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Work-Related Amputations in Washington State, 1997–2005

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Background *Work-related amputations are infrequent but devastating injuries. Attempts to more accurately estimate the burden of amputations and industries at risk have led the Washington State occupational surveillance program to explore new methods for case identification in Washington State workers' compensation data.*

Methods *Two methods were utilized for case identification of work-related amputations. The first method used the ANSI Z16 nature code for amputation. An alternative method utilized medical, hospital, and claim administration coding of medical bills and bill payment systems. After identifying suspected amputation claims, a sample of the medical records associated with different case identification methods were reviewed to verify that an amputation likely occurred.*

Results *From 1997 to 2005, 2,528 amputations were identified using the ANSI Z16 code for amputation (Nature = 100) and an additional 3,912 amputations were identified using the alternative method. There was an increasing trend of amputation injuries over the time period using the ANSI amputation definition; however, the trend in amputation injuries captured by the alternative method was decreasing. This may indicate a bias in estimating a trend due to misclassification of amputation injuries. The sectors with the highest amputation claims rates were Manufacturing; Construction; Agriculture, Forestry, Fishing and Hunting; Accommodation and Food Services; and Wholesale and Retail Trade.*

Conclusions *Current methods to identify work-related amputations in the workers' compensation data system underestimate the burden of amputations in Washington State. By utilizing alternative case identification methods, we estimate that there were about 150% more amputations in Washington State over the time period.* Am. J. Ind. Med. 53:693–705, 2010. *© 2010 Wiley-Liss, Inc.*

KEY WORDS: amputations; surveillance; occupational injury; occupational injury surveillance; work-related amputations; workers'compensation

INTRODUCTION

Amputations are devastating, costly, and preventable occupational injuries. During the years 1997–2005, the Bureau of Labor Statistics (BLS) estimated 82,903 work-related amputations in the US and 2,633 in Washington State. The majority of amputations involve fingers, machines, and male workers in manufacturing and construction [McCaffrey, 1981; Olsen and Gerberich, 1986; Sorock et al., 1993; Boyle et al., 2000a; Liang et al., 2004]. In addition to medical costs and time loss days, amputations are associated with serious and lasting personal and occupational

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consequences, including: pain, partial or permanent disability, lengthy absence from work, impact on ability to work, loss of employment or earning power, and the need to change jobs [Gruneberg and Spence, 1974; Personic, 1997; Boyle et al., 2000b; Brown, 2003; McCall and Horwitz, 2006].

Surveillance guides prevention by focusing scarce resources on high-risk industries to mitigate hazards associated with amputation injuries. State surveillance programs in Michigan and Minnesota have estimated the burden of amputation injuries by using a combination of state specific data sources (state workers' compensation data, hospital discharge data, emergency department data, or employer first reports of injury). In order to identify suspected amputation cases, these states used the available injury classification systems (i.e., the International Classification of Diseases 9th Edition Clinical Modification codes, Occupational Injury and Illness Classification system, American National Standards Institute (ANSI), or others) within the data source and subsequently confirmed the cases with medical record reviews or injured worker interviews.

Many of the data sources used for state-based surveillance report cases rely on case reporting at defined time points during the medical care of the injured worker (i.e., at the Emergency Department visit or hospital discharge) and rely on a single injury classification system to identify suspected cases [Boyle et al., 2000a; Stanbury et al., 2003].

At the time of injury or immediately after the injury event, it may not be apparent that the injury resulted in the loss of a protruding part. This may be due to the limitations in the reporting system associated with identifying the injury or because the classification system rules require use of an alternative nature code (e.g., multiple injuries).

Current use of the Washington workers' compensation data often relies on the use of the ANSI Z16 injury classification system (nature code = 100) for identifying amputation cases. These codes are assigned at the time the claim is filed by a worker and the health care provider for a work-related injury or illness from information provided on the initial claim form [CSTE Indicators, 2006].

This study focuses on the use of a single data source, but uses multiple case classifications systems to identify suspected amputations at different points in the care of an injury which resulted in the loss of a protruding body part.

We estimate the magnitude of the problem, and explore the differences, if any, between the additional amputations identified from using ICD-9 and procedure codes and those identified by the ANSI codes assigned at the beginning of the workers' compensation claim. We describe work-related amputations in Washington State worker's compensation claims during the period 1997–2005 using the two methods. This research aims to describe the demographic, employment, and outcome characteristics of amputations reported to the Washington workers' compensation system and to propose new methods for identifying amputation claims within the records of a workers' compensation insurer.

METHODS

The Washington State Department of Labor and Industries (L&I) State Fund (SF) is the exclusive provider of workers' compensation insurance to all Washington employers except those that are able to self-insure or are covered by alternative workers' compensation systems (e.g., the federal government and the Longshore and Harbor Workers' Compensation Act). Elective workers' compensation coverage is available to the self-employed, employers of one household worker, or other minor occupational groups exempt from mandatory coverage (Revised Code of Washington, 51.12.020).

In the Washington SF, a claim is initiated after a work-related injury or illness, when a worker and his health care provider file a Report of Industrial Injury or Occupational Disease (RIIOD). A RIIOD includes information regarding the worker's demographics, occupation, and the worker's description of the occupational injury or illness. Health care providers complete a portion of the RIIOD which documents the diagnosis, objective findings, treatment plan, and an opinion about the relationship between the injury or illness to the workplace. From the narrative descriptions of the injury or illness submitted by the worker and health care provider on the RIIOD, trained L&I personnel classify the injury according to the ANSI Z16 injury codes [1969].

