic injuries**.

Further, the Centers for Disease Control and Prevention (CDC) define MSDs as disorders of the muscles, nerves, tendons, ligaments, joints, cartilage, or spinal discs that are **caused by sudden or sustained** force, vibration, repetitive motion, or awkward postures, **are not the result of any instantaneous non-exertion event** (e.g., slips, trips, or falls), **may be mild to intense and cause occasional to chronic pain**, and can be a leading indicator for disability (NIOSH, 2024). For work-related MSDs, the work environment and performance of work contribute significantly to the condition; and/or the condition is made worse or persists longer due to work-related factors.

There are a combination of risk factors, both physical and **non-physical**, that could lead to an MSD. Consider tasks performed (e.g., lifting a box), the force exerted (e.g., the level of effort required to lift a box or weight of the box being lifted), posture (e.g., reaching overhead or bending), repetition (e.g., number of times the task was performed, the duration of task per shift, or work-rest cycles), environment (e.g., temperatures, noise, or light), and other factors such as long working hours, low job control, or behavioral factors when determining causes of MSDs. Some employees may also be predisposed to ergonomic injuries and illnesses due to factors such as age, obesity, sex, or diseases.

Ergonomic injuries or work-related MSDs range in severity from mild, periodic symptoms to severe, chronic and debilitating conditions. While MSDs should be diagnosed using objective signs and symptoms by a health care provider, the most common signs and symptoms associated with MSDs include:

- Burning
- Cramping
- Stiffness
- Loss of strength
- Pain
- Tenderness
- Swelling
- Redness
- Reduced range of motion
- Tingling
- Numbness
- Reduced circulation in the extremities

Generally, ergonomic injury classification should meet the following criteria:

1. **The nature of injury aligns with ergonomics-related risk factors** and results in common MSDs such as strain, low back pain, or carpal tunnel syndrome.
2. **The incident type aligns with work-related risk factors** such as sudden or sustained force, vibration, repetitive motion, awkward postures and duration of the task. In other words, the underlying cause of the injury that triggered the events leading to the injury, such as unsafe working conditions, improper lifting techniques, or equipment failure. It explains why the injury occurred.

The nature of injury and incident type may slightly vary from situation to situation, but the below table highlights injury and incident types that generally constitute MSDs. A comprehensive list of common MSDs can be found in the MSD Solutions Lab's MSDs 101 resource.

Nature of Injury	Incident Type
Acute strain/sprain	Force
Chronic strain/sprain/MSD	Overexertion
Carpal tunnel syndrome	Repetitive motion
Inflammation – MSD-related	Posture
Minor musculoskeletal discomfort	Vibration

The table below constitutes injury and incident types that ***do not commonly constitute*** an MSD:

Nature of Injury	Incident Type
Concussion	Abrasion
Dislocation	Caught in/under/between
Electric shock	Fall from heights/same level
Fracture	Foreign body
Foreign body	Slip/trip
Puncture	Struck against/by
Weld flash	Vehicle accident

Bringing it all together, the table below highlights comparisons between injuries considered ergonomics-related (where the underlying cause is attributed to ergonomics-related risk factors) and injuries that are not ergonomic in nature.

Ergonomic Injuries May Include:	Ergonomic Injuries May Not Include:
Back pain developing while lifting heavy parts	Back pain from catching a part that slips from a fixture
Back strain from reaching into a container	Back strain from running into a container
Shoulder impingement from application of high force with torque wrench	Torn rotator cuff from jerking on a hoist that hung up on a rail
Wrist pain from repetitive, forceful gripping	Strained wrist resulting from a fall
Trigger finger from using hand tools	Knee strain from slipping on wet floor
Back strain while bending to pick up a pencil after lifting heavy parts	Pain in knee when stepping off a lift truck
Shoulder bursitis from working overhead	Knee 'popped' while walking up stairs at the beginning of the shift

Case Definition of MSDs

Consensus-building efforts on case definitions, especially concerning diagnostic criteria, are essential and should be continually explored.

A case definition is the minimum set of symptoms, signs, and diagnostic tests used to identify a disease or disorder (Verbeek, 2012). Published literature and organizations often fail to accurately classify MSDs while reporting incidents as no clear case definitions or uniform criteria of MSDs are available, creating a significant gap in effective injury tracking, prevention, and accurate estimates of injuries (Punnett & Wegman, 2004; Hagberg & Violante, 2007, Tamminga et al., 2021; van der Molen et al. 2021, Violante, 2020).

Punnett and Wegman (2004) reported that the lack of standardized case definitions for MSDs partly stems from the difficulty of fitting the wide range of symptoms and signs reported into fixed diagnostic categories. Conditions with clear, identifiable pathology, like carpal tunnel syndrome, make up only a small portion of all MSDs. Additionally, the reliability of physical exams for diagnosing specific conditions varies, making consistent diagnoses more challenging.

Hegman et al. (2014) evaluated how varying definitions of cases affect the estimated prevalence of MSDs in the upper extremities. They compared symptoms-based definitions (which rely on reported symptoms) to those that include diagnostic testing (which requires medical tests for confirmation). Variations in definitions and methodologies can lead to significant discrepancies in reported cases, which may cause MSD risk factors to differ between those defined by symptoms and those confirmed by diagnostics. Organizations should partner with occupational medicine professionals to help classify MSDs and assist with case management.

Similarly, Tamminga et al. (2021) examined case definitions for seven types of MSDs by attempting to get consensus from occupational health professionals and epidemiology researchers across 24 countries. However, consensus on a case definition was only achieved for one MSD type (medial elbow tendinopathy). Case definitions that include instructions for imaging, physical examinations, and work-related factors are needed for work-related MSDs to improve prevention efforts.

Some organizations and states use workers compensation claims to develop case definitions for MSDs based on the information from incident reports. Since incident reports often capture the events leading to the injury/illness and its nature, the data and physician's diagnosis can be used to assign **Occupational Injury and Illness Coding System** (OIICS) codes, and describe the event, injury type, source, and affected body part (Marcum, 2020). For example, for the state of Washington to classify a claim as an MSD, it must involve a condition that disrupts the musculoskeletal system due to specific work activities, such as forceful exertion, repetitive motion, awkward postures, or vibration.

Despite understanding the need for common case definitions of MSDs, education on the common types of MSDs, and consistent information about what constitutes as "ergonomic", the accurate tracking and reporting of MSDs has been difficult. Insufficient training for those who input and interpret injury data, differences in typical incident types and nature of injuries between industries, and a lack of national standardization around the reporting of MSDs have all led to challenges in organizational injury surveillance. Yet, as will be suggested, there are guidelines and suggestions around injury surveillance that can aid in the consistent reporting of MSDs at the organizational level. Further, below are some strategies specific to record keeping of MSDs.

Strategies for MSD record keeping

While many suggestions and best practices exist for organizational surveillance, there are several suggestions specific to MSD record keeping:

- **Focus on categorization**
  - Group MSDs by the:
    - √ Nature of the injury or illness
    - √ Part of the body affected by the specified condition
    - √ Source of the injury or illness that directly produced the condition
    - √ Event or exposure that describes the manner in which the injury or illness was inflicted
    - √ Severity of injury
- **Focus on training**
  - If employees who input the data are not consistently trained on the way that ergonomic injuries or MSDs are categorized in the organization, data will be less meaningful and more difficult to interpret. Employers should integrate injury reporting education into both initial and ongoing job training, emphasizing the legal, workers' compensation, and safety management benefits for both workers and employers (Tucker et al., 2014). For more guidelines, refer to the **OIICS Manual**.
  - Without proper training, a single category of 'ergonomics-related injury event' may be too broad and could be interpreted differently by different personnel. Alternatively, the two suggested criteria can be used to determine on the back end if an injury is ergonomics-related, without relying on personnel having a consistent interpretation of what constitutes an ergonomic injury.
- **Create systems that work for the implementing organization**
  - While this may seem obvious, organizations may be lured by the promises of third-party injury reporting software or applications. And while many of these reporting platforms may fit the scope of work well, ensuring that the surveillance system will work for the organization of interest is most important. This may mean a system that is internally developed or modified from options available off the shelf.
- **Utilize an injury record keeping form that is straightforward**
  - If the form used to collect injury information is not easy to understand and does not contain the necessary variables of interest, it may be hard to enact meaningful solutions and get the most from the data. Example injury record keeping forms can be found in the Appendix.
- **Ensure all employees feel comfortable reporting injuries**
  - Organizations and government agencies need to recognize common reasons workers under report injuries, such as perceived injury severity, concerns about self-identity, desire to return to work, and self-blame. Issues around underreporting are explained more in the following section.
- **Ensure supervisors and management encourage accurate reporting**
  - Supervisors must be receptive to and support injury reports. This can be aided by adopting a **culture of safety**.

Part II: Issues with MSD Reporting

At the international level, the Programme on Safety and Health at Work and the Environment of the International Labour Office voiced that no country fully records or compensates for all occupational injuries and work-related diseases (ILO, 2013). While injuries are documented more often than diseases, the data remain insufficient. Underreporting is widespread, and official reporting often excludes key worker groups. Accurate collection, recording, and notification of occupational incidents and diseases are vital for prevention. Understanding their causes is essential to develop effective preventive measures and improve workplace safety.

