Characteristics of Occupational Burns in Oregon, 2001–2006

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Background *Occupational burns are known to be a serious public health concern. This article describes work-related burns in Oregon between 2001 and 2006.*
Methods *Oregon Workers' Compensation (WC) burn claims were analyzed; data from a commercial insurance carrier (CIC) was used to characterize non-disabling burn claims. To ensure that our primary data source (WC) captures as many burn cases as possible, we compared hospitalized cases to a regional burn center (RBC) and Oregon hospital discharge index (HDI) data.*
Results *The WC burn injury rate ranged from a high of 1.8 per 10,000 workers in 2001 to a low of 1.4 per 10,000 in 2004. We identified 2,165 accepted burn claims in CIC data, of which 85% were non-disabling. We matched data from a regional burn center to a subset of hospitalized claims from WC data and found an additional 44 cases of occupational hospitalized burns representing a 3% increase in total cases captured.*
Conclusions *Occupational burns continue to be a problem for working Oregonians, and the use of additional data sources outside of WC augments our surveillance system.* Am. J. Ind. Med. 52:380–390, 2009. © *2009 Wiley-Liss, Inc.*

KEY WORDS: burns; occupational health; surveillance; workers' compensation

INTRODUCTION

Occupational burns are a major cause of work-related injuries [Centers for Disease Control and Prevention (CDC), 1993]. In 2005, there were a total of 23,459 occupational burns requiring days away from work with an incidence rate of 1.9 per 10,000 workers [Bureau of Labor Statistics, 2006]. In 2004, the number of persons treated for non-fatal occupational burns in hospital emergency departments was estimated at 100,000; 72% of these cases were in males [Centers for Disease Control and Prevention (CDC), 2007]. The Bureau of Labor Statistics (BLS) reports the median days away from work for an occupational burn was 5 days [Bureau of Labor Statistics, 2006]. Costs associated with occupational burns are high; between 1990 and 1997, accepted burn claims in Oregon cost an average of $1.6 million annually [Horwitz and McCall, 2004]. A similar analysis of burn claims in Washington State found that average direct costs incurred by the state fund insurance system between 1994 and 1998 were approximately $5.1 million annually. Further, hospitalized burn claims accounted for 55% of all costs, even though they constituted only 1.5% of all burn claims [Baggs et al., 2002]. Limitations in BLS data, such as exclusion of the self-employed, government workers, or farms with fewer than 11 employees, result in underestimates of the true magnitude of burn injuries in the United States. The number of

Abbreviations: BLS, Bureau of Labor Statistics; BOC, Bureau of Census; CIC, commercial insurance carrier; COSS, Consortium of Occupational State-based Surveillance; CPS, Current Population Survey; DCBS, Department of Consumer and Business Services; HDI, hospital discharge index; ICD-9, International Classification of Disease, 9th Revision; MO, medical only (non-disabling); NAICS, North American Industry Classification System; NCCI, National Council on Compensation Insurance; NIOSH, National Institute for Occupational Safety and Health; OAHHS, Oregon Association of Hospitals and Health Systems; OWC, Oregon Workers' Compensation; RBC, regional burn center; SIC, Standard Industrial Classification; SOC, Standard Occupational Classification; TL, time loss (disabling); WC, Workers' Compensation.

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work-related injuries and illnesses in Michigan was found to be three times greater than that reported by the BLS [Rosenman et al., 2006]. Thus, using other data sources to better characterize occupational burn injuries is imperative.

Oregon is one of 15 states funded by the National Institute for Occupational Safety and Health (NIOSH) to conduct fundamental surveillance, and is currently the only state funded to conduct expanded surveillance of occupational burn injuries. To enhance our surveillance efforts, we have developed partnerships with various state agencies to track occupational burns. The Oregon Department of Consumer and Business Services (DCBS) provides us with workers' compensation claims data (OWC) which we use as our primary source of information to characterize work-related burn injuries. Oregon augments these WC claims data with commercial insurance carrier (CIC) data, regional burn center data (RBC), and hospital discharge index (HDI) data.

This article characterizes accepted burn claims found in WC in Oregon from 2001 to 2006, and also describes accepted non-disabling claims from the commercial carrier. We also compare WC claims for burn injuries with hospitalization to case reports received from the RBC and to HDI data. These supplemental data sources enable us to evaluate the completeness of our primary data source, that is, how many cases might not be captured in the WC system.

METHODS

Oregon Workers' Compensation System

Oregon law mandates that employers within the state have workers' compensation insurance benefits for their employees [Anon., 2007a]. Employers can choose one of three options for workers' compensation (WC) insurance: self-insurance, insurance through a private company, or insurance through the state fund (now known as SAIF Corporation). SAIF is an independent public corporation providing workers' compensation insurance. In 2006 SAIF held 46% of the market share for workers' compensation insurers, while private insurers held 40% and self-insured companies held nearly 14%. Not all Oregon employees are required to have WC coverage (e.g., sole proprietors, private residence workers) nor are all workers captured in the WC system (e.g., federal workers, maritime workers are excluded) [Information Management Division, 2006].

