

Claims Incidence of Work-Related Disorders of the Upper Extremities: Washington State, 1987 Through 1995

ABSTRACT

Objectives. This study examined the claim incidence rate, cost, and industry distribution of work-related upper extremity disorders in Washington.

Methods. Washington State Fund workers' compensation claims from 1987 to 1995 were abstracted and categorized into general and specific disorders of gradual or sudden onset.

Results. Accepted claims included 100 449 for hand/wrist disorders (incidence rate: 98.2/10 000 full-time equivalents; carpal tunnel syndrome rate: 27.3), 30 468 for elbow disorders (incidence rate: 29.7; epicondylitis rate: 11.7), and 55 315 for shoulder disorders (incidence rate: 54.0; rotator cuff syndrome rate: 19.9). Average direct workers' compensation claims costs (medical treatment and indemnity) were \$15 790 (median: \$6774) for rotator cuff syndrome, \$12 794 for carpal tunnel syndrome (median: \$4190), and \$6593 for epicondylitis (median: \$534). Construction and food processing were among the industries with the highest rate ratios for all disorders (>4.0).

Conclusions. Upper extremity disorders represent a large and costly problem in Washington State industry. Industries characterized by manual handling and repetitive work have high rate ratios. The contingent workforce appears to be at high risk. (*Am J Public Health*. 1998;88:1827-1833)

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The incidence of specific upper extremity disorders such as epicondylitis and rotator cuff syndrome has not been well described in the general population or in large working populations. There have been several epidemiologic studies, mainly of carpal tunnel syndrome, conducted within specific working populations.¹⁻³ Distribution of the magnitude of these disorders across different industries has not been fully documented. In some cases, disorders have been grouped together by means of administrative databases.⁴ The relationships between grouped categories and specific diagnoses are often not known, particularly with respect to identifying potentially high-risk industries for further exploration and prevention efforts. The extent to which these disorders may have a sudden or gradual onset (or both) has important implications for primary preventive actions. Gradual onset disorders are more likely to be prevented by reductions in the duration, frequency, or intensity of exposure to high force or repetition encountered over time. Sudden onset disorders (e.g., amputations and fractures) are more likely to be prevented by, for example, appropriate machine guarding or nonslippery surfaces.

We used workers' compensation claims data from Washington State to examine hand/wrist, elbow, and shoulder disorders and, respectively, carpal tunnel syndrome, epicondylitis, and rotator cuff syndrome as more specific diagnoses within each of these body regions.

Work-related carpal tunnel syndrome (compression of the median nerve at the wrist) has been associated with high repetition, force, awkward wrist postures, and segmental vibration.⁵ Work-related factors associated with epicondylitis (inflammation of the tendon at the elbow) include repetitive rotation of the forearm with force, as in using a screwdriver. Work-related rotator cuff syndrome (inflammation, degeneration,

and tear of the tendons surrounding the shoulder) has been associated with high static or repetitive loads on the shoulder girdle, particularly in combination with abduction, rotation, or flexion.⁶ Each of these specific conditions has also been associated with an acute traumatic onset (e.g., falls).

The objectives in this study were to determine the overall and yearly trends in claim incidence rates, costs, and days lost from work, over the period 1987 through 1995, for general and specific work-related musculoskeletal disorders. In addition, we wanted to identify high-risk industries for these disorders so that both research and prevention efforts can be more focused.

Methods

Workers' Compensation System

In Washington, employers are required to obtain workers' compensation insurance through the Department of Labor and Industries industrial insurance system unless they are able to self-insure (except for the self-employed, who are not required to have coverage). Approximately two thirds of the workers in the state are covered by the department's State Fund (the remainder work chiefly for the largest employers and

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are covered by these self-insured employers). Washington is the only state where workers contribute to the medical aid portion of the state fund.

Claims Management Database

Workers' compensation claims data and employment data for the years 1987 through 1995 were obtained from Washington State Department of Labor and Industries files. The department's claims management database consists of 2 major data processing systems. The Medical Information and Payment System receives all billing information generated by provider medical bills. This system records such relevant items as dates of service, associated *Current Procedural Terminology* (CPT) codes, and physician diagnosis according to *International Classification of Diseases, Ninth Revision* (ICD-9) code for each provider visit. The Department of Labor and Industries insurance system contains all data necessary for the administration of claims, including industry, occupation, age, employment status, health care provider information, nature of injury, type of injury, source of injury, body part affected, date and time of injury, days away from work, and claim status (rejected, pending, accepted, medical only, compensable, permanent partial disability, pension, fatal, etc.). American National Standards Institute z16.2 codes are used in coding injury information.