In the U.S., OSHA's record keeping regulation (29 CFR 1904.4(a)) mandates that certain employers who are required to maintain injury and illness records must document each case that: 1) meets the definition of "injury or illness", 2) is work-related, 3) is a new case, and 4) meets one or more of the general recording criteria in section 1904.7 or the specific criteria in sections 1904.8 through 1904.11. A case is recordable only if it fulfills all these criteria. Additionally, under section 1904.7, a work-related injury or illness must be recorded if it results in death, days away from work, restricted work or job transfer, medical treatment beyond first aid, or loss of consciousness. Any significant injury or illness diagnosed by a healthcare professional must also be recorded, even if it doesn't result in these outcomes.

Recordability

In the U.S., an incident is defined as 'recordable' by OSHA when it results in days away from work, restricted work, or being transferred to another job and/or required medical treatment beyond first aid. Some organizations may rely heavily on recordable injuries and give less attention to non-recordable injuries. However, it is encouraged to track all injuries, regardless of their recordability, to better understand hazards. For example, an employee might experience low back pain as a result of manual material handling. While not recordable yet, this can still be added to an injury surveillance system as an injury related to ergonomics. The hazard for the injury is present given the back pain suffered, and ergonomic fixes for the job task are needed to prevent future pain and potentially recordable injuries. There is much to be learned from non-recordables and near-misses.

OSHA also classifies some treatments as **first aid**, such as massages and hot or cold therapy, meaning they do not need to be recorded unless referred to as physical therapy. If a licensed healthcare provider identifies the treatment as a massage, it remains first aid; if termed physical therapy, it becomes recordable. Therefore, injuries treated solely with massages are not required to be recorded, provided they do not meet other recording criteria, such as days away from work or medical treatment beyond first aid.

Lastly, while pain scales may help assess the severity or impact of an injury, they do not directly determine whether an injury is recordable under OSHA guidelines. The focus of OSHA remains on the nature of the treatment received and the outcomes related to work restrictions or medical intervention. For example, an injury is not recordable if it requires only first aid, regardless of the worker's reported pain level. However, it becomes recordable if the worker receives medical treatment beyond first aid, such as prescription medication, physical therapy, or other interventions, irrespective of pain severity. Therefore, although pain scales can provide valuable insights into employee experiences and help manage perceptions of pain, these scales are subjective and not a criterion OSHA uses for record keeping decisions.

OSHA collects work-related injury and illness data from establishments that meet specific size and industry criteria through the OSHA Form 300A (Summary of Work-Related Injuries and Illnesses), 300 (Log of Work-Related Injuries and Illnesses), and 301 (Injury and Illness Incident Report) electronically once per year. However, a section for organizations to denote the number of MSDs incurred is not included on OSHA logs. This leads to organizations being inconsistent in their defining, tracking, and reporting of MSDs.

However, the extent of true reporting of injuries remains difficult for OSHA to assess (Fagan & Hodgson, 2017). Inspectors are often unable to interview workers who have quit or been terminated, and high turnover rates—sometimes exceeding 100% per year—further complicate data collection. Absentee or disciplinary programs that penalize employees for missing work, even for medical appointments, can also lead to job loss, contributing to the issue. Their work on OSHA's Record keeping National Emphasis Program and subsequent enforcement activities revealed persistent barriers to accurately counting occupational injuries and illnesses.

Barriers for Injury Reporting

In addition to a lack of standardization in national reporting of MSDs, there are several issues with record keeping that can lead to inaccurate data collection and an incomplete understanding of the pervasiveness and impact of workplace injuries, including MSDs within organizations (Azaroff et al., 2002, Fagan & Hodgson, 2017, Kreshpaj et al., 2022, Miller, 2008, Petitta et al., 2017, Rosenman et al., 2000, Ruser 2008, Tucker et al., 2014, VelocityEHS, 2022, Wuellner & Bonauto, 2014). For example, a systematic review by Kyung et al. (2023) identified key factors contributing to injury and illness underreporting are the injury type and severity, sociodemographic factors, general health, worker knowledge of reporting procedures, job characteristics, psychosocial work environment, and the role of healthcare providers.

In the sections below, common issues surrounding injuries, including MSD record keeping and reporting, are highlighted

Lack of direct causation

Since MSDs often develop gradually over a period of time due to work-, worker- and work environment-related factors, establishing direct causation of work-relatedness for an MSD is challenging. Identifying the direct causation when workers are exposed to multiple risk factors at the workplace that pertain to the types of work being performed and the work environment is even more complicated. Importantly, workers might not experience symptoms immediately after exposure, coupled with a lack of knowledge of MSDs, thus making it more challenging to report an injury and its work-relatedness. Additionally, workers may have pre-existing medical conditions, including prior work- or non-work-related injuries contributing to their MSD. For example, what if workers have a second or third job and get injured at those workplaces compared to the primary workplace where they report an injury? What if an employee got hurt while fixing things at home but aggravated it while working at the primary workplace? Distinguishing between work-relatedness and pre-existing or non-primary job-related conditions can be difficult, especially if there is no (or minimal) exposure to contributing risk factors at the primary workplace. The right diagnosis of work-relatedness needs a well-trained occupational health provider who is an expert in the workers' activities. Such medical care providers can be in-house at the workplace, off-site, or from outside clinics, but their knowledge is paramount in attributing an MSD to its work-relatedness.

Underreporting of injuries

Common reasons for underreporting include fear of retaliation or job loss, pressure to have a low recordable injury rate, the complexity of reporting for both employees and employers, incentive programs that reward low rates of absenteeism or low rates of injuries/number of days without an incident or injury, lack of access to healthcare, lack of knowledge, perception of injuries as minor or routine, and distrust in the reporting process. Some corporations with employer-self-funded health insurance have at least a year to report an employee's work-related injury from its actual occurrence, further complicating proper injury reporting. Under-reporting rates of workplace incidents in 2019-2021 varied significantly across countries, ranging from less than 10% to nearly 100% (Jacquetin, 2024).

Similarly, issues identified by OSHA inspectors, such as employer programs that discourage reporting, workers' fear of retaliation or job loss, and employer misunderstandings of record keeping requirements, mirror those outlined in the 2009 Government Accounting Office report and previous research. Fagan & Hodgson (2017) also identified a new factor contributing to underreporting is medical management practices, particularly in onsite medical units.

As an example, Qin et al. (2014) examined workers' compensation claims among nursing home employees. Only 8.7% of those reporting low back pain (LBP) filed claims over eight years, with the most severe injuries more likely to be claimed. While not all instances of LBP are expected to be filed, a filing of less than 10% of instances of LBP is low and highlights the vast amount of underreporting.

Special populations and reporting

Shore and Chung (2022) explored the relationship between workplace inclusion and employees of color and found that inclusive environments encourage people to voice their opinions, while exclusive environments cultivate cultures of silence that suppress employee voices. Voice suppression can prove particularly harmful to employees of color, as they may already perceive their voices and opinions as less valued than the majority group. As a result of this disparity, Black and Hispanic workers state the most unease about reporting unsafe work conditions when compared to other racial and ethnic groups (Mabud et al., 2021). Therefore, Black and Hispanic workers may be more uneasy reporting conditions with MSD risk. Low-wage workers and workers of color are also commonly more fearful of reporting an occupational injury, inclusive of MSDs, due to potential job loss and subsequent economic instability, intimidation from employers and co-workers to not report workplace injuries, or stigma around getting injured and feeling pain (Topete et al., 2018; The Committee on Education and Labor, 2008). More information on special populations and MSDs is available in **this report**.

Men may also be less likely to report MSDs in comparison to women (McGeary et al., 2003). In a sample of working individuals 50 years of age or older with arthritis, women reported more severe symptoms and limitations than men (Gignac et al., 2018). Another study looking at MSDs in veterans found women were more likely to report moderate to severe pain while men were more likely to report no pain (Higgins et al., 2017).

Tucker et al. (2014) also identified ten reasons for not reporting lost-time injuries by workers younger than 25, with the most common being perceived low severity of the injury, fear of negative reactions from others, and uncertainty about whether work caused the injury. Their further analysis showed that young males were more likely than young females to cite concerns about self-identity as a reason for not reporting injuries. Overall, the type of work being performed or stereotypical gender norms around admitting pain and seeking help may amplify differences in speaking up and MSD reporting.

Undercounting of injuries

If employees are prone to underreporting, then an organization will likely undercount injuries. Undercounting refers to the incomplete or inaccurate representation of the actual number of injuries, thus a discrepancy between reality and recorded data (Ruser, 2008; Ruser, 2010). The potential undercount of workplace injuries and illnesses at the national level can be categorized into four dimensions: failure to capture most occupational illnesses with long latency periods; exclusion of injuries and illnesses affecting out-of-scope workers, such as public-sector employees, the self-employed, household workers, and workers on small farms; omission of some injuries and illnesses reported in other data systems, like workers' compensation, and lack of reporting for certain injuries and illnesses in any data system. While willful underreporting is a factor, other explanations include differences in the types of cases captured by various data systems and methodological variations in undercount research.

Incomplete documentation can be a barrier to both employers and federal agencies. Based on employers' OSHA logs, previous reports suggest that the BLS Survey of Occupational Injuries and Illnesses (SOII) substantially underestimates the U.S. total number of workplace injuries and illnesses, therefore assuming that organizational estimates of workplace injuries and illness are also undercounted. Research indicating an underestimation of cases suggests that both the SOII and alternative data sources (e.g., workers' compensation claims) fail to capture all instances of injury and illness, implying that no individual data source can fully encompass the entirety of such cases.

(Lack of) understanding of legal and regulatory requirements

Despite the availability of no-fault insurance covering wage replacement and medical care costs, most workers diagnosed with occupational diseases do not file for workers' compensation. Rosenman et al. (2000) found that only 25% of workers with work-related musculoskeletal conditions filed for workers' compensation, challenging the common belief that such individuals are likely to make a claim. The strongest predictors for filing were linked to the severity of the condition (measure of 7 or more consecutive days off from work), along with factors such as longer tenure, lower annual income, and dissatisfaction with coworkers.

Employers need to have a clear understanding and follow state and federal regulations related to record keeping requirements and (state) workers' compensation regulations. However, each workers' compensation system operates independently with unique laws, regulations, and legal precedents, and it is a challenge to understand the nuances of these regulations. For example, in the state of Washington, by law, a claim can be accepted only if the provider states that a condition is work-related on a "more probable than not" basis, meaning greater than 50% certainty. This would be indicated by circling either "yes" or "probably" on the incident report. Knowledge and compliance with these requirements can be challenging for employers. Employer medical management practices can also affect record keeping and the actual incidence and severity of work-related injuries and illnesses (Fagan & Hodgson, 2017). To this effect, Berkowitz et al. (2023) stressed that medical consultants have an ethical duty to ensure that occupational health clinics are structured to minimize conflicts of interest, deliver quality care to workers, and enhance workplace health and safety. Healthcare providers must undergo workplace safety training, visit the plant floor to observe jobs linked to reported injuries and illnesses, and identify hazardous tasks requiring safety improvements. Healthcare providers in occupational health clinics can and must play a pivotal role in flagging dangerous jobs and preventing workplace injuries.

Overall, these barriers indicate significant work needed to systematically address reporting and record keeping challenges. To improve compliance with OSHA regulations, Wuellner & Bonauto (2014) recommended that federal agencies should expand outreach and enhance training, particularly regarding injuries among temporary workers. However, education alone may be insufficient without a mandatory requirement for record keeping training. Revising OSHA forms or providing clearer instructions could be more effective in reaching a broader audience than education efforts alone. Additionally, the BLS could reinforce this by emphasizing the need to record temporary worker injuries in their survey instructions and simplify reporting procedures. While BLS can improve communication with respondents, individual establishments must also address gaps in record keeping.

Early Intervention Programs

Early intervention programs (EIPs) that aim to detect early signs of an injury, such as discomfort and fatigue, can be an important part of a holistic approach to MSD prevention. These programs encourage employees to report symptoms and prevent the progression of discomfort before they escalate into more severe conditions, thereby reducing the incidence of workplace injuries and associated costs for employers. For example, companies that have adopted these programs report a decrease in total recordable incident rates by as much as 29% within the first two years of implementation (Schmoyer, 2023).

Many EIPs provide onsite services where intervention specialists can assess and treat employees immediately. This includes OSHA-approved first aid interventions like hot or cold therapy, soft tissue massage, and ergonomic assessments. Initially, EIP deployment may lead to a rise in reported cases as intervention specialists identify, coach, and treat employees with minor musculoskeletal discomfort.

Some organizations may classify these minor musculoskeletal discomfort cases as first aid (non-recordable) if the treatment aligns with 29CFR1904.7(b)(5)(ii) and related interpretation letters. Thus, while the total cases may increase, the number of recordable cases decreases due to visits, coaching, and treatments. Yet, some organizations may not classify early intervention as first aid for recording purposes, as it involves proactively addressing minor musculoskeletal discomfort. They only consider a case as first aid if objective signs and symptoms emerge, requiring additional treatment by a healthcare provider.

It is important to consider record keeping regulations when an EIP is in place, as EIPs are a way to detect early signs and symptoms, not a treatment for early signs and symptoms. Since early intervention activities are classified as first aid under OSHA guidelines, they do not count as recordable injuries if properly managed. This means that effective EIPs can help organizations maintain compliance with OSHA record keeping requirements while simultaneously fostering a safer work environment.

It is vital for organizations to be current on record keeping regulations to determine when incidents need to be recorded, when they can be treated with first aid, or when they are just detected as minor musculoskeletal discomfort. This proactive approach of knowing the regulations helps organizations meet OSHA record keeping requirements and promotes a safer and healthier work environment.

Part III: Injury Surveillance Systems

Injury surveillance systems are available in many countries to track, record and evaluate the impact of injury burden. In the U.S., population-based injury surveillance systems for workplace injuries are available in the form of the OSHA Tracking Application, BLS SOII, National Electronic Injury Surveillance System - Work (NEISS-Work), and Injury Facts® from the National Safety Council. For example, BLS conducts an annual survey that estimates the number and frequency of nonfatal workplace injuries and illnesses based on records maintained by private industry employers. Similarly, **Injury Facts®** reports data sourced from the BLS on preventable injuries' causes, frequency, and costs and how they affect individuals by age, sex, and race.

Globally, the International Labour Organization (ILO) maintains a **database** on occupational safety and health, compiling data on occupational injuries from national sources around the world. In addition, the ILO publishes the **Code of Practice on Recording and Notification of Occupational Accidents and Diseases**, offering guidance for countries to establish national systems for recording and reporting workplace injuries. Several countries have developed their own injury surveillance systems in alignment with the World Health Organization (WHO) guidelines.

These population-based injury surveillance information systems gather, analyze, and share injury data to support planning and inform prevention efforts (Miriani et al., 2020). These systems are essential for understanding workplace injuries, guiding policy decisions, and improving occupational safety measures worldwide.

Another option for injury surveillance is case-based surveillance which focuses on specific incidents or cases, tracing them back to identify causes and develop targeted interventions.

In contrast to injury surveillance information systems at the national level, organizations are similarly tasked with conducting injury surveillance to improve safety outcomes and remain in compliance with federal mandates. Organizational injury surveillance entails the tracking and recording of work-related injuries at the organizational or workplace level. Organizational injury surveillance systems can range from being internally developed by an organization, for example through Microsoft Excel or SharePoint, to robust, online or application-based injury surveillance management systems provided by third parties. Regardless of their origin, there are several important elements of effective injury surveillance systems and steps to take when designing and building a system.

Characteristics of an effective injury surveillance system

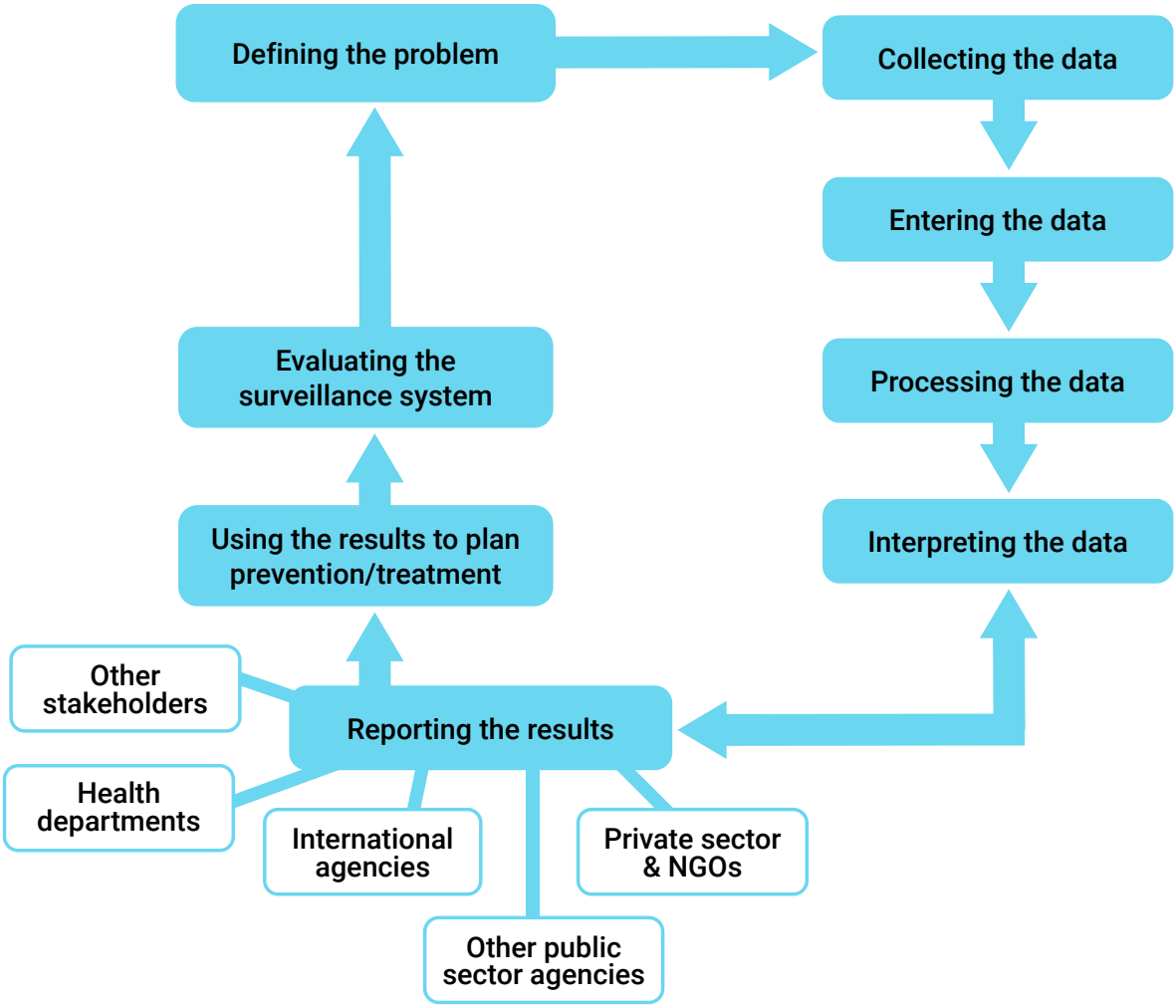
An efficient injury surveillance system for any workplace should safeguard workers from injury events and near misses by establishing a process for: 1) identifying risks for injuries, 2) documenting casual factors (i.e., risks) and reporting incidents that lead to injuries, 3) classifying collected data, 4) analyzing the data to understand root causes and injury trends, and 5) investigating and implementing risk reduction efforts.

