

Occupational Burns in Washington State, 1989–1993

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Occupational burns cause significant morbidity in the United States each year; however, there are few studies that report industries or workplaces where workers are at an increased risk of burn injuries. Washington State's Department of Labor and Industries (L and I) computerized workers' compensation database was used to describe work-related burns over 5 years. From 1989 to 1993, L and I accepted 27,323 claims for occupational burns, 71.4% of them thermal burns and 26.8% chemical burns. The most common sources of injury were cooking oils (14%) and hot water/steam (13%). Workers involved in food preparation or food handling accounted for the highest proportion of injured workers (30%). Industries involved in the smelting, sintering, or refining of ore had the highest rate for thermal burns, with a rate of 15.0 burn injuries per 100 full-time equivalent workers per year, followed by paper, pulp, or wood fiber manufacturing, with a rate of 5.8, then roof work, with a rate of 4.3. Industries involved in hazardous waste landfill clean-up had the highest rate for chemical burns, with a rate of 4.9, followed by portable cleaning and washing, with a rate of 3.5, and paper, pulp, and wood fiber manufacturing, with a rate of 2.6. Further study is needed to identify work practices that result in burn injuries in order to decrease the incidence of this preventable occupational injury.

Work-related burns are a leading cause of occupational injury in the United States. In 1994, the Bureau of Labor Statistics reported that 53,800 occupational burns resulted in time loss from work, representing 2.4% of all time-loss injuries and illnesses.¹ In studies of occupational burns, the frequency of work-related admissions to burn units range from 21% to 30% of all admissions² and 20% to 30% of all serious burns.³

Several studies identified specific groups at increased risk for occupational burns. Hayes-Lundy and associates reported that adolescents in the fast food industry are at increased risk for work-related burns from contact with hot grease.⁴ The Colorado and Minnesota State Health Departments reported that adult workers have a disproportionately high number of grease burns as well.⁵ Lyndorf found that restaurants and the metal industry were the most common workplaces in which burns occurred, and that the majority of the burns involved the upper extremity.⁶ Inancsi and Guidotti found that Hispanic males had the highest risk for occupational burns in southern California.³

Most occupational burn research focuses on hospitalized workers, which underrepresents the scope of the problem because most burn victims do not require hospitalization.⁷ In addition, few studies have surveyed occupational burns over a wide geographic area that encompasses different regions, populations, and industries. They have also suffered from lack of occupation- or industry-specific rates; only fre-

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quency distributions are reported, which may not reveal the groups at highest risk. To address these limitations, we studied all workers employed in the state of Washington covered by the State Industrial Insurance Fund or self-insured employers over a 5-year period.

Methods

Occupational burn claims in Washington State's Department of Labor and Industries workers' compensation database were identified by American National Standards Institute Z16.2 codes of 120 and 130, indicating thermal and chemical burns, respectively.⁸ This database contains information on any workplace injury or illness for which medical benefits are paid and those with or without time loss or wage replacement. Approximately two-thirds of Washington's 2.3 million workers are covered through the State Industrial Insurance Fund for workers' compensation benefits, while approximately one-third are covered through self-insurance, which generally includes the state's larger employers.⁹ Only limited information is computerized for self-insured claims, and data is typically incomplete for many claims, especially those with medical benefits. In addition, Z16.2 codes are often unavailable, and no details on medical payments are available for claims for self-insured employers. Not included in the State Industrial Insurance Fund or self-insurance programs are people employed by the federal government, longshoremen and harbor workers, railroad workers, the self-employed, and those for whom workers' compensation is not required, such as domestic employees and those working on family farms.

