

Michigan Work-related Amputations, 2008

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Background: Michigan's work-related amputation surveillance system quantifies and characterizes occupational amputations and facilitates remediation of workplace hazards. **Objective:** To identify and mitigate the hazards that cause amputations, to facilitate workplace investigations, and, ultimately, to significantly reduce the incidence of serious injury. **Methods:** Data were abstracted from medical records of patients treated for work-related amputations at Michigan hospitals in 2008 and linked to workers' compensation claims data. Incidents occurring at specific high-risk industries were referred to the Michigan Occupational Safety and Health Administration for potential worksite inspection. **Results:** A total of 616 Michigan residents sustained a work-related amputation (13.6/100,000 workers). Rates were highest for men, workers aged 20 to 24 years, and those in paper and wood product manufacturing. The Michigan Occupational Safety and Health Administration conducted 39 enforcement inspections in response to specific amputations. **Conclusions:** The surveillance system identified more than twice the number of work-related amputations as estimated by the Bureau of Labor Statistics ($N = 250$) in 2008 and was the impetus for many worksite inspections that otherwise may not have occurred.

Amputations are one of the most debilitating injuries that can occur in the workplace and often cannot be fully mended through surgical treatment. Thus, workers sustaining amputations are forced to make significant physical and psychological adjustments both in the workplace and their personal lives.

Data on the incidence of work-related amputations are essential for targeting prevention activities. In its Survey of Occupational Injuries and Illnesses (SOII), the Bureau of Labor Statistics (BLS) collects data in nearly all states on work-related injuries based on a sampling of employers. In their most recent year of data, 2010, they estimated that 5540 amputations resulting in days away from work occurred nationally with 21 median lost workdays for amputation cases compared with 8 days for all work-related injuries.¹

Reducing the incidence of work-related amputations is a priority, nationally and in Michigan. In 2011, the federal Occupational Safety and Health Administration proposed amending rules requiring employers to report hospitalized and fatal work-related injuries to them, which would include reporting of hospitalized work-related amputations.² The Michigan Occupational Safety and Health Administration (MIOSHA) strategic plan for 2004 to 2008 included an objective to reduce amputations by 20%.³ Michigan's surveillance data on work-related amputations are used in targeting MIOSHA worksite inspections in specific facilities.

This report describes Michigan's work-related amputation surveillance system, summarizes cases identified by the system for

2008, and presents the results of MIOSHA worksite inspections that were triggered by the surveillance data.

METHODS

Public health surveillance data for Michigan's work-related amputations in 2008 came from hospitals, including inpatient and emergency departments (EDs), and the Workers' Compensation Agency within the Michigan Department of Licensing and Regulatory Affairs. Under Michigan's Public Health Code, hospitals are required to report injuries as requested by the Michigan Department of Community Health.⁴ Michigan State University has been designated as the bona fide agent of the state to carry out surveillance for work-related conditions. All 134 Michigan acute care hospitals including Veterans' Administration hospitals were requested to provide medical records to the surveillance system on patients diagnosed with an amputation. The Workers' Compensation Agency provided data for claims for wage replacement due to lost work time. To be eligible for wage replacement in Michigan, an individual must be out of work seven consecutive days (ie, five weekdays and two weekend days) or have sustained "specific losses." These specific losses include amputations in which at least a full phalanx is lost.

A case identified using hospital medical records was defined as an individual aged 16 years or older who lived in Michigan and received medical treatment at a Michigan hospital for whom (1) an amputation diagnosis was assigned *International Classification of Diseases, Ninth Revision, Clinical Modification*⁵ codes 885.0-.1, 886.0-.1, 887.0-.7, 895.0-.1, 896.0-.3, and 897.0-.7; and (2) the incident was documented as having occurred at work between January 1, 2008, and December 31, 2008. The level of hospital care included outpatient surgery, ED visit, and hospital admission. In cases in which submitted medical records did not specify work-relatedness or patient employer, telephone interviews were performed to ascertain the missing information. A case identified using the workers' compensation (WC) system was defined as a Michigan resident aged 16 years or older with an accepted claim for lost work time wage replacement for an amputation occurring in 2008.