During the course of medical treatment, physician, hospital, and other medical services are billed to the workers' compensation system with ICD-9 CM codes, ICD-9 Surgical Procedure codes, Current Procedural Terminology (CPT) codes, and Diagnosis-Related Group codes assigned to each bill. Claims adjudicators assign ICD-9 codes to allow medical diagnoses under the claim, authorize medical or surgical procedures or allow medical bill payment. This study was restricted to SF claims because ICD-9 CM, CPT, and DRG codes are unavailable for self-insured claims.

Case Ascertainment

On November 5, 2008, we identified all SF workers' compensation claims between January 1, 1997 and December 31, 2005. Data obtained for each extracted claim included: the unique claim identification number; the claimant's date of birth; the date and hour of injury; claimant age, sex, marital status, and language preference; the ANSI Z16 injury codes—nature, type, source, and body part; the assigned North American Industrial Classification System (NAICS) code for the employers' account and business location [OMB, 2007]; the claim status code; the claimant's occupation code according to the 2000 Standard Occupational Classification (SOC) system; the costs of the claim; the

duration of the workers' employment with the employer of record; company size; time loss duration; and the claim text from the RIIOD form. Workers' compensation claim costs represent those paid to date for closed claims. For those claims that remained open on the date of extraction, the claim costs represent those paid to date and an estimate by the workers' compensation case reserve unit of future expected claim costs. Indirect costs to employers and workers and the administrative costs of managing the claim are not included in the claim costs. Costs were adjusted to the 2005 consumer price index (CPI). Accepted claims can be categorized into compensable and non-compensable. Compensable claims are those with the claim status codes: "compensable," "kept on salary," "total permanent disability," "fatal," or "loss of earning power." Accepted claims that are non-compensable are medical-only claims.

Using Different Case Classification Systems to Identify Amputations

We identified possible amputations in the workers' compensation data by using selected ANSI Z16 codes, ICD-9 diagnosis codes, ICD-9 surgical procedure codes, CPT codes, and DRG codes with descriptions relevant to an amputation injury (Table I). We excluded those cases where the workers injury involved a body part unlikely to be amputated (Table II).

We proceeded to develop a method to categorize groups of claims by the presence or absence of different codes or combinations of codes and validate whether the injury was an amputation (Fig. 1). For possible amputation cases identified via the initial data extract, an epidemiologist (N.J.A.) reviewed the workers' compensation claim record (all medical records relevant to the claims are stored in an imaging system for a sample of claims with various coding assignments (n = 372; Fig. 1)).

From the possible pool of accepted claims identified by the data extract and the presence or absence of relevant codes, a selection of claim identification numbers from each group was chosen (~2% of claims for ANSI 100 code, as this is already the standard code for identifying amputation claims; and approximately 7–8% of claims for the other codes; see Fig. 1). The imaging system allows viewing of all medical and administrative records associated with the claim, so individual claim identification numbers that were sampled for validation were entered into the system, and all records associated with the claim were reviewed. A claim was considered an amputation case when medical or legal documentation indicated that the worker lost a protruding body part due to a work-related injury (this information was typically found in the hospital records). The amputation could have resulted from an acute traumatic event or as a result of a work-related injury over time. A record was kept of how many claims were validated by code group (ANSI, procedure, diagnosis codes) and where the validation rate was high, we included all cases in that group as amputations and included them for analysis.

The first group of claims validated were those with ANSI Nature code 100 (Nature Description: "Amputation"), our standard method for identifying an amputation claim. Out of the claims with Nature = 100, 55 were reviewed to check if they were indeed amputations. The ANSI Z16 Nature code identified an amputation in more than 97% of medical records validated for this code; this yielded 2,528 claims.

Next, in the absence of an ANSI code Nature = 100, the presence of codes that indicated treatment for an amputation were located. Treatment codes include ICD-9 Surgical Procedure codes, DRG, and Service Procedure (Hospital or Medical) codes. Of claims that had no Nature = 100 but that had at least one amputation treatment code, 110 were reviewed. The validation rate for treatment codes was >97%; this yielded an additional 1,454 cases.

For claims in which there was no Nature = 100, *and* no treatment code, diagnosis codes (ICD-9 CM) suggestive of amputations were examined, and 203 were reviewed for validation (Fig. 1). ICD-9 codes are generally grouped into three administrative areas of the L&I databases—bills from physicians' offices, bills from hospitals, and in the situation where a claims manager assigns a code to a claim. When diagnosis codes appeared in two or three different administrative areas of the L&I database >90% of claims were amputations, whereas when only one administrative area had a relevant ICD-9 code (even when refined by part of body and nature of injury) the medical record revealed an amputation in ~50% of claims checked. As such, claims without Nature = 100 or treatment codes, and with only one diagnosis-code, were not included in our case identification method. Further analysis of these cases likely would increase the number of amputation cases identified. In general, claims that had more information (several codes in combination) proved to be better predictors. Claims in which there was no Nature = 100, *and* no treatment code, but having a diagnosis code in at least two areas, yielded an additional 2,458 cases (Fig. 1).

The total number of claims included in the analysis was 6,440 (2,528 ANSI 100, 3,912 alternative codes; Fig. 1). Hereafter, claims identified by ANSI Nature = 100 are referred to as being identified by the ANSI method, while claims identified by the additional codes are referred to as identified by alternative method.

Additional analyses suggest that of the 2,528 amputation cases identified by the ANSI Nature = 100 code, 82.5% (2,086) could also be identified by one or all of the alternative codes. Using the alternative method alone would have led to the capture of 93.1% (n = 5,998) of the 6,440 total cases included in this analysis.