The Oregon DCBS provides quarterly claims data to the Oregon Worker Illness and Injury Prevention Program (OWIIPP) of the Oregon Public Health Division. Data include information needed to administer claims, such as source and nature of injury, injury event, occupation, employer information, employee demographics, hospitalization status, and claim status. Nature of injury, part of body, and source of injury are encoded using BLS Occupational Illness and Injury Coding System (OIICS) [Bureau of Labor Statistics, 2002]. Data on claim costs is not included in the claims file. Industries are coded using the North American Industry Classification System (NAICS) [U.S. Department of Management and Budget, 2002], although years prior to 2005 are coded using Standard Industrial Classification (SIC) [U.S. Office of Management and Budget, 1987]. Correspondence tables (crosswalks) were utilized to convert industry data from 2001 to 2004 from SIC to NAICS so that rates could be calculated for the complete time period. Occupations are coded using both Bureau of Census (BOC) [U.S. Office of Federal Statistical Policy and Standards, 1980] and Standard Occupational Classification (SOC) [U.S. Office of Management and Budget, 2000]. Due to cross-coding complexities, rates were only calculated for years where SOC was fully available (2005–2006).

For this analysis, we focused on accepted burn claims regardless of their disabling status. A claim is accepted when the insurance company agrees to pay for it; disabling status is defined by missing three or more days of regularly scheduled work, hospitalization, or likely permanent disability. There are limited numbers of records for non-disabling claims, because reporting of these claims is voluntary. To identify work-related burn claims in the time period of interest (2001–2006), we used date of injury. The following nature of injury codes (OIICS) were used to isolate burn claims: 050–059 (includes heat burns, chemical burns, electrical burns, and unspecified burns); 083 (burns with fractures); and 085 (burns with other injuries).

Workers' compensation data does not contain information on employment levels. Thus, the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) data from 2001 to 2006 was utilized. These data are obtained for all employees for whom an employer must pay unemployment insurance taxes, and therefore includes almost all workers except self-employed, sole proprietors, domestic workers, and federal workers [Bureau of Labor Statistics, 2003]. The WC data contained information on ownership (e.g., private, local, state, or federal government), so denominators for rates were constructed using the appropriate ownerships.

Data from the U.S. Census Bureau Current Population Survey (CPS) were used to estimate Oregon employment numbers by gender. The CPS is a monthly survey of about 50,000 U.S. households; it is a primary source of labor force characteristic information of the U.S. population. It is a rotating survey, meaning a housing unit is interviewed for 4 months, dropped out of the sample for 8 months, and then brought back in the following four months. This strategy improves the accuracy of month-to-month and year-to-year estimates [U.S. Census Bureau, 2006].

Frequencies of claims by year, gender, source of injury, industry, occupation, age, hospitalization status, and body part were calculated to describe the characteristics of work-related burns in Oregon during the time period. Rates of burn

injury by year, gender, industry, and occupation were calculated and multiplied by 10,000 to represent injuries per 10,000 workers. Because estimates were used in calculating burn injury rates, 95% confidence intervals are presented. Rate ratios between genders and some industry categories were calculated. These were computed by calculating the ratio of the injury rate of one particular category and the injury rate of a baseline category; a ratio greater than one indicates a higher rate ("risk") of injury in that category versus the baseline category. Again, estimates were used to derive the numerator and denominator data, so 95% confidence intervals are presented.

Commercial Insurance Carrier (CIC) Data

All workers' compensation carriers report accepted disabling, denied disabling, and denied non-disabling, but are not required to report accepted non-disabling claims to the Oregon Workers' Compensation division. One advantage of Oregon's relationship with one CIC is access to their accepted non-disabling claims data. These claims, also called medical only (MO), can augment the surveillance system by providing information on trends and "hidden" costs on what may be more frequent, but less severe, burn injuries that would not be captured otherwise.

To extract occupational burns from one CIC between 2001 and 2006, we used the date of injury and Workers [sic] Compensation Insurance Organization nature of injury code 104 [Anon., 2007b] and ICD-9 codes 940–949 [U.S. Department of Health and Human Services, 1989]. To verify that time loss (disabling) claims in the CIC data were reflected in the larger OWC database, we performed matching using claimant name and date of injury.

Frequencies of claims by claim type, gender, age group, body part, and National Council on Compensation Insurance (NCCI) code for medical only claims were calculated to describe characteristics of occupational burns in the CIC data. NCCI codes are a classification system that attempt to classify the overall business of an employer, not the particular work of a specific employee. There are approximately 600 classification codes that are designed to cover workplace exposures [National Council on Compensation Insurance, 2001].

All analyses were conducted with SAS, v9.1 (SAS Institute, Cary, NC, 2003).

Comparison of Data Sources

To evaluate the WC data, which is our primary source of occupational burn injuries, we compared WC claims data to two other data sources. First, we compared WC to Oregon's sole regional burn center (RBC) that provides our agency data on hospitalized occupational burn cases occurring in the state. This data source does not include patient identifiers, but is filtered by the burn center to include Oregon residents with a burn ICD-9 code of 940–949 and a payer of workers' compensation. Variables include date of birth, date of admission and discharge, date of injury, sex, etiology of burn, and event description. To match these records to claims data, we used date of birth, sex, and date of injury. To improve the match rate, cases in the OWC claims data were included if hospitalization status was either yes, unknown, or missing.

The second data source used is the Oregon Association of Hospitals and Health Systems (OAHHS) HDI data. We used primary payer of WC and ICD-9 codes of 940–949 during the years of interest 2001–2006. The number of work-related burn cases was estimated as the count of the discharge records that fit the above criteria. Due to limitations in the HDI data, such as lack of date of birth for some years and duplicate records for multiple admissions, these were not matched to the WC records.

RESULTS

There were 1,640 accepted occupational burn claims in the Oregon WC database between 2001 and 2006; of these, 96% (1,570) were disabling. Burn claims constituted 1.2% of all accepted claims during this time period. The overall burn injury claim rate was 1.7 per 10,000 workers and ranged from a high of 1.8 per 10,000 workers in 2001 to a low of 1.4 per 10,000 in 2004. The most common type of burn was heat burn or scald, which for all years ranged between 73% and 79%. The second most common burn type was chemical, which varied from 11% to 16% per year (Table I). Rate of burn injury by year and gender are presented in Figure 1. The total rate of burn injuries decreased until 2005 and then rose slightly in 2006. The rate ratio between genders was significantly greater for men than women for all years. Figure 2 shows that men had a 1.5 times or greater risk of burn injury compared to women for all years studied.

The most common source category assigned to an occupational burn was "other" which accounted for nearly 31% of total claims (Table II). The most common "other" sources were fire, flame, or smoke (160/502 or 31.9% of category total) and steam, vapors, or liquids (318/502 or 63.3% of category total). Chemicals and chemical products was the second most common source category assigned to burn injuries (19.6%). The third most common source category was persons, plants, animals, and minerals at 18.2%. Nearly all of the claims in this latter group were from fresh or processed food products (289/299 or nearly 97%) (Table II).

Rates of burn injuries for industries with greater than 20 accepted burn claims are shown in Table III. Accommodation and food services had the highest burn injury rate at 5.9 per 10,000. Manufacturing had the next highest burn rate (3.0 per 10,000), followed closely by construction with 2.8 per 10,000. Transportation, warehousing, and utilities

TABLE I. Number and Percentage of Accepted Burn Claims by Type, Oregon Workers' Compensation Data, 2001–2006

	Year											
	2001		2002		2003		2004		2005		2006	
Type of burn	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Total	306	100.0	298	100.0	262	100.0	249	100.0	243	100.0	282	100.0
Heat burn	242	79.1	217	72.8	201	76.7	200	80.3	179	73.7	217	77.0
Chemical burn	39	12.7	35	11.7	44	16.8	32	12.9	41	16.9	30	10.6
Electric burn	7	2.3	14	4.7	9	3.4	5	2.0	11	4.5	9	3.2
Burns and other injuries	7	2.3	8	2.7	3	1.1	7	2.8	5	2.1	10	3.5
Burn, unspecified	4	1.3	14	4.7	2	0.8	—	—	4	1.6	4	1.4
Burn, not elsewhere classified	3	1.0	5	1.7	2	0.8	4	1.6	2	0.8	3	1.1
Fractures and burns	4	1.3	3	1.0	—	—	1	0.4	1	0.4	5	1.8
Multiple burn	—	—	2	0.7	1	0.4	—	—	—	—	4	1.4

had an overall burn rate of 1.0 per 10,000, but when utilities were considered separately, the accepted burn injury rate rose to 8.5 per 10,000 (95% CI 5.3–11.6), making this category the highest in the rankings.

Rates of burn injuries for occupations with greater than 10 accepted burn claims are listed in Table IV for 2005–2006 (prior years are not available). Major groups are listed, with subgroups of interest below each major category. Overall, the

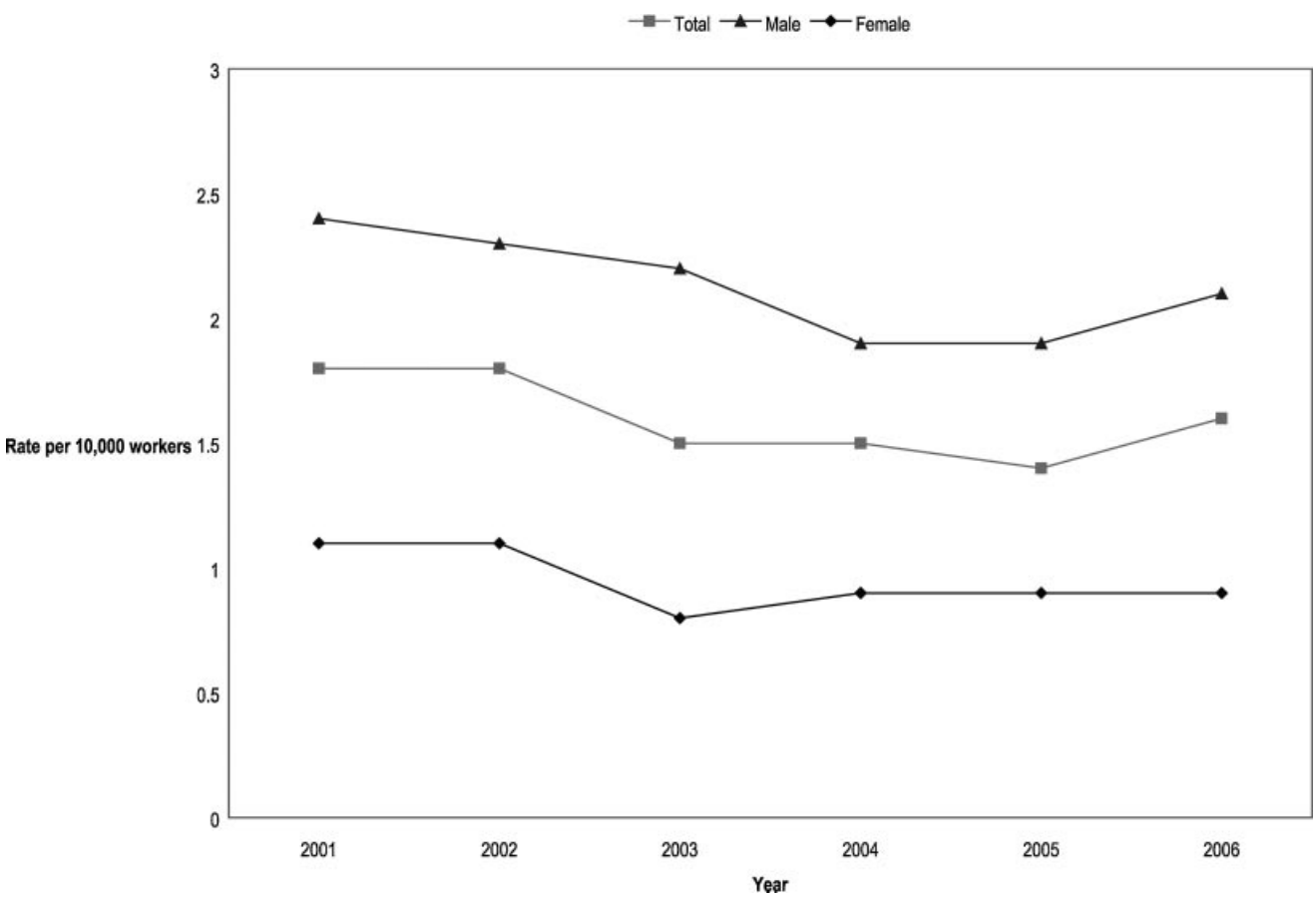

FIGURE 1. Rate of accepted burn claims by gender per 10,000 workers, Oregon Workers' Compensation Data, 2001–2006.

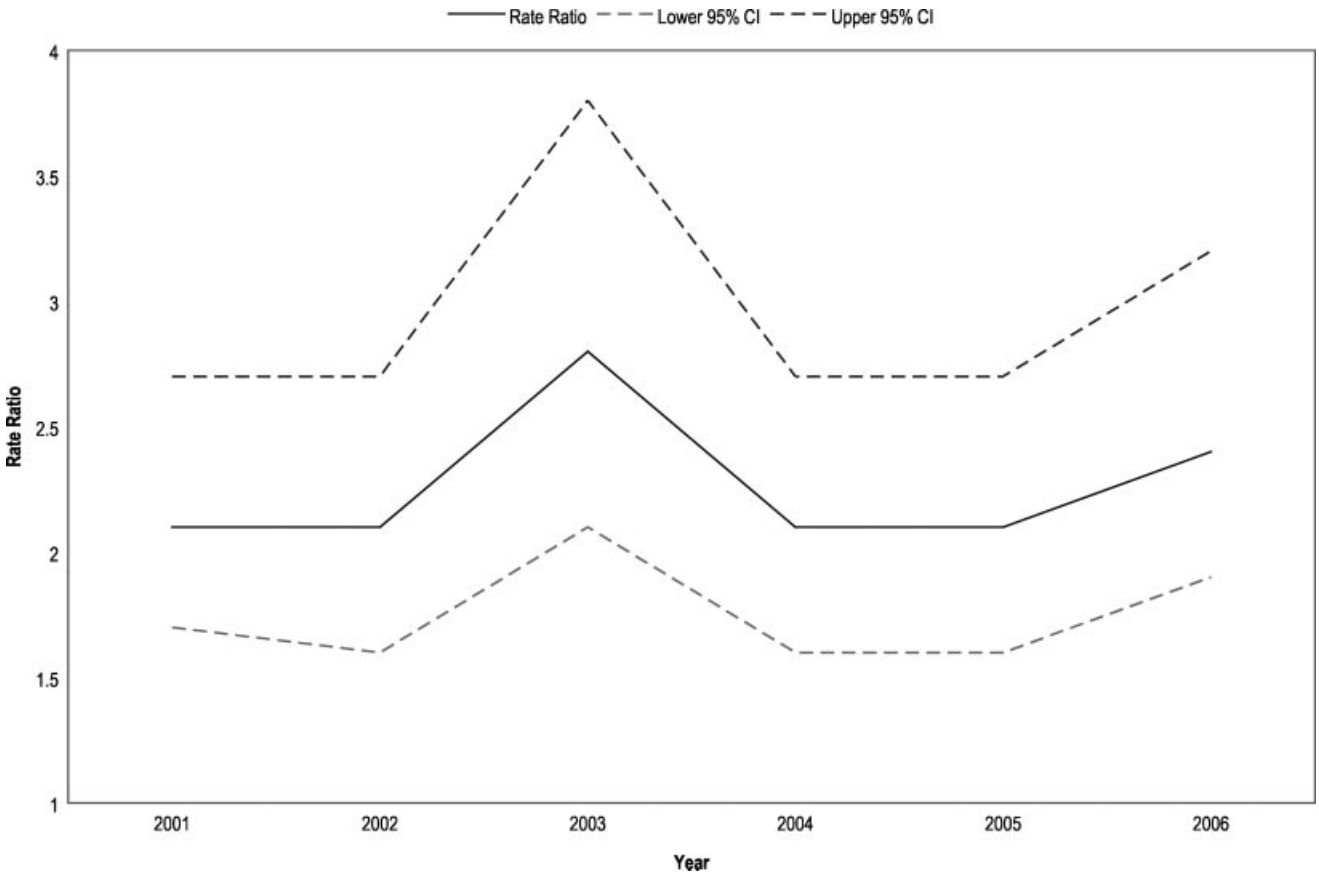

FIGURE 2. Rate ratio (male vs. female) for accepted burn claims, Oregon Workers' Compensation Data, 2001–2006. Dashed line indicates 95% upper and lower confidence intervals.

TABLE II. Number and Percent of Accepted Burn Claims by Selected Source, Oregon Workers' Compensation Data, 2001–2006

Source of injury or disease (selected)	Total	%
Total	1,640	100.0
Chemicals and chemical products	322	19.6
Containers	36	2.2
Furniture and fixtures	7	0.4
Machinery	122	7.4
Parts and materials	164	10.0
Persons, plants, animals, and minerals	299	18.2
Food products—fresh or processed	289	17.6
Fats and oils	209	12.7
Structures and surfaces	13	0.8
Tools, instruments, and equipment	45	2.7
Vehicles	18	1.1
Other sources	502	30.6
Fire, flame, smoke	160	9.8
Steam, vapors, liquid	318	19.4
Unknown	112	6.9

occupation group with the highest burn injury rate was food preparation and serving related occupations (23.3 per 10,000, 95% CI 20.2–26.3). Within this group, the subcategory of cooks and food prep workers was nearly double that value (45.6 per 10,000, 95% CI 38.4–52.8). Second overall was production occupations (12.0 per 10,000). A subgroup in this category, metal workers and plastic workers, had a burn injury rate of 20.1 per 10,000.

Approximately half (50.8%) of all burn claims occurred to persons aged younger than 35 years. Of those, 54 (3.3%) were in individuals 17 years or younger, 369 (22.7%) were in those 18–24 years, and 399 (24.6%) were in those 25–34 years. Workers 45–54 years accounted for 312 (19.2%) of all burn claims, followed by workers 55–64 years with 101 (6.2%), and workers 65 years and older with 18 (1.1%). The median age for heat scalds was 33 years; for chemical and electrical burns combined, the median age was 37 years. Individuals with heat scalds were more likely to be younger than individuals with chemical or electrical burns ($P < 0.0001$, Kruskal–Wallis test).

For all burn claims where hospitalization status was known (85%), males were more likely than females to be

TABLE III. Estimated Rates of Accepted Burn Claims by Industry,* Oregon Workers' Compensation Data, 2001–2006

Industry	# Claims	Rate per 10,000	95% CI
Accommodation and food services	487	5.9	5.4–6.4
Manufacturing	362	3.0	2.7–3.3
Construction	141	2.8	2.3–3.2
Retail trade	112	1.0	0.8–1.2
Transport. warehousing, and utilities	79	2.2	1.7–2.7
Utilities only	28	8.5	5.3–11.6
Health care and social assistance	87	0.8	0.6–1.0
Administrative and waste services	60	1.1	0.8–1.4
Other services, except public admin.	51	1.4	1.0–1.8
Agriculture, forestry, fishing, hunting	50	1.8	1.3–2.3
Wholesale trade	45	1.0	0.7–1.3
Educational services	36	0.5	0.3–0.6
Public administration	28	0.6	0.4–0.8

*North American Industry Classification System [2-digit]. Only industries with greater than 20 claims are presented.

TABLE IV. Estimated Rates of Accepted Burn Claims by Occupation,* Oregon Workers' Compensation Data, 2005–2006**

Occupation	# Claims	Rate per 10,000	95% CI
Food preparation and serving related occupations	226	23.3	20.2–26.3
Cooks and food prep. workers	153	45.6	38.4–52.8
Food and beverage serving workers	44	8.2	5.8–10.6
Other food prep. and serving workers	17	14.9	7.8–22.0
Supervisors, food prep. and serving workers	12	12.5	5.4–19.6
Production occupations	137	12.0	10.0–14.0
Metal workers and plastic workers	44	20.1	14.2–26.0
Installation, maintenance, and repair occupations	64	10.8	8.2–13.5
Other install., maint., and repair occupations	43	14.7	10.3–19.0
Vehicle and mobile equipment mechanics	18	11.0	5.9–16.0
Transportation and material moving occupations	59	5.4	4.0–6.7
Construction and extraction occupations	58	5.8	4.3–7.3
Bldg and grounds cleaning and maintenance workers	18	6.4	3.4–9.3
Management occupations	11	0.5	0.2–0.8
Sales and related occupations	11	0.5	0.2–0.9
Office and admin support occupations	10	0.4	0.2–0.7
Farming, fishing, and forestry occupations	10	3.0	1.2–4.9

*Standard Occupational Classification.
**Twenty-four occupations were unclassifiable.

hospitalized, 12.1% versus 5.9% (Chi-square, $P < 0.001$). Further, individuals with chemical or electrical burns were more likely to be hospitalized than those with scalds, 17.3% versus 8.2% (Chi-square, $P < 0.0001$). When electrical burns were removed from this calculation, there was no difference in hospitalization status between thermal and chemical burns, 8.2% versus 6.9% (Chi-square, $P = 0.55$). When examined separately, those with electrical burns were significantly more likely to be hospitalized than those with chemical or thermal burns, 57.1% versus 8.0% (Chi-square, $P < 0.001$). For all accepted claims that resulted in a hospitalization ($n = 145$), the rate for the utilities sector was higher than any other industry group (3.9 per 10,000; 95% CI 1.7–6.1). Compared to the lowest industry category (retail trade, hospitalized burn injury rate of 0.8 per 10,000), the rate ratio for a hospitalized utility worker was 49.4 (95% CI 20.8–117.3). The rate ratio for hospitalized utilities claims compared to all other industries was 16.0 (95% CI 8.8–29.0).

The most commonly reported body part affected by a burn was upper extremities (43.3%). Of these, hands (excluding fingers) were most commonly injured (42.0% of upper extremity burns). The next most commonly reported part of the body was multiple body parts (23.8%). Chemical burns most commonly affected the head (40.7% of total chemical burns), while electrical burns most commonly affected upper extremities (52.7% of electrical burns).

We identified 11 fatalities in the claims data. Sources of fatalities varied but 6 (54.5%) were due to contact with fire or flame; 4 (36.3%) were due to vehicles, and 1 (9.1%) was due to a chemical (hydroxide). All fatal occupational burn claims occurred in males.

Commercial Insurance Carrier (CIC) Data

There were 2,165 burn claims with a status of accepted identified in the CIC data between 2001 and 2006. Of these, 85% were non-disabling or medical-only claims, while 15% were time loss or disabling. When we matched these time loss claims to the Oregon Workers' Compensation database using name (last and first) and date of injury, we had a match rate of 96%. Therefore characteristics of medical only claims are presented here. Consistent with the OWC data, the majority of claimants were male (65.9%) and younger than 35 years of age (61.8%). The specific age distributions were 83 (3.9%) claims in individuals 17 years and younger; 604 (28.5%) in those 18–24 years; 625 (29.4%) in those 25–34 years; 400 (18.8%) in those 35–44 years; 306 (14.4%) in those 45–54 years; 92 (4.3%) in those 55–64 years; and 13 (0.6%) in those 65 years and older. Thermal burns predominated in the CIC claims (69.2%); chemical burns were second most common at 16.3%. The majority of burns were to the

upper extremities (45.1%). Eyes were the second most common part of the body affected (25.6%). The most frequent NCCI description found in the CIC data was "restaurants or taverns" at 37.7%. No denominator data were available for this data source, so rates by occupation or industry could not be calculated.

Comparison of OWC to Other Sources of Burn Data

There were 106 burn injuries identified from the burn center data over the 6-year time period. Like the WC data on hospitalized workers, the burn center records were predominantly male (n = 100, 94.3%). The age distribution was as follows: 17 years or younger (n = 1, 0.9%); 18–24 years (n = 18, 17.0%); 25–34 years (n = 24, 22.6%); 35–44 years (n = 27, 25.5%); 45–54 years (n = 22, 20.8%); 55–64 years (n = 11, 10.4%); 65 years or greater (n = 3, 2.8%). The most common etiology was ignition of highly flammable material (n = 20, 18.9%) followed by contact with hot object (n = 11, 10.4%). Electric power plants and lines was third (n = 10, 9.4%). There is no standard coding for occupation in this data (data are recorded from patient records or interview); the most commonly reported occupation was laborer (n = 28, 26.4%), followed by electrician (n = 10, 9.4%) and cook (n = 7, 6.6%).

Burn claims with a hospitalization status of "yes" or "unknown" were matched to the RBC records by date of birth, gender and date of injury. Forty-four additional cases were found in the burn center data that were not captured in WC claims data over the 6-year period. Including these cases in our surveillance system increases the total number of occupational burns captured by 3%. If we look at fatalities associated with work-related burns, the RBC data captured an additional death not found in WC. Including this fatality in our surveillance system would increase the number of occupational burn fatalities to 12.

We compared the number of hospitalized WC burn claims for the time period to the number of occupationally related burns in the HDI data (data were not matched to claims data due to a lack of identifiers for some years and duplication of records in the former data set). For the 6-year period, we identified 162 cases of hospitalizations for occupational burns in the HDI data compared to 145 hospitalizations in the WC claims data, resulting in a difference of 12%. This difference may be partially accounted for by WC claims with unknown hospitalization status (n = 246). As seen in the comparison to RBC data described above there were claims matched to RBC cases where the WC hospitalization status was unknown. Since we do not have identifiers with which to match WC and HDI data, we are not able to verify that these unknown claims account for the difference. However, the number of hospitalized cases in HDI is likely an under representation of the true number of burns, since some cases may not file claims or be eligible to file a claim (e.g., self-employed). The RBC data can be considered a subset of HDI data and thus no matching was attempted.

DISCUSSION

This article describes the burden of occupational burns in Oregon and compares the surveillance program's main sources of burn injury data (WC claims and CIC claims) to two other sources: a regional burn center and hospital discharge data. Administrative claims records remain a rich data source for analysis of occupational conditions, although some limitations exist, including lack of data on medical costs, as well as limitations on who is covered (self-employed) or who chooses to file a claim. An analysis by the DCBS using the 2004 Oregon Population Survey found that approximately 37% of workers did not file claims for workplace illnesses or injuries which translates to 32,000 unreported work-related injuries and illnesses [Information Management Division, 2005]. Given that all data sources described in this article rely on workers' compensation claims somewhere in the selection algorithm, there is still a large undercount problem for workers not eligible or not covered under workers' compensation. One possible solution is to use other population-based data, such as from the National Health Interview Survey (NHIS). This source includes individuals not covered under workers' compensation, such as self-employed and undocumented workers. A recent study using NHIS found that work-related burn injuries accounted for 42.5% of all burn injuries [Smith et al., 2005]. Another potential data source is the Behavioral Risk Factor Surveillance System (BRFSS) survey. Oregon is currently working with nine other states to analyze an occupational injury module added to the 2007 BRFSS Survey. Although burns are not specifically addressed, there are questions about why injuries were or were not paid by workers' compensation. This data could augment the 2004 Oregon Population Survey and provide us with an estimate of how many injuries and illnesses are not reported into workers' compensation.

Burn injuries, previously among the leading causes of acute work-related injury, continue to decline in the United States; the rate of heat burns and scalds with days away from work declined by 48.1% between 1992 and 2001 [National Institute for Occupational Safety and Health, 2004]. Burn rates in Oregon have also declined. A previous analysis of Oregon WC claims showed a steady decline from 1990 to 1997. Further, the rate of burns for 2001 calculated in this study (1.8 per 10,000) is lower than the rate calculated for 1997 (2.4 per 10,000) [Horwitz and McCall, 2004]. Differences in state workforce distribution, denominator calculations for rates, and reporting requirements for claims can make it difficult to compare results of studies using workers' compensation claims. Rhode Island, a state with a similar indemnification period to Oregon (3 days), was found to have

a higher rate of burn injury claims (between 20.0 and 27.2 per 10,000 over the reporting period) [Horwitz and McCall, 2005]. However, unlike Rhode Island, Oregon law does not require reporting of accepted, non-disabling claims (medical-only claims) to the workers' compensation division. This results in an underestimate of the true burden of occupational burns in Oregon, since non-disabling claims have the potential to increase costs and result in 1–2 lost workdays. Using the CIC data, where a large percentage of the claims are non-disabling, is one method to increase our surveillance system's ability to capture a wider spectrum of burn injuries. We did not find a 100% match rate when we matched the CIC disabling claims to the OWC claims. This could be attributable to multiple factors, including the different coding systems used in each database (e.g., the burn definition is not identical), or from data entry errors (e.g., incorrect date of injury). The high match rate achieved for disabling cases (96%) suggests that using OWC as the primary data source for disabling burn data is acceptable. However, the surveillance system would be markedly enhanced if all insurance carrier non-disabling data were included or if non-disabling claims were also reportable to WC because, based on data from the CIC, 85% of occupational burns are medical only.

The inclusion of outside data sources, including burn center records, increases Oregon's capacity to accurately monitor burn injuries. This analysis showed that by using the RBC data, we increased the number of cases detected for the time period by around 3%, and increased the number of fatal injuries identified by one case. These 44 cases are an important addition to Oregon's surveillance system. Hospitalized burns are among the most serious of burn injuries. Understanding the circumstances around these injuries would better inform our prevention messages and allow for targeted efforts towards the most impacted industries and occupations. Although we did not match the HDI data and WC data, we found an absolute number of 17 more hospitalized cases in HDI versus WC. Occupational burns are likely underrepresented in the WC database given that some cases never file a claim and some workers are not covered by the WC system. Given that the RBC records are a subset of HDI records, as are some of the hospitalized WC claims, it does not appear that using HDI data in its current form augments the burn surveillance system. Other authors have worked on algorithms for matching claims data to anonymous hospital discharge data [Keller et al., 1991]; future projects could attempt this or other methodologies for matching to improve the usefulness of this data source.

The most common type of burn injury found in this study was heat or thermal (Table I). These results are similar to those of other investigators [McCullough et al., 1998; Baggs et al., 2002; Horwitz and McCall, 2004, 2005]. Others authors have found higher percentages of chemical burns [Hunt et al., 2000; Munnoch et al., 2000]. When we look at source of burn, rather than nature, chemicals and chemical products account for nearly 20% of burns (Table II), which is similar to the latter two studies. These findings may not be inconsistencies but rather differences in how the data are classified. They could also be due to coding issues (e.g., grease being incorrectly classified as a chemical source instead of a thermal source); this is unlikely for our data because Bureau of Labor Statistics standard source coding (OIICS) was used. This finding also points to a need for increased training and/or use of effective protective equipment, since 90 (40.7%) chemical burns in the WC data occurred to the head, of which 75 (83.3%) were to the eyes. Other authors have noted the preventability of nearly all occupational eye injuries with regular use of protective equipment [Fong and Taouk, 1995].

We found that higher burn injury rates occurred in the accommodation/food service industries, and in food preparation and serving-related occupations. These results are consistent with other studies [McCullough et al., 1998; Hunt et al., 2000; Islam et al., 2000]. Cooks and food preparation workers, when examined by themselves, had a burn injury rate that was nearly double of any other group (Table IV). These workers might be more likely to suffer burns than other food service workers, due to the nature of their task requirements [Alamgir et al., 2007]. The data highlight the need for prevention policies to reduce the risk of workplace burns, especially in these higher risk industries and occupations. A prevention strategy for industries with many worksites and many workers at risk (e.g., restaurants) might incorporate enforcement and consultation, along with education and outreach activities [Silverstein et al., 2002; Curwick, 2006]. Previous research has found a significant association between enforcement inspections and decreased compensable workers' compensation claims [Baggs et al., 2003; McCall and Horwitz, 2004].

