Costs of Occupational Injuries and Illnesses in California[1]

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Objectives. The purpose of this study was to estimate the annual incidence, the mortality, and the direct and indirect costs associated with occupational injuries and illnesses in California in 1992. To achieve this, we performed aggregation and analysis of national and California data sets collected by the U.S. Bureau of Labor Statistics, California Workers' Compensation Insurance Rating Bureau, California Division of Industrial Relations, the National Center for Health Statistics, and the U.S. Health Care Financing Administration.

Methods. To assess incidence of and mortality from occupational injuries and illnesses, we reviewed data from state and national surveys and applied an attributable risk proportion method. To assess costs, we used the cost-of-illness, human capital, method that decomposes costs into direct categories such as medical expenses and insurance administration expenses as well as indirect categories such as lost earnings, lost home production, and lost fringe benefits. Some cost estimates were drawn from California data, whereas others were drawn from a national study but were adjusted to reflect California's differences. Cost estimates for injuries were calculated by multiplying average costs by the number of injuries. For the majority of diseases, cost estimates relied on the attributable risk proportion method.

Results. Approximately 660 job-related deaths from injury, 1.645 million nonfatal injuries, 7,079 deaths from diseases, and 0.133 million illnesses are estimated to occur annually in the civilian California workforce.

The direct ($7.04 billion, 34%) plus indirect ($13.62 billion, 66%) costs were estimated to be $20.7 billion. Injuries cost $17.8 billion (86%) and illnesses $2.9 billion (14%). These estimates are likely to be low because: (1) they ignore costs associated with pain and suffering, (2) they ignore home care provided by family members, and (3) the numbers of occupational injuries and illnesses are likely to be undercounted.

Conclusion. Occupational injuries and illnesses are a major contributor to the total cost of health care and lost productivity in California. These costs are on a par with those of all cancers combined and only slightly less than the cost of heart disease and stroke in California. Workers' compensation covers less than one-half of the costs of occupational injury and illness. © 2001 American Health Foundation and Academic Press

Key Words: economics; OSHA; jobs.

INTRODUCTION

National estimates of occupational injuries and illnesses have received some attention because of their great cost [1]. In this study, we extend an earlier national analysis to generate cost estimates for California. We incorporate data specific to California as well as rely on proportion estimates from national sources where California data are not available.

Costs have become critical statistics in medical care debates. Cost estimates are available for many diseases and injuries whether or not occupational. Within California, costs are available for cardiovascular disease ([2] $6.4 billion, 1991, indirect only, no direct estimate for 1991), cigarette smoking ([3] medical expenditures only, 1993, $8.7 billion), and motorcycle crash injuries ([4] medical and productivity costs, roughly $700 million in 1991). They are also available at the national level for diabetes ([5] medical only $47.9 billion, 1995) and for all circulatory disease ([6] $127.8 billion, 1995

medical only). No other published study has estimated occupational injury and illness costs for California. Every state has a workers' compensation (WC) insurance system and state legislators and governors must evaluate each of these from time to time. The first purpose of this study is to advance our understanding regarding the overall costs as well as which injuries, illnesses, and conditions contribute to great or small costs. This understanding will allow us to better allocate limited resources to improve the effectiveness of medical care and preventive interventions. In addition to this larger cost-effectiveness purpose, this study has a narrower one: to serve as a template for estimating costs in other states.

This study relies on standard counting and cost methods. Definitions of injuries and illnesses are conventional. We do not invent new methods or theories of what constitutes an occupational injury or illness. This study relies on published data whenever possible and on estimates when data are not available. These estimates are carefully explained in a background report available from the authors. Here, we summarize our methods and findings.

METHOD

Number of Injuries

Deaths.   We rely on the Census of Fatal Occupational Injuries (CFOI) [7] as well as national estimates [8] to estimate California deaths. California contributed 10.36% of the national death toll in 1992 within the CFOI. The national estimate [8] was 6,371, which is a little higher than the U.S. CFOI count of 6,063 civilian deaths. The product of 0.1036 times 6,371 is 660, which is our estimate of California injury deaths in 1992. We prefer the national estimate [8] over the CFOI count since the national estimate allows for a likely undercount of minorities in the CFOI.

Nonfatal injuries.   Estimates for nonfatal injuries are generated in a similar manner. First, a percentage unique to California is obtained (12.3%). This 12.3% is California's contribution to U.S. injuries estimated in the Bureau of Labor Statistics' (BLS) Annual Survey (Annual Survey) in 1992. Second, this percentage is then multiplied by the national estimates [8] (13,337,000). Third, a special California adjustment is made to estimate disabling and nondisabling injuries. Disabling injuries are those that result in at least 1 day of work loss. Nondisabling injuries are all others.

The national estimates account for the poor and incomplete data in the BLS Annual Survey on farmers, domestics, immigrants, the self-employed, minorities, government workers, and workers in small firms. The national estimate relies on two assumptions. (1) The injury rate for persons and firms excluded from the

BLS Annual Survey (many farmers, domestics, farm workers, the self-employed, government workers) is the same as the rate for private firms included in the Annual Survey. (2) Firms face an economic incentive to underreport. The national estimate assumed 20% underreporting for disabling injuries and 35% for nondisabling injuries.

The special disabling/nondisabling adjustment allows for a greater number of injuries that qualify for WC indemnity benefits in California than in other states [9]. To qualify for indemnity benefits, the injured workers must have missed at least 3 days of work. Hence, all of these worker injuries would be classified as disabling, i.e., missing at least 1 day. For the nation, we estimate 40% of all injuries are disabling and 60% are nondisabling [8]. For California, in this study, we assume 45% are disabling and 55% are nondisabling.

Number of Illnesses

Deaths.   Since few diseases are caused solely by occupational exposures, our approach uses the population attributable risk (PAR) method. In this method, percentages of deaths in major disease categories are attributed to occupational exposures. Given the uncertainty in knowledge of the exact proportions of deaths attributable to occupations, ranges and point estimates of proportions of deaths are used, including 6 to 10% for cancer, 5 to 10% for cardiovascular and cerebrovascular disease, 10% for chronic respiratory disease, 100% for pneumoconioses, and 1 to 3% for nervous system disorders and renal disorders. In estimating these deaths, we ignore decedents age 24 years or younger for all categories of deaths, and for circulatory (cardiovascular and cerebrovascular) diseases we also exclude decedents older than 64 years.

The rationale for the PAR method and these specific percentages are available [1, 8]. The limitations of the attributable proportion method are considerable. For example, because of synergistic effects, the proportions for all causes of a given disease can sum to more than 100%. However, given the great difficulty associated with counting occupational disease deaths, this method is heavily relied on in the literature [10, 11]. Numerous studies indicate that our PARs for cancer and chronic obstructive diseases are reasonable [8, 12, 13]. Our PARs are also consistent with the few studies on occupational circulatory disease and nervous system and renal disorders [8, 14].

Morbidity.   To estimate chronic occupational diseases that might lead to death, we again use the PAR method. To estimate the number of acute occupational diseases that are unlikely to lead to death (e.g., dermatitis, poisonings, repetitive strain injuries), the following data sources are used: the BLS Annual Survey, the Federal Occupational Workers' Compensation Program

(OWCP), Leigh et al. [8], and the Adult Blood Lead Epidemiology and Surveillance (ABLES) program maintained by the Occupational Health Branch of the California Department of Health Services.

To obtain an estimate of the number of new cases of major chronic diseases, including cancer, obstructive pulmonary disease, and circulatory disease, we apply the same percentages to morbidity estimates as we apply to mortality estimates as noted in the previous section. Numbers of new cases of these diseases in the general U.S. population were obtained from the American Cancer Society, the American Heart Association, and the National Heart, Lung and Blood Institute. Again, we restricted analyses to persons ages 25 years and older and, in the case of cardiovascular and cerebrovascular disease, to persons younger than 65 years.

But morbidity numbers based upon the PAR method do not explicitly count any of the data available on job-related illnesses in the BLS Annual Survey, most of which is acute, nor similar data from the OWCP or the ABLES program [8, 15]. We do not use these data "as is," however. In the Annual Survey, the self-employed, government workers, and small farms are excluded. Domestics and immigrants are undercounted. Moreover, there is an economic incentive to underreport. We adjust for each of these factors. First, we use the California illness rate per 10,000 employees from the Annual Survey to multiply by all Californians working in 1992. This then accounts for the self-employed, government workers, farmers, domestics, and immigrants. Second, we adjust for the economic incentive to underreport by roughly 20% for disabling illnesses and 35% for nondisabling illnesses. The underreporting statistics are based upon studies by Glazer et al. [16] and data in Ruser [17] as interpreted by Leigh [8]. Finally, we adjust for the BLS undercount of poisonings with data from ABLES.

Costs

We adopt the human capital/cost-of-illness method for calculating costs. The human capital/cost-of-illness method is the most widely used method in the medical and legal literature in large part because estimates are available and reliable. It is especially useful in dividing costs into direct and indirect components, unlike the willingness-to-pay method.

Direct costs represent actual dollars spent or anticipated to be spent on providing medical care to an injured or ill person as well as administrative costs for delivering medical care and indemnity benefits. Medical costs include physicians' and nurses' services, hospital charges, drug costs, rehabilitation services, ambulance fees, payments for medical equipment, and supplies. Administration costs for medical insurance cover medical insurance firms' expenses as well as expenses for government insurance such as Medicare and Medicaid (Medi-Cal). Indemnity benefit administrative costs do not include the benefits themselves; rather, they include the administration costs associated with providing workers' compensation indemnity or Social Security disability payments to injured or sick workers and their families.

Indirect costs represent losses to the individual injured, the family, the firm, and the society. We take a "societal perspective" and thus, for example, do not subtract the individual's consumption from his or her earnings [18]. The largest indirect costs include the injured or sick worker's pretax lost earnings, fringe benefits, and home production. Fringe benefits and pretax earnings are included because they are part of the contribution to economic output. To stay in business, employers need to recover these expenses from the production of the workers. Home production includes the value of home repairs and rearing children. Other indirect costs include employer costs associated with retraining and restaffing.

Two approaches can be used in estimating the cost of injury or illness by the human capital method: prevalence and incidence techniques. Prevalence-based costs provide an estimate of the burden in a base year as a result of the prevalence of injury or disease. Included are the injury or illness costs during the base year whether the injury or illness began in the base year or any year prior to the base year. Incidence-based costs represent the lifetime costs resulting from a new injury or illness originating in the base year. In the aggregate, incidence costs in a given year reflect the likely course of an injury or a disease and its duration, including survival rates, medical care that will be used, and costs for the duration of the injury or disease. We use the incidence method for all injuries and morbidity estimates of reported incidence of disease such as those illness cases reported in the Annual Survey. We use the prevalence method for the estimates of deaths caused by diseases and morbidity obtained by the PAR calculations described above. This mix of methods is standard in the literature in which investigators recognize the difficulty with forecasting disease incidence and especially disease costs [8, 19, 20]. For example, researchers have justifiably avoided incidence questions such as this one: How will medical care for cancer be different 30 years from now and what will those costs be in the year 2030?

Cost for Injuries

Direct costs for injuries. To calculate medical costs we multiply our estimates of number of injuries by estimates of average costs in Telles and Fox [9]. The disabling injuries are divided into the WC categories so that we can match them with average WC cost figures. The following categories apply: death, permanent total (PT),

permanent partial (PP), temporary total and partial combined (TTP), and medical only. Adjustments are made for lack of WC coverage for all injuries as well as the greater medical expense associated with WC as opposed to non-WC injuries.

The California per-injury costs are quite different from those for the United States [21, 22]. The permanent total expenses in California are 3.8 times the expenses for the United States, per injury. The permanent partial expenses for California are 87% of those for the United States. The temporary disability expenses are 69% of those for the United States. All other categories are 146% of the U.S. expenses per injury. Since permanent partial and temporary total and partial make up the lion's share of total expenses we find evidence for the impression that Carol Telles [9], William Nelson [21], and other WC researchers have: California offers relatively low benefits per person but California allows a high, disproportionate number of people to qualify for WC benefits.

Medical expenses represent only what is paid to hospitals, doctors, drug companies, and so on. Someone must pay these bills, collect premiums, and service the financial reserves. Insurance companies or their government agency equivalents have costs of administration, maintaining a reserve of funds, interest payments, and, in the case of companies, providing a profit to owners or shareholders via dividends or value of stock. We assume a WC insurance administration overhead of 31% and an "all other" overhead of 15% [8]. The "all other" includes private health insurance, Medicare, and Medi-Cal. The 31% is drawn from a calculation of the ratio of premiums to benefits paid for WC insurers minus one [21]. The 15% is drawn from Cutler [23].

Neither the 31% WC rate nor the 15% non-WC rate would apply to medical costs paid directly by patients, however. These costs are referred to as out-of-pocket expenses. In 1992, 18.4% of medical expenses were out-of-pocket, nationwide [8]. Before we apply the 15% administrative rate, we therefore subtract the amount equivalent to 18.4%.

Calculation of administrative costs for lost earnings is more complicated than for medical expense. Administrative costs would not accrue for earnings or wages, but for indemnity benefits. We use a factor from our lost earnings estimate to calculate indemnity benefits. WC undoubtedly contributes the most for total indemnity, but Social Security disability payments, private disability insurance, and Welfare payments for the disabled would also contribute some indemnity payments. Labor economists generally assume that all indemnity payments, on average, cover 50% of lost wages [24]. Our WC average for California was assumed to be 45%. Since Social Security and private insurance must also be accounted for, and since their rate is likely to be

higher than the California rate, we assume a 47% overall (including WC, Social Security, and private disability insurance) rate for California. We assumed a 50% rate for the United States [8]. The different rate for California again reflects the difference between the California WC system and WC systems for the rest of the United States.

Indirect costs for injuries. The largest category of indirect costs is lost wages. There are two components of lost wages: morbidity costs (nonfatal injuries) and mortality costs (fatal injuries) [20]. The WC Telles and Fox [9] data are useful in estimating morbidity, but not mortality costs. We will first describe morbidity and second morality costs.

The WC Telles and Fox [9] report contains data on the average amount of indemnity dollars paid by WC in the various WC categories. Within the deceased category, WC payments are not for lost wages. We, therefore, rely on present value calculations for the deceased.

The WC Telles and Fox estimates of incurred indemnity payments for PTs and PPs involve some forecasted dollars. Actuaries in insurance companies make these forecasts and we assume they are reliable.

The indemnity data for PT, PP, and TTP can be used to construct lost earnings. We assume that before-tax wage replacement rates are 0.35 for PTs, 0.45 for PPs, and 0.55 for TTPs. We do not use a calculation in the 1 to 3 days-lost category. A wage-replacement rate of 0.55 means that the WC indemnity payment for TTP equals 55% of the before-tax lost wage. Wages, therefore, equal benefits divided by 0.55.

For our purposes, employer-financed fringe benefit losses include employer-provided health, dental, life, and unemployment insurance; child care; Social Security contributions; and pensions. Our calculation of fringe benefits will not include employee contributions or supplemental pay (bonuses). We do not include employee contributions, benefits, vacations, or holiday pay since these are already reflected in our estimate of before-tax earnings. Our assumed rate for fringe benefits (23.3% above wages) is drawn from Jacobs' [25] study of 1996 BLS data.

Fatalities require a present value calculation. We assume that persons who died would have earned what others of the same age and gender earned. This is the same assumption used by Rice et al. [20], Miller and Galbraith [26], and all other mortality cost estimates using the human capital method with which we are familiar. We use the age and gender composition of our deceased workers from the CFOI. We adjust for a high California wage [27] (14.2% above the national average).

Home production losses are based on Douglas et al. [28], in which more home production is attributed to women and especially to women in child-bearing years.

We assume that home production losses for nonfatal injuries would be proportional to those for fatal injuries. The ratio of home production losses to lost earnings for the fatalities for men and women combined is 0.138. We assume the same percentage applies to nonfatal injuries.

Any injury resulting in work loss will create some disruption at the workplace. For fatalities, permanent total injuries, and permanent partial injuries, these will be serious disruptions. In the short run, other workers will have to fill in for the deceased or injured worker. In the long run, new persons will have to be hired and trained. We assume that these hiring, training, and disruption costs would be proportional to the 1992 national estimate for training costs ($2.185 billion) compared with national costs for wage losses ($64.5214 billion) [8]. The percentage is 3.39%.

We omit costs for travel delays, home health care, family disruptions, and injuries to innocent third parties. These are discussed briefly under Discussion.

Costs of Disease

Direct costs for deadly diseases. Our approach to estimating direct costs for disease is similar to that of Fahs et al. [29], Rice et al. [19], and Leigh et al. [8]. Estimates rely on ratios involving hospital days multiplied by national estimates of medical spending. These hospital day ratios act as anchors in the estimation of all direct costs. Hospitalization data are highly regarded, are collected annually, and are summarized within the same definitions, thus permitting comparisons across diseases. Moreover, hospitalizations are the most expensive category of medical care, contributing to 44.6% of medical costs in 1992. Doctors' services are second at 20.9% [27]. We assume that spending on all other direct costs is proportional to hospital spending.

Our California estimates use national estimates multiplied by California correction factors, e.g., contribution of California to national health expenditures. We therefore must review the "top–down" approach for national estimates [8].

The top–down approach begins with an estimate of national expenditures on medical care—$820.3 billion or 13.6% of the Gross Domestic Product in 1992. These $820.3 billion in health care expenditures included payments for hospitalizations, doctor and dentist visits, nursing home care, drugs, and medical supplies. They also include public health care expenditures, such as construction of hospitals and offices, government public health activities, and research, as well as some estimate of program administration and net cost of public health insurance. We include public health care expenditures on the grounds that without occupational disease, some portion of these public expenditures would not be necessary. We did not include the last category—"program administration and net cost of public health insurance"—in our calculations, however. We believe it is an underestimate. The National Center for Health Statistics (NCHS) estimates this amount to be $39.5 billion. This would be the equivalent of roughly 5.06% of expenditures (39.5/780.8 = 0.0506). Studies have shown that administrative costs can add up to an additional 45% to the total cost of medical care [23, 30]. Cutler's [23] estimate of 15% appears to be the most reliable and the one used in previous analyses [1, 8]. As a result, we will exclude the $39.5 billion but include a 15% administrative expense to our calculations. We, therefore, use $820.3 billion − $39.5 billion = $780.8 billion to begin our calculations.

Using the National Hospital Discharge Survey [31], we then calculate the total number of days spent in the hospital by patients with a primary diagnosis for the attributable occupational diseases (cancer, circulatory, COPD, neurological, and renal) and divide by total hospital days for all diseases and injuries (whether or not occupational) in the United States in 1992 (190,386,000). This percentage is subsequently multiplied by $780.8 billion, which in turn is multiplied by the ratio of occupational deaths to total deaths for our six diseases. Finally, our California estimates multiply the national estimates by California's contribution (12.284%) to national health expenditures.

Indirect costs for deadly diseases. Indirect mortality costs were estimated using a standard present value equation [1]. Information for use in the present value equation applied to age-specific, sex-specific, and disease-specific mortality data from the NCHS, Vital Statistics Division, as well as life table estimates [32, 33] and earnings and labor force participation data from the Bureau of Labor Statistics, *Employment and Earnings* [34].

Finally, we calculated national disease-specific ratios for morbidity costs to direct costs from Rice et al. [19] to obtain an estimate of the morbidity costs. Again, these national estimates are multiplied by California's contribution to employment (11.74%) as well as a wage adjustment (14.2% above the national average).

Direct and indirect costs for nonfatal diseases. To calculate direct costs, we multiply the national estimate for nonfatal diseases by a California factor of 0.12284. This 0.12284, or 12.284%, is California's contribution to total illnesses reported in the BLS Annual Survey and by the California Division of Labor Statistics and Research. We feel justified in using the BLS 0.12284 number since the lion's share of the nonfatal disease estimate comes from the BLS Annual Survey numbers. The national direct medical costs for all nonfatal diseases and conditions was $2.02267 billion [8]. Multiplying $2.02267 by 0.12284 yields $0.24846 billion or $248.5 million. This 0.12284 is also multiplied by the

national estimates of administration costs for medical and indemnity insurance.

To calculate the indirect costs for nonfatal diseases and conditions we multiply the national estimate ($1.410494 billion) [8] by the California contribution to indirect costs of *injuries* (13.43%) as well as the California Blood Lead adjustment factor (0.9902). In California, the blood lead level standard for poisoning is 50 μg/dl, not 25 μg/dl. The latter was used for the national estimate. Thus, the national estimate must be adjusted downward by roughly 1% (1−0.9902). This 13.43% is multiplied by categories for indirect costs: lost earnings, fringe benefits, and home production. The BLS illness data are probably more similar to BLS injury data than BLS illness data are similar to estimates from the PAR model. Moreover, the 13.43% accounts for the higher wages in California compared with the rest of the United States. Finally, if again BLS injury records are similar to BLS illness records, this 13.43% also would account for California's unique WC system. We therefore believe our 13.43% factor is justified.

RESULTS

Table 1 presents data on the estimates for deaths and nonfatal injuries. We estimate 660 deaths and 1,645,400 nonfatal injuries in 1992. Table 1 provides additional information on lower and upper bounds as well as estimates within the WC categories of permanent total, permanent partial, and temporary total and partial. California has roughly 24.5% of disabling injuries occurring as permanent total. That compares with 13.9% for the United States. Again, this is consistent with the hypothesis that California WC qualifies a higher percentage of people for the permanent partial category than the rest of the U.S. WC systems' qualify for permanent partial disability.

Table 2 presents the estimated occupational disease mortality attributed to the six deadly diseases for the United States and California. Columns 2 and 4 apply to the United States. Columns 5 and 6 apply to California. Column 3 applies to both.

Numbers in column 5 correspond to similar numbers in column 4, multiplied by 0.1174. This 0.1174 represents the percentage of national employment generated by California. It is preferred over a simple population percentage since 11.74% reflects job conditions (employment), whereas population does not. The point estimates are midway between the lower and the upper bounds.

Among an estimated 7,079 occupational illness deaths in California in 1992, cancer was the greatest killer, followed by chronic respiratory diseases and cardiovascular diseases. Among the 134 pneumoconiosis deaths that the NIOSH study [35] found in the state,

TABLE 1

Estimates of Injury Deaths and Nonfatal Injuries in California and the United States in 1992

	USA	California
Deaths	6,371	660[a]
Lower and upper bounds for deaths		630 to 732[b]
Total nonfatal injuries	13,337,000	1,645,400[c]
Lower and upper bounds for total		1,168,000 to 2,059,000[d]
Nonfatal injuries		
Nondisabling	8,011,000	904,970[e]
Disabling	5,326,000	740,430[f]
Permanent total	12,124	1,256[g]
Permanent partial	741,000	181,604[h]
Temporary total and partial	1,947,000	224,942[i]
One to 3 days lost in California (1 to 7 days for United States)	2,626,000	332,628[j]

Note. Source: U.S. numbers from Leigh et al. [8]. California numbers drawn from background report [22] as well as calculations in footnotes.

[a] Proportion for 1992 deaths, 10.36% of national estimate.

[b] Fatal lower bound percentage, 95.48%; fatal upper bound percentage, 110.86% [8].

[c] Proportion factor for 1992 nonfatal, 12.34% of national estimate. This 12.34% is the ratio of California's nonfatal injuries to U.S. nonfatal injuries as recorded in the BLS's Annual Survey.

[d] Nonfatal lower bound percentage, 70.99%; nonfatal upper bound percentage, 125.14% [8].

[e] Proportion for nondisabling, 8.011/13.337 = 0.60066, for the United States. But California's WC benefits, while lower than those of the nation, are easier to qualify for. The percentage of nondisabling injuries in the BLS's Annual Survey was 50.6% in 1992 for California. For reasons explained in Leigh et al. [8] the Annual Survey is more likely to miss nondisabling than disabling injuries. We assume nondisabling injuries contribute to 55% of all injuries in California but 60% for the United States: 1,645,400 × 0.55 = 904,970.

[f] Proportion for disabling, 5.326/13.333 = 0.39934 for the United States (see footnote *e*). 1 − 0.55 = 0.45 for California. 1,645,400 × 0.45 = 740,430.

[g] Proportion for permanent total: Assume same as death percentage, 660 (CA)/6371 (U.S.) = 0.10359; 0.10359 × 12,124 (U.S.) = 1,256 estimate for California.

[h] Permanent partial percentage (44.67%) from Telles and Fox [9]: 0.4467 × (740,430 − 1,256 − 332,628) = 0.4467 × 406,546 = 181,604.

[i] Temporary total and partial: Disabling − PT − PP − (1 to 3) = 740,430 − 1,256 − 181,640 − 332,628 = 224,942.

[j] One to 3 days lost percentage, 2.626/5.32 = 0.493 for United States. See footnotes *e* and *f*. We assume 0.45 for California. 0.45 × (740,430 − PT) = 0.45 × (740,430 − 1,256) = 0.45 × 739,174 = 332,628.

95 were due to asbestosis, 22 to coal worker's pneumoconiosis, 12 to silicosis, 1 to byssinosis, and 4 to unspecified pneumoconioses.

Table 3 is structured similar to Table 2. Table 3 captures our morbidity estimates for four of the deadly diseases. Nervous system and renal disorders are omitted because no reliable data exist on the number of new cases. Our point estimate for the total in California is 35,694.

Table 4 presents estimates for the nonfatal diseases

TABLE 2

Estimates of Occupational Disease Mortality Attributed to Selected Causes: United States and California, 1992

Selected causes of death	U.S. number of deaths ages 25 and over	U.S. and California percentage attributed to occupation	U.S. