Comparison of Work-Related Amputations in Illinois to National Estimates

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THESIS

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LIST OF ABBREVIATIONS AND NOMENCLATURE

ADR	Alternative Dispute Resolution
BLS	Bureau of Labor Statistics
CFOI	Census of Fatal Occupational Injuries
FIPS	Federal Information Processing System
HD	Hospital Discharge
ICD	International Classification of Diseases
ITR	Illinois Trauma Registry
IWCC	Illinois Workers Compensation Commission
NAICS	North American Industry Classification System
NEP	National Emphasis Program
OSHA	Occupational Safety and Health Administration
RTW	Returning to work
SENSOR	Sentinel Event Notification System for Occupational Risks
SIC	Standard Industrial Classification
SOII	Survey of Occupational Injury and Illnesses
TR	Trauma Registry
VPP	Voluntary Protection Program

SUMMARY

There are multiple studies showing that the Bureau of Labor Statistics (BLS) undercounts the estimate of amputations that occur in the workplace. This study uses the linkage of multiple databases to give a representation of the actual cases of workplace amputations in Illinois between the years of 2000 and 2007 and compares them to the government estimates by year. The study also identifies where the injuries occur on the body, the counties they occur in, time series data, and what industries have the highest number of amputations.

The linked dataset shows that there were a total 3,984 cases of work-related amputations in the State of Illinois. The majority of amputation injuries occurred in males (88.87%) with the distribution of body part predominately thumbs and fingers (thumb N = 1691, finger N = 1523). The time series data show that the injuries for each month of the year showed a steady trend across the months with a small decrease between September and December. The industries with the most amputation injuries came from the manufacturing, the public sector, and temporary agencies. Highly populated counties experienced elevated numbers of amputations, whereas the smaller counties had higher prevalence rates per 10,000 employees.

The results from the comparison of linked datasets to the government estimates agree with previous studies showing undercounted amputations. Between the years 2000 and 2007 the Bureau of Labor Statistics undercounted cases of workplace amputations by as much as 55%. Undercounting was attributed to the changes in the

government's surveillance, the use of only private sector data, and depending on the employer's ability to report the injuries. Both the government's system and the linked dataset miss cases, but the study shows that there are other effective ways to identify amputation injuries in the workplace.

1. INTRODUCTION

1.1 Background

Between the years 1992–1999, there were an average of 21 fatal workplace amputations and more than 11,000 nonfatal incidents annually. More than 50% of these injuries occurred in the manufacturing sector, where operators, fabricators, and laborers had the most injuries of all other occupations nationally (Brown, 2003). The estimated average cost per claim for amputation injuries is about $18,120 and result in a median number of days away from work of 18 days and 25 days when fingertip amputations were excluded (Brown, 2003).

Based on BLS data, the annual number of occupational amputations from 1992 through 2001 was steadily declining from 12,352 in 1992 to 8,612 in 2001. This decreasing trend is also seen in recent data from 2003 through 2009. The average number of amputations per year has declined to 7,461 and the total nonfatal workplace amputations were reduced to 52,230 cases from 2003 through 2009 nationally (Bureau of Labor Statistics). When compared to the nonfatal cases involving days away from work in private industries in Illinois the same trend is occurring. The annual number of estimated amputations in Illinois has decreased from 540 amputation injuries in 2003 to 320 in 2009 (Bureau of Labor Statistics). Between these years the decline levels out and stays in the range of 200 to 400 amputations per year (Bureau of Labor Statistics).

The rates of nonfatal workplace amputations nationally were around 1.6 per 10,000 full-time employees in 1992 and were reduced to 1.1 per 10,000 full-time employees in 1999 (Brown, 2003). In more recent years these rates have continued

dropping. Between 2003 and 2009 the rate has ranged from 0.7 and 0.9 per 10,000 full-time employees. The rates of amputations have been declining for the past 17 years, but are starting to level off as seen from the smaller reduction between 2003 and 2009 (Bureau of Labor Statistics). In both the national data and Illinois data we see the same trends of declining rates over time and a leveling off since 2003, which could be attributed to better work practices and regulations within the workplace. However, the trends observed in the BLS data may be misleading as a result of reporting biases (Friedman and Forst, 2007; Rosenman, 2006; Ruser, 2010).

The majority of nonfatal amputations nationally from 2003 through 2009 occur within the industries of manufacturing (44%), Trade Transportation and Utilities (19%), and Construction (14%) (Maxfield et al., 2003 – 2009). These industries have been the leaders in workplace amputations for years since studies done in 1977 when manufacturing accounted for 30% of employment, but about 60% of the amputations (McCaffery, 1981). The lower percentages of nonfatal amputations nationally were in professional and business services (6%), leisure and hospitality (5%), and financial, education, and health services (2%) (Maxfield et al., 2003 – 2009).

1.2 **Literature Review**

1.2.1 **Surveillance**

A study in Washington State also found that the majority of amputations occurred in manufacturing and construction (Anderson et al., 2010). Their study shows that men were more often injured than woman and smaller employers had higher rates

of amputations. Many employers in the study had at least one amputation, but the ones that had the most multiple amputations between 1997 and 2005 were (44%) in manufacturing, construction (12.7%), wholesale trade (8.1%), agriculture, forestry, fishing, and hunting (6.9%), and food service accommodation (6.7%) (Anderson et al., 2010). The main sources of these amputations were machines such as saws, shears/slicers, presses, planers/molders, buffers/polishers, and mowers (Anderson et al., 2010). Other common sources included powered and non-powered hand tools (including power saws, power drills, chainsaws, and knives), metal items (structural metal), wood items (timber, kick back), and vehicles (Anderson et al., 2010). When comparing the size of companies where amputations of upper-limb extremities occurred, one study found the majority (74%) of the amputees worked in large companies and 26% in small/medium sized companies (Fernandez et al., 2000).

Occupational amputations can be tracked by using different databases available to researchers. A group in Kentucky used the workers' compensation data to quantify the rates, risk factors, and costs of occupational amputations in the workplace (McCall and Horwitz, 2006). The workers' compensation program covers over 1.7 million employees and provides data variables in terms of employee age, gender, occupation, industry, injury date, and body part affected, source of injury, and claim-cost information. These variables are important indicators to quantify and analyze amputation data. The study's findings are similar to those of other studies when looking at gender, age, industry, body part injured, and sources. "The state of Kentucky only provides workers' compensation payments for claims that resulted in 7 or more days

away from work, only indemnification costs for amputations that took a week or more of recovery time were recorded" (McCall and Horwitz, 2006). The average total indemnity payment per claim was $8,822, with the total cost of indemnification for amputation injuries equaling $20,264,134 over the 10-year period, thus representing more than 2 million dollars on average annually (McCall and Horwitz, 2006). The data was right skewed and non-normal so the median costs were calculated to show a better value for the cost. The study found that men and women had different averages per claim as well as median costs. Males tended to have about $1,400 more per claim and had a median cost about $500 more than women. The highest costs were associated the age group 55 – 64 and the lowest costs from age 65and over (McCall and Horwitz, 2006).