The results of this analysis represent the evaluation of accepted claims from the state fund and self-insured program for the 5-year period of 1989 through 1993. All claims are coded to the specific industry by Standard Industrial Classification (SIC) codes.¹⁰ Injuries and

illnesses are coded as nature, body part, source, type of exposure, and secondary source that caused the injury, using the Bureau of Labor Statistics Occupational Injury and Illness Classification System codes.¹¹ All cases are also coded for risk classification, an industrial insurance rating system with codes specific to Washington State. A risk class is a grouping of businesses or industries sharing common work practices or similar exposures without regard to the separate occupations or operations that comprise the employer's workforces.¹² Occupation is classified in accordance with the 1980 Census Occupational Classification System, which is commonly referred to as the Bureau of Census coding structure.¹³ Adolescents are defined as claimants who were less than 18 years of age at the time the injury occurred.

Occupational burn-injury rates in each risk class were computed using the number of accepted claims and number of reported hours for each risk class covered by the State Industrial Insurance Fund. Rates were calculated by the following formula: (Number of claims per year \times 200,000 hours)/(Sum of hours for each risk class in 1 year). The 200,000 hours represent 100 workers employed 40 hours per week for 1 year or 100 full-time equivalents (FTEs). Risk classes were excluded from the analysis if they had fewer than 100 FTEs and fewer than two claims per year. Rates could not be calculated by age or occupational class because hours worked are not reported by these characteristics to the Department of Labor and Industries. There was inadequate data from self-insured employers to calculate burn-injury rates; thus rates are limited to employees covered by the State Industrial Insurance Fund.

Rate ratios (RR) were calculated separately for thermal and chemical burns. RRs were obtained by first calculating the weighted-average rate for all risk classes that reported 100 or more FTEs and two or more

claims per year and by then calculating the ratio of the rate for the stratum-specific rate for each risk class to the weighted-average rate. The number of burn injuries in each risk class was weighted by the number of work hours reported. Ninety-five percent confidence intervals (95% CI) for RRs were calculated using a formula for the approximate variance of the natural logarithm of the RR.¹⁴

Results

The Department of Labor and Industries received 27,323 accepted claims for occupational burns from 1989 to 1993. Thermal burns accounted for 71.4% of all burns, and chemical burns accounted for 28.6%. The mean age was 26.8 years, and most burns occurred in males (69%). Four hundred sixty-one workers (1.7%) with burn injuries were hospitalized. The medical costs over the 5-year period were \$21,151,093 (median cost per claim was \$774, excluding wage replacement).

The number of accepted occupational burn claims decreased each year under study, from a high of 6,712 in 1989 to a low of 4,397 in 1993 (average, 5,464.6). The most common sources of burn injuries were cooking oils and hot water or steam (Table 1). Three hundred fifty-two occupational classes had at least one accepted burn claim. Workers involved with food preparation accounted for the highest proportion of injured workers (Table 2). The upper extremity, particularly the hands and fingers, was the most common body part injured by thermal burns. A high proportion of the burns to the eyes were due to chemical burns (Table 3).

Fatalities

Five people died of occupational burns; all were male. Three deaths were related to fire or smoke exposure, one to steam, and the other to crude or fuel oil. Each worker was employed in a different industrial classification (farms, grain milling,

TABLE 1
Agents Causing Occupational Burns in All Industries Combined

Agents	Number	Percentage
Cooking oils	3,762	14.0
Hot water/steam	3,492	13.0
Chemicals, unspecified	2,173	8.0
Fire/flame	1,722	6.2
Heating equipment	1,531	5.6
Liquids, unspecified	1,301	4.8
Soaps/detergents	906	3.3
Food products	805	3.0
Pots/pans	617	2.3
Solvents/degreasers	604	2.2
Scrap/waste	580	2.1
Molten metal	520	1.9
Asphalt/road oil	509	1.9
Calcium hydroxide	462	1.7
Sulfuric acid	451	1.6
Chlorine compounds	488	1.6
Sodium hydroxide	371	1.4
Other* or unknown	7,577	25.3
Total	27,323	100.0

* Includes 224 other agents.

TABLE 2
Occupational Classes Reporting Work-Related Burns

Occupational Class	Number	Percentage
Cooks	4,038	15.0
Food-counter workers	1,385	5.1
Food preparation	1,230	4.5
Mechanics	1,220	4.2
Occupation, unknown	1,143	4.2
Laborers, excluding construction	1,033	3.8
Waiters/waitresses	997	3.6
Managers/administrators	975	3.6
Dishwashers	797	2.9
Welders/cutters	789	2.9
Sales workers	543	2.0
Vehicles washers	503	1.8
Construction laborers	465	1.7
Supervisors, food preparation	464	1.7
Truck drivers	451	1.6
Other*	11,290	41.8
Total	27,323	100.0

* Three hundred thirty-seven occupational classes are included in this category.

packing house, temporary services, and insulation or soundproofing material installation).

Temporary and Permanent Disabilities From Burn Injuries

A total of 4,047 claimants (15%) had burn injuries resulting in 4 or more days of lost work time (range, 4–47 days), which qualify workers

for wage-replacement benefits. The mean age was 27.5 years, and 72.4% were male. Hot water or steam were the most common sources of burn injury. Cooks reported the most occupational burns (609 cases), followed by food preparation workers (208). The body parts most often burned were the hands and fingers (Table 4). Most burns occurred in restaurants (709), followed by fast

food drive-ins (360), roof work (136), and grocery stores (119).

Two hundred fifty-eight workers (0.9%) received permanent partial disability (PPD) awards. Cooks had the most PPD awards (20), followed by general laborers (18), and roofers (18).

Adolescents

A total of 2,076 burn injuries occurred in workers under 18 years of age (mean age, 16.4 years; range, 12–17 years), representing 7.6% of all work-related burn injuries. Most burns occurred in males. Sixteen adolescents (0.7%) were hospitalized, 504 (24.3%) had burns of a severity that required they lose time from work, and 4 (0.2%) were given PPD awards. The number of claims has decreased in each year under study. Food services are the most common risk classes in which the injuries occurred (Table 5). The most common occupational classes reported were food counter workers, with 481 (23.1%); cooks, with 458 (22.0%); dishwashers, with 170 (8.2%); and kitchen workers involved in food preparation, with 160 (7.7%). The most common agents causing the burns in this age group were cooking oils, with 561 (27%); hot water or steam, with 283 (13.6%); and heating equipment, with 227 (10.9%).

Burn Injury Rates and Rate Ratios

Burn injury rates were calculated for risk classes that reported 100 or more FTEs and two or more burns per year over 5 years. Rates were calculated for 209 risk classes for thermal burns and 176 risk classes for chemical burns. The weighted average rate for thermal burns was 0.455 burns per 100 FTEs/year and 0.173 burns per 100 FTEs/year for chemical burns. Risk classes with the greatest number of thermal burns were restaurants (4,556 cases), fast food drive-ins (2,780), grocery stores (409), and roof work (331). The most chemical burns were found in restaurants (448), fast food drive-ins (204),

TABLE 3
Body Parts Injured by Occupational Burns

Body Part	Heat Burns (%) [*]	Chemical Burns (%) [*]	Total Burns (%) [†]
Hands/fingers	6974 (91.6)	636 (8.4)	7610 (27.8)
Eyes	1212 (19.8)	4916 (80.2)	6128 (22.6)
Lower extremity	2933 (79.3)	766 (20.7)	3699 (13.5)
Multiple body parts	1617 (80.3)	398 (19.7)	2014 (7.4)
Head/face, except eyes	1130 (71.8)	445 (28.2)	1575 (5.7)
Upper extremity, except hands/fingers	1780 (90.8)	179 (9.1)	1959 (7.2)
Trunk	669 (85.0)	118 (15.0)	787 (2.8)
Unclassified			3551 (13.0)

^{*} Parentheses represent the proportion of burns classified as heat versus chemical.

[†] Parentheses represent column percentages.

TABLE 4
Body Parts Injured in Compensable* Burn Claims

Body Part	Number (%)
Hands/fingers	1140 (28.2)
Upper extremity, excluding hands/fingers	660 (16.3)
Multiple body parts	649 (16.0)
Feet/toes	562 (13.9)
Lower extremity, excluding feet/toes	490 (12.1)
Eyes	247 (6.1)
Face/head, excluding eyes	159 (3.9)
Trunk	136 (3.4)
Not classified	4 (0.0)

* Compensable claims are injuries that resulted in 4 or more days of lost work time and qualify workers for wage-replacement benefits.

and auto, truck, or mobile home sales (204).

The RRs showed the risk of burn injury within a risk class, compared with the overall risk of the population under study. The industries with the highest thermal burn injury rates include smelting, sintering, or refining ore, and paper, pulp or wood fiber manufacturing (Table 6). Industries with the highest RRs for chemical burns were hazardous waste landfill clean-up; portable cleaning and washing; paper, pulp, and paper manufacturing; and chemical mixing, blending, and manufacturing (Table 6). The lowest RRs for both thermal and chemical burns were in clerical office workers, sales personnel, and medical clinic workers.

Discussion

Occupational burns result in significant morbidity to workers and

substantial cost to industries. These injuries are preventable, and more resources are needed to identify risks and implement preventive measures. However, few studies report sufficient detail to determine which workers are at increased risk or which work practices place workers at increased risk for occupational burns. Our study has presented information to aid in describing risks for occupational burns. We have reported the highest risks associated with work-related burns in different risk classes covered by Washington State's Industrial Insurance.

We found that the food service industry accounted for the highest proportion of burn injuries; approximately one-third of all burns occurred in eating establishments. Most burns resulted from contact with hot cooking oil or hot water or steam. The upper extremity, particularly the

hands and fingers, was the most common site of work-related burns. Thermal burns were the most common and frequently occurred on hands and fingers, while chemical burns, representing 28% of all burns, frequently occurred in the eyes. The number of work-related burns has decreased every year under study; the reason for the decrease is unclear, but a comparable decrease in overall workers' compensation claims occurred during this same period.

One previous study did report occupational burn rates. Rossignol et al reported on 485 hospitalized patients with work-related burns and found that the incidence rate was higher for occupational burns than for non-occupational burns. They did not report industry-specific rates but reported that food preparation and consumption, along with motor vehicle maintenance and repair, accounted for the majority of work-related burns.¹⁵ In addition to calculating industry-specific rates, we were able to show the degree of risk in many industries by obtaining RRs. We did find that the greatest proportion of burn injuries occurred in the food service industry, but the highest RRs for thermal burns were found in industries that were involved in smelting, sintering or refining ore; paper, pulp, or wood fiber

TABLE 5
Common Risk Classes Associated With Occupational Burn Claims Among Adolescent*

Risk Classes [†]	Number (%)
Fast food drive-ins	836 (40.2)
Restaurants	450 (21.7)
Pizza parlors	57 (2.7)
Service station	28 (1.3)
Grocery stores	24 (1.1)
Other [‡]	681 (32.8)

* Adolescents were defined as claimants who were less than 18 years of age when the injury occurred.

[†] Risk class is a group of industries that share common work practices or similar exposures.

[‡] This category includes 122 risk classes.

TABLE 6
Rate Ratios (RR) for Chemical and Thermal Burns, by Risk Class*

Thermal Burns			Chemical Burns		
Risk Class†	Burns (N)	RR (95% CI)	Risk Class	Burns (N)	RR (95% CI)
Smelting, sintering or refining ore	79	34.7 (27.8–43.3)	Hazardous waste landfill cleanup	36	27.8 (20.0–38.6)
Paper, pulp or wood fiber manufacturing	43	12.6 (9.3–17.0)	Portable cleaning and washing	28	19.6 (13.5–28.4)
Roof work	331	9.4 (8.4–10.5)	Paper, pulp and wood fiber	15	14.6 (8.8–24.3)
Foundries	195	8.5 (7.4–9.8)	Chemical mixing and blending	47	14.0 (10.5–18.7)
Hospitals: religious and charitable	47	7.6 (5.7–10.2)	Electroplating	64	13.8 (10.8–17.6)
Scrap metal dealers	62	7.8 (6.1–10.0)	Metal plating and polishing	17	12.4 (7.7–19.9)
Railroad car manufacturing	24	7.5 (5.0–11.2)	Fruit syrup or fruit juice manufacturing	66	10.6 (8.3–13.5)
Rendering works	19	7.6 (4.8–11.9)	Oil refining	18	10.3 (6.5–16.4)
Aluminum smelting	152	7.3 (6.2–8.6)	Chemicals, NOC‡	64	10.3 (8.0–13.1)
Fast food drive-ins	2780	6.8 (6.5–7.1)	Cement or lime manufacturing	13	10.2 (5.9–17.5)
Pipe or tube manufacturing	31	6.8 (4.8–9.7)	Aircraft manufacturing	16	9.7 (5.9–15.8)
Electric light and power plants	17	6.2 (3.9–10.0)	Septic tank cleaning	16	9.6 (5.9–15.7)
Fruit syrup and juice manufacturing	92	5.8 (4.7–7.1)	Ammonia and nitrogen production	20	9.4 (6.0–14.5)
Food, drink, candy concession	41	5.0 (3.7–6.8)	Fruit and vegetable preserving	26	9.4 (6.4–13.7)
Die castings manufacturing	19	4.9 (3.1–7.7)	Auto or truck detailing	28	8.7 (6.0–12.6)
Iron or steel works (nonstructural)	34	4.8 (3.4–6.7)	Painting in shops, NOC	19	8.4 (5.4–13.2)
Iron works (railings)	16	4.7 (2.9–7.6)	Dairy products, NOC	28	8.1 (5.6–11.7)
Railroad construction or repair	13	4.8 (2.8–8.2)	Anhydrous ammonia, fertilizer dealers	69	7.5 (5.9–9.5)
Eating establishments, NOC	74	4.6 (3.7–5.8)	Auto/truck radiator manufacturing	14	7.5 (4.4–12.6)
Fruit and vegetable, preserving	32	4.5 (3.2–6.4)	Slaughterhouses	14	6.9 (4.1–11.6)
Aircraft manufacturing	18	4.4 (2.8–7.0)	Masonry	41	6.8 (5.0–9.2)
Restaurants	1760	4.2 (4.0–4.4)	Butter or cheese manufacturing	18	6.7 (4.2–10.6)
Oil refining	11	4.0 (2.2–7.3)	Boiler installation	11	6.2 (3.4–11.2)
Confectionary and chewing gum manufacturing	47	4.0 (3.0–5.3)	Breweries or malt houses	13	6.1 (3.5–10.5)
Glassware manufacturing	17	3.9 (2.4–6.3)	Brick and slate work	17	6.0 (3.7–9.7)
Bakeries	52	3.8 (2.9–5.0)	Auto or truck car wash	22	5.8 (3.8–8.9)
Iron or steel works (structural)	83	3.7 (3.0–5.6)	Temporary services	25	5.7 (3.8–8.4)
Class H restaurants§	2796	3.6 (3.5–3.8)	Plastics: fiberglass manufacturing	19	5.4 (3.4–8.5)
Boiler installation, NOC	20	3.7 (2.4–5.7)	Auto/truck engine manufacturing	12	5.3 (3.0–9.4)
Auto body manufacturing	67	3.6 (2.8–5.5)	Plastic goods manufacturing	96	5.3 (4.3–6.5)
Boilermaking	43	3.6 (2.7–5.9)	Sidewalk and driveway, NOC	65	5.2 (4.0–6.6)

* Standardized rate ratios were only calculated for risk classes that reported both 100 or more full-time equivalents (FTEs) for each year and at least two burn claims per year from 1989 through 1993. There were 209 risk classes that met these criteria for thermal burns and 176 for chemical burns.

† Risk Class is a grouping of industries that share common work practices or similar exposures.

‡ NOC, not otherwise classified.

§ Class H restaurants are restaurants that have a state license to sell mixed drinks.

manufacturing; and roof work. The highest RRs for chemical burns were found in industries involved in hazardous waste landfill cleanup; portable cleaning and washing; and paper, pulp, and wood fiber manufacturing.

Few studies have reported precisely which industries account for the most burns. Lyndorf found that most occupational burns (26%) occurred in restaurants.⁶ However, Ng et al reported that most occupational burns occurred in the manufacturing industries (40%) and in construction (38%). They also reported that most burns occurred in unskilled and

semi-skilled laborers, followed by the service industry, which included the food industry.¹⁶ Our study showed that most of the occupational burn claimants were employed in the food service industry. These different findings may reflect the different industry bases of the study populations and the severity of the injuries. In addition, many of these studies relied on occupational information obtained from medical records. Information on employment obtained from the workers' compensation database is likely to be more accurate than that obtained by medical record

abstraction, given the incompleteness of medical records regarding occupation and industry.¹⁷

The risks to adolescents differed from that of the overall population. Adolescents had a greater proportion of total burn claims resulting in temporary total disability (24% for adolescents vs 15% for the general population of workers), suggesting more severe injuries in this group. Approximately 65% of these workers were injured in the food service industry. Prevention strategies targeted at this industry should significantly reduce the morbidity associated with occu-

pational burns for adolescents as well as the general population. A more detailed analysis of all claims in adolescents in Washington State has been prepared.¹⁸

The use of workers' compensation data has several limitations. First, the injuries are likely to be underreported because only those workers with injuries that resulted in the filling of a workers' compensation claim are recorded. First-degree burns are less likely to be reported than are second- or third-degree burns.⁷ Also, burns of the eyes, face, hands, and fingers may be more likely to be reported than those of other areas. Some employers may discourage reporting of injuries to preclude a workers' compensation insurance rate increase.¹⁹ Thus the data presented may underestimate the number of occupational burns.

Another limitation is the misclassification of information at data entry. This is most pronounced when burns are classified as either thermal or chemical. Also, contact dermatitis may be classified as chemical burn. The extent of misclassification is unknown, but the proportion of chemical burns may be overrepresented in our analysis.

The use of workers' compensation databases as a surveillance tool, if used effectively, can help reduce the incidence of occupational injuries and illnesses. The Washington State workers' compensation database represents a unique opportunity to identify workers and workplaces that are at increased risk for occupational injuries and illnesses. The use of this database allowed the first population-based descriptive study that encompasses a wide geographic area and allowed reporting on outpatient and inpatient occupational burns. Industry-specific rates and RRs could also be calculated to better target interventions.

The Oregon and Colorado state health departments developed surveillance systems for workers hospitalized with occupational burns, which are typically the most severe

burns. The goal of their NIOSH-funded Sentinel Event Notification System for Occupational Risks (SENSOR) programs were to target industry groups for interventions to reduce incidents of exposure to hazards and to focus industry, health care providers, and public health attention on work-related burns (Hospitalized Occupational Burn Surveillance Program, unpublished results, 1993). These interventions are important; however, our study demonstrated that hospitalized burns represent only a small proportion of all work-related burns—1.7% in our study. Hence, hospital-based systems may miss sentinel cases that highlight important burn hazards not yet linked to severe burns. This suggests that to significantly reduce the public health impact of occupational burns, a more complete surveillance system should include hospitalized and non-hospitalized burns, especially as burn care is increasing in outpatient settings.⁷

A successful intervention strategy to reduce the incidence of work-related burns should include the identification of workplaces that are at increased risk, workers at increased risk, agents involved, and the activities that put workers at increased risk. It should also target those industries with both an increased risk, large number of injuries, and increased severity of burn injuries. We have identified the workplaces and the workers at increased risk for occupational burns in Washington State. Further study must identify the work practices that result in burn injuries in different industries. Interventions can then be made to prevent this preventable injury.

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