The National Academies of Sciences, Engineering, and Medicine (2018) outlines six guiding principles for an ideal occupational safety and health surveillance system at the national level. Those elements, adapted for organizational injury surveillance, are as follows:

- **Collaborative Leadership:** In collaboration with employees from all levels of the organization, strong leadership is essential for effective injury surveillance. Engaging the broader community of users who rely on this information for actionable insights is critical to success.
- **Data Quality and Program Monitoring:** Continuous monitoring of data quality and surveillance activities is crucial to maintain efficiency and maximize the impact of surveillance efforts.
- **Privacy and Data Access:** Safeguarding privacy, confidentiality, and access to data is vital while ensuring that surveillance information is effectively utilized for injury prevention.
- **Timely Analysis and Dissemination:** Regular analysis and prompt interpretation of surveillance data, along with disseminating information in accessible formats, ensures that all stakeholders can take timely, informed actions.
- **Trained Professionals:** A successful organizational surveillance system depends on well-trained employees to input and/or interpret data equipped with the necessary tools, trainings, and technology to meet surveillance goals.
- **Standardization for Efficiency:** Consistent use of standardized methods for data collection, analysis, and information dissemination will enhance the overall efficiency and effectiveness of MSD surveillance.

Moreover, Figure 1 and the information below, adapted from Holder and colleagues (2001), highlights specific, important steps for building injury surveillance systems to ensure they are running smoothly and producing useful information. Whether just building an organizational injury surveillance system or looking to make refinements, the steps outlined below are important to consider. Further, important attributes for injury surveillance systems have been identified by the CDC and are included in the Appendix. Of note, these attributes were created with national, disease-related surveillance in mind, but have been adapted for workplace injuries and are still widely applicable.

Figure 1. *Steps for Building an Injury Surveillance System*



Note. Adapted from Holder et al., 2001

Defining the problem

Injury surveillance systems should be designed with a problem to solve or goal in mind. Likely, many injury surveillance systems for organizations have been designed to answer the question of how many injuries, and of what type, are sustained by workers. When building a system, it is necessary to discern what the data collection system will be able to tell the user. This also entails determining the data are accessible for collection.

When determining the problem, it is also imperative to determine how the data collected will be used. Collecting data without a plan for use can result in an overabundance of data with little actionable plans for analyses and future impact.

ACTION ITEM Collect injury data with a plan for use and understand which jobs and tasks pose the most risk.

Collecting data

The next step is to go out and collect the data. For organizations collecting injury data, this will entail determining which information from an injury is important (e.g., place of incident, body part, or severity, type) to collect. A minimum data set should include information regarding individual demographics, the circumstances of the injury event, and the injury outcome (Mitchell et al., 2009, Holder et al., 2001). Additionally, during this stage, organizations should decide who will be responsible for inputting such data (e.g., employees, supervisors, safety and health professionals), and on what frequency these data are input (e.g., how soon after an injury do the data need to be recorded).

While organizations likely include lagging indicators, such as counts of injuries or days away from work, collecting leading indicator information is also important. As per a **2013 report** from the Campbell Institute, while environment, health and safety (EHS) practitioners still rely on lagging metrics like injury rates and absenteeism, these measures are increasingly seen as ineffective for driving continuous improvement. In contrast, leading indicators, such as trainings completed, leadership engagement or near misses, provide more valuable insights by offering early warnings of potential risks, allowing organizations to address issues before they result in incidents or injuries.

Effective safety and health programs combine leading indicators to drive improvements with lagging indicators to assess overall effectiveness. As such, utilizing leading indicators in MSD reporting could help organizations better understand necessary steps for MSD mitigation.

ACTION ITEM Determine which data to collect to gain a full picture of the incident. Consider collecting both leading and lagging indicators, as available.

Entering and processing data

Entering data into a digital system or on a form and processing that data are the next step. Likely, these are completed with the use of digital systems that allow for the data to be entered and processed at once. As mentioned, it is also necessary to ensure that those who are entering the injury data have proper training and education on how to utilize the injury surveillance system, inclusive of how to categorize injuries (see Part IV to practice categorization).

Accurate categorization of injuries is vital for a number of reasons. Having an accurate count of injury types can help determine resources to invest in injury prevention, determine where further risk reduction is needed, and help to communicate safety concerns to leadership.

Organizations can classify the type of tasks and related injuries into appropriate injury Custom Cause Codes by developing standard case definitions to ensure consistency in identifying injuries. For example, NIOSH has developed the Standardized Occupation and Industry Coding system - **a free software package** that reads occupation and industry narratives and assigns 3-digit numerical occupation and industry codes (NIOSH, 2001).

ACTION ITEM

Enter and record data into a system, whether digital or paper and pen. Ensure the individual inputting the data has proper training on the system being used.

Interpreting data

Analysis of data is often needed to make sense of trends in recorded injuries. Organizations may be interested in raw counts of injuries, relationships between injuries and other variables (e.g., location, department, and shift), or other trends in the data. A separate employee trained in data interpretation may be necessary for this step.

Employers are urged to **determine the root cause** of injuries, incidents, and near misses as a means to interpret data and make data actionable. Tools that might be helpful for identifying the root causes of MSDs include the **Haddon Matrix**, the **5 Whys**, and the **Fishbone Diagram**.

ACTION ITEM

Determine how to interpret the data (e.g., counts, correlations, trends, or percentages) as makes the most sense for your organization. Consider tools for determining the root causes of incidents.

Reporting results

Once results are entered and interpreted, results then need to be disseminated to others in the organization to share information and learnings. Addressing injury-related data often requires novel methods to effectively communicate injury trends to EHS professionals and decision makers (Martinez et al., 2016). Often, this is done through weekly, monthly, or annual reports highlighting injury patterns and recommendations for improvement.

Increasingly, organizations may also utilize data dashboards that help to quickly interpret data and easily show trends in injuries by location, type, body part, or other common variables of interest. Advances in data visualization using new visual analytics tools offer a unique opportunity to communicate data to get buy-in from senior leadership in decision making. Additionally, there are several example dashboards to use as a guide for displaying data (see Appendix). The CDC also developed an interactive, online collection of analysis tools for injury data, the **Web-based Injury Statistics Query and Reporting System**, that highlights different ways to display a variety of variables related to occupational injuries. Injury Facts also showcases ways to meaningfully display data related to workplace musculoskeletal injuries. Using data dashboards can empower data into impactful, meaningful conversations.

ACTION ITEM

Select the appropriate cadence for incident reporting and utilize data visualization to make the data more palatable for leadership.

Using data

Actual use of data is key to a surveillance system. Systems should only be in place if there is a plan and process to utilize the data to inform decisions and make safety improvements within the workplace. Incorporating discussions of injuries into safety huddles or other important organizational meetings can be a good way to ensure data are being recognized and used to make meaningful change.