Workers younger than 25 years accounted for 26.0% of burn claims in the OWC data and 32.4% of burn claims in the CIC data. It is well-established that younger workers are at higher risk of occupational injuries [Runyan and Zakocs, 2000; National Institute for Occupational Safety and Health, 2004; McCall et al., 2007]. Younger workers commonly work in industries and occupations where they may be at higher risk for burns, such as accommodation and food services (Table III) and food preparation and serving-related occupations (Table IV) [Centers for Disease Control and Prevention (CDC), 1993; Brooks and Davis, 1996; Miller and Kaufman, 1998; Runyan and Zakocs, 2000]. Increased training, along with safety interventions, enforcement of current labor regulations, and education about occupational hazards to young workers, will be necessary to reduce burn injuries among younger workers [Brooks and Davis, 1996; Miller and Kaufman, 1998; McCall et al., 2007]. Other states have established partnerships and resource centers to build capacity for young worker safety and health that go beyond training and education (e.g., Massachusetts Young Worker Initiative Task Force) [Massachusetts Department of

Public Health, 2003]. In Oregon, staff at the University of Oregon Labor Education & Research Center helped organize a Young Worker Health and Safety Coalition to coordinate efforts among various state and federal agencies and other young worker stakeholders to develop strategies and raise awareness of issues affecting young workers, including burn injuries [Anon., 2008].

The distribution of hospitalizations was not equal among the different burn types; those with electrical or chemical burns were significantly more likely to have been hospitalized than those with thermal burns. When electrical burns were removed from the calculation, the difference in hospitalization status between chemical and thermal burns was no longer significant. Electrical burns are a well-documented hazard, tending to be both expensive and severe [Baggs et al., 2002; Cawley and Homce, 2003; Curwick, 2006; Fordyce et al., 2007]. Nearly 43% of the burns in the utilities sector were electrical in nature; given the higher rate of burn injuries among this group in Oregon (Table III), the data suggest that targeted interventions are needed to reduce their incidence. Other authors recommend that industries with low counts but high rates of injuries implement a prevention strategy with a focused approach based on enforcement and consultation [Silverstein et al., 2002; Curwick, 2006].

Some results from the current investigation have been well documented, including the gender and age distribution of occupational burns [McCullough et al., 1998; Hunt et al., 2000; Islam et al., 2000; Horwitz and McCall, 2005]. Higher rates of burn injury for workers in the utilities industry sector has been shown in some studies [Horwitz and McCall, 2005] but not others [Islam et al., 2000; Horwitz and McCall, 2007]. One possible reason for this discrepancy is the different coding schemes used by workers' compensation systems. In the older, SIC system, utilities is grouped with sanitary services; in the more current NAICS, it is found alone or combined with transportation and warehousing. This is an important consideration. For example, if the utilities industry is combined with transportation and warehousing (Table III), the burn injury rate drops from 8.5 per 10,000 workers to 2.2 per 10,000 workers. There could also be differences in the formation of the denominators necessary to calculate rates, or unique state regulations that result in differential reporting of injuries. As states move into using modern coding systems, the impact of coding on calculation of rates can be re-examined.

We lacked data on the costs of occupational burn injuries in Oregon. Since medical cost data were not available in the claims data, we could not calculate the financial burden of occupational burns during the time period of interest. However, employers with more than 100 accepted disabling claims are required to report their medical payment data to the workers' compensation division. In 2004, around 82% of total medical payments were reported, and estimated total medical payments for 2004 were around $259 million [Hackenbruck, 2004]. A previous analysis using Oregon WC data from 1990 to 1997 data found that costs of burn injuries averaged around $1.6 million per year, or $4,276 per claim [Horwitz and McCall, 2004]. An unpublished analysis by our section using medical encounter data found that the median payment for any burn claim between 2004 and 2006 was $1,054 (mean $7,554); for hospitalized burn claims, the median was $15,562 (mean $49,232) [Oregon Worker Illness and Injury Program, unpublished work, 2008]. Washington State data from 2000 to 2005 showed that hospitalized occupational burns in that state had a median cost of over $15,600 per claim (mean cost $50,194 per claim) [Curwick, 2006]. The National Safety Council, using data from the National Council on Compensation Insurers, reported an average cost of nearly $17,000 per workers' compensation claim filed for burns in 2002 and 2003 [National Safety Council, 2007]. We plan to continue to improve our algorithm for matching claims data to medical encounter data. It is important to remember that indirect costs associated with occupational injuries (e.g., loss of productivity) may not be reflected in claims data [Horwitz and McCall, 2005].

CONCLUSIONS

Workers' compensation claims, despite some limitations, remain a valuable source of data on work-related injuries, including burns. Underreporting of occupational injuries and illnesses in these and other systems has been well documented [Leigh et al., 1997; Azaroff et al., 2002; Smith et al., 2005]. Population-based survey data, such as NHIS and BRFSS, may provide insight into characteristics of injuries to workers not covered under workers' compensation. This analysis shows that adequate burn injury surveillance is accomplished using the WC database and burn center records; however, the system is enhanced with the addition of CIC data which highlights the less severe medical-only cases. Novel and supplementary data sources (e.g., hospitalization combined with laboratory, clinic, or death certificate data) will be necessary to identify more cases of occupational burn injuries [Leigh et al., 1997; Azaroff et al., 2002; Smith et al., 2005], as well as document relevant exposures that can be used to create prevention strategies.

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