Many articles revealed their data sources as state workers' compensation data, hospital discharge data, emergency department data, or employer first reports (Anderson et al., 2010). These data sets can allow us to get a better understanding of the problem of work place amputations, but most data sets lack complete information on the injury etiology, severity, or outcome making the information incomplete. A Study on "Nature, Incidence, and Cause of Work-Related Amputations in Minnesota," used the Minnesota Sentinel Event Notification System for Occupational Risks (SENSOR) surveillance system for information on hospitalized and non-hospitalized work-related amputation injuries (Boyle et al., 2000). The SENSOR program identified amputations as any finger amputation (with or without bone loss) or the loss of any other body part which is consistent with the determination of a compensable amputation under the rules guiding workers' compensation in Minnesota. The program consists of information

on amputation injuries from the Department of Labor and Industry, a news clipping service, on large urban hospital/clinic, three rural hospitals, and two rural clinics (Boyle et al., 2000).

The three major industries with the highest rate of amputation injuries per 100,000 workers over a two-year period included agriculture, forestry and fishing, manufacturing, and construction. A more refined industry division showed that the highest rates fell within the manufacturing division including transportation equipment manufacturing, stone, clay, glass, and concrete manufacturing (Boyle et al., 2000). The occupational groups of the most injuries were machine operators and tenders, handlers, equipment cleaners, and laborers, precision products occupations, and fabricators, assemblers and hand working. Within these groups the majority had one or more fingers amputated (95%) with the index or middle finger being the most commonly reported (Boyle et al., 2000). Machines were the primary source for most of the injuries, more specifically, saws, presses, and food and beverage machines. The most frequent reason for injury reported by the employees suffering amputations was that shields or guards were absent and typically had never been equipped with a shield or guard. When injuries occurred at machines with guards in place they occurred because the guard was in the wrong place, did not enclose the dangerous parts of the machines, malfunctioned, or hands or feet passed through the safeguards (Boyle et al., 2000).

1.2.2 **Designing Tasks for Amputees**

Amputations make it difficult to complete tasks at home like personal hygiene, dressing, exercise, hobbies, child rearing, and home maintenance, as well as tasks in the work place that can affect the ability to carry out a job. Some examples of the jobs in manufacturing that can be difficult for amputees to complete are; machinists, welders/cutters, assemblers, inspectors, shipping/receiving, and maintenance. Each job requires the use of arms, hands, fingers, thumbs, legs, feet and toes for different tasks. If the employee operating machinery in jobs such as these experiences an amputation, it makes it impossible for the employee to complete the assigned tasks and necessitates a transfer to a different work assignment. When transferring an amputee to another task it is important to understand the basic activity limitations that are associated with each type of amputation. A person with a whole-arm amputation will have abilities that differ from someone who has lost a leg or even just a finger, and the accommodations for each injury will differ as well. Work places can be accommodated by fitting the task to the amputee, modifying the physical work environment/workspace, practical work aids, or prosthetic devices (Girdhar et al., 2001).

1.2.3 **Lower- and Upper-Limb Amputations**

Traumatic work-related amputations cause a number of problems for the worker as well as the employee when it comes to returning to work (RTW) and the tasks that can be completed by the worker with an amputation. A large percentage of amputations occur in younger male workers, who are also the demographic to more likely return to

productive employment (Hebert and Ashworth, 2006). A study done on “Predictors of return to work following traumatic work-related lower-extremity amputation,” looked at data tracked by the Workers Compensation Board of Alberta to understand the factors that predict why people with lower-extremity amputations are able to RTW while others are not (Hebert and Ashworth, 2006). The study consisted of 88 subjects, 97% of whom were male, and the average age was 34 years old. The workers that did not return to work accounted for 23%, 58% returned to work, and the remaining 19% were deemed fit to work. Of the 51 subjects that returned to work only 35 returned to the same occupation (Hebert and Ashworth, 2006).

The workers that did not return to the same task were transferred to a modified job that required less physical demand, rather than require greater intellectual skills or job modifications. Within these new jobs there is a reduced potential for salary increases and fewer opportunities for job promotion among those who are disabled. (Schoppen et al., 2001). A questionnaire was given out to 219 people working with an amputation in the Netherlands; they were asked if they had changed jobs to one with fewer physical tasks because of their amputation and if the amputation was a consideration in choosing their present job. Thirty three percent of the participants claimed that their amputation caused them to transfer to jobs with fewer physical tasks, and 44% said that the amputation was a consideration in choosing their current job (Schoppen et al., 2001). Most of the jobs held by this study group were substantially different from the general Dutch population (agrarian, trade, industrial, transport), but

after their amputations the new jobs were much more comparable with those of the general population (Schoppen et al., 2001).

A study in Asturias, Spain looked at employees with upper-limb amputations at the workplace and their reintegration into the social work environment. The study was carried out in the Prosthesis Service of Rehabilitation Centre of the Hospital Central de Asturias in 1977. Only upper-limb accidents that occurred at work were included in the study (minor amputations of the fingers being excluded). The study found that after the amputation 51% of patients continued working, of which 59% went back to the same company with new tasks, 36% changed companies, and 5% kept the same job and tasks. Of those that did not return to work, 95% went into early retirement, and 5% remained unemployed. One significant finding from this study was that 80% of those that returned to work used prostheses. In contrast only 58% among those that did not return to work reported using a prosthetic (Fernandez et al., 2000).

A similar study followed nineteen patients that underwent prosthetic limb fitting for the upper limbs. Fifteen of 18 patients underwent preparatory prosthetic limb fitting within 30 days of the amputation. Eighteen of the 19 patients were available for follow-up evaluation. Twelve of the 18 patients returned to work in positions that require two-handed function. Nine laborers returned to their former jobs and three changed to physically less demanding jobs. Patients were questioned about limb pain, and only three patients stated that they were pain free. Ten of the injured workers experienced occasional dysesthesias, tingling, and mild discomfort in their amputated limbs

(phantom limb sensation). Five patients experienced occasional localized non-phantom limb or residual limb discomfort (Pinzur et al., 1994).

One key finding of this retrospective study was that although some patients experienced discomfort and phantom limb sensations, they were not of significant magnitude to either impair their functional prosthetic utilization or limit their ability to return to work. This shows that patients that undergo traumatic upper-limb amputation can achieve functional use with prosthetic device and return to work without residual limb and phantom limb pain affecting their return (Pinzur et al., 1994).

1.2.4 **Safe Guarding**

Many studies have shown that the major cause of amputations is machinery. Machinery can cause amputation injuries by malfunctioning, improper guarding of moving parts, or improper training for that machine. A paper on “Mapping Safety Interventions in Metalworking Shops” describes some of the issues small business owners incur with the proper guarding of machines (Brosseau et al., 2007). The study consulted an advisory board of small metal fabrication businesses, consultants from the Minnesota Department of Economic Development and Minnesota Occupational Health and Safety Administrations to collect information on the metal fabrication business. The goal of the study was to compare the effectiveness of safety interventions directed toward owners only with interventions directed toward owners and employees, with the objective of reducing machine related amputations (Brosseau et al., 2007). An Intervention Mapping process was set up for four small metal fabrication businesses.

The process was made up of 5 steps: define program objectives, select methods and strategies, design a program plan, adoption and implementation plan, and monitoring and evaluation plan.

The study found that the reason behind machine-related amputations is often the lack of knowledge of best practices and regulatory requirements for employee protection. (Brosseau et al., 2007) Smaller businesses typically have older machines that are more difficult to retrofit with safety devices. (Brosseau et al., 2007) Many companies are safety conscience, but do not have the resources for machine safety or proper knowledge of their options. Occupational Safety and Health Administration (OSHA) is an example of a free resource for companies to gain knowledge about machine safety, but do not seek help until there is a serious injury (Brosseau et al., 2007). Implementing intervention mapping into company policies was found to be a good tool in small businesses to change behaviors toward a safety conscience mindset.

1.2.5 **Occupational Safety and Health Administration Programs**

The Occupational Safety and Health Administration provide different programs to help companies strive to create safer environments for their employees. One such program is the Voluntary Protection Program (VPP). Voluntary Protection Program was created in 1982 to recognize and partner with businesses and worksites that excel in occupational safety and health the Voluntary Protection Programs are designed to help employers identify, evaluate, prevent, and control occupational hazards that cause employee injuries or illnesses. Average VPP worksites have at least 50% below the

average lost workday incidence rates compared to other companies in the same industry. A benefit to being in the VPP is that OSHA removes participants from programmed inspection lists (OSHA Fact Sheet, 2009).

To be in the VPP program, companies need to have an effective, ongoing safety and health program. The participant is expected to use safety and health programs tailored to each worksite, that uses management leadership and employee participation as well as evaluations to ensure the program is meeting the needs of the company. Participants are selected based on their health and safety management system and ongoing performance. The VPP does not replace OSHA's enforcement duties, but rather complements the enforcement duties, making it easier for OSHA to focus on higher-risk establishments. There are two different levels of VPP, Star and Merit. The star program is reserved for companies with injury and illness rates at or below the national average in their industry. Star participants are reevaluated every three to five years. Merit is for companies with safety and health programs, but they need some improvement. On-site evaluations occur every 18 to 24 months (OSHA Fact Sheet, 2009).

Another program available through OSHA is the National Emphasis Program (NEP). Occupational Safety and Health Administration provides instructions that describe policies and procedures for implementing an NEP. The NEP can be used to identify and reduce workplace injuries in any industry. OSHA has different NEP programs for different workplace hazards and industries. The OSHA Directive CPL-03-00-003 focuses on the elements that are causing or likely to cause amputations. The specific purpose of this NEP is to "describe the policies and procedures for implementing a

National Emphasis Program to identify and to reduce workplace machine and equipment hazards which are causing or likely to cause amputations (OSHA Instruction, 2006)."

The program includes four activities: outreach, targeting/selection, inspection, and program approval. The outreach portion requires regional and area offices to develop and offer outreach programs with employers, professional associations, and local unions. These programs can include meetings, training, educational materials, mailings, speeches, or other activities to help companies in the identification and elimination of hazards associated with machinery commonly found in their respective industries (OSHA Instruction, 2006).

The targeting/site selection component is used to target workplaces with machinery and equipment that are likely to cause amputations and workplaces where amputations have occurred in the past. Some of the workplaces associated with high numbers of amputations are: meat packing plants, food preparations, textile goods, logging, millwork, and fabricated structural metal (OSHA Instruction, 2006).

Inspection procedures include scheduled and assigned inspections for the identified establishments. At the opening conference of the inspection, the machinery and equipment used by the employer will be referenced to in Appendix D of the NEP for machinery and equipment that could cause amputations. If any machinery or equipment in Appendix D is present in the workplace, inspections of the machinery and equipment will be performed. Inspections will look for nip points, pinch points, shear points, and cutting points that create hazards to employees. Other areas to inspect are: regular

operation of the machine, setup, clearing jams, making adjustments, cleaning of the machine, scheduled maintenance, and locking and tagging out. Before any of the inspections take place, the OSHA logs are reviewed to identify previous injuries (OSHA Instruction, 2006).

The program approval portion of this NEP pertains to inspection programs that deviate from this NEP. Any program that does needs to be approved by the National Office, Directorate of Enforcement Programs (OSHA Instruction, 2006).

1.3 Introduction to Occupational Safety and Health Statistics

Data on safety and health conditions for workers on the job have been produced by the BLS since before World War I. The first report issued summarized industrial accidents in the iron and steel industries during this time. The BLS reported on the frequency and severity of injuries, the occupation of the injured workers, and the nature of their injuries. In 1970 the BLS was delegated to develop a comprehensive statistical system covering work-related injuries, illnesses, and fatalities in private industry. In 1972, BLS collaborated with state governments to design the annual Survey of Occupational Injuries and Illnesses (SOII) to estimate the number and frequency of work-related injuries and illnesses by detailed industry for the nation as well as the participating states (Occupational Safety and Health Statistics, 2010).

The first design of SOII had some shortcomings as is usual in the beginning stages. The survey showed dangerous work settings, but didn't pinpoint the types of injuries or illnesses and failed to produce a reliable count of workplace fatalities or

profiles of the victim's demographics or (where pertinent) circumstances surrounding their deaths. In 1987 it was recommended that the deficiencies be corrected by collecting detailed data on severe, nonfatal occupational injuries and illnesses reported in the SOII and compiling records from administrative records; for example death certificates and workers' compensation reports. After multiple years of redesigns and tests with help from some 40 participating states and technical support for the safety and health community, an improved statistical system was implemented in 1992. The changes included having three different health statistics programs: National Census of Fatal Occupational Injuries, which includes detailed case characteristics and worker demographics for work-related fatalities, Workplace Injuries and Illnesses, which includes industry-level estimates of nonfatal work-related injuries and illnesses from the SOII, and Nonfatal Occupational Injuries and Illnesses Requiring Days Away From Work, which includes detailed case characteristics and worker demographics for cases involving days away from work from the SOII (Occupational Safety and Health Statistics, 2010).

1.3.1 **Common Coding systems**

The two programs, SOII and the Census of Fatal Occupational Injuries (CFOI) share several systems to classify industry, occupation, and case and worker characteristics. The two programs started using the Standard Industrial Classification (SIC) system as their foundation for data statistics. The SIC was revised multiple times in order to keep up with a changing economy, but despite the updates to the system, there

was need for a more comprehensive classification system. The SIC did not keep up with the changing developments in information services, new forms of health care provision, expansion of the services sector, and high-tech manufacturing. Therefore, the North American Industry Classification System (NAICS) was developed to replace the SIC system (Occupational Safety and Health Statistics, 2010).

The new system began using the statistics from reference year 2003 and uses a production oriented conceptual framework to group establishments into industries that use similar primary activities, raw materials, capital equipment, and labor. The downside to this change is that the improved statistics resulted in time-series breaks due to the differences between SIC and NAICS. To account for a changing economy the NAICS restructured and redefined every sector. Nine new service sectors and 250 new service-providing industries were recognized with the 2002 adoption of NAICS. Some of the new sectors include: A new information sector that combined communications, publishing, motion picture and sound recording, and online services. Manufacturing was restructured to recognize new high-tech industries, retail trade was redefined, and eating and drinking places were put into a new accommodation and food services sector. Because of the differences between NAICS and SIC systems and the break in time-series data, users are advised against comparing industry data from 2003 to previous years (Occupational Safety and Health Statistics, 2010).

1.4 Survey of Occupational Injuries and Illnesses Literature

1.4.1 Background

The current SOII evolved from the annual BLS surveys that were conducted in the 1940s. The surveys provided useful measuring and monitoring tools for injury frequency and severity, but had some flaws. The survey's data only consisted of employers who volunteered their work injury reports, and work injuries were limited to those that resulted in death, permanent impairment, or temporary disability, which was deemed as the inability to perform regular job duties beyond the day of injury. When the OSHA Act passed in 1970, most private industry employers were required to maintain records and prepare reports on work-related injuries and illnesses. These records included all disabling, serious, or significant injuries and illnesses, whether or not involving time away from work (Occupational Safety and Health Statistics, 2010).

The number and frequency of workplace injuries and illnesses are estimated by SOII based on logs kept by employers during the year. On January 1, 2002, OSHA revised its requirements for recording occupational injuries and illnesses, which included guidelines for recording hearing loss cases as a separate category of illness. The changing of requirements makes the SOII estimates for 2002 not comparable to those from prior years as well as SOII estimates for 2003 forward due to changes in industry and occupation coding systems. Under the recordkeeping guidelines of OSHA the recording criteria for nonfatal recordable workplace injuries and illnesses are any that result in one or more of the following: loss of consciousness, days away from work, restricted work activity or job transfer, and medical treatment beyond first aid.

Employers must also record any work-related injuries or illnesses that are diagnosed by a physician or other licensed health care professional (Occupational Safety and Health Statistics, 2010).

1.4.2 Measurements

The number and incidence rates of nonfatal workplace injuries and illnesses are reported by NAICS for total recordable cases, days-away-from-work, and other recordable cases. The days-away-from-work are categorized by SOII with two measures of severity, the median number of lost workdays, and the number and percent distribution by their duration. A median number of lost workdays is used to get a better number of days due to outliers in the data since some injuries in the same categories may have a longer or shorter duration of recovery time to return to work. The incidence rates are used to evaluate the safety performance of an industry over time or to compare them to other states (Occupational Safety and Health Statistics, 2010).

There are an estimated 230,000 private industry establishments each year from employers with 11 employees or more reported by SOII. Excluded personnel include self-employed, private households, United States Postal Service, and federal government workers. The establishments in states covered by federal grants have a portion of the cost paid to develop estimates of occupational injuries and illness and to collect data for the BLS to publish nationally. The states that do not these grants have their data collected directly by the BLS for national estimates. The surveys completed by participating state agencies are validated by the regional offices of the BLS to ensure

uniformity and consistency. State participation in SOII can vary from year to year depending on the needs determined by each state office (Occupational Safety and Health Statistics, 2010).

1.4.3 **Collection**

Data was originally collected solely through mail-based surveys by SOII. State agencies would mail the surveys out to employers and they were required to return the injury and illness report back each year for the previous year. As time went on and technology evolved, so did the collection techniques of SOII. Employers were then able to transmit their surveys electronically through the internet, email form, fax form, or through the telephone or mail. The advancement in collection technology allowed employers to provide more accurate data and earlier submission to SOII, which allowed them to produce a better, more timely publication of SOII estimates. The new technology systems allow SOII to produce their estimates months earlier than they were able to with the old system (Occupational Safety and Health Statistics, 2010).

1.4.4 **Reliability and Limitations**

Estimates from SOII are based on a selected probability sample, which has results that differ from a census of the whole population. “Sampling methodology makes it possible to collect data from a sample from which inferences can be made regarding the characteristics of the population from which the sample was selected” (Occupational Safety and Health Statistics, 2010). Sampling and nonsampling errors are

at risk because observations are made on samples and not on populations. Nonsampling errors can be attributed to the inability to obtain information about all cases in the sample, mistakes in recording or coding data, or definition difficulties. Many other factors can influence the estimates made by SOII in a given year. These factors include the knowledge of which cases are required by OSHA to be recorded; the effect of economic activity on injuries and illnesses, working conditions and practices, worker experience and training, and the number of hours worked (Occupational Safety and Health Statistics, 2010).

A review of studies that have shown that the BLS SOII undercounts the United States total number of workplace injuries and illnesses was done as research to understand and explain differences between SOII estimates and other studies. After review of the studies, four categories were created to categorize the underestimates: underrecording of illnesses, SOII scope restrictions, incomplete capture of cases reported in other systems, and unreported cases. Cases of long-term illnesses can be difficult to recognize, diagnose, and report due lengthy time between exposure and manifestation caused by some carcinogens, and are not typically reported (Ruser, 2010).

Scope restrictions cause SOII to be limited when estimating injuries and illnesses. It excludes the self-employed, farms with fewer than 11 employees, private households, and federal government agencies. Collecting data on these workers is problematic because these workers are also outside the scope of the OSHA Act of 1970 and are not required to record injuries and illness on OSHA logs. Studies reporting on the SOII undercounts use other approaches to collect data from this scope. Insurance claims,

emergency room visits, and hospital discharges are used to compile data for these cases (Ruser, 2010).

Another study that looked at employer interviews is “Exploring Differences in Reporting Work Injuries and Illnesses in the Survey of Occupational Injuries and Illnesses and State Workers’ Compensation Claims.” One of the key findings of this study was that a majority of employers that used workers from temporary help agencies did not include them on their OSHA logs. The employers hiring theses types of workers assumed that the staffing companies reported these injuries on their company log, but the OSHA definition states that “workers from temporary help agencies that receive data-to-day supervision from the contracted company and not the temporary help agency should be included on the OSHA log,” (Phipps and Moore, 2010).

2. METHODS

2.1 Case Definition—Work Related Amputations

The goal of this project was to identify all work-related amputations among Illinois residents that occur within state boundaries as reported in three mandatory state databases: the Illinois Hospital Discharge dataset, the Illinois Trauma Registry (ITR) and the Illinois Workers' Compensation Commission Claims (IWCC) dataset. The patients that were included in the study were patients employed in both public and private sectors suffering amputations at work. Only individuals with a reported place of residence in Illinois were included.

An amputation was defined as any amputation with bone loss affecting the extremities. Amputations were identified in both the Illinois Hospital Discharge dataset and the ITR through the International Classification of Diseases (ICD) coding system (ICD-9-CM): N-codes 885: traumatic amputation of thumb, 886: traumatic amputation of other finger(s), 887: traumatic amputation of the arm and hand, 895: traumatic amputation of toe(s), 896: traumatic amputation of foot, and 897: traumatic amputation of leg(s). The ICD-9 definition excludes fingertip amputations without bone loss. The IWCC dataset used an internal coding system for describing injury type and body part affected. Worker's compensation codes for amputations not involving bone loss were excluded from the analysis.

Work-related cases were those that occurred at the facility of employment, or were filed for workers' compensation. Cases were defined as work-related based on

variables within each database. Trauma registry used the variable work-related (yes/no) and/or payer = workers' compensation insurance. For hospital discharge, payer source was used to identify workers' compensation carriers, but because these insurance companies also provide non-workers' compensation insurance, the individual suffering an amputation had to have E-codes for place of injury in industrial facility and/or injuries by machinery likely to in industrial workplaces (918, 919, and 920). Worker's compensation included all work related cases by the nature of the claim process.

2.2 **Data Sources**

There were three different databases used for this research; Trauma Registry (TR), Hospital Discharge (HD), and Workers' Compensation from 2000 to 2007. The TR includes patients treated in the emergency department of a level I or II Trauma Center for 12 or more hours. The TR does not include patients admitted to a hospital that is not designated as a trauma center, those who die at the scene of the traumatic injury but are not transported to a trauma center, and patients that are at a trauma center for less than 12 hours (Trauma Registry Database). The variables in this data set that we used for the analysis are: age, birth date, gender, race, injury date and time, home and scene Federal Information Processing System code, E-codes (place and cause of injury), N-codes (type of amputation injury), discharge criteria, admit time, and home zip code.

The data for the HD database is collected by the Illinois Hospital Association. This database provides us with information from all inpatient hospitalizations within the state. Inpatients are individuals with a hospitalization length of stay of 24 or more hours.

Anyone that stays in the hospital for less than 24 hours is considered an outpatient and is not included in the database. The variables used in the HD database are: Demographic characteristics (birth date, gender), hospital ID number, hospital name, zip residence, injury conditions (N-codes, P-codes, E-codes), hospital outcomes, payer source, and hospital billing charges.

The Workers' Compensation database consists of persons filing disputed claims for their injuries. Workers not included in this database are those that settle claims outside of workers' compensation and do not make it to arbitration. Employees are covered by worker's compensation the day they begin their job. For any injury that occurs at the workplace the employer must be notified by the employee. When notifying the employer the date and place of accident must be provided. The employer will then inform the insurance carrier responsible for the Workers' Compensation program, provide all necessary first aid and medical services, and pay temporary total disability benefits when due, and if the employee cannot work for more than three days because of the injury the employer must either begin payments of temporary total disability, provide the employee with a written explanation of what additional information the employer needs before payments can begin, or provide the employee with a written explanation of why benefits are being denied. The employee can choose up to two doctors for treatment at the employer's expense. Referrals by the two doctors will also be covered by the employer. Thereafter, the employee must obtain the employer's approval of additional doctors or hospital services. Claims may be settled between the employer and the employee directly; otherwise, an arbitrator appointed by

the Industrial Commission acts as fact-finder and judge, conducts the hearing, and decides on the amount of benefits to which the employee is entitled. Variables included in the Workers' Compensation database include demographic variables (age, gender, marital status, number of dependents), nature of injury, part of body, date of injury, pro-se, date of claim filing, employer name, total medical costs, weekly wages, total weeks of temporary total disability, percent permanent disability awarded to the employee, and monetary compensation distributed to the injured employee.

TABLE I

DESCRIPTION OF THREE STATE DATASETS USED FOR DATA LINKAGE PROJECT: ILLINOIS TRAUMA REGISTRY, HOSPITAL DISCHARGE DATABASE, AND THE ILLINOIS WORKERS' COMPENSATION COMMISSION CLAIMS DATABASE

Database	Data Elements				
	Inclusion Criteria	Demographics	Exposure Data	Health Data	Economic Variables
Illinois Trauma Registry (ITR)	Persons treated in level 1 or 2 trauma unit for > 12 hours (~45,000/yr)	Gender, Age, DOB, Race/Ethnicity, Zip Code	ICD9 E-codes showing external causes of injury E849, showing location where injury occurred Time, day, date of injury	ICD 9 N & E-codes Body site, Severity, Hospital procedures, Treatment, Discharge Status	Cost of hospitalization, Hospital procedures, Hospital days
Hospital Discharge (HD)	All individuals hospitalized in Illinois	Gender, Age, DOB, Time Period, County of Residence	ICD-9 N, and E codes (Diagnoses, and cause) Date of admission	ICD 9 N, E codes Hospital procedures (P-codes) Hospital cost Discharge status	Hospital Charges, Length of Stay, Payer source
Illinois Workers' Compensation Claims (IWCC)	Persons filing workers compensa-tion claims for arbitration through IWCC (~70,000/yr)	Gender, Age, DOB, Zip Code	Employer Name, Nature of injury, Part of body	ICD 9 codes Hospital procedures, Level of disability	Total medical costs, Lost wages, Cost of compensation, Payer source

2.3 Data Linkage

Probabilistic data linkage was used to link the three datasets. The first step of the data linkage was to find and delete duplicate data and data that did not meet the means of the study. The data were then linked by organizing the patients by treating hospital, birthday, gender, residential zip code, date of injury, date of admittance, date of discharge, and given a linkage ID number. By merging the data upon a greater number of criterions the chance of the patients being the same are greater. To validate the merge, the information was compared on the type of amputation or body part affected. Once all the linked data were merged the final result was a database with all of the unique work-related amputations in Illinois.

2.4 Comparison with National Data

We compared the linked data with the government estimates for public sector employees. We used the BLS SOII from the same years 2000 – 2007. An estimated 230,000 private industry establishments make up SOII each year from employers with 11 employees or more. Excluded personal include self-employed, private households, United States Postal Service, and federal government workers. Employers are able to send in their injury and illness surveys electronically through the internet, email, fax, telephone, or mail each year the survey is distributed. The survey is based on what employers provide in their surveys and can have limitations on the information provided. The survey relies on the employer's knowledge of which cases are required by OSHA to be recorded.