Definition of Outcome

We used accepted State Fund claims (for the 1987–1995 period, 9% of the State Fund claims were rejected). Self-insured claims were excluded because of incomplete information (no ICD-9 codes and no "medical only" claims data). Furthermore, we only included claims from the Medical Information and Payment System database that had authorized or allowed medical bills for specific diagnoses, ICD-9 codes, or appropriate CPT codes: for carpal tunnel syndrome, ICD-9 354.0 or CPT 64721 (median nerve compression at the carpal tunnel); for epicondylitis, ICD-9 726.31 to 726.32 or CPT 24350 (lateral or medial fasciotomy); and for rotator cuff syndrome, ICD-9 726.1, 726.10, 727.61, and 840.4 and CPT 23410, 23412, 23415, and 23420 (various rotator cuff repairs). In addition, we extracted any claim that involved a wrist or hand condition (or both) from the Department of Labor and Industries insurance system claim history data set by using the American National Standards Institute z16.2 body area code. Similar methods were used to extract claims for general elbow and shoulder disorders.

The specific disorders were defined as accepted claims based on presence of ICD-9 codes and/or CPT codes.

Because a workers' compensation claim may include disorders involving more than 1 body area, only the primary site is assigned a z16.2 code. When specific disorders (e.g., carpal tunnel syndrome) were examined in detail as to type of onset (sudden or gradual), the ICD-9 diagnosis in the Medical Information and Payment System database had to be matched with the appropriate body area code (e.g., hand or wrist) in the Department of Labor and Industries insurance system (since type and nature codes are available only for the primary site of disorder).

For each claim, we extracted claim status ("compensable" lost time claim of 4 or more days or medical treatment claim only); ICD-9 codes; z16.2 codes for body area, nature, and type of disorder; 4-digit Washington Industrial Classification; claim identification number; Social Security number; date of injury; age; gender; total cost of claim; days of time loss; dollar amount of time loss payments; and dollar amount of medical aid payments. We used the first date of injury to estimate incidence.

We categorized gradual and sudden onset to differentiate "cumulative" trauma exposures from acute trauma exposures, such as falls; a combination of body part, nature, and type was required to categorize exposure. Gradual onset type (z16.2) codes included disorders caused by rubbing or abrasion (080), further restricted to disorders caused by objects being handled (not vibrating) (082), those caused by vibrating objects (083), those caused by repetition of pressure (080), and those caused by repetitive motion (086), overexertion (12), and bodily reaction (10). These type codes were combined with the following nature codes: inflammation or irritation of the joints, tendons, or muscles (260), including bursitis, tendinitis, synovitis, and tenosynovitis; sprains and strains (310); and diseases of the nerves and peripheral ganglia (562). Disorders that were not of gradual onset were regarded as sudden onset (e.g., slips, trips, and falls).

Case Definition Validation Exercises

Two claim records abstraction exercises were conducted to evaluate the coding schemes used for both onset type (sudden or gradual) and specific diagnosis. In the first exercise, we took a random sample of 96 compensable claims coded as carpal tunnel syndrome ($n = 56$), epicondylitis ($n = 15$), and rotator cuff disorders ($n = 25$). The coded diagnosis was recorded in each of the claim medical records, indicating that the

physician's statement in the medical records was accurately coded in the claims database. There was fair to good agreement on gradual vs sudden onset for carpal tunnel syndrome (76%; $\kappa = 0.49$) and epicondylitis (80%; $\kappa = 0.41$) but less agreement for rotator cuff syndrome (64%; $\kappa = 0.39$). The codes tended to underestimate gradual onset relative to the actual records.

The second exercise involved abstracting medical records from 100 random claims from 1995 coded as acute onset carpal tunnel syndrome and 98 coded as gradual onset hand/wrist disorders. As in the first exercise, the case definition for carpal tunnel syndrome included symptoms in the median nerve distribution and one of the following: positive electrodiagnostic study, carpal tunnel release surgery, or positive physical examination. Eighty-one percent of the first group met the case definition for carpal tunnel syndrome, and 43% of the second group met the definition. All cases coded as gradual onset met the definition of gradual onset. Of those coded as sudden onset, 64% were actually gradual onset. Nonetheless, this was the scheme used for abstraction in the present study.

Data were extracted from the Department of Labor and Industries database as of August 1997. Claim costs and time loss days reported here reflect actual totals for closed claims. For claims that were not closed, these values reflect actual totals as of August 1997 combined with total future estimated costs and time loss days (as calculated by agency actuarial staff). Cost and lost time data were expected to develop further for the most recent years. For example, as of August 1997, approximately 5% of all 1994 wrist claims were still open, as were 9% of 1995 wrist claims.

Washington State Employment by Industry

Information on employment is reported to the Department of Labor and Industries by employers as the number of hours worked by employees. For example, for 1994, State Fund employers reported 2 482 730 085 hours. Hours by age and gender were not available. Numbers of employees working per year were calculated assuming that each full-time employee works 2000 hours per year (40 hours per week for 50 weeks per year). Worker hours represent hours of exposure according to the Washington Industrial Classification. They were converted to full-time equivalent workers (total hours reported divided by 2000). An industrial classification is a grouping of industries that share similar workplace exposures. Washington Industrial

TABLE 1—Washington State Fund Workers' Compensation Claims for Specific Body Areas and Diagnoses, 1987–1995

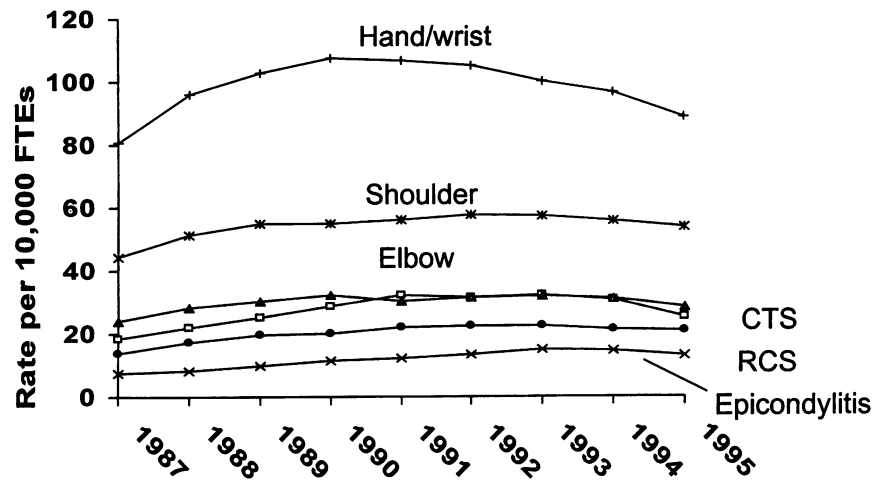
	Hand/Wrist			Elbow			Shoulder		
	All Hand/Wrist	Hand/Wrist Gradual Onset	Carpal Tunnel Syndrome	All Elbow	Elbow Gradual Onset	Epicondylitis	All Shoulder	Shoulder Gradual Onset	Rotator Cuff Syndrome
Claims per year, mean	11 161	4 892	3 132	3 385	1 351	1 351	6 146	3 427	2 282
Individuals per year, mean	10 180	4 631	2 918	3 208	1 297	1 281	5 700	3 250	2 159
Female, %	40.2	51.0	55.9	31.1	36.2	39.7	32.0	35.6	33.0
Median age, y	32	33	36	36	38	39	34	34	38
Yearly claim rate per 10 000 full-time equivalents, mean (95% confidence interval)	98.3 (91.4, 105.1)	42.8 (38.2, 47.3)	27.3 (23.5, 31.1)	29.7 (27.8, 31.7)	11.9 (10.3, 13.3)	11.8 (10.2, 13.3)	54.0 (50.9, 57.1)	30.1 (28.1, 31.8)	19.9 (17.8, 22.1)
Time loss claims per year, %	35.5	42.1	69.3	31.8	36.4	46.8	43.2	39.3	65.5
Time loss days per claim, mean	209	210	228	206	231	205	244	213	263
Time loss days per claim, median	56	63	87	48	62	66	55	41	97
Total cost per claim, \$, mean	6 977	7 658	13 031	6 233	7 412	6 593	10 776	7 980	15 790
Total cost per claim, \$, median	257	428	4 246	241	413	534	439	350	6 774

Classifications are more specific than Standard Industrial Classifications because employers must subclassify their employees based on type of work. Washington Industrial Classifications are used in presenting upper extremity claim incidence rates. As a means of eliminating unstable rates, only those classifications with a minimum of 5 cases and 100 full-time equivalents per year over the 9-year period were included in the industry analyses.

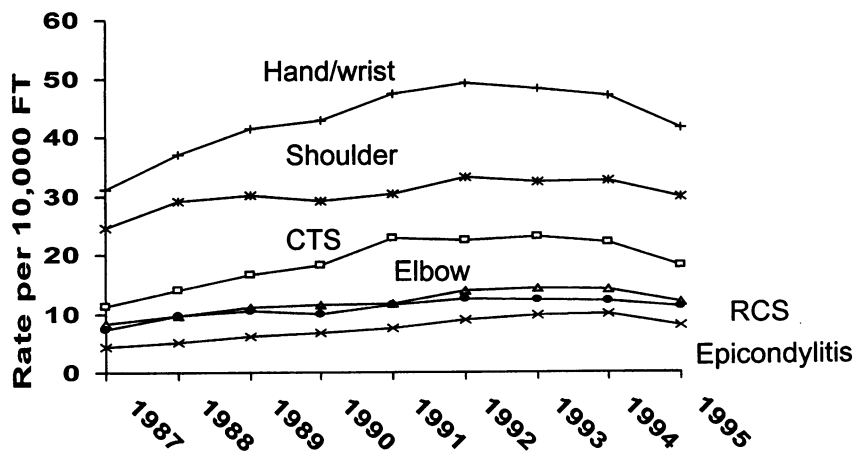
Statistical Analysis

Statistical analyses were carried out for all hand/wrist, elbow, and shoulder claims and for claims with the specific ICD-9 diagnosis codes (and/or appropriate CPT codes) and type of onset. Descriptive analyses included a summary of claims by year, direct workers' compensation costs, lost time, age, and gender. Claim incidence rates were calculated by year and industry class and are expressed as the number of upper extremity claims per 10 000 full-time equivalents (using SAS version 6.12). The GENMOD procedure, with a Poisson distribution, was used to evaluate trends over time. Each Washington Industrial Classification specific rate was compared with the industrywide rate, and a crude claim incident rate ratio was calculated.

To assess how well the State Fund data represented the entire state, we compared 1992 through 1995 State Fund compensable claims and self-insured compensable claims rates using only z16.2 codes. Hours for the earlier years of this study were not available for the self-insured data. We compared 1994 overall upper extremity compensable claims rates and then limited the analysis to those Washington Industrial Classifications that were common in both databases as the employment-weighted compensable claims rate.



a. All general and specific upper extremity disorders



b. gradual onset disorders

Note. FTEs = full-time equivalents; CTS = carpal tunnel syndrome; RCS = rotator cuff syndrome.

FIGURE 1—Upper extremity musculoskeletal claim incidence rates: Washington State Fund, 1987–1995.

Results

Magnitude of Upper Extremity Disorders in Washington State

Over the 1987–1995 period, 100 449 State Fund claims for hand/wrist disorders, 30 468 claims for elbow disorders, and 55 315 claims for shoulder disorders were accepted (averages of 11 161 hand/wrist claims per year, 3385 elbow claims, and 6146 shoulder claims) (Table 1). Claimants had a median age of 32 to 36 years, depending on body region. Female claimants accounted for 40% and 56%, respectively, of all hand/wrist and carpal tunnel syndrome claims; 31% and 40% of all elbow and epicondylitis claims; and 32% and 33% of all shoulder and rotator cuff syndrome claims.

Over the study period, the average claim incidence rate for hand/wrist disorders was 98.2 per 10 000, with 44% of cases having a gradual onset; for carpal tunnel syndrome, the rate was 27.3, with 69% involving carpal tunnel syndrome of gradual onset (Table 1). The rate for elbow disorders was 29.7 per 10 000 full-time equivalents per year (40% gradual onset), and the rate for epicondylitis was 11.7 per 10 000 full-time equivalents per year (64% gradual onset). For shoulder disorders, the claim incidence rate was 54.0 per 10 000 full-time equivalents per year (56% gradual onset); for rotator cuff syndrome, the rate was 19.9 per 10 000 full-time equivalents (54% gradual onset). Overall, the specific diagnosis represented 28% to 40% of the musculoskeletal injuries and illnesses in the relevant body area.

A greater proportion of claimants with specific diagnoses had claims resulting in 4 or more days of lost time than for the general body area claimants (Table 1). One half of epicondylitis and two thirds of carpal tunnel syndrome and rotator cuff syndrome claims involved 4 or more days lost from work, with medians of 87 days lost from work per carpal tunnel syndrome claim, 66 days per epicondylitis claim, and 97 days per rotator cuff syndrome claim. The median costs (medical treatment and indemnity) were \$4246 per carpal tunnel syndrome claim, \$534 per epicondylitis claim, and \$6774 per rotator cuff syndrome claim.

The State Fund compensable claim incidence rate (4 or more days of lost time) for combined shoulder, elbow, and hand/wrist disorders was 50 per 10 000 from 1992 through 1995, as compared with 62 per 10 000 for the self-insured. The 1994 employment-weighted compensable claim incidence rate was 35 per 10 000 for the State Fund vs 62 for the self-insured.

Figure 1 shows claim incidence rates by year. The number of claims and the rate increased for all general and specific disorders up through 1993 and then seemed to level off. The overall claims rate in Washington State experienced a steeper decline. The rate for all claims decreased from 1681 per 10 000 full-time equivalents in 1988 to 1242 per 10 000 in 1995 (slope = -0.0453 , $P < .0001$). On the other hand, a roughly twofold rate increase over the study period was found for the gradual onset disorders of epicondylitis (slope = 0.07 , $P < .0001$) and rotator cuff syndrome (slope = 0.04 , $P < .003$). The gradual onset carpal tunnel syndrome slope was more quadratic (year slope = 0.07 , $P < .0001$, squared year slope = -0.03 , $P < .001$). The differences in slopes between all upper extremity claims and gradual onset upper extremity claims relative to nonmusculoskeletal disorder claims were statistically significant ($P < .0001$). The claim incidence rates remained stable for the sudden onset disorders.

There were decreases in the percentage of claims that were compensable (4 or more lost workdays) for rotator cuff syndrome (from 69% in 1987 to 60% in 1995), epicondylitis (from 55% in 1987 to 40% in 1995), and carpal tunnel syndrome (from 77% in 1987 to 63% in 1995).

For general and specific hand/wrist and elbow disorders, there was roughly a 125% increase in the proportion of female claimants over the 9-year period. For shoulder and rotator cuff disorders, there was only a slight increase. Women represented the majority of claimants for carpal tunnel syndrome (60% in 1995) but not epicondylitis (41% in 1995) or rotator cuff syndrome (34% in 1995). Women were more highly represented in the specific diagnostic categories of gradual onset than in those of acute onset.

High-Risk Industrial Classes

Tables 2 through 4 show the 10 industries with the highest claim incidence rates

TABLE 2—Top 10 Highest Rate Ratios for 4-Digit Washington Industrial Classifications (WIC) and Claim Incidence Rates per 10 000 Workers, 1987–1995: Shoulder Disorders

WIC	Incidence Rate (95% CI)	Rate Ratio
All Shoulder		
Tree topping	385 (285, 510)	7.1
Wallboard installation	353 (317, 392)	6.5
Logging	332 (310, 356)	6.1
Ski facilities	316 (260, 381)	5.8
Roofing	313 (284, 344)	5.8
Shake mills	286 (221, 365)	5.3
Garbage collection	282 (256, 310)	5.2
Garage door installation	278 (204, 369)	5.1
Fence erection	265 (211, 327)	4.9
Temporary help—machine operators	251 (183, 336)	4.6
Gradual Onset Shoulder		
Shake mills	207 (152, 275)	6.8
Wallboard installation	199 (172, 228)	6.6
Garbage collection	172 (152, 194)	5.7
Temporary help—assembly	169 (139, 203)	5.6
Fence erection	161 (120, 211)	5.3
Glass installation	152 (121, 187)	5.0
Nursing homes	143 (137, 149)	4.7
Seafood canneries	142 (116, 171)	4.7
Roofing	141 (122, 163)	4.7
Meat products manufacturing	133 (111, 157)	4.8
Rotator Cuff Syndrome		
Wallboard installation	155 (131, 181)	7.7
Roofing	124 (106, 144)	6.1
Garbage collection	113 (97, 131)	5.6
Logging	111 (98, 126)	5.5
Commercial concrete construction	107 (79, 142)	5.3
Masonry	103 (84, 126)	5.1
Insulation installation	96 (79, 116)	4.8
Meat/poultry wholesale	93 (69, 122)	4.6
Plywood manufacturing	84 (69, 101)	4.1
Sawmills	80 (70, 92)	4.0

Note. The rate ratio reference group is all industries combined. Classifications with less than 900 full-time equivalents (100 per year) or 45 cases (5 per year) were excluded. CI = confidence interval.

TABLE 3—Top 10 Highest Rate Ratios for 4-Digit Washington Industrial Classifications (WIC) and Claim Incidence Rates per 10 000 Workers, 1987–1995: Elbow Disorders

WIC	Incidence Rate (95% CI)	Rate Ratio
All Elbow		
Wallboard installation	195 (168, 224)	6.5
Shake mills	189 (137, 255)	6.3
Roofing	170 (149, 193)	5.7
Fence erection	167 (125, 218)	5.6
Insulation installation	160 (139, 185)	5.4
Logging	136 (122, 152)	4.6
Iron merchants	126 (100, 157)	4.2
Masonry	126 (105, 151)	4.2
Glass installation	124 (96, 156)	4.1
Building construction, NOC	117 (105, 130)	3.9
Gradual Onset Elbow		
Wallboard installation	87 (70, 108)	7.3
Roofing	74 (60, 90)	6.2
Foundries, NOC	62 (49, 78)	5.2
Masonry	59 (45, 76)	5.0
Airline ground crew	54 (41, 69)	4.5
Furniture/casket manufacturing	53 (40, 70)	4.5
Paper products manufacturing	52 (40, 66)	4.4
Iron merchants	52 (35, 72)	4.3
Wood frame building construction	47 (43, 51)	3.9
Building construction, NOC	47 (39, 56)	3.9
Epicondylitis		
Wallboard installation	100 (82, 122)	8.4
Roofing	69 (56, 85)	5.8
Masonry	61 (46, 79)	5.1
Foundries, NOC	52 (40, 67)	4.3
Building construction, NOC	49 (41, 57)	4.1
Furniture/casket manufacturing	48 (35, 64)	4.0
Wood frame building construction	47 (43, 51)	3.9
Paper products manufacturing	45 (34, 58)	3.8
Meat dealers wholesale	44 (37, 53)	3.7
Concrete construction	44 (36, 53)	3.7

Note. The rate ratio reference group is all industries combined. Classifications with less than 900 full-time equivalents (100 per year) or 45 cases (5 per year) were excluded. CI = confidence interval; NOC = not otherwise classified.

(and rate ratios) for the 3 body area general disorders and the 3 specific diagnoses. Construction industries dominated the high-risk categories for shoulder and elbow disorders. Other heavy manual handling industries involving high risk included logging, garbage collection, nursing homes, and foundries. Gradual onset carpal tunnel syndrome was dominated by the food processing and manufacturing industries. The highest rate ratios for carpal tunnel syndrome were found in shake mills and food processing (seafood canneries and processors, meat and poultry dealers, and creameries). The incidence rate for these industries ranged from 166 to 216 per 10 000 full-time equivalents.

For the most part, the same industries were in the top 10 in terms of high risk consistently throughout the 9-year period. However, a more recent trend that did not show up in the 9-year summary was the inclusion of temporary help agencies as high-risk industries. These agencies were separately

classified by type of work (e.g., assembly, machine operator, construction, food processing, and health care) in Washington Industrial Classifications largely after 1989. Although the claim incidence rates have been high, the denominators have been relatively small until recently, thus making the rates unstable. Nonetheless, temporary assembly help has been in the top 10 industries for shoulder disorders every year since 1990 with the exception of 1991, and temporary machine operator help was in the top 10 industries for shoulder disorders in 1993 and 1995. Likewise, temporary assembly help was in the top 10 industries for elbow disorders in 1990, 1991, and 1994. Temporary help agencies have been in the top 10 high-risk industries for hand/wrist disorders every year since 1989, primarily assembly and machine operators but construction as well.

The State Fund and the self-insured involved slightly different industry mixes, as reflected in the 1992 through 1995 top 10 industry classifications by compensable

claim incidence rate for gradual onset shoulder and hand/wrist disorders (Table 5).

Discussion

We looked at general and specific hand/wrist, elbow, and shoulder disorders and claims considered to involve a gradual onset based on nature and type of disorder. We found the overall workers' compensation claim incidence rate to be highest for hand/wrist disorders (98.2 per 10 000 full-time equivalents), followed by shoulder (54.0 per 10 000 full-time equivalents) and elbow disorders (29.7 per 10 000). For compensable disorders, the rate was lower in the State Fund than among the self-insured (Table 5).

Upper extremity disorders represent a significant cause of morbidity in the working population. Rossignol et al. reported the surgical incidence rates of carpal tunnel syndrome in Montreal male and female manual workers as 19 and 18 per 10 000, in comparison with 9 per 10 000 for the overall adult population.⁷ Among these workers, 75% and 55% of all surgical carpal tunnel syndrome was attributable to work. Food and beverage processing and material handling were also among those occupations at increased risk. Tanaka et al.³ estimated the overall prevalence of self-reported carpal tunnel syndrome among the recently working general US adult population at 1.47%. Although Webster and Snook⁴ were unable to estimate incidence rates for upper extremity cumulative trauma disorders, they identified 6067 claims in 1989 for policy holders in 45 states with an average cost of \$8070. They then estimated the national cost to be \$563 million. For that same period (1989), we identified 8791 shoulder, elbow, and hand/wrist lost time and medical-only claims with gradual onset in Washington State. The average cost of our 1989 claims ranged from \$7093 to \$8250. If one assumes that there are 96 million workers in the United States (the number covered by the Occupational Safety and Health Administration [OSHA]) with an overall incidence rate of 85.3 per 10 000 and an average claim of about \$7500, the total direct workers' compensation cost (medical and indemnity) would have been approximately \$6.1 billion in 1989. None of these figures take into account indirect costs to employers in terms of lost productivity, quality, training of replacement workers, recruitment, and other administrative costs. Nor do these figures take into account the quantitative and qualitative costs to the claimant and family, as well as those workers who never file a workers' compensation claim but suffer from a work-related upper extremity disorder.

TABLE 4—Top 10 Highest Rate Ratios for 4-Digit Washington Industrial Classifications (WIC) and Claim Incidence Rates per 10 000 Workers, 1987–1995: Hand/Wrist Disorders

WIC	Incidence Rate (95% CI)	Rate Ratio
All Hand/Wrist		
Reinforced steel installation	899 (720, 1109)	9.1
Temporary help—machine operators	692 (576, 826)	7.0
Shake mills	665 (563, 780)	6.8
Temporary help—assembly	638 (580, 702)	6.5
Seafood canneries	584 (531, 640)	5.9
Roofing	517 (480, 557)	5.3
Tree topping	465 (354, 599)	4.7
Meat products manufacturing	457 (417, 501)	4.6
Meat/poultry dealers wholesale	443 (388, 503)	4.5
Saw mills	441 (415, 467)	4.5
Gradual Onset Hand/Wrist		
Reinforced steel installation	506 (375, 669)	11.7
Seafood canneries	341 (301, 384)	7.9
Temporary help—assembly	330 (289, 376)	7.7
Shake mills	291 (225, 370)	6.7
Meat/poultry dealers wholesale	259 (218, 306)	6.0
Meat products manufacturing	250 (220, 282)	5.8
Creameries	221 (186, 266)	5.1
Meat dealers wholesale	211 (194, 229)	4.9
Christmas tree farms	205 (157, 264)	4.8
Roofing	197 (174, 222)	4.6
Carpal Tunnel Syndrome		
Shake mills	216 (160, 285)	7.8
Seafood canneries	188 (159, 222)	6.8
Meat/poultry dealers wholesale	169 (136, 207)	6.1
Creameries	165 (133, 202)	6.0
Meat products manufacturing	139 (117, 164)	5.0
Meat dealers wholesale	133 (120, 147)	4.8
Wallboard installation	131 (109, 155)	4.8
Aluminum smelting	127 (103, 156)	4.6
Roofing	117 (99, 136)	4.2
Logging	116 (103, 130)	4.2

Note. The rate ratio reference group is all industries combined. Classifications with less than 900 full-time equivalents (100 per year) or 45 cases (5 per year) were excluded. CI = confidence interval.

The Bureau of Labor Statistics, using a stratified random sample of employer OSHA log reports, estimated that the rate of disorders associated with repeated trauma was 37.8 per 10 000 full-time equivalents in 1995. Although some of these disorders were

related to hearing loss, they were largely upper extremity disorders that could be roughly compared with our combined shoulder, elbow, and hand/wrist disorders with gradual onset. It should be noted that the Bureau of Labor Statistics does not include

upper extremity disorders associated with “overexertion due to lifting, pushing, pulling, or carrying” in the preceding category, whereas we included this injury type in our gradual onset case definition. Nonetheless, our 1995 rate of 83.1 per 10 000 full-time equivalents was more than twice the Bureau of Labor Statistics rate. Likewise, our 1995 estimated rate for carpal tunnel syndrome (15.8 per 10 000 full-time equivalents) resulting in more than 4 lost workdays was almost 4 times the bureau’s estimate of carpal tunnel syndrome resulting in more than 1 lost workday (3.9 cases per 10 000 full-time equivalents in private industry) in 1995.⁸ It is unlikely that this difference can be explained by the inclusion of both public and private industry in Washington State data or by the difference in industry mix.⁹ Although there had been some increase in these disorders in Washington State between 1987 and 1995, the increase has been quite modest relative to the rapid rise in rates reported by the Bureau of Labor Statistics, suggesting potential underreporting in the bureau’s data.

The incidence of work-related carpal tunnel syndrome found in this study was 27.3 per 10 000 full-time equivalents over the years 1987 through 1995, while Franklin et al.,¹ who also used Washington state workers’ compensation data, reported a claim rate of 17.4 per 10 000 full-time equivalents for carpal tunnel syndrome over the period 1984 through 1988. The increase in claim rate over the years is consistent with national data.

The construction industries ranked high in overall upper extremity claims in the State Fund data. Although tasks in these industries are quite varied, they are characterized by manual handling of heavy materials, high peak hand force with periodic repetitive motions (sometimes with segmental vibration, as in sawing or drilling), and awkward postures. Construction industries are not identified in the top industries for repetitive

TABLE 5—Top 10 Industries Ranked by Incidence Rate: Comparison of 1992–1995 State Fund and Self-Insured Compensable Claims

Shoulder Disorders—Gradual Onset		Hand/Wrist Disorders—Gradual Onset	
State Fund	Self-Insured	State Fund	Self-Insured
Wallboard installation	Bus companies	Temporary help—assembly	Boat building/repair
Roofing	Newspaper publishing	Creameries	Telephone companies
Garbage collection	Fruit and vegetable packing	Roofing	Wholesale stores
Temporary help—assembly	Warehouses, NOC	Wallboard installation	Aluminum products manufacturing
State health care facilities	Parcel package delivery	Meat dealers wholesale	Bakeries, NOC
Airline ground crew	Cities—all other employees	Paper products manufacturing	Fruit and vegetable packing
Moving companies	Airline ground crew	Sawmills	Bus companies
Insulation installation	Schools—all other employees	Logging	Schools—all other employees
Meat products manufacturing	Trucking, NOC	Meat products manufacturing	Supermarkets
Laundries—commercial	Aluminum products manufacturing	Furniture/casket manufacturing	Cities—all other employees

Note. NOC = not otherwise classified.

motion disorders in the Bureau of Labor Statistics data. The reason for this difference may be that we chose to include overexertion in lifting as a gradual onset disorder (whereas the Bureau of Labor Statistics separates overexertion from repetitive motion). Industries associated with food processing (meat, poultry, and seafood processing) were also consistently ranked in the high-risk industries in our data, as they were in the Bureau of Labor Statistics repetitive motion data.

The percentage of female claimants increased over the years 1987 to 1994. A reason could be the steady increase in the proportion of women in the workforce since 1960. In Washington State, the female portion of the workforce increased from 45.3% in 1987 to 46.9% in 1995.¹⁰ The average percentage of women with hand/wrist claims from 1987 to 1995 was 40%; the corresponding rates for hand/wrist disorder with gradual onset, carpal tunnel syndrome, and carpal tunnel syndrome with gradual onset were 51%, 56%, and 61%. This is more than would be expected when taking into account that the percentage of women in the total Washington State Fund claim database steadily increased from 23% in 1987 to 26.5% in 1993. It may be that women differentially select or are selected into highly repetitive work that puts them at increased risk.

This study involved a number of limitations. The first, potential misclassification of the outcome measures—particularly differentiating gradual from sudden onset—was discussed earlier. The American National Standards Institute z16.2 codes are particularly cumbersome and are more easily usable with acute traumatic injuries. Nonetheless, we felt it important to attempt this differentiation, because the prevention strategies might be different for gradual onset (reducing duration, intensity, or frequency of repetitive or forceful tasks as compared with installing machine guarding, for example). The second validation exercise indicated that 62% of the “sudden onset” hand/wrist disorders should have been coded as gradual onset, suggesting that the incidence of gradual onset disorders may have been underestimated.

The second limitation was potential misclassification of exposure. Using broad industrial categories as surrogates for expo-

sure may mask high-risk jobs in heterogeneously exposed industries. However, because the Washington Industrial Classification refers to subclasses of industries based on actuarial assessment of “risk,” misclassification was probably less pronounced than would be the case with the Standard Industrial Classifications system, which is based on commerce.

Third, this study excluded the largest employers in the state (including large aerospace and forest products employers, industries known to have jobs with work-related risk factors for these upper extremity disorders). In some respects, because smaller employers were more represented, it may be that costs were overestimated owing to the greater capacity of large employers to return employees to work, even in light-duty jobs, thereby reducing lost days and costs. However, the limited analysis we were able to perform on 1992 to 1995 compensable claims indicated that the overall compensable claim incidence rate for upper extremity disorders was greater for the self-insured than for the State Fund. The industry mix of these 2 workers' compensation sectors may be different, as seen in Table 5. However, when an employment-weighted compensable claim incidence rate was calculated, the rate for the self-insured was still higher than that for the State Fund employers.

A fourth limitation was the bias inherent in reporting: the acute disorders, instead of the more gradual onset illnesses, tend to gain more ready acceptance in the workers' compensation system. The medical records review indicated that the databases were quite useful for correctly identifying carpal tunnel syndrome, epicondylitis, and rotator cuff syndrome and that our coding scheme for determining gradual and sudden onset was fair to good.

In this study, we were able to define specific disorders with gradual onset. This allowed us to identify some high-risk industries that would not have been identified otherwise (e.g., rotator cuff disorders in nursing homes). We were also able to identify some emerging trends among workers in temporary service agencies. We hope our findings will generate a closer look at health and safety issues affecting contingent workers.

Although much has been written about carpal tunnel syndrome, the magnitude and

distribution of rotator cuff syndrome and epicondylitis have not been previously described in US working populations. The claim incidence rate of rotator cuff syndrome was two thirds that of carpal tunnel syndrome (19.9 vs 27.3) but more costly (Table 1). Epicondylitis involved half of the rate and cost but still presented a major lost time problem. Research and prevention activities focused on manual handling and construction industry risk factors should contribute to reductions in these work-related disorders. □

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