Data analytics of injury trends, particularly regarding MSDs, plays a crucial role in enhancing workplace safety and reducing costs associated with worker compensation. These injuries are not only prevalent but also disproportionately expensive, particularly those involving shoulders and backs, which lead to both lost time and high financial costs for an organization. Analyzing these trends reveals significant insights into the nature and impact of injuries, guiding organizations in implementing effective safety measures. By focusing on injury patterns, organizations can target high-risk areas for intervention. For example, only 20% of an organization's injuries may be related to ergonomics, but 80% of workers' compensation claims could be due to ergonomic injuries. This highlights the importance of properly analyzing data to ensure important trends are discovered. Such a trend can also shift how an organization thinks about their injuries, can more strongly make the case for resource allocation to prevent MSDs, and can help leadership to more tangibly understand the importance of addressing ergonomic issues.

Proactively addressing these risks by thoroughly analyzing the data can lead to ergonomics improvements and enhanced employee well-being, reduced downtime, and significant cost savings, underscoring the value of leveraging data for informed decision-making. It is important to remember that **good ergonomics is good economics**.

ACTION ITEM

Ensure there is a plan for data use before data collection. Consider important ways to analyze data to convey injury trends and relationships to other important variables such as workers' compensation.

Evaluation

As with any system, evaluation is imperative to ensure it is performing as intended and produces useful information. Evaluation may be necessary to determine if the data being collected are helpful, if the reporting of the results is informative and easy to understand, and if the end users of the information are satisfied with the system. Additionally, as per the WHO framework, evaluating surveillance systems is very important as it helps assess the usefulness of collected data, clarity of reporting, and user satisfaction.

Surveillance systems will likely change over time to adapt to changes in the organization and the workforce, and thus evaluation will need to remain flexible too.

ACTION ITEM Evaluate the surveillance system on a set cadence. Ask users of the system their perceptions of the system (e.g., ease of use, data quality, and system structure).

Part IV: Injury Categorization Self-Guided Exercise

As discussed previously in this paper, determining classification and causation of an MSD or ergonomic related injury can be a difficult task that requires an increased understanding of the work tasks and root cause of the incident. A thorough understanding of classification is needed to create a successful injury surveillance program which may take time to put in place and time for employees to feel proficient in conducting. This section of the resource is a self-guided exercise to help organizations become more familiar and comfortable with the process of incident classification.

Warm Up

Below are a few examples of common workplace incidents to help us think about injury classification.

- An employee reports back pain from a long drive in a truck, resulting in a very uncomfortable ride.
- An employee is powder coat painting while holding a 3.5 lb/1.6 kg tool. The employee is reaching to about head level. During the task, they felt their shoulder 'pop'.
- An employee falls off a step stool and sprains their ankle.

How would you classify these events?
Let's ask some simple questions to help with classification using the information presented in the beginning of this report.

1. What is the nature of the injury?
2. What is the incident type?
3. Is the event a recordable injury?
4. Is the event an ergonomic injury?

The first example appears to be due to exposure to static postures while sitting in the vehicle as well as whole body vibration from driving which results in low back and other pain. This could be due to chronic or extended exposure to the risk factors. The underlying cause of this injury is the ergonomic risk factors. **Based on this, it would be classified as an ergonomic injury.**

For the second example, the injury is due to exposure to awkward postures while lifting objects above shoulder level. Again, this is likely due to a chronic exposure of completing this task or work similar in nature. **Although the event resulted in a pop, it is likely due to weakened shoulder muscles and joints due to the extended exposure to the risk factors, which would be classified as an ergonomic injury.**

We likely do not have enough information to determine if the first two example injuries are recordable or do not yet know if they will result in a recordable injury. As discussed, recordability is dependent on days away from work, work restrictions, or medical treatment beyond first aid. It typically takes time for incidents to result in recordability, given that the days away from work and medical treatment needed is not always known at the onset of the injury. However, that does not mean preventing the incident and working to find a solution is not important.

For the third example, the employee did suffer a recordable injury (a sprain, which will require medical attention and some type of altered work). The nature of the incident was also a sprain, which could classify as an MSD. However, the incident type was from an acute fall, which does not constitute an MSD due to the cause not being ergonomic in nature. **Therefore, this example is not an ergonomic injury.**

Exercises – Categorization

Ergonomic injury, or not?

The following vignettes describe injuries from real organizations. For each, answer the three questions: 1) what is the nature of the injury?, 2) what is the incident type?, and 3) is the event an OSHA recordable injury?. Once you have determined your answers to those three questions, make an overall decision for the fourth question, which is to determine whether this injury is an ergonomic injury. Answers will be displayed below the item in green.

1. An associate in a manufacturing setting reported chest and shoulder pain. The associate stated that earlier in the shift, they were pulling very thick wire. As they were on their break preparing to eat, they felt an instant pain in their chest and shoulder. This sudden pain was about 30 minutes after the associate was pulling wire. The associate received a health observation from the safety team with significant pain, but the pain quickly subsided to a tolerable level. The employee was given ibuprofen and returned to work.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

The incident was likely due to the repetitive nature of pulling thick wire, causing an acute strain across the shoulder and chest muscles and is therefore ergonomic in nature and an ergonomic injury. The incident is not an OSHA recordable injury, but the safety team should continue to monitor the employee for an increase in symptoms, especially if the employee continues to perform the work activity that caused the initial onset of pain.

2. An employee doing order picking in a warehouse pulls product from bins and shelves ranging in height from 10" to 70", loading the product onto a cart and delivering it to the packaging area, for six hours every day. The employee experiences low back pain as a result of this job task and misses 3 days of work.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

Low back pain was likely due to the repetitive nature of the work in awkward postures, causing chronic strain which is ergonomic in nature. Because the employee missed work, this is a recordable, ergonomic injury. The organization should prioritize ergonomic interventions for this job that reduce bending and reaching.

3. A warehouse receiving employee was attempting to push 13 pallets down a conveyor so that they could be loaded on a fork truck. The employee reported that as they were pushing, they felt a strain in their lower back and were referred to a physician for follow up. The physician recommended over the counter (OTC) medications and massages. Training provided to employees stipulates that employees are to only push one pallet at a time down the conveyor.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

The incident was likely due to the forceful exertion needed to move the pallets, which caused an acute strain and is therefore ergonomic in nature. This ergonomic injury however is not an OSHA recordable injury since OTC medication and massages were recommended, but the safety team should continue to monitor the employee for an increase in symptoms. If symptoms persist and the physician determines the employee needs transfer to a different job, restricted duty, or prescription medications, then the injury would be recordable. It is recommended that all employees in this department receive refresher training on the task to reduce the risk of this happening again.

4. A nurse was pulling a patient up in bed with the help of a nursing assistant and felt something pop in their knee. When they sat down to look at their knee, the knee was so swollen that they could barely get the pant leg up. They were treated with ice and the swelling subsided.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

The incident was likely due to force needed to move the patient, which caused an acute overexertion injury that is ergonomic in nature and therefore an ergonomic injury. Since the employee was provided ice and able to return to work, the incident is not an OSHA recordable injury, but the safety team should continue to monitor the employee for an increase in symptoms and prioritize patient handling interventions to aid employees.

5. An employee noted that they were experiencing swelling in their right knee and a "red mark" on their right shin. The employee had slight bruising and a minor abrasion on their right shin and determined that it most likely came from scraping it on a structure the previous day. They were given antiseptic ointment and a bandage and returned to work.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

This is not a recordable injury as the event resulted in first aid only with the application of a bandage. The nature of the event was due to contact with an object and is not ergonomic in nature. Therefore, this is not an ergonomic injury or MSD.

6. After work, an employee was walking to the parking lot. They slipped on ice and fell onto their back/tailbone. They felt instant pain and soreness in their tailbone. They continued to their car and returned to work the next day with no medical attention needed.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

This is not a recordable injury as the event did not result in medical treatment as only an ice pack and diagnostic tests were completed to rule out a break or fracture. The nature of the event was due to a fall and contact with an object and is therefore not ergonomic in nature or an ergonomic injury or MSD.

7. An employee completing manual palletization of product onto a pallet was moving 30 lb. cases from a conveyor to a pallet and reworking/repalletizing as needed for specific orders. The employee performs this work for 8 hours per shift. Over time, the employee has some concerns with low back stiffness, and eventually requires a transfer to a new job after having a low back injury.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

The incident was ergonomic in nature due to the repetitive nature of manual material handling, which over time caused a chronic strain to the back and is therefore an ergonomic injury. Because the employee needed a job transfer due to the injury and nature of the work, this is an OSHA recordable injury. The safety team should prioritize automated systems, a height adjustable turntable under the pallet, or vacuum material handling systems to reduce the exposure.

8. An employee is lifting parts from carts and placing them onto racks throughout the day. Toward the end of the day, a pen falls from the employee's clipboard. The employee bent over to pick up the pen. As they were standing up, they felt a burning in their back which turned out to be a muscle strain. The employee required prescription strength pain relievers and was put on muscle relaxers and restricted duty until the pain had subsided the following week.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

This is a recordable injury as the event resulted in treatment and restricted duty. While the nature of the event was due simply bending over to pick up an object, which is not ergonomic in nature, the cumulative effect of lifting and placing items throughout the day led to the muscles to fatigue and fail later in the day, which does make this injury count as ergonomic in nature. The final act of bending over was not the sole cause but rather the culmination of repeated stress, resulting in muscle strain.

9. After assisting a patient to the standing position, the patient began to fall back and to the right. The employee had a hold of their gait belt and held on to them from behind to keep the patient from falling. The employee felt immediate pain in their right shoulder all the way down to their hand. The employee was seen by the in-house medical team and put on work restriction until they could be seen by a specialist outside of the workplace.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

This was an acute injury due to the patient falling and is therefore not an ergonomic injury or ergonomic in nature. However, this would be a recordable injury as the employee was put on restricted duty until they could be seen by a specialist.

10. On break, an employee sat in some chairs near the locker room. When trying to get up, the employee was on the edge of the chair when they felt it tip. The employee threw their arms back to rebalance themselves and felt a muscle pull in their left shoulder.

    a. What is the nature of the injury?
    b. What is the incident type?
    c. Is the event a recordable injury?
    d. Is the event an ergonomic injury?

This would be considered a recordable injury as the fall resulted in a muscle sprain. The nature of the event was due to contact with an object and although a muscle sprain is considered an MSD, the injury was not due to an ergonomic risk factor and is therefore not an ergonomic injury.

In summary, one should examine the underlying cause for each vignette to identify the factors that initiated the sequence leading to an injury. It is important to identify what started the chain of events that resulted in the injury when classifying for record keeping. Understanding the causes emphasizes prevention; therefore, addressing root causes, such as risk factors for MSDs, makes it possible to reduce the occurrence of ergonomic injuries.

Leveraging Emerging Technologies for Injury Surveillance: A Proposed Smart Injury Surveillance System

While organizational injury surveillance may currently have its challenges, there is an **increase in available technologies** to assist with such reporting. The effective and innovative use of information technology is vital to a successful and smarter surveillance system (National Academies of Sciences, Engineering, and Medicine, 2018). This approach includes the automated coding of occupational data across relevant records, electronic reporting from both traditional and emerging sources, and the development of hardware and software for simplified, efficient, and real-time data collection. The National Academies further emphasizes that to fully realize a system's potential, new methods and tools must be created for the timely collection and analysis of surveillance data. Additionally, software should be designed and made accessible to all relevant stakeholders, enabling them to independently analyze surveillance data and quickly act on findings to enhance worker safety and health.

Leveraging emerging technologies can significantly reduce incident underreporting by capturing events, including near misses, as they happen. This proactive approach minimizes the need for employees to self-report injuries later, a process often hindered by many factors, as explained previously. These technologies ensure more accurate and timely documentation by fostering immediate reporting and improving safety outcomes. However, smaller organizations may face challenges in scaling artificial intelligence (AI) models or using Internet of Things [IoT] sensors to develop data-driven interventions. Resource limitations may also hinder advanced system integration and data management. Thus, organizations should evaluate and selectively adopt technological elements that fit their operational capacity and technology readiness.

Since Industry 5.0 emphasizes collaboration between workers and automation (e.g., using technologies like IoT, big data, cloud connectivity, and analytics powered by AI and machine learning [ML]), **harnessing algorithm-driven intelligence** and other emerging technologies presents a powerful opportunity to leverage strengths, enabling the development of smarter injury surveillance systems to meet the evolving needs of various stakeholders. The NIOSH surveillance briefing document also emphasizes that a robust surveillance program should identify emerging illness, injury, or exposure issues, track trends over time, guide priority setting, and evaluate the long-term impact of research and interventions.

Considering these ideas from the National Academies, Holder and colleagues, the arrival of human-centric Industry 5.0, and insights from the NIOSH surveillance program, a smart workplace surveillance system is proposed here in the figure below and is explained in more detail in the accompanying report.

A Smart Workplace Injury Surveillance System

Workplace Systems Integration

- Enterprise resource planning-integrated occupational health and safety (OHS) management system
- Integrated data exchange: incident reporting, claims, return-to-work, medical and compliance tools
- Integration of AIoT devices with OHS management system
- Real-time monitoring dashboards: lagging and leading indicators
- Customizable visual analytics and metrics for stakeholders
- AI-driven insights for EHS and C-suite decision-making

Automated Coding of Incidents

- Standardize occupational codes for injuries
- Machine learning and natural language processing for coding job descriptions and injury reports

Data Integration & Management

- Flexible data storage: cloud for real-time access, local for offline/backup
- Secure data solutions: encryption and role-based access control
- Data sharing: application programming interface Integration with enterprise resource planning systems

Reporting of Incidents

- From traditional sources: injury reports, OSHA 300/300A/301, etc.
- From emerging tech sources (e.g., IoT devices and wearable sensors)

AI-Powered Risk Assessment

- Artificial intelligence of things (AIoT)-powered data analysis and risk prediction
- Computer vision for pattern recognition risk scores
- Real time data-driven decision making and actionable insights
- Predictive analytics (worker-based, task-based, and workplace-based)

Data Collection

- Worker data
- Task data
- Workplace data

Supervisor/EHS Manager/Ergonomist

- Real-time reports: worker, task, workplace metrics and MSD risks
- AI-driven alerts for physical/psychological risk factors
- AI-driven alerts for high-risk work/workers
- Proactive alerts based on predictive analytics
- Insights on ergo interventions; priority setting for risk mitigation

Note: Dotted double-headed arrow signifies a two-way relationship between individual modules; facilitating continuous improvement between modules

Data Collection

A worker wearing IoT-enabled sensors while carrying out a task can capture data in real-time, along with information about the task and the work environment. Workers' data can include biomechanics (e.g., joint angles, movements, or posture), physiology (e.g., heart rate, or blood pressure), and other relevant data. Task data can be in the form of type of task, physical risk factors (e.g., load being handled), and task frequency. Workplace data can include environmental conditions such as temperature, noise, humidity, and air quality.

If emerging technology is not available, observe workers performing tasks to identify ergonomic risks and collect data on the worker, task, and work evironment. If someone is able to video record footage of employees during their work activities, this can help document and assess potential ergonomic issues. For more on the benefits and challenges of sensor technologies (e.g., placeable, wearable, and implantable) in the future of work, please refer to Howard et al. (2022).

Incident Reporting

Emerging technologies such as wearables with IoT-powered sensors can collect worker-, task- and workplace-relevant incidents in real-time and can be utilized to gain deeper insights into underlying injury trends and potential risks (Patel et al., 2022). Using this technology can minimize underreporting by allowing immediate reporting of incidents, including near misses. This approach also reduces reliance on employees to self-report injuries later, which is often a source of underreporting due to forgetfulness or fear of repercussions (Azaroff et al., 2002, Kyung et al., 2023).

AI algorithms can analyze IoT data to detect unsafe conditions that may lead to injuries. For example, if a worker is lifting an unsafe load, the system can automatically alert supervisors and generate an incident report without manual input. Many IoT-enabled reporting systems feature **mobile apps** that streamline the process, allowing employees to report injuries quickly and easily. Such ease of use could encourage more reporting of incidents that might otherwise be overlooked. Organizations can also implement anonymous injury reporting to further reduce underreporting, lessen fears of retaliation, and encourage more employees to report unsafe conditions.

Automated Coding of Incident Data

The data collected from these incidents can be manually coded or automated to standardized occupational codes. However, standardizing occupational codes for injury case definitions involves creating a consistent system for categorizing jobs and injuries across industries (Carmichael et al., 2022). This approach ensures that injury data is accurately classified, enabling better analysis, comparison, and tracking of workplace injuries. It also helps develop targeted prevention strategies, improve reporting accuracy, and align with national or international occupational safety and health standards.

Various systems and guidelines have been developed to achieve this standardization, each with its own focus and methodology. For example, to lighten manual coding, **NIOSH** is exploring ML as a way to streamline the assignment of standardized industry codes (SIC). This SIC code assignment is crucial for identifying high-risk industries in nonfatal occupational injury data from NEISS-Work. Presently, coding is done manually from unstructured employment data, a time-consuming process dependent on trained coders. Similarly, **BLS** converts text entries from OSHA forms to standard codes used by their own system. Before 2014, the BLS relied solely on human coders for case coding, but now uses ML to code a subset of cases. This allows for the identification of patterns and associations between features—such as words or word pairs—and the corresponding codes. Also, the American Society for Testing and Materials (ASTM) International has developed a standard guide for recording occupational injuries and illnesses (**ASTM E2920-19**). This guide defines work-related injuries and illnesses for easy understanding and measurement across countries. It enables evaluation, comparison, and improvement of worker safety programs. While varying severities may be noted, the focus is on cases with a clear work connection and significant prevention value. The resulting data and rates aim to enhance consistency in global safety benchmarking.

Using specialized software applications, such as autocoders, can streamline the process of assigning industry and occupation codes to free-text descriptions (e.g., from injury reports or job descriptions) based on the chosen classification system. Key benefits of using an autocoder include significantly faster processing compared to manual coding, improved consistency across records, reducing human errors, and eliminating the extensive training and experience required for manual coding. This streamlined approach can improve reporting accuracy and efficiency (including identifying high-risk tasks) and improve an organization's ability to target injury prevention efforts.