We compare the observed counts of amputation injuries in the linked dataset with the estimates reported by the BLS. Because SOII data include private sector employees, we also provide an adjusted count for private sector employees only (total count multiplied by 97.8%). Patients with workers' compensation claims had information about the employer (60%), and only 2.5% of these injured workers were employed in the public sector. We defined public sector employers as working for the state, local government, or city public works.

Data Analysis: The variables used for the data analysis were: age, gender, marital status, number of dependents, weekly wage, pro-se, employer name, Federal Information Processing System (FIPS) scene and FIPS residency, day of the week, month, season, and year of injury, part of body, and cause of injury. Ethnicity was not included in the analysis because we only had data for 35% of the cases because the variable was only present in the trauma registry. We did not do a trend analysis across time because the large lag in workers' compensation claims likely results in a major undercount of cases in 2006 and 2007. The median number of days from accident to filing was 224.5, with a quartile range of 68 to 306.25 (25th percentile to 75th). The amputation injuries by county (cases and prevalence) were found using the FIPS codes. A map was created to show the top 10 prevalence rates and highest numbers of amputation injuries by county. Analysis was done using SAS version 9.2.

3. RESULTS

From 2000 to 2007 there were a total 3,984 cases of work-related amputations in the State of Illinois. The distribution of body part amputated in the final merged database was as follows: Thumb N = 1691 (42.5%), finger N = 1523 (38.2%), arm or hand, N = 465 (11.7%), toe, N = 88 (2.2%), leg, N = 93 (2.3%), foot N = 63 (1.6%), multiple N = 38 (1.0%), and unclassified N = 22 (0.6%).

The majority of amputation injuries occurred in males (88.87%) and individuals between the ages of 25 and 54 (71.22%). Among those with workers' compensation claims, 55.9% were married, 63.12% lived with no dependents, 13.7% lived with 1 dependent, 12.1% with 2 dependents, and 11.1% with 3 or more. In addition, the median weekly wage was $495, with an interquartile range of $340 to $730 (25% to 75%tile). Workers' compensation data shows that of these cases 52.6% decided to represent themselves in court rather than having legal representation.

The distribution of injuries for each month of the year showed a steady trend across the months with a small decrease between September and December. The same trend is seen when categorizing the months into seasons, with the lowest amputation injuries occurring in the winter; winter N = 901 (22.6%), spring N = 1012 (25.4%), summer N = 1090 (27.4%), and fall N = 981 (24.6%). The distribution for day-of-the-week shows that most amputations occur between Monday and Friday (89.4%) and decrease on the weekends. Of the cases in the trauma registry database with time of injury information (N = 741), 22.2% of amputation injuries occurred between the times 9:00 am and 11:59 am, 20.2% between 12:00 pm and 2:59 pm, and 19.4% between 3:00 pm

and 5:59 pm. The sources of the amputations were most commonly due to machinery such as power hand tools (63.77%) or caught in or between machinery (11.6%). There were two cases in the data that had amputation injuries and died. The amputation injuries were not the cause of the death, but other complications due to the injury, namely, electrocution and cardiac arrest.

The number of amputations by company showed the type of companies and industries that had amputation injuries occur at their facilities. The top ten employers had between 7 and 13 amputation injuries between the years 2000 and 2007. Five of the 10 employers were employment service companies or temporary agencies, and the others included food manufacturers, the State of Illinois, heavy machinery manufacturing, and a grocery store. Thirteen percent of the employers in Illinois had 2 or more amputations between these times. Twenty eight percent of these employers had major amputation injuries of the hand or more excluding fingers and thumbs. The most major injuries came from State of Illinois departments, with 8 (5 arm or hand, and 3 leg); Labor Network temporary agency, with 6 (4 arm or hand and 2 legs); Caterpillar, with 4 legs; Gilster-Mary Lee Corporation (food manufacturing), 4 arm or hand; Granite City Steel, with 3 (2 arm or hand, and 1 foot); and Waste Management, with 3 arm or hand.

Of the top 20 companies with the most amputations, 13 had no OSHA investigations. Of the top 10 companies with the most amputations, only 4 had OSHA investigations. Among the top 5 employers with the most major amputations, there were a total of 12 inspections between years 2000 and 2008 identified under the

amputation national emphasis program. Only one inspection occurred within 60 days of a major amputation, and 3 of the 5 had inspections that resulted in violations for a related amputation hazard. No advance notice of inspection was given to any employer, and violations were typically abated within 30 days of the violation.

Using FIPS codes the site of injury can be categorized into the counties of residence. From our data, the counties of employment/injury with the largest number of workplace amputation injuries were Cook, DuPage, Kane, Lake, and Will. The top 10 crude prevalence rates (per 10,000 employees) for scene and employer location excluding counties with 10 or less injuries are: Cass (20.8), Iroquois (20.4), Randolph (16.9), Woodford (10.84), Effingham (10.83), Kendall (10.82), Whiteside (10.4), Ogle (9.3), Vermillion (9.0), and Adams (9.0). The lowest 10 crude prevalence rates (per 10,000 employees) excluding counties with 10 or less amputation injuries are: McLean (3.3), Sangamon (3.5), Lake (3.8), St. Clair (3.9), Rock Island (4.3), Peoria (4.4), La Salle (4.5), Jackson (4.6), Macon (4.9), and Cook (5.0).

Compared to the SOII estimate of private sector amputation injuries of 3,637, the government underestimates the cases by 3%. Table 2 shows the comparison of actual amputation cases to the SOII estimates for each year from 2000 to 2007. The data shows the estimates to be between 0% and 90% different in the years studied. The biggest differences are seen in 2004 and 2006 with underestimates by 60.7% and 80.9% respectively. Prior to 2004 the estimates were overestimated by as much as 16.4% and 13.7% in the years 2001 and 2003.

TABLE II

COMPARISON OF AMPUTATION INJURIES OF RESIDENTS IN ILLINOIS TO SOII ESTIMATES FROM 2000 TO 2007

Year of Amputation	Total Cases (Obs)	Private Sector (Obs)	SOII Estimated Cases (Exp)	Percent Difference Total	Private Sector Percent Difference
2000	658	639	696	-5.46%	-8.19%
2001	550	536	658	-16.41%	-18.54%
2002	492	480	453	8.61%	5.96%
2003	466	458	540	-13.70%	-15.19%
2004	450	435	280	60.71%	55.36%
2005	450	440	450	0.00%	-2.22%
2006	416	408	230	80.87%	77.39%
2007	341	335	330	3.33%	1.52%

*Obs – Observed in linked medical datasets; Exp – Expected based on SOII estimates

The number of inpatient and outpatients can be calculated by subtracting the number of cases that only had workers' compensation claims from the patients that went through the trauma registry or hospital discharge and filed workers' compensation. The numbers that are calculated are the outpatients that came up only in the data as workers' compensation claims and did not come up in the hospital discharge or trauma registry. From the data there are 2,178 cases from workers' compensation and 3,984 total cases showing 55% of the cases are outpatients.

4. DISCUSSION

The cases of this study were predominantly males (88.9%) between the ages of 25 and 54 (71.2%) with injuries occurring between Monday and Friday. Although there was a small sample of cases with time-of-day information, the data are consistent with other literature. As expected, the majority of amputation injuries occured during normal working hours of 9:00 am 3:00 pm. Of the 3,984 amputations identified through the data linkage of the three datasets, 20% of them were major amputations excluding fingers and toes compared to the 6% found in SOII data. The data found by SOII showed that 94% of amputations were fingers and 71% fingertips, whereas our study found 80% fingers excluding fingertips. This difference is caused by the missing data in the linked dataset. Employees with minor amputations of the finger or fingerprint can go unreported through these databases due to their inclusion criteria. Because of the low severity of fingertip amputations, these workers will generally be treated as outpatients in emergency departments or clinics that do not report to these databases. For this reason, the linked dataset undercounts total amputations in the state. Another factor that plays a role in the undercounting of amputation cases in the linked dataset is the lag time of reporting cases to workers' compensation. The linked dataset showed the median number of days from accident to filing was 224.5, with a quartile range of 68 to 306.25. The lag time from accident to filing will affect the last three years of data, with the most in 2007. If lag time were not an issue the linked dataset, there would likely have been more amputation cases included during the last three years of the study inclusion period, showing an even more dramatic undercount by SOII.

In the earlier years, 2000 – 2003, the SOII estimates do not vary as distinctly from the observed counts in the linked dataset. In 2003 and 2004, there were major changes to recordkeeping rules and the survey itself. In the years after 2003 the SOII estimates varied more dramatically from the observed counts. Underestimates in SOII are as great as 60.7% and 80.9% in the years 2004 and 2006. These estimates are much lower than the linked dataset, despite the fact that SOII data should technically provide an estimate of all amputation types, whereas the linked dataset blatantly misses most minor amputations in the hospital record data sources and worker's compensation claims due to WC lag time.

Public sector employees are not included in SOII criteria and are therefore left out of the survey. In order to account for these employees in our dataset, a 2.5% correction rate was applied to hospital discharge and trauma registry databases since they do not include employer information. All public sector cases in the workers' compensation database were excluded as well. When accounting for the differences in the databases, including the 1% of farm cases, the linked data set still shows an undercount of amputation by SOII.

When the cases were analyzed by the counties in which they occurred, the study showed that the highly populated areas experienced elevated numbers of amputations, whereas the smaller counties had higher prevalence rates per 10,000 employees. The counties with the highest prevalence rates did not show or follow any pattern other than being smaller counties. The counties with lower prevalence rates excluding counties with less than 10 amputations tended to be located near major cities (Chicago,

Springfield, Decatur, St. Louis, Carbondale). The denominator data consisted of all employees from all industrial sectors, and is not restricted to high-risk industries only. Therefore, the counties with the lowest prevalence rates might be misinterpreted by the high number of workers outside of hazardous industries.

The top industries with amputations in the linked dataset were manufacturing, the public sector, and temporary agencies. Manufacturing is often seen as high-risk industry for amputation injuries as seen in other literature. Sources of amputation injuries and machinery associated with them are used widely in manufacturing. The public sector employees that were identified in the workers' compensation database by employer name were made up of State of Illinois employees. Illinois is one of 5 states with its own public sector health and safety plan that is enforced by the Illinois Department of Labor so these cases are not identified in SOII. The high number of amputations in temporary agencies raises a concern for the reporting of the injuries. Multiple studies have found that the majority of employers use temporary workers, but did not include them on their OSHA log (Phipps and Moore, 2010). "OSHA requires that the entity directly supervising the worker should record an injury, regardless of who pays the worker's wages and benefits and regardless of who pays for workers' compensation insurance" (Ruser, 2010). Although OSHA requires the employers that contract out temporary workers to file 300 logs, they do not, and temporary workers fall through the cracks and are not reported as workplace injuries at the site in which the injury occurred.

Of the cases with workers' compensation data, 52.6% defended themselves in court compared to a state average of 10%. The high percentage of amputees defending themselves in court rather than having attorney representation may be an indicator that employees experiencing these injuries are uneducated on their workers' compensation rights. The median weekly wage of $495 puts these workers just above the poverty line and when dependents are figured in, puts them below the poverty line, a high-risk population. This factor could play a role in the knowledge of their legal rights.

4.1 **Safety Plan**

The idea that reducing the frequency of any workplace injuries will also reduce the frequency of major injuries is a common public perspective. Some studies have shown that this is not a true statement. On the other side of the argument are those that believe major injuries are the predictors of poor safety standards when excluding motor vehicle crashes. Severe injuries often occur during non-routine work, in non-production activities, where sources of high energy are present, and during at-plant construction operations (Manuele, 2005). In order to prevent major workplace injuries like amputations, it is important to predict where they will occur and abate the problem before it occurs. The first step in preventing a major injury like an amputation is to have a safety plan tailored to the facility. A typical safety plan would have the procedures to reduce risk of all areas of health and safety, but for the scope of this study, a safety plan will be created with amputations as the focus of the health hazard.

The first part of the safety plan designed to reduce major injuries is a plan overview with information about the site location, description of the process, site owner, site contacts, and emergency contacts. The contacts that should be listed would be the principal client, the health and safety contact, and emergency contacts for the site, fire station, police station, and nearest medical facilities. Also in the first section of the safety plan, standard emergency procedures and detailed directions to the nearest hospital and should be included.

By using the data from the NEP on amputations, a list of high-risk machinery can be assembled. The machines that are listed in the NEP that are found in the facility of the particular company can then be evaluated on their level of risk. Machines that cut, crush, grind, or drill are the main sources for amputation injuries. Typical machines would be presses, shears, lathes, saws, and grinders. The risks associated with these machines can be abated with proper hazard evaluation and risk assessment as well as proper safety training. In the risk assessment phase, the safety manager should look at all high-risk machines as directed by the NEP and determine the quality of safety controls in place. Some questions to ask about the equipment are: Are all moving parts guarded so that an employee cannot accidentally come in contact with them? Have employees working on the equipment been trained to use the equipment? What is the reasonable consequence of an injury and how likely would it be to occur? The greater the consequence and greater the likelihood creates the highest risk occurrence.

Once the risk is assessed, the hierarchy of controls can be determined. The levels of control are elimination of the hazard, substitution of processes, engineering controls,

administrative controls, and personal protective equipment. The type of control used will depend on the resources available to the company. In many cases eliminating the hazard and substitution are not feasible, so engineering controls, administrative controls, and personal protective equipment are often the controls of choice.

When implementing engineering controls, it is important to make sure that employees can still access vital parts to keep the machine running without exposure to the hazards. Most engineering controls involve guarding of energized parts involving pinch and nip points or rotating, slicing, and shearing parts. Another useful method of control is administrative controls.

Within administrative controls, companies can put together training programs and lock-out/tag-out procedures to reduce the risk of a major injury while working with high-risk machinery. Lock-out/tag-out can be used when servicing machinery or cleaning, to shut the equipment down and de-energize it ensuring the machine cannot be restarted until the work is completed. Lock-out/tag-out is a key administrative tool that should be taught to all new employees during training in worksites with machines that benefit from lock-out/tag-out controls. When training is given to an employee, proper documentation of the training should be filed and given to the health and safety manager to keep for recordkeeping. After all engineering and administrative controls have been put in place; personal protective equipment should be given to employees and they should be trained how and when to use it. Common types of personal protective equipment that would reduce the risk of amputation injuries are steel toe boots and cut-resistant gloves.

Good housekeeping techniques within the facility should be followed at all times. No objects should be left in walk ways creating trip hazards. All working surfaces should be dry and clean so as to reduce slip hazards. When working at heights above six feet, proper fall protection such as harnesses, fall-arrest systems, energy absorbing safety lanyards, or tripod systems for lowering employees into areas should be implemented. Good housekeeping techniques also include safe storage of heavy objects.

An emergency action plan should be in place in case of a major injury, and every employee in the facility should be trained to take care of the situation. It is important to know what to do in the case of an accident so that the injured person can be properly cared for and treated immediately. Proper incident report and injury forms need to be filled out and delivered to the appropriate agencies when accidents or injuries occur. Any injury resulting in the loss of a work day, loss of conscience, restricted work activity or job transfer, and medical treatment will result in an OSHA 300 log.

If a company takes the time to assess their equipment and develop a safety plan tailored to their industry, they can reduce the chances of major injuries greatly. The implementation of a safety plan involves all aspects of a company: the employees, management, and work environment. Companies have to be pro-active with health and safety issues and continually look for ways to improve their safety programs and reduce risks in the workplace. The final step of a safety plan is to evaluate the program put in place by inspecting procedures and training to ensure that they are preventing employees from risks associated with machinery or the work environment.

4.2 **Limitations**

The limitations of this study come from the method for identifying unique cases of amputations in Illinois using linked state databases. Although the linked databases produced an effective occupational surveillance tool, the individual datasets miss cases for various reasons causing an undercount. Each database is made up of different criteria that include different categories of information regarding demographics, types of patients admitted, type of injuries, and work relatedness. The main limitations are due to missed workers' compensation cases, cases without work-relatedness, and demographic information.

The Workers' Compensation Claims database misses cases that were settled before arbitration. Many of the cases that are settled outside workers' compensation are minor amputations of the fingers or fingertips. An estimated 96% of amputation cases were fingers in SOII, whereas this study showed 80%, which leads to a major underestimation of minor amputations. This problem with the dataset can be fixed by making it mandatory for all insurance carriers to report all work-related injuries that are treated to workers' compensation. Since this study a bill has been passed requiring reporting to workers' compensation.

> Annually, each ADR plan administrator shall submit a report to the Commission containing the following information:
> (1) The number of employees within the ADR program;
> (2) The number of occurrences of work-related injuries or diseases;
> (3) The breakdown within the ADR program of injuries and diseases treated;
> (4) The total amount of disability benefits paid within the ADR program;

> (5) The total medical treatment cost paid within the ADR program;
> (6) The number of claims filed within the ADR program; and
> (7) The disposition of all claims (Illinois House Bill 1698).

Work-relatedness is a limitation within the hospital discharge and trauma registry datasets. The Hospital Discharge dataset does not include a variable for work-relatedness so other variables must be used to determine if the injuries were work-related. The variables used to determine work-relatedness were payer source and injury conditions. Since the payer source was a known variable, workers' compensation insurance carriers could be used as evidence of a work-related variable. To verify these cases were work-related, the injury conditions (N-codes, P-codes, E-codes) were cross-referenced with common machines and causes of work-related injuries. This method of determining work-relatedness for the hospital discharge will cause the study to miss cases and can be fixed by adding a work-related variable to patient surveys. In the trauma registry dataset, the workers' compensation payer and work-related variable were used to determine work-relatedness. This information can be skipped during a medical evaluation by doctors and not included in the patient information.

The results section of this study did not identify ethnicity because of the lack of cases with ethnicity variables. The trauma registry database is the only dataset that includes this information and did have enough cases to make the findings significant.

The last limitation seen in this study was due to the difference in the linked dataset to SOII estimation. The two datasets were not based on the same criteria so the data will not be perfect. The major differences were the types of injuries captured and

missed. The linked data captures more severe amputations, inpatients, public sector, and workers' compensation claims and misses outpatients with minor amputations, and injuries not filing workers' compensation claims. The SOII data captures only cases reported by employers and the private sector, and misses the public sector, self-employed, omissions by employers, and farms. Although the databases are different, the linked database captures cases that SOII does not capture and vice versa. Table 3 provides a description of the comparison of the two datasets.

TABLE III

COMPARISON OF LINKAGE DATASET TO THE SURVEY OF OCCUPATIONAL INJURIES AND ILLNESSES

	Linkage Data	Survey of Occupational Illnesses and Injury Data
Types of Injuries	• 80% Fingers	• 94% Fingers
Captured	• More severe amputations • Inpatient • Workers' comp claims	• Employer reported cases only • Private sector only • Farm 10+ employees
Missed	• Outpatients with minor amputations • Injuries not filing workers' comp claim	• Small Farms • Public Sector • Omission by employer • Self-Employed
Impact of Missed Cases	• Miss work comp cases because of lag time • Miss fingertips treated as outpatients	• Miss self-employed, contractors, small employers • Miss farm and public sector employees
Solution for Identifying Missed Cases	• Identify source of emergency department visit • Clinic data and WC private insurer data	• Improve recordkeeping auditing to determine underreporting • Use a correction factor

4.3 Conclusion

The government estimates of work-related amputations are underestimated in more recent years when compared to the linked dataset based on medical records and workers' compensation claims. In this study we compared the estimates of work-related amputations in Illinois from SOII data to the total number of amputations identified in Illinois by the HD, TR, and IWCC databases.

Current recordkeeping procedures of medical and workers' compensation databases are missing information on patients. Based on the limitations of the study, the missed cases are associated with recordkeeping and proper reporting.

Temporary agencies are unique industries that have injuries that go unreported to OSHA. This study shows that of the top industries with major amputations, temporary agencies do not receive violations or inspections of their work practices.

Data linkage has proven to be an effective occupational surveillance tool. Data linkage can be used as a cost effective way to supplement more frequently used data sources.

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