On the basis of medical record review and patient interviews, cases were categorized as "work-related," "non-work-related," or "undetermined." For all work-related cases, worker demographics, employer industry, injury characteristics, and cause and date of injury were abstracted from medical records; for non-work-related and undetermined, a subset of these variables was collected. Records in the resulting database were then linked to records in the WC claims database using social security number, date of birth, first and last name, date of injury, and employer. This process was performed using the entire (ie, all health conditions) WC claims database. This allowed for linkage to WC cases for which the health condition was coded as something other than amputation.

Work-related amputation rates were calculated by sex, age group, and type of industry by dividing the number of Michigan resident workers sustaining an amputation by the number employed and multiplying the result by 100,000. Employment figures were provided by the Current Population Survey, conducted by the US Census Bureau for the BLS.⁶

Data linkage and analysis was performed using SAS software, version 9.1 of the SAS System for Windows (copyright 2002 to 2003 by SAS Institute Inc, Cary, NC).

Worksites of cases identified via medical records that met the following criteria were referred to MIOSHA: (1) the worksite was

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This work was supported by US Centers for Disease Control and Prevention and National Institute for Occupational Safety and Health (U60 OH008466).

The authors declare no conflict of interest.

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DOI: 10.1097/JOM.0b013e31827945be

located in Michigan; and either (2) the company was within an industry identified by MIOSHA as having a high injury rate or (3) the amputation potentially was caused by a mechanical power press. MIOSHA staff reviewed referred cases to determine if a worksite inspection would be conducted. MIOSHA provided inspection reports for worksites referred to MIOSHA by the amputation surveillance system for inspection. These reports were the source of information about the number of violations cited and total penalties assessed. This project was approved by the Human Subject's Review Boards at Michigan State University and Michigan Department of Community Health.

RESULTS

Case Ascertainment

A total of 616 Michigan resident workers were identified as having had a work-related amputation in 2008. This was a rate of 13.6 amputations per 100,000 workers.

Table 1 illustrates the number of cases ascertained by the two data sources and the results of record linkage. A description of the case ascertainment process is as follows. A total of 127 Michigan acute care and Veterans' Administration hospitals submitted medical records to Michigan State University. Seven hospitals did not submit records—six reported that they had no work-related amputation cases, and the seventh, a small rural hospital, was unable to report because of technical difficulties. The total number of records reviewed was 1694. From these records, 534 Michigan residents were identified as having had been treated at a Michigan hospital after a work-related amputation. The WC database contained 235 accepted claims for lost work time or specific losses from Michigan residents with amputations.

Interviews were attempted with 188 patients for whom work-relatedness or employer information critical to making a MIOSHA referral was missing. Interviews were not attempted for a wider scope of individuals because sufficient information could be obtained from the medical or WC record. A total of 119 interviews (63%) were completed. Sixty-nine interviews could not be completed because we were unable to locate the individual due to a change in their mailing address and phone number, inability to talk to someone despite five attempted phone calls, or refusal by the individual to participate. Time delay between the amputation event and the interview attempt likely hindered the interview success rate.

A total of 157 of the 235 WC claims (67%) matched an amputation case identified from medical record review (first row of Table 1). In one case, the medical record indicated the amputation was not work-related; however, the case was matched to a WC file. Seventy-eight WC claims for an amputation injury could not be

linked to a medical record. A total of 128 of the 534 hospital-record-based amputation cases (24%) matched WC claims records for which the type of injury listed in the claims data was something other than an amputation (eg, crush, fracture, laceration). Finally, of 77 cases for which work-relatedness could not be determined via medical records, three matched WC files (two with an amputation, one with a nonamputation injury) (third column of Table 1). In sum, 82 work-related amputation cases, 13% of the total identified, would not have been identified had only medical records been used and not linked to WC claim records. If only WC records coded as an amputation had been used, then only 235 of the 616 cases (38%) would have been identified.

Descriptive Summary of Work-Related Amputation Cases

Age and Sex

Men comprised 88% of workers who sustained an amputation with the highest rates among those aged 20 to 24 years. Figure 1 displays amputation rates by age group and sex.

Body Part and Severity

A total of 694 body parts were amputated among the 616 work-related amputation cases, with 59 individuals experiencing an

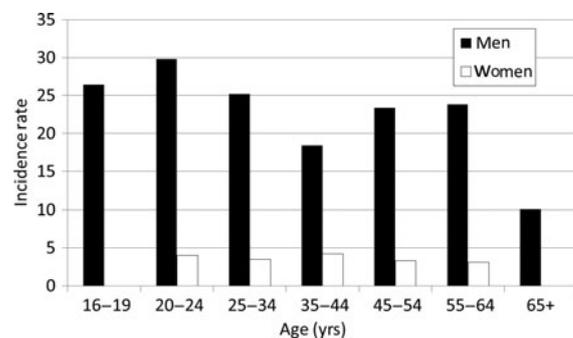


Figure 1. Work-related amputation rates by age group and sex, Michigan residents, 2008. Rates represent the number of workers sustaining an amputation per 100,000 workers (number of workers by age group used to calculate rates: Bureau of Labor Statistics' Current Population Survey). Statistically valid rates could not be calculated for women aged 16 to 19 years and 65 years and older because of insufficient number of amputations in these age groups.

TABLE 1. Results of Linking Michigan Resident Work-Related Amputation Cases Ascertained From Hospital/ED Medical Records and Workers' Compensation Wage Replacement Claims, 2008

Was Michigan Resident in Workers' Compensation Database?	Was Michigan Resident Amputation Work Related per Hospital/ED Medical Record?			No Match to Medical Record	Total
	Yes	No	Unknown		
Yes, with amputation injury	154	1	2	78	235
Yes, with a nonamputation condition	128	0	1	28,568	28,697
No	252	874	74	NA	1,200
Total	534	875	77	28,646	30,132

Shaded cells constitute work-related amputation cases. N = 616. ED indicates emergency department; NA, not applicable.

amputation of more than one body part. Nearly all (97%) amputations were to fingers (Table 2).

The analyses regarding which fingers were amputated are limited to the 521 finger amputations for which hospital/ED medical records were available (WC claims data do not contain detailed injury information). The distal phalanges (sections A, D, G, J, and M in Fig. 2) comprised 89% of all finger sections lost. The index and middle fingers sustained the greatest number of injuries (59%) (sections G to L in Fig. 2). Fifty-eight incidents (11%) involved multiple fingers.

Nearly 90% of injured workers were right-handed (among those for whom hand dominance was known). Sixty-one percent of finger amputations among right-handed persons were to their left hand.

Industry

Table 3 illustrates the number and corresponding rate of work-related amputations by industry. For 13% of cases, there was insufficient information in the medical records provided, the patient interviews, or WC claims data to make an industry classification. Thirty-nine workers (6.3%) were described in the medical records

as self-employed. Industry could be ascertained for 21 of these self-employed workers; the remaining 18 were included in Unknown Industry. Among two-digit North American Industry Classification System⁷ industry sectors, Agriculture/Forestry/Fishing/Hunting had the highest rate (33.8 per 100,000 workers). Nevertheless, there were 14 times as many incidents within Manufacturing as in Agriculture (238 vs 17). Although the overall rate in Manufacturing (29.2 per 100,000) was lower than that in Agriculture, certain three-digit North American Industry Classification System subsectors within Manufacturing had very high rates, notably Paper Manufacturing (125 per 100,000) and Wood Product Manufacturing (119 per 100,000).

CAUSES OF AMPUTATIONS

Causes of work-related amputations are illustrated in Table 4. (This information was unavailable in WC claims data, so the table is limited to the 538 cases for which a medical record was available.) Sharp objects were identified in nearly one third of the cases (31%). Power saws (eg, table saws, miter saws) comprised one half of sharp object injuries. Presses caused 1 in 8 amputations (12%). Medical records generally did not specify the type of press. Another frequent cause of amputations was workers getting pinched or crushed between objects, such as doors. Medical records provided no information about cause for 63 cases (12%).

SOURCE OF PAYMENT

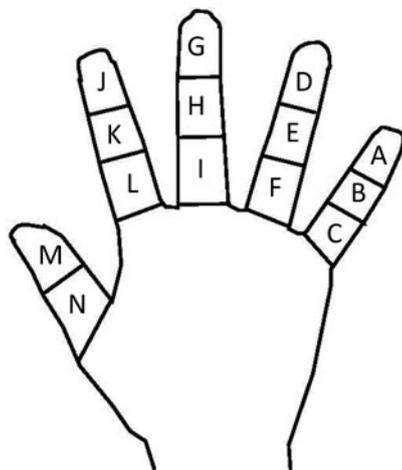
As shown in Table 5, WC was the expected payer in 404 of the 538 cases (75%) for which there was a medical record. For 30 cases, payment source could not be identified. Note that of the 134 cases for which WC was not listed as a payment source in medical records, 40 were linked to WC claims data. Workers' compensation was the expected payer for 81% of the 499 patients who were not self-employed.

WORKSITE INSPECTIONS

A total of 111 worksites were referred to MIOSHA. Of these, MIOSHA conducted 39 inspections. MIOSHA did not inspect 72 of the referred worksites for a variety of reasons, including: the

TABLE 2. Work-Related Amputations by Body Part Lost, Michigan Residents, 2008

Body Part	No.	%
Thumb/finger	671	96.7
Hand	3	0.4
Arm	7	1.0
Toe	8	1.2
Foot	2	0.3
Unknown	3	0.4
Total	694	100.0



Finger	Section	Number	%
Little	A	46	8.2
	B	9	1.6
	C	4	0.7
Ring	D	70	12.5
	E	9	1.6
	F	3	0.5
Middle	G	144	25.7
	H	11	2.0
	I	5	0.9
Index	J	149	26.6
	K	15	2.7
	L	7	1.2
Thumb	M	88	15.7
	N	1	0.2
Total		561	100.0

Figure 2. Work-related finger amputations by digit and portion of finger lost, Michigan residents, 2008. In 37 cases, the section of finger lost was unknown; in 1 case, the digit was unknown.

TABLE 3. Number and Rate of Work-Related Amputations by Worker Industry, Michigan Residents, 2008

North American Industry Classification System industry sector (code)	No.	Rate
Agriculture, forestry, fishing, hunting (11)	17	33.8
Mining (21)	2	*
Utilities (22)	4	*
Construction (23)	73	28.8
Manufacturing (31–33)	238	29.2
Food manufacturing (311)	20	59.9
Wood product manufacturing (321)	16	119.3
Paper manufacturing (322)	12	125.2
Plastics & rubber products manufacturing (326)	20	62.4
Primary metal manufacturing (331)	22	82.9
Fabricated metal product manufacturing (332)	50	95.6
Machinery manufacturing (333)	26	36.8
Transportation equipment manufacturing (336)	37	10.0
Furniture & related product manufacturing (337)	11	40.1
Wholesale trade (42)	30	30.2
Retail trade (44–45)	46	8.4
Transportation & warehousing (48–49)	15	8.5
Information (51)	2	*
Finance & insurance (52)	1	*
Real estate and rental & leasing (53)	6	9.6
Professional, scientific, and technical services (54)	7	2.9
Administration & support services and waste management & remediation services (56)	10	6.1
Educational services (61)	6	1.5
Health care & social assistance (62)	5	*
Arts, entertainment, & recreation (71)	7	9.3
Accommodation & food services (72)	48	15.4
Food services & drinking places (722)	47	16.7
Other services (81)	12	4.9
Public administration (92)	6	3.6
Unknown industry	81	NA
Total	616	13.6

Rates are the number of workers sustaining an amputation per 100,000 workers (number of workers by industry used to calculate rates: Bureau of Labor Statistics' Current Population Survey).

*Statistically reliable rate could not be calculated.

NA indicates not applicable.

referral was not within 6 months of the incident, the company was out of business or had moved, and the cause of injury—as gleaned from medical records—was not specific enough to allow MIOSHA to perform a focused inspection. With respect to the 39 inspections, the maximum number of violations was 44 and the median was 10 (for one inspection, no violations were identified). The highest penalty associated with these citations was \$13,800 and the median was \$1350. The total amount was \$109,625. MIOSHA cited six companies for mechanical power press violations. Three examples of amputations and the results of MIOSHA inspections follow.

- A 38-year-old worker had his hand caught in a grinding press, severing his left index finger at the proximal interphalangeal joint. The amputated portion of the finger could not be surgically replaced. The case was referred to MIOSHA. They identified six violations and fined the company \$900.

TABLE 4. Number of Work-Related Amputations, by Cause of Injury, Michigan Residents, 2008

Cause of Injury	No.	%
Sharp object	165	30.7
Power saw	83	15.4
Knife	31	5.8
Meat slicer	18	3.3
Router	5	0.9
Lawn mower	2	0.4
Other sharp object	26	4.8
Press	66	12.3
Mechanical/punch/stamping press	7	1.3
Hydraulic press	4	0.7
Other press	6	1.1
Unspecified type of press	49	9.1
Pinched between objects	68	12.6
In door	12	2.2
Struck by falling object	29	5.4
Struck by object—other	7	1.3
Caught in chain/pulley/gears/belt	40	7.4
Grinder	11	2.0
Fan	4	0.7
Snow blower	4	0.7
Machine—other specified type	18	3.3
Machine—unspecified type	44	8.2
Other specified cause	19	3.5
Unspecified cause	63	11.7
Total	538	100.0

Workers' compensation claims data do not contain cause of injury information and thus are excluded from the table.

TABLE 5. Work-Related Amputations by Payment Source Overall and for Non-Self-Employed Workers, Michigan Residents, 2008

Expected Source of Payment	Total		Non-Self-Employed	
	No.	%	No.	%
Workers' compensation	404	75.1	404	81.0
Commercial insurance	70	13.0	51	10.2
Other	34	6.3	18	3.6
Not specified	30	5.6	26	5.2
Total	538	100.0	499	100.0

- A 37-year-old worker was hired at a company through an employment agency. He had his right hand caught in a band saw, amputating almost his entire index finger along with the tip of his middle finger. When interviewed, he reported that the saw was very old and had no safety guards. The case was referred to MIOSHA, which subsequently found 44 violations at the worksite and fined the company \$9000.
- A 38-year-old worker had his arm caught in a hydraulic press, crushing his left distal forearm and hand. He subsequently underwent surgery in which his hand was removed at the wrist. The case was referred to MIOSHA and resulted in three violations and \$3100 in fines.

DISCUSSION

Our surveillance system found that 616 Michigan residents sustained a work-related amputation in 2008, corresponding to an annual incidence rate of 13.6 per 100,000 workers. A previous study⁸ of work-related amputations in Michigan during 1997 produced a similar rate (14.4 per 100,000).

High-risk groups were young male workers and those working in agriculture or manufacturing—specifically, paper manufacturing and wood product manufacturing. Ninety-seven percent of all amputations were to fingers. These findings are consistent with previous work-related amputation studies in Kentucky,⁹ Michigan,⁸ and Minnesota,¹⁰ as well as the national estimate by BLS for 2008.¹ A recent study of occupational amputations in Illinois¹¹ found a lower proportion of finger amputations (80%), but relied only on trauma registry and inpatient data for case finding. The Illinois system provided information about more seriously injured patients than those treated and released in EDs, which were included in our study.

We found that the index and middle fingers were the digits most often amputated. This was also found in Minnesota¹⁰ and in a study of nonoccupational amputations.¹² In a study of all types of hand injuries,¹³ the thumb and index finger were most often injured. We found that 11% of finger amputations involved multiple fingers; this was lower than in other studies (Stanbury et al,⁸ 23%; Boyle et al,¹⁰ 18%). Nevertheless, the finding that 6.8% of nonoccupational amputations involved multiple fingers¹² suggests that work-related amputations have more serious outcomes than those that do not occur at work.

Seventy-five cases were identified as the most severe. They either involved amputation of an arm, leg, hand, foot, entire fingers (ie, loss of the proximal phalanx), or multiple fingers. Power presses were the cause of 25% of these injuries (as compared with 12% overall) and 57% of the incidents occurred in manufacturing (vs 29% overall). The age-group distribution for severe injuries was comparable with the distribution for all amputations.

The BLS estimated that in 2008, Michigan had 250 work-related amputations with a corresponding rate of 0.8 per 10,000 full-time employees (or 8 per 100,000 full-time employees). The BLS estimate is 59% lower than our count of 616, whereas its rate is 41% lower than our rate of 13.6 per 100,000 workers. It should be noted that there are some definitional differences between the two systems: The BLS measures those who work in Michigan, not Michigan residents, excludes the self-employed and individuals without lost work time, and requests that employers do not report amputations that do not result in bone loss. The BLS number is not a count of all amputations but rather is an estimate based on a sample of employer-reported injuries and thus is dependent on the sample drawn and the degree to which employers record worker injuries. Some injuries classified as amputations in medical records may have been recorded by employers as something else (eg, crush, laceration). Finally, the denominator in BLS rate calculations is based on the number of hours worked, rather than the total number employed.

Although the Michigan surveillance system identified more than twice the number of work-related amputations as the BLS for 2008, for several reasons it is likely that even this multiple-sourced system is an underestimate. First, there may have been incomplete reporting from hospitals. Michigan's comprehensive inpatient and outpatient database* identified 12 Michigan residents with an amputation diagnosis and WC as payer source who were treated at 3 of the 6 hospitals that claimed they did not have work-related amputation cases. On the basis of matching zip code of residence, date of birth, and date of injury/hospital admission, 2 of these 12 individuals were among the 77 cases identified solely through WC claims data

(ie, although these two cases were not submitted by hospitals, the surveillance system was able to capture them).

Second, 23 hospitals submitted medical records only for amputations that they identified as work related. Because work-relatedness is not always readily apparent in the medical record (eg, in some cases work relatedness was determined only through an interview), it is likely that these hospitals did not submit records for all true work-related cases. Furthermore, in 42 instances, an interview to determine work relatedness was attempted but was not successfully completed. Some of these 42 incidents were likely work related.

Third, the surveillance system does not obtain medical records from out-of-state hospitals. Thus, hospital/ED records were unavailable for workers injured at a Michigan worksite and treated out of state. Fourth, work-related amputations that were treated in a non-hospital/ED setting and were not reported to the Workers' Compensation Agency would not have been identified. Fifth, we excluded non-Michigan residents who were treated in Michigan hospitals after sustaining amputations at Michigan worksites ($n = 4$). Finally, some work-related injuries may have initially presented as nonamputations (eg, crushes, lacerations) and were coded as such, but patients subsequently had surgery to remove nonviable sections at the injury site.

A statewide ED data system would provide another estimate of under-reporting due to incomplete record submission by hospitals, given that most hospitalized amputation cases are first treated in the ED. Nevertheless, this data source currently does not exist in Michigan. The surveillance system's sensitivity will be improved in future years by requiring hospitals to submit medical records for all amputations rather than allowing hospitals to filter out cases.

Our finding that the BLS SOII undercounts work-related amputations supports findings from research studies looking at the undercount across all injuries (Leigh et al,¹⁴ Rosenman et al,¹⁵ Boden and Ozenoff¹⁶) and from occupational health surveillance systems in Michigan (Kica and Rosenman,¹⁷ Stanbury et al,⁸ Rosenman et al¹⁵). The BLS has responded to these findings by funding research studies in California, Massachusetts, and Washington piloting the use of multiple data sources (the BLS SOII, WC, ED visits, and hospitalizations) to count amputations and carpal tunnel syndrome.¹⁸

Beyond providing a more complete count of the burden of work-related amputations in Michigan and detailed information about the characteristics and causes of these injuries, our surveillance system facilitates interventions in potentially high-risk worksites through collaboration with MIOSHA. In 2008, MIOSHA performed 39 worksite inspections based on surveillance system-based referrals. These referrals support MIOSHA's current strategic plan¹⁹ for reducing "by 20% the rate of work injuries and illnesses in high-hazard industries." In six inspections, MIOSHA cited companies for mechanical power press violations. Power press safety is of special interest to MIOSHA because of the high risk of serious injury from these machines. MIOSHA has been performing workplace follow-up of individuals who have become injured or sick from work in the last 24 years. It is made clear to the employer that the inspection is based on hospital and health care provider reporting and that the injured worker did not request the inspection nor have a role in the inspection occurring. We are unaware that any worker has suffered an adverse action from his or her employer because of these inspections. Many employer referrals were not actionable by MIOSHA because of a lengthy lag time between the date of an amputation and the date of the referral. Subsequent to 2008, the case ascertainment procedures for the surveillance system have been modified to obtain medical records quarterly rather than annually, which allows for a quicker response by MIOSHA.

In addition to the possible undercounting noted earlier, several other limitations to the surveillance data should be noted. First, self-employed workers suffering amputations were more likely than other workers to be undercounted because they would not be in the

*This database is composed of all outpatient procedures and hospitalizations (inpatient stays). Thus, it misses most patients who are treated and released from EDs. It does not include personal identifiers.

WC data or be easily identifiable by having WC as the payer in the hospital record. Seventeen of 74 hospital-reported individuals (23%) were determined to be self-employed but whether they were working at the time of the amputation could not be determined. Second, although medical records were valuable in identifying the circumstances and causes of the amputations, they often lacked the level of detail that would be useful for prevention. For example, although they identified a “press” as the machine involved in 66 records, the specific type of press (eg, rolling press, punch press, and stamping press) was rarely noted. Third, hospitals varied substantially in the degree to which they provided information about patient race and Hispanic ethnicity, and WC data did not include these important demographics at all. Neither medical records nor WC claims provided information to identify the immigrant status of workers. This would have been an important population to examine because they may be more likely than nonimmigrants to accept hazardous work conditions and less likely to receive effective training due to language barriers. Fourth, WC did not include information about injury cause or detailed injury information; medical records were the only source for this information. Finally, if there was a failure to link hospital cases with WC cases, despite not requiring an exact match in all variables to consider the injuries a match, because of inaccuracies in the linking variables, the cases could have been mistakenly counted more than once.

CONCLUSIONS

This surveillance system, which uses hospital reporting and WC claims data, provides a more accurate estimate of the true number of work-related amputations than the employer-based reporting system maintained by the BLS, which is the basis for the official count of workplace injuries. In 2008, Michigan’s surveillance system identified nearly two-and-a-half times more workers sustaining amputations than the BLS estimate (616 vs 250). In addition, the hospital-based data can be used for public health interventions to identify and mitigate the hazards that cause amputations. Given the success of the surveillance system, we plan to continue tracking amputations and facilitating workplace investigations. The ultimate objective is to significantly reduce the incidence of this serious injury.

REFERENCES

1. US Department of Labor, Bureau of Labor Statistics. Occupational injuries/illnesses and fatal injuries profiles. Available at: <http://data.bls.gov/gqt/InitialPage>. Accessed July 26, 2012.
2. US Department of Labor, Occupational Safety and Health Administration, Office of Communications. OSHA Trade News Release. Washington, DC: Occupational Safety and Health Administration; 2011.
3. Michigan Department of Licensing and Regulatory Affairs, Michigan Occupational Safety and Health Administration. Strategic plan fiscal years 2004–2008. Available at: http://www.michigan.gov/documents/Strategic_Plan_04-08_77152_7.pdf. Accessed July 26, 2012.
4. Michigan Department of Licensing and Regulatory Affairs. Michigan Administrative Code Rule 325.301–306. Available at: http://www7.dleg.state.mi.us/orr/Files/AdminCode/103_07_AdminCode.pdf. Accessed July 26, 2012.
5. Public Health Services and Health Care Financing Administration. *International Classification of Diseases, Ninth Revision, Clinical Modification*. Washington, DC: Public Health Service; 1980.
6. US Census Bureau. Employment data from the Current Population Survey. Available at: <http://dataferrett.census.gov/>. Accessed July 26, 2012.
7. Executive Office of the President, US Office of Management and Budget. *North American Industry Classification System, United States*. Springfield, VA: National Technical Information Service; 2002.
8. Stanbury M, Reilly MJ, Rosenman KD. Work-related amputations in Michigan, 1997. *Am J Ind Med*. 2003;44:359–367.
9. McCall P, Horwitz I. An assessment and quantification of the rates, costs, and risk factors of occupational amputations: analysis of Kentucky workers’ compensation claims, 1994–2003. *Am J Ind Med*. 2006;49:1031–1038.
10. Boyle D, Parker D, Larson C, Pessoa-Brandao L. Nature, incidence, and cause of work-related amputations in Minnesota. *Am J Ind Med*. 2000;37:542–550.
11. Friedman L, Krupczak C, Brandt-Rauf S, Forst L. Occupational amputations in Illinois 2000–2007: BLS vs. data linkage of trauma registry, hospital discharge, workers compensation databases and OSHA citations. *Injury*. 2012. doi: 10.1016/j.injury.2012.01.007.
12. Conn J, Annett J, Ryan G, Budnitz D. Non-work-related finger amputations in the United States, 2001–2002. *Ann Emerg Med*. 2005;45:630–635.
13. Sorock G, Lombardi D, Hauser R, Eisen E, Herrick R, Mittleman M. Acute traumatic occupational hand injuries: type, location, and severity. *J Occup Environ Med*. 2002;44:345–351.
14. Leigh J, Marcin J, Miller T. An estimate of the US Government’s undercount of nonfatal occupational injuries. *J Occup Environ Med*. 2004;46:10–18.
15. Rosenman K, Kalush A, Reilly MJ, Gardiner J, Reeves M, Luo Z. How much work-related injury and illness is missed by the current national surveillance system? *J Occup Environ Med*. 2006;48:357–365.
16. Boden L, Ozonoff A. Capture-recapture estimate of nonfatal workplace injuries and illnesses. *Ann Epidemiol*. 2008;18:500–506.
17. Kica J, Rosenman K. Multisource surveillance system for work-related burns. *J Occup Environ Med*. 2012;54:642–647.
18. Ruser J. *Allegations of undercounting in the BLS Survey of Occupational Injuries and Illnesses*. Paper presented at: 2010 American Statistical Association Joint Statistical Meetings; August 2010; Vancouver, British Columbia, Canada. Available at: <http://www.bls.gov/osmr/pdf/st100170.pdf>. Accessed June 29, 2012.
19. Michigan Department of Licensing and Regulatory Affairs, Michigan Occupational Safety and Health Administration. MIOSHA goals for FY 2009–2013. Available at: http://www.michigan.gov/documents/dleg/MIOSHA_Goals_for_FY09-13_248575_7.pdf. Accessed July 27, 2012.