TABLE I. Amputation Codes by Classification System, for Identification of Cases in Washington State Workers' Compensation Data

American National Standards Institute	
Nature code = 100	Amputation and enucleation
International Classification of Diseases 9th Edition codes	
885, 885.1	Thumb amputation
886, 886.1	Finger amputation
887.4, 887.6, 887.7	Arm amputation
895, 895.1	Toe amputation
896, 896.2, 896.3	Foot amputation
897, 897.1, 897.4, 897.6, 897.7	Leg amputation
905.9	Late effect of traumatic amputation
997.6, 997.61, 997.62, 997.69	Amputation stump complication
V49.71,V49.75,V49.76	Lower limb amputation status
Current Procedural Terminology (CPT) codes	
20834	Replantation leg
20838, 20840	Replantation foot
23900	Amputation interthoracoscapular (forequarter)
24900, 24925, 24930	Amputate arm through humerus
25900, 25909, 25915	Amputation, forearm
25924	Disarticulation through wrist; reamputation
25927, 25931	Transmetacarpal amputation, reamputation
26910	Amputate metacarpal, finger, or thumb
26951, 26952	Amputate finger/thumb
27295	Amputate disarticulation of hip
27590, 27592, 27596	Amputate thigh through femur/reamputation
27880, 27884, 27886	Amputate leg through tibia/fibula; secondary closure; reamputation
27888	Amputate ankle
28800, 28805	Amputation foot midtarsal; transmetatarsal
2810, 28820, 28825	Amputate toe
ICD9 CM Surgical Procedure codes	
84.03	Amputation through hand
84.05	Amputation through forearm
84.07	Amputation through humerus
84.12	Amputation through foot
84.14	Amputation through malleoli
84.3	Amputation stump revision
84.91	Amputation not otherwise specified
Diagnosis-Related Group (DRG) codes	
113	Amputation for circulatory system disorder except upper limb and toe
114	Upper limb and toe amputation for circulatory system disorders
213	Amputation for musculoskeletal system and connective tissue disorders
285	Amputation of lower limb for endocrine, nutritional, and metabolic disorders
565	Amputation for endocrine, nutritional and metabolic disorders, except lower limb

TABLE II. Codes Used to Exclude Possible Case of an Amputation in Washington State Worker's Compensation Data

Body part		Nature	
Abdomen	Forehead	Artificial appliance	Teeth
Artificial appliance	Head, unspecified	Burn—chemical	Toxic
Back	Invalid	Bursitis	Umbilical
Back/neck	Mouth	Concussion	
Body system	Multiple body systems	Hearing loss	
Brain	Neck	Heart condition	
Cheeks	Nerve system	Heat stroke	
Chest	Nose	Influenza, etc.	
Digestive	Respiratory system	Inguinal single	
Ear—Internal	Scalp	Nerve conditions	
Eye	Shoulder	Scratches	
Face, multiple	Skull	Sprains	
Face, unspecified	Unclassified	Strokes, etc.	

Analysis

Employers within the Washington SF are required to report the cumulative number of hours worked by their employees on a quarterly basis for their account. Employer hours were aggregated by account and assigned the employer's NAICS code. Claim incidence rates were determined by assigning an FTE as 2,000 work hours.

We generated a ''prevention index'' to identify NAICS industries most in need of prevention and research activities. The prevention index is generated by first rank ordering NAICS industries by claim count and claim rate. The rank

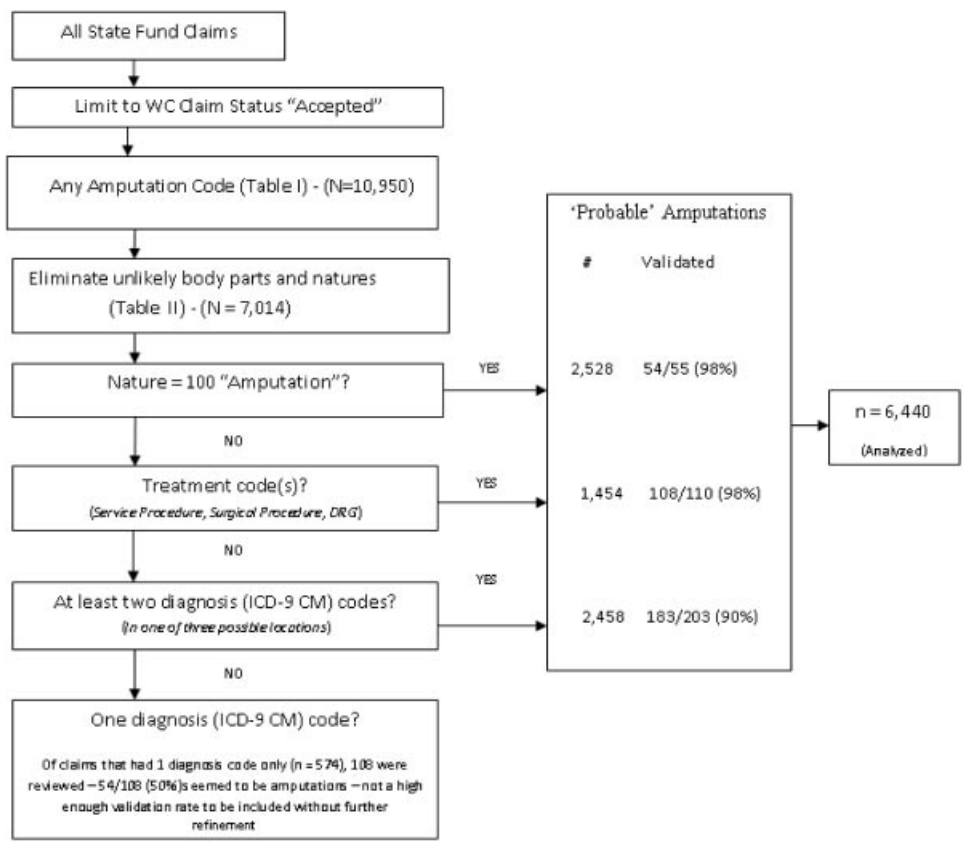

FIGURE 1. Case identification algorithm used to identify amputation cases in the Washington State fund, 1997–2005.

orders are then averaged to generate the prevention index; alternatively, the PI = (Industry's Count Rank + Industry's Incidence Rank)/2. For determination of the PI, NAICS industries were limited to those with ≥25 accepted workers' compensation claims over the time period of the study. The rationale for use of the prevention index has been described previously [Silverstein et al., 2002; Bonauto et al., 2006].

All descriptive analyses were performed with SAS Version 9.1.

RESULTS

Using the ANSI Nature 100 code, we identified 2,528 (39.3%) accepted claims that resulted in an amputation. An additional 3,912 (60.7%) were identified through use of an alternative case classification system (Fig. 1). Of the accepted claims, 73% were compensable, and 27% were non-compensable or ''medical-only.''

The data on case and injury characteristics is presented in Table III.

Demographics

Amputation injuries occurred more often in males (88.5%) than females (Table III). The majority of amputations occurred in workers aged 25–54, 21.5% of amputation cases occurred in those 18–24, and 1% in workers under age 18. Fifty-five percent of amputation cases were not married. There were no significant differences between cases identified by the ANSI or alternative methods in the distribution by age, sex, or marital status (Table III).

Foreign-language preference has only been asked on the ROIID form since 2003. Out of 1,970 work-related amputation claims between January 1, 2003 and December 31, 2005 there were 332 claimants (17%) that indicated a foreign-language preference, 286 (86%) were a preference for Spanish and 87% of Spanish-language preferring claims were compensable. Case identification method for Spanish preference claims was split between ANSI (50%) and alternative (50%). Comparatively, among all accepted State Fund claims during the same time period, 4.3% indicated preference for Spanish language, and 39% of these were compensable.

Smaller employers had higher rates of amputation injures—with those less than 11 employees having the highest amputation rate (68/100,000 FTE), followed by those 11–25 (55/100,000 FTE), and those 26–50 (59/100,000 FTE); employers with 51 or more employees had the lowest amputation rate (35/100,000 FTE).

While approximately 50% of all State Fund claims (both medical-only and compensable claims) are for injury/illness that occurs within 1 year of employment, a higher proportion (67%) of amputation claims (medical-only and compensable, both ANSI and alternative) were for injury occurring within 1 year of employment ($P < 0.021$). This proportion of claims with injury occurring within 1 year of employment was also found in Spanish-language preferring amputation claims (66%).

For accepted SF claims that had unique Account ID numbers (99%), there were 4,848 employers identified: 1,858 accounts identified with Nature 100 amputations; and 2,990 identified using the alternative coding. While most employers (82%) only had one amputation to their account, 872 employers had multiple claims during 1997–2005, ranging from 2 (565 employers) to 18 (1 employer). Of the 872 employers with multiple amputation claims to their account, the distribution by industry and sector was similar to that of all amputation claims, with the majority (44%) being in Manufacturing (including the employer with 18, in the Other Wood Product Manufacturing industry), followed by Construction (12.7%), Wholesale Trade (8.1%), Agriculture, Forestry, Fishing and Hunting, (6.9%) and Food Service and Accommodation (6.7%). By industry, the highest number of employers with multiple amputation claims were found in Full-Service Restaurants (NAICS 72211); Temporary Help Services (NAICS 56132); Sawmills and Wood Preservation (NAICS 32111); and Wood Kitchen Cabinet and Countertop Manufacturing (NAICS 33711).

Injury: Part of Body Affected and Nature

For amputations occurring during the study period, the most prevalent body parts lost were fingers (89%). Using the ANSI method, 94% of amputations were to an upper extremity, 5% to the lower extremity, and 1% to other/multiple parts (Table III). Cases identified by the alternative method had a different distribution by body part, with proportionately more upper extremity (other than fingers) and lower extremity amputations (including toes) ($P < 0.0001$). ''Cut'' and ''Fracture were the ANSI Nature codes assigned to 60% and 28%, respectively, of the 3,912 amputation claims not originally assigned the ANIS ''Amputation'' nature code.

Injury Source and Type

Machines (primarily saws, unspecified/not elsewhere classified (NEC) machinery, shears/slicers, presses, planers/molders, buffers/polishers, and mowers) were the primary source of work-related amputations (Table IV) both in all industries, and also when looking specifically only at manufacturing or construction. Other common sources in all industries included powered and non-powered hand tools (including power saws, power drills, chainsaws, and knives), metal items (primarily structural metal), wood items (timber/slab, kick back), and vehicles. The top 10 sources account for 88% of claims (all industries). Punch and power presses are

TABLE III. Demographic, Employment, and Injury Characteristics of Work-Related Amputations in Washington State Accepted State Fund Worker's Compensation by Case Identification Method, 1997–2005

	ANSI*method, n (%)	Alternative method, n (%)	*P*-value**	ALL, n (%)
	2,528 (39.3)	3,912 (60.7)		6,440 (100)
Demographics				
Male	2,253 (89.1)	3,446 (88.1)	0.21	5,699 (88.0)
Age (Years)	n = 2,508	n = 3,872		n = 6,380
≤ 17	30 (1.2)	56 (1.5)	0.43	86 (1.4)
18–24	542 (21.6)	845 (21.8)	0.85	1,387 (21.7)
25–54	1,722 (68.7)	2,623 (67.7)	0.44	4,345 (68.1)
55+	214 (8.5)	348 (9.0)	0.53	562 (8.8)
Married	1,148 (45.4)	1,746 (44.6)	0.55	2,894 (44.9)
Employer size (FTE)	n = 2,321	n = 3,873		n = 6,194
<11	709 (30.5)	1,130 (29.2)	0.25	1,839 (29.7)
11–25	337 (14.5)	586 (15.1)	0.53	923 (14.9)
26–50	331 (14.3)	542 (14.0)	0.79	873 (14.1)
51+	944 (40.7)	1,615 (41.7)	0.44	2,559 (41.3)
Injury characteristics				
Body part				
Finger(s) only	2,421 (95.8)	3,309 (84.6)	0.001	5,730 (89.0)
Upper extremity	45 (1.8)	274 (7.0)	0.001	319 (5.0)
Toe(s) only	21 (0.8)	77 (2.0)	0.001	98 (1.5)
Lower extremity	22 (0.9)	190 (4.9)	0.001	212 (3.3)
Other	19 (0.8)	62 (1.6)	0.003	81 (1.3)
Claim costs (dollars)†				
All claims (total cost)				
n = 6,440	n = 2,528	n = 3,912		
Average	25,129	33,677	0.0001	30,321
Median (Q1, Q3)	8,019 (1,926, 21,008)	7,315 (1,425, 22,015)	0.02	7,599
Medical only claims (total cost)				
n = 1,716	n = 623	n = 1,093		
Average	2,447	2,250	0.57	2,321
Median (Q1, Q3)	615 (305, 1,655)	732 (384, 1,698)	0.01	690
Compensable only claims (total cost)				
n = 4,724	n = 1,905	n = 2,819		
Average	32,547	45,861	0.0001	40,492
Median (Q1, Q3)	11,918 (5,653, 27,303)	12,795 (5,207, 31,332)	0.18	12,460
Claim time loss (days)±				
Average	105	163	0.0001	140
Median, (Q1, Q3)	22 (1, 68)	31 (7, 97)	0.0001	27

*Amputation claims were identified by two different methods: by the standard American National Standards Institute (ANSI) Nature code = 100 (Amputation and Enucleation) here referred to as the "ANSI" method; and the "Alternative" method—which is described in the paper and includes ICD-9 DM codes, Current Procedural Terminology (CPT) codes, ICD9 CM Surgical Procedure codes, and Diagnosis Related Group (DRG) codes.

**Tests are Chi-square for proportions, Wilcoxon Rank Sum for ordinal data, or t-test for continuous data.

†All costs are in CPI 2005 adjusted dollars.

±Compensable claims only.

commonly mentioned as major sources of amputation injury, however, in our data very few claims specified a type of press, and these were mainly punch presses found in the Manufacturing sector. In lower extremity amputations, the most common sources were metal items (primarily structural metal, unspecified metal items, and fasteners), vehicles (powered carriers, highway vehicles powered), machines (unspecified, mowers, highway construction machinery),

TABLE IV. Top 10 Sources of Injury Associated With Amputation by Industry Sector in Washington State Accepted State Fund Workers' Compensation, 1997–2005

	All industries (%)			Manufacturing (%)			Construction (%)		
Claim identification method[a]	**All (n = 6,440)**	**ANSI (n = 2,528)**	**Alternative (n = 3,912)**	**All (n = 1,925)**	**ANSI (n = 801)**	**Alternative (n = 1,124)**	**All (n = 1,248)**	**ANSI (n = 464)**	**Alternative (n = 784)**
Source[b]									
Machines	36.1	38.6	34.5	51.1	53.4	49.4	28.4	31.5	26.7
Hand tools, non-powered	11.0	11.0	11.1	4.5	4.1	4.8	5.6	5.2	5.9
Metal items	8.4	7.6	8.8	9.4	7.9	10.5	10.8	10.3	11.1
Hand tools, powered	7.9	7.6	8.0	4.4	5.1	3.8	22.0	21.6	22.2
Miscellaneous/NEC	7.0	6.7	7.2	7.8	8.7	7.2	7.0	5.8	7.7
Vehicles	5.4	4.9	5.8	1.8	2.0	1.7	5.4	5.8	5.2
Unknown/unidentified	4.8	5.1	4.6	4.9	5.0	4.9	3.5	4.7	2.8
Wood items	2.7	2.0	3.1	3.3	2.4	4.0	3.7	3.4	3.8
Mechanical power transmission	2.6	3.5	2.1	3.2	4.0	2.6	—	—	—
Buildings and structures	2.5	3.0	2.2	—	—	—	2.2	2.4	2.0
All other sources	11.6	10.0	12.6	6.7	5.0	7.9	9.1	8.6	9.3
Conveyors	—	—	—	2.9	2.4	3.2	—	—	—
Work surfaces	—	—	—	—	—	—	2.3	0.6	3.3

NEC, not elsewhere classified.

[a]Amputation claims were identified by two different methods: by the standard American National Standards Institute (ANSI) Nature code = 100 (amputation and enucleation) here referred to as the "ANSI" method; and the "Alternative" method—which is described in the paper and includes ICD-9 DM codes, Current Procedural Terminology (CPT) codes, ICD9 CM Surgical Procedure codes, and Diagnosis-Related Group (DRG) codes.

[b]By ANSI Z16 system.

work surfaces, and miscellaneous/NEC; these accounted for 64% of lower extremity claims.

The most prevalent types of injury were Struck By, Caught In/Under/Between, and Struck Against for all industries (accounting for 89.5% of claims) and Construction. In Manufacturing, Caught In/Under/Between was the leading type of injury, followed by Struck By and Struck Against. For lower extremity claims, the primary sources were the same as for all industries, with Struck By as the leading cause, specifically ''Struck By Falling Object'' which accounted for 25% of lower extremity claims.

Industry

The industry sectors with the highest amputation incidence rates were: Manufacturing, Mining, Construction, and Agriculture, Forestry, Fishing and Hunting (Table V). The Manufacturing sector alone accounted for 30% of the claims and had the highest accepted amputations claim rate (163.8/100,000 FTE), which was ~3.3 times higher than that of all industry sectors (49.1/100,000 FTE). Most of the industries with highest rates were contained within the Manufacturing sector (Table V).

Washington has used a prevention index ranking of NAICS industries to guide further prevention and research activities [Bonauto et al., 2006]. Using the prevention index to rank NAICS industries for prevention activities for amputation injuries, both Wood Kitchen Cabinet and Countertop Manufacturing (NAICS 33711) and Millwork (NAICS 32191) both have high count and claim rank among the 62 industries meeting the criteria for ranking (Table VI). Restaurants (NAICS 72211 and 72221) both have high claim count ranks but lower claim rate ranks. We found few prevention index ranking changes between the two case identification systems; the inclusion of the additional amputation cases added All Other Fabricated Metal Product Manufacturing (NAICS 33299) and Temporary Help Services (NAICS 56132) to the top 25 industries.

By industry, the highest rates were found in Manufacturing—All Other Wood Product Manufacturing; Wood Kitchen Cabinet and Countertop Manufacturing; Paper Mills; Sawmills and Wood Preservation; and Millwork (Table VI). Non-Manufacturing industries with high rates included Framing Contractors (and several others in Construction); Logging; and Metal Service Centers and Other Metal Merchant Wholesalers. Restaurants, (both Full-Service Restaurants and Limited-Service Eating Places), while having very high numbers of amputations, have much lower numbers of amputations resulting in lost work-time (compensable claims).

TABLE V. Washington State Accepted State Fund Workers' Compensation Claims for Amputations by North American Industrial Classification System (NAICS) Industry Sector With ≥25 Claims, 1997–2005

NAICS	Industry sector name	Amputation claims (%)	Claim rate[a]	% Compensable	% ANSI method[b]
31–33.	Manufacturing	1,925 (30.0)	163.8	81.0	41.6
23.	Construction	1,248 (19.4)	112.7	81.4	37.2
72.	Accommodation and Food Services	650 (10.1)	58.8	32.7	38.2
11.	Agriculture, Forestry, Fishing and Hunting	494 (7.7)	94.4	82.2	43.1
44–45.	Retail Trade	452 (7.0)	29.1	64.6	38.3
42.	Wholesale Trade	446 (6.9)	54.6	76.5	40.1
56.	Administrative Support and Waste Management and Remediation Services	366 (5.7)	50.4	80.3	36.9
81.	Other Services (except Public Administration)	159 (2.5)	23.6	65.4	37.7
48–49.	Transportation and Warehousing	143 (2.2)	40.0	86.0	31.5
54.	Professional, Scientific and Technical Services	79 (1.2)	8.0	63.3	27.9
92.	Public Administration	77 (1.2)	13.4	72.7	40.3
61.	Educational Services	76 (1.2)	11.4	65.7	43.4
62.	Health Care and Social Assistance	74 (1.2)	6.3	70.2	46.0
53.	Real Estate and Rental and Leasing	70 (1.1)	16.7	64.2	40.0
71.	Arts, Entertainment, and Recreation	69 (1.1)	39.4	55.1	27.5
51.	Information	37 (0.6)	11.9	75.6	37.8
21.	Mining	35 (0.5)	133.1	80.0	40.0
	Other NAICS Industry Sector	40 (0.6)	13.4	67.7	41.9
Total		6,440 (100)	49.1	73.4	39.2

[a]Rate is per 100,000 FTEs.

[b]Amputation claims were identified by two different methods: by the standard American National Standards Institute (ANSI) Nature code = 100 (Amputation and Enucleation) here referred to as the "ANSI" method; and the "Alternative" method—which is described in the paper and includes ICD-9 DM codes, Current Procedural Terminology (CPT) codes, ICD9 CM Surgical Procedure codes, and Diagnosis-Related Group (DRG) codes.

Distribution of industry by identification method was generally similar to the overall distribution between the two methods, ~60% alternative, 40% ANSI (Table VI).

Rate

By year, the overall rate ranged from a high of 62.4 per 100,000 FTE in 1997 to a low of 43.2 in 2002, and remains fairly level in the years after 2002 (Fig. 2). In contrast, the rate of ANSI method identified amputations had a low in 2001 (14.4) then an upward trend through the end of the study period. The amputation rate of cases identified by the alternative method had a declining trend in the latter years of the study period.

Costs

Using 2005 CPI adjusted dollars, the average cost of a work-related amputation in this study was $30,321 and the median was $7,599 (Table III). Among all claims, those identified by the alternative codes had higher costs and more days of time loss than those identified by Nature 100 (both $P < 0.0001$). In medical-only claims, those identified by other codes had higher median costs ($P < 0.01$). For compensable claims, those identified by the alternative codes had higher average costs, and more time loss days (both $P < 0.0001$).

Lower extremity amputations had higher overall costs than upper extremity amputations, higher medical costs, and more time loss days (all with $P < 0.0001$).

DISCUSSION

In this study we developed a new case ascertainment method to identify amputations within a large workers' compensation insurance database. By using the coding systems for payment of medical services and procedures associated with a workers' compensation claim over 150% more amputation cases were identified than by using a standard case identification method [Council of State and Territorial Epidemiologists, 2005]. More importantly, the additional cases were more likely to be lower extremity and proximal upper extremity amputations, were more costly, and had higher time loss duration. The additional amputations were distributed in known high-risk industries for

TABLE VI. Top 25 North American Industry Classification System (NAICS) Industries by Prevention Index (PI) for Washington State Fund Accepted Claims for Amputations, 1997–2005

NAICS[a]	Industry name	Count	Count rank	Claim rate[b]	Rate rank	PI	% Compensable	% ANSI method[c]
33711	Wood Kitchen Cabinet and Countertop Manufacturing	121	7.0	515.2	2.0	4.5	83.5	34.7
32191	Millwork	124	6.0	414.8	5.0	5.5	79.0	37.9
23813	Framing Contractors	259	3.0	293.3	10.0	6.5	84.2	39.8
32199	All Other Wood Product Manufacturing	83	14.0	516.7	1.0	7.5	91.6	42.2
32111	Sawmills and Wood Preservation	96	11.0	418.8	4.0	7.5	89.6	36.5
11331	Logging	91	12.0	280.8	11.0	11.5	89.0	39.1
23611	Residential Building Construction	288	2.0	182.0	21.0	11.5	81.6	34.0
33231	Plate Work and Fabricated Structural Product Manufacturing	68	17.5	341.4	7.0	12.3	85.3	33.8
32121	Veneer, Plywood, and Engineered Wood Product Manufacturing	74	16.0	310.9	9.0	12.5	83.8	41.9
33712	Household and Institutional Furniture Manufacturing	62	21.0	353.7	6.0	13.5	75.8	38.7
56173	Landscaping Services	117	8.0	171.6	24.0	16.0	84.6	39.3
33232	Ornamental and Architectural Metal Products Manufacturing	66	19.0	228.4	14.0	16.5	80.3	36.4
33299	All Other Fabricated Metal Product Manufacturing	60	23.0	234.3	13.0	18.0	70.0	40.0
32619	Other Plastics Product Manufacturing	64	20.0	192.0	19.0	19.5	84.4	40.6
31171	Seafood Product Preparation and Packaging	55	24.0	217.4	16.0	20.0	76.4	45.5
72211	Full Service Restaurants	354	1.0	83.0	46.0	23.5	30.2	38.7
44511	Supermarkets and Other Grocery (except convenience)	114	9.0	97.4	39.0	24.0	57.0	44.7
31161	Animal Slaughtering and Processing	48	31.0	186.8	20.0	25.5	81.3	56.3
32192	Wood Container and Pallet Manufacturing	33	43.5	316.4	8.0	25.8	72.7	45.5
56132	Temporary Help Services	151	5.0	67.4	48.0	26.5	80.1	37.1
44419	Other Building Material Dealers	75	15.0	96.6	40.0	27.5	80.0	38.7
42351	Metal Service Centers and Other Metal Merchant Wholesalers	37	38.5	204.9	17.0	27.8	81.1	43.2
23816	Roofing Contractors	50	27.0	131.0	30.0	28.5	82.0	36.0
33151	Ferrous Metal Foundries	31	46.0	258.7	12.0	29.0	71.0	35.5
72221	Limited-Service Eating Places	189	4.0	52.7	55.0	29.5	31.7	38.6
32212	Paper Mills	26	59.0	437.9	3.0[d]	31.0	92.3	73.0

[a]Industries were included for PI calculations if they had $\geq$25 claims (62 industries met this criterion for ranking).
[b]Rate per 100,000 FTEs.
[c]Amputation claims were identified by two different methods: by the standard American National Standards Institute (ANSI) Nature code = 100 (Amputation and Enucleation) here referred to as the "ANSI" method; and the "Alternative" method—which is described in the paper and includes ICD-9 DM codes, Current Procedural Terminology (CPT) codes, ICD9 CM Surgical Procedure codes, and Diagnosis-Related Group (DRG) codes.
[d]Included are industries in the top 5 by count or rate rank (gray shade) but not in the top 25 by PI.

amputation injuries, which may confirm the methods for identifying the amputation cases, but also reflect the underestimate of the burden of amputation in those industries. The high proportion of Spanish-language preferring workers in amputation claims may reflect the distribution of Spanish-speaking workers in high-risk industries.

The increasing claim rate trend for amputations identified using the ANSI method is not observed in cases identified by the alternative method where the injury rate trend is decreasing over the study period. This suggests the potential inability to assess the impact of an intervention or the inability to accurately characterize the trends in the occurrence of the injury. Since there are several national and state OSHA emphasis programs targeting high-risk industries for amputation injuries [US Department of Labor, 2006], the implications of the varying patterns of the injury trend bears on the success of OSHA efforts in this area.

The ANSI codes for an amputation injury are assigned by L&I at the time of claim filing. By using the alternative codes, we capture amputations over a longer period of time. The ability to capture such cases depends on the amount of services or administrative processes associated with the claim. In essence, the ''case definition'' for an amputation expands from the loss of the body part at the time of the injury event to loss of the body part resulting from the injury event. The relative absence of lower extremity and non-finger upper extremity amputations reported in the literature may reflect this criterion for injury and illness reporting.

The ability to search within a large administrative database using multiple different case classification systems,

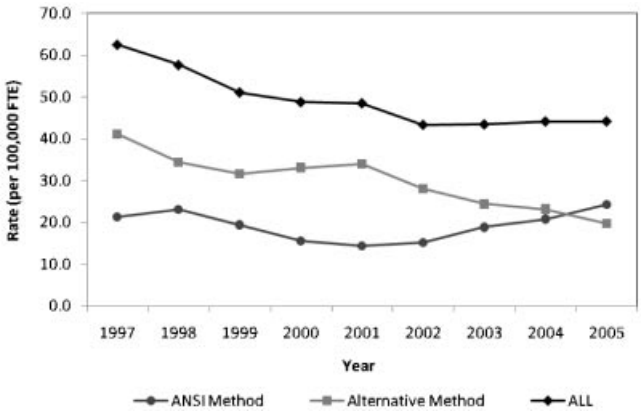

FIGURE 2. Claims incidence rate of work-related amputations identified in Washington State accepted state fund workers' compensation claims, 1997–2005.

for example, ICD-9 diagnosis and procedure codes, or CPT codes, ANSI codes, combined with medical record review represents a strength of using the primary workers' compensation insurance record. Often occupational health surveillance data sources rely on records obtained from mandatory reporting of cases to a state-administered data base (e.g., hospital discharge data, a first report of injury from an employer or physician, or a workers' compensation record to a state workers' compensation rating bureau or state department of labor) and are limited to a defined point in time related to medical care of the injury (a hospital discharge) or a threshold related to injury severity (payment of a certain number of days of time loss). Typically, the data reporting requirements are restricted to a very limited set of data elements and descriptors of the injury. Therefore, there are very few opportunities to test and validate alternative data systems definitions within an individual database. While the case identification method used in this study is unique among the published peer reviewed literature on amputations, it establishes that there are potentially a greater number of amputations than are currently identified in the workers' compensation datasets or other administrative datasets used for occupational injury and illness surveillance. Boyle et al. [2000a] used workers' compensation records to identify amputation cases in Minnesota. By adding disability rating records to the Minnesota Department of Labor and Industry's first report of injury forms and other/multiple sources, they identified an additional 211 amputation cases or 35% (211/601) of the total. These additional amputations were considered to have ''inadequate injury descriptions'' and were recorded as lacerations, cuts, or crush injuries on the original form describing the injury.

There is currently an Occupational Safety and Health Administration (OSHA) National Emphasis Program on Amputations, CPL 03-00-003, which went into effect in 2006. This program focuses on industries and establishments associated with amputations, replacing an existing emphasis that focused on equipment, and utilizes selection criteria using BLS data and OSHA inspection data [US Department of Labor, 2006].

All of the industries in the Manufacturing Sector in the top 25 by the prevention index except Seafood Product Preparation and Packaging (NAICS 31171) were included in CPL 03-00-003, the National Emphasis Program on Amputations. None of the industries except Logging (11331) outside of the Manufacturing Sector were included in the NEP on amputations. Additionally, our finding of an increased injury rate in smaller employers suggests some differentiation of the NEP relative to employer size.

As noted in the results, the employer with 18 amputation claims to their account was in the Other Wood Product Manufacturing industry group, which along with another four of the employers with $\geq$10 amputation claims, would be included as a priority focus under CPL 03-00-003. However, the four other employers with $\geq$10 amputation claims (including such varied industry groups as Seafood Product Preparation and Packaging, and Temporary Help Services, among others) are not; this indicates that improved surveillance could help identify more high-risk industries to target for prevention. Seafood Product Preparation and Packaging and Temporary Help Services are both included in the PI rankings.

Limitations

Exclusions of the self-insured employers' injury experience and exposure may bias the estimate of the Washington State amputation rate. Regardless, the annual amputation rate ranged from 43.2 to 62.4/100,000 FTE during the study period. This rate is nearly triple those reported from other state amputation injury reports [Boyle et al., 2000a; Stanbury et al., 2003; McCall and Horwitz, 2006]. Our rates reflect improved case identification methods and better estimates of the periods of exposure by using FTE rather than number of workers. Inclusion of all estimated FTE of the self-insured employers, approximately a third of the Washington workforce, even without any injury experience would likely not lower the rates to approximate those of other states.

The number of amputations occurring to those employed in Washington State is likely underestimated. Amputations among the self-employed, federal workers, and others ineligible for Washington workers' compensation are not included. Those employers and workers not reporting economic activity to the workers' compensation system likely bias the amputation rate. A large portion of the ''rejected'' workers' compensation claims were covered by alternative state or federal workers' compensation jurisdictions. Some cases are likely eligible for workers' compensation but not reported, however, this seems less likely for amputation injuries [Stanbury et al., 2003]. Finally, the amount of services provided to a claimant likely depends on

injury severity, options for return to work, and other administrative factors. Therefore, a portion of the additional cases identified should be more severe and require more services and this may increase the average claim costs.

The algorithm created to catch the alternatively coded amputations is a prototype and not exhaustive. Additional codes could possibly be added such as those for replantation procedures (they would only have added <5 cases not already included in the algorithm by other codes). Further analysis of cases that had only one diagnosis code and no other codes (excluded in our study) could also have yielded additional cases.

Our approach to identifying amputations within the workers' compensation insurance databases provides a couple of important observations for state-based surveillance. First, while not all states have Washington's ability to look at the primary workers' compensation record, some states have a significant proportion of their workers insured by relatively few workers compensation carriers. Voluntary or mandatory data sharing agreements may be expanded for more detailed access to record level claims data. For example, the top 10 private insurance carriers in Oregon have 27% of the written premium market share (~70% of the private workers' compensation insurance market share) and the State Accident Insurance Fund writes an additional 42.6% of the workers compensation insurance premiums [Oregon Department of Consumer and Business Services, 2008].

Secondly, the available case classification systems within the primary insurance record may provide a reasonable rationale for expanding the requirements of reportable conditions legislation to workers' compensation insurers. Typically, notifiable conditions regulations require reporting of occupational conditions by physicians, laboratories, or hospitals. Given the expanded number of cases existing within insurance records but not reported to public health personnel, it may be reasonable to consider expanding these reporting requirements to workers' compensation insurance carriers.

CONCLUSION

Work-related amputations are devastating but preventable injuries that remain an issue in Washington State and nationally. This study indicates the poor sensitivity of using the ANSI Z16 nature code to identify amputations in Washington workers' compensation data. The amputations missed comprise a unique population of more severe and costly injuries, more upper extremity non-finger amputations, and more lower extremity amputations. The methods described in this study can help improve the use of existing workers' compensation data to better capture the burden of occupational amputations by expanding the case definition to allow for amputations that develop over time. Rates estimated, including the additional cases, can be used to further refine the targeting of resources for prevention.

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