AI-Powered Risk Assessments

In the recent NSC report on the **utility of AI**, we stated that AI could be used to identify risk factors for MSDs (e.g., using ML and natural language processing), monitor and analyze data from wearable sensors to model the injury risk (e.g., using ML), predict work environment risk factors to identify jobs and specific MSD risks (e.g., using neural networks), and to conduct for MSD risk assessments and interpret real-time camera images to alert workers if their postures and movements are potentially hazardous (e.g., using computer vision).

AI-powered algorithms can predict injuries including MSDs earlier in the injury process by examining historical data from the workplace and current working conditions, allowing organizations to implement preventive measures proactively (Chan et al. 2022, Jetha et al., 2023). More importantly, by integrating AI technologies with the IoT infrastructure, one can analyze data in real-time and make intelligent decisions autonomously, thereby improving work-related processes and human-machine interactions. Furthermore, IoT infrastructure can use AI's deep learning ability to analyze past injury data and workplace factors (related to the worker, task and the work environment), predict potential risks, and develop mitigation strategies.

Supervisor/EHS Manager/Ergonomist

In a typical workplace, when injuries occur, a supervisor, EHS manager, or ergonomist leads investigations to determine the root causes. In this reactive approach, they collect evidence, interview witnesses, and analyze incidents to develop corrective actions. Alternatively, some knowledgeable EHS professionals can proactively develop potential ergonomics and safety solutions instead of opting for a reactive approach by eliminating or redesigning task- and workplace-related risk factors, thus fitting the job to the worker. These risk-reduction efforts can be **augmented by AI,** for example, by investigating the root causes and analyzing data related to the incidents. They could design out MSD risks by integrating insights from the AI models into prevention through the design process, thereby allowing organizations to create safer environments that protect workers.

Using **AI and IoT-driven sensors and cameras**, one can monitor tasks, work environment, and workers' postures and behaviors in real-time and alert workers and supervisors (Liu et al. 2022, Kong et al. 2021). With the predictive analytics features of AI, these organizations can develop training programs by identifying areas where workers may need additional support based on their incident history. Thus, tailored safety and ergonomics education and training can be developed to address MSDs and other safety concerns, improving workplace safety culture. AI-driven approaches can also automate some administrative tasks related to data entry and workflow scheduling and staff allocation. This automation frees up time allowing these professionals to spend more time on interventions that are critical for creating safer workplaces and reducing MSD risk.

Workplace System Integration

The ILO encourages employers to establish an effective occupational health and safety management system to maintain a safe and healthy work environment and comply with national occupational safety and health laws and regulations. Furthermore, the Campbell Institute's **research** on "world-class" EHS programs identified five key elements of an integrated EHS management system: strong management commitment and involvement, EHS integration into policies and operations, a comprehensive audit program with external verification, proactive management of cultural challenges, and inclusion of contractors, suppliers, and vendors. To this effect, the **International Organization for Standardization (ISO) 45001** specifies requirements for an occupational health and safety management system and utilizes the Plan-Do-Check-Act methodology to manage health and safety requirements. It provides a framework for organizations (regardless of size, type, or nature) to manage risks and proactively improve health and safety performance by integrating occupational health and safety into their business management systems and processes, leading to fewer incidents. With ISO 45001's integrated approach to occupational health and safety management, organizations can enhance success by adopting a systematic, IT-enabled strategy, and comply with legal and regulatory requirements.

While occupational health and safety management can operate using paper records, spreadsheets, or separate IT systems, far greater efficiency and better outcomes could be achieved with an enterprise resource planning (ERP)-integrated occupational health and safety management system. Such a system, embedded within the enterprise architecture, provides real-time context and situational awareness, allowing all departments to operate from a unified source. A robust ERP system also enforces safety regulations and standards across the organization by managing training, certifications, incident reporting, and inspections. This helps ensure a safer, compliant, and more productive work environment for all employees.

Advances in data visualization using new visual analytics tools make it possible for supervisors, EHS managers, or ergonomists to track and report injury trends and workers' compensation data. The enhanced visual communication of data creates a unique opportunity for these leaders to communicate the data to get buy-in from senior leadership on key decisions. However, effectively communicating current injury related data to the decision makers requires novel methods (Martinez et al., 2016).

Data Integration & Management

Safeguarding workplace data involves establishing clear policies for data collection and storage, maintaining oversight for data accuracy, defining access permissions based on the role of various stakeholders and purposes, investing in strong security software, encrypting files with user authentication, masking the personal information of workers, and regularly monitoring and upgrading AI-driven models to prevent cybersecurity threats.

Implementing **end-to-end encryption** for workplace safety management systems is vital for protecting sensitive information, ensuring compliance with regulations (e.g., General Data Protection Regulation and the Health Insurance Portability and Accountability Act), building trust, mitigating cyber threats, enhancing data integrity, and promoting collective responsibility among employees. Role based access control is an advanced permissions management model that assigns user access based on organizational roles. Permissions are linked to a user's position, helping to prevent unauthorized access, which reduces the risk of data theft, leaks, and security breaches.

In summary, an injury surveillance system that leverages emerging technologies to enhance efficient real-time data collection, analysis, and continuous reporting may be of benefit to organizations that are technology ready. Additionally, Miraini et al. (2020) emphasized that using standardized data elements, ensuring data quality, linking sources, and maintaining security and privacy protocols can achieve accurate, precise, and complete injury data documentation and management. Systems should include a minimum data set (e.g., demographics, injury type, nature, and mechanism), supplementary data (e.g., environmental conditions), and key functions such as data linkage, monitoring, reporting, analysis, and distribution. While their recommendations focused on public health surveillance systems, they are equally relevant to workplace surveillance systems.

It should be noted that this hypothetical smart system needs not only a secure IT infrastructure but also buy-in from various stakeholders of the organization and, most importantly, from the workers, as these systems are supposed to be dynamic, meaning the systems continuously monitor their work. To this effect, NIOSH researchers (Haas & Cauda, 2022) found that in addition to the reliability and validity of data from emerging technology, acceptability and trust in technology, ease of use, and support and guidelines are essential in emerging technology integration to occupational safety and health management systems. Furthermore, they emphasized that management commitment, communication and coordination, and employee involvement during technology integration are important. To tackle such a precarious issue, it is recommended to follow an ethical framework for worker monitoring, as suggested by NIOSH. Similarly, the US Department of Labor is partnering with its workforce, unions, and stakeholders to ensure AI benefits workers and supports their mission to promote their welfare. Their aim is to launch programs integrating AI across departments, offering employees more training and support while enhancing productivity and job satisfaction.

Overall, the proposed surveillance system remains conceptual and needs thorough evaluation to assess its practicality and effectiveness. While the boxes outlined may not be universally applicable, organizations must recognize their unique capabilities. For instance, small organizations may struggle to scale AI models or implement IoT sensors. Similarly, some organizations may lack the resources for advanced workplace system integration or comprehensive data management. Therefore, it is crucial for each organization to critically evaluate these elements and selectively adopt those that align with their operational capacity, enabling them to establish a streamlined and effective surveillance system.

Conclusion

Accurate injury categorization and injury surveillance are vital to ensure that risks and injuries are properly understood and that the right resources and solutions are provided. If organizations are unaware of the impact of ergonomic injuries and risks within their workplace, leadership may not invest in ergonomics solutions and programs. This resource highlights standard ways to categorize and think about ergonomic injuries, injury surveillance methods, and provides examples of injury cases and ways to categorize and record such injuries. The Appendix also contains example data dashboards and injury record keeping forms for organizations to pull inspiration from when developing or refining their own injury surveillance methods.

While organizations may conceptualize ergonomic injuries differently or have different parameters in place to determine if something gets categorized as ergonomic or not, the goal is to have a consistent definition of what an ergonomic injury is across the organization. This helps to ensure an accurate count of ergonomic injuries is recorded, which in turn provides accurate information to decision makers regarding investing in ergonomic risk mitigation. Standardization of injury categorization within industry or within the US may feel out of reach given the absence of MSD reporting on OSHA logs, but standardization within an organization is a great first step.

Additionally, organizations should focus on developing systems that work for them. For some organizations, this may be recording injuries on spreadsheets, while other organizations may utilize sophisticated software or autocoders to assist in categorization. Either way, a good surveillance system is one that is easily used and understood by the workforce interacting with it.

Lastly, proper training in using an injury surveillance system is essential. The employees expected to interact with the system need training on how to use the system itself and how to interpret workplace injuries. The worksheet provided here is aimed to help employees practice and better understand ergonomic injury classification. Such exercises may be beneficial when training employees. Refresher training is also important to ensure employees are up to date on the system.

A smart surveillance system is also proposed but needs more thorough evaluation to assess its practicality as not all organizations can apply all proposed aspects suggested. For example, smaller organizations may face challenges in scaling AI models or using IoT sensors to develop data-driven interventions. Resource limitations may also hinder advanced system integration and data management. Thus, organizations should evaluate and selectively adopt elements that fit their operational capacity to create an effective system.

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Appendix

Attribute	Definition	Examples	Questions to Ask
Simplicity	Ease of operation of surveillance system (ease of data collection/ reporting for example). Refers to both structure and ease of operation	• Number and type of data sources reporting to system • Number of organizations involved in reporting	• Is the surveillance system design, elements, and levels difficult to understand and describe? • Are users of the system able to use it easily? At all levels?
Flexibility	Ability of a surveillance system to adapt to changing information needs or operating conditions with little additional time, personnel, or funds	• Number of components that need modification when adding a new element • Time required to change reporting source	• Does the system use data standards and formats that allow integration with other systems (interoperability)? • How much effort (time, staff, and funds) is required to modify the system to changing needs?
Data Quality	Completeness and validity of the data recorded in the surveillance system	• Percentage of data missing • Percentage of impossible data values (e.g., ages or dates out of range)	• What percentage of missing or invalid data exists in the system? • Are case definitions, forms, training, and data management optimized for quality?
Acceptability	Willingness of persons and organizations to participate in the surveillance system	• Number or percentage of individuals reporting timely information into the system • Interviews of users about their motivation or lack thereof for using the surveillance system	• What percentage of reporting departments participate? • How complete and timely is reporting? • Are participants satisfied with the system and willing to participate?
Sensitivity	Proportion of injuries detected by the system	• Proportion of injuries detected by the system out of total injuries detected or estimated by external verified sources	
Predictive Value Positive	Proportion of reported cases that qualify as the event under surveillance	Proportion of confirmed ergonomic injuries out of all ergonomic injuries reported to the system	• How often are reported injuries confirmed as true cases?

Appendix (con't)

Representativeness	Accurately describes the occurrence of injuries over time and their distribution in the population	Proportion of departments or units reporting data to surveillance system	• How well do the data reflect the actual distribution of the injuries? • Are certain data systematically excluded? • How consistent is data entry over time?
Timeliness	Reflects the speed between steps in a surveillance system	• Time between injury and it being reported to surveillance system	• How quickly are injuries reported after their onset?? • How long does it take to identify trends
Stability	Refers to the reliability (ability to collect, manage, and provide data properly without failure) and availability (operational when needed)	• Average number of hours of system downtime per month • Percent of personnel that have completed all required trainings	• How often does the system experience unscheduled outages? • What are the costs associated with system repairs? • Is the system fully operational most of the time?

Example Data Dashboards

Figure 1. *Occupational Injuries Involving Days Away from Work Dashboard from Injury Facts*

Example Data Dashboards

Figure 1. *Occupational Injuries Involving Days Away from Work Dashboard from Injury Facts*

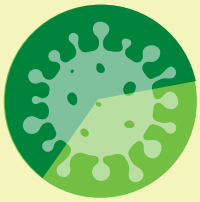
OCCUPATIONAL INJURIES INVOLVING DAYS AWAY FROM WORK
UNITED STATES, 2021-2022

TOP 3

1

Exposure to harmful substances or environments

- **Injury rate:** 31.9 per 10,000 full-time workers
- Before the pandemic the 6th ranked. Increased to #1 because of COVID-19 cases
- **Industry** most at risk: healthcare and social assistance
- **Typical days lost:** 13
- Most frequent **case type:** Other diseases due to viruses, not elsewhere classified



28%

634,080

2

Overexertion bodily reaction

- **Injury rate:** 26.2 per 10,000 full-time workers
- **Age group** most at risk: 45 to 64
- **Industry** most at risk: transportation and warehousing
- **Typical days lost:** 14
- Most frequent **part of body** hurt: back

23%

521,350

3

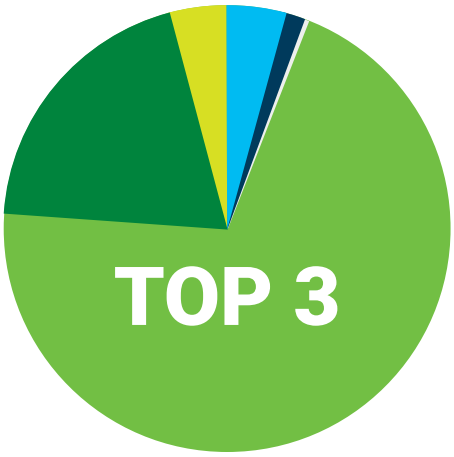
Falls, slips trips

- **Injury rate:** 22.6 per 10,000 full-time workers
- **Age group** most at risk: 55 and over
- **Industry** most at risk: transportation, warehousing and agriculture
- **Typical days lost:** 14
- Most frequent **type of injury:** sprains, strains and tears

20%

450,540

OTHER EVENTS OR EXPOSURES



4 **Contact with objects and equipment**
450,050 injuries

5 **Violence and other injuries by persons or animals**
85,410 injuries

6 **Transportation incidents**
85,000 injuries

7 **Nonclassifiable**
17,280 injuries

8 **Fire and explosions**
3,190 injuries

Example Data Dashboards

Figure 2. *Safety Dashboard from a Small Manufacturer*

Figure 3. *Occupational Safety Metrics Monthly Data Report from a Large Manufacturer*

Performance Summary

Lost Time Rate	Lost Time Severity Rate	DART Recordable Rate
0.64	12.17	1.86
Recordable Rate	First Aid Rate	Combined Rate
1.39	4.42	5.81
Ergonomic Recordable Rate	Near Miss Rate	Hours Worked
0.51	14.23	67.98M

Example Injury Record keeping Forms

Example 1. *Injury Recording Form for a Large Hospital System*

Client Name: _____

Account Name: _____

State/Province: _____

EMPLOYEE INFORMATION

HR Employee ID _____ Job Title _____ Gender _____ Age _____

Date Hired _____ Department Name _____ Unit Name _____

Supervisor Name _____

INJURY INFORMATION

Date of Injury _____

Case Location (where it happened) _____

Cause Time _____ Cause Code _____ Cause Category _____

Cause Description (Interaction) _____

Event Description _____

Body Part Desc _____ Loss Desc _____

OSHA Recordable (yes or no) _____

First Aid (yes or no) _____

Work Status (normal, off work, terminated) _____

WORKERS COMPENSATION/INSURANCE INFORMATION

Date of Loss _____

Date Reported to Workers Comp _____ Date Opened by Workers Comp _____

# of Lost Work Days _____ Calendar Restricted-NTL Days _____

Claim Status (Deferred [or New], Open or Active, Denied, Closed or Inactive)

Claim Type (Incident Only, Medical Only, Indemnity) _____

Net Total Incurred _____

Claim Incurred – Total _____

Example 2. *Injury Reporting Forms from a Small Metal Manufacturer*

Employee's Report of Injury Form

Instructions: Employees shall use this form to report all work-related injuries, accident, or "near miss" events (which could have caused an injury or illness) - no matter how minor. This helps us to identify and correct hazards before they cause serious injuries. This form shall be completed by employees as soon as possible and given to a supervisor for further action.

I am reporting a work related: Injury/Illness Accident/Damage Near Miss	
Your Name	
Job Title:	**Supervisor:**
Have you told your supervisor about this injury/near miss? Yes No	
Date of injury/near miss:	**Time of injury/near miss:**
Names of witnesses (if any):	
Where, exactly, did it happen?	
What were you doing at the time?	
Describe step by step what led up to the injury/near miss. (Continue on the back if necessary):	
What could have been done to prevent this injury/near miss?	
What parts of your body were injured? If a near miss, how could you have been hurt?	

Witness Report of Injury Form

Witness Name:
Job Title:
Injured Employee Name:
Where did the incident occur?
Description of Incident: Please provide what caused the incident, how it happened, why it happened.
How could this have been prevented?

Example Injury Record keeping Forms

Supervisor's Accident Investigation Form

Name of Injured Person:	
Date of Event:	**Time of Event:**
What part of the body was injured?	
Description of Incident: Please provide what caused the incident, how it happened, why it happened.	
What equipment and/or tools were being used?	
Exact location of the event:	

Check all that apply:

PHYSICAL FACTORS

- ☐ Footing/Area was in good condition, uncluttered and accessible
- ☐ Work area/ergonomic set-up/environment was hazardous
- ☐ Unrecognized hazard
- ☐ Equipment/tool defect or failure
- ☐ Equipment/tool unavailable
- ☐ Improper equipment/ tool used
- ☐ Protective equipment (PPE) not worn

SYSTEM FACTORS

- ☐ Assistive device not used
- ☐ Failure to get help or assistance
- ☐ Lack of communication
- ☐ Procedure not followed
- ☐ Duties or task not clear
- ☐ Procedure lacking or incomplete
- ☐ Training lacking or incomplete
- ☐ Improperly informed of procedure

IMMEDIATE FIX

- ☐ Provide safety training/retraining
- ☐ Develop/revise safety procedures
- ☐ Maintain good housekeeping
- ☐ Maintain tools/equipment
- ☐ Post safety signs
- ☐ Perform job hazard analysis
- ☐ Provide/Change PPE
- ☐ Remove defective equipment

Add any additional comments on immediate fixes: _____

_____

_____

Identify Three (3) Corrective Actions to Prevent this from happening in the future:

1. _____
2. _____
3. _____

Supervisor Printed Name:_____ Date: _____

Supervisor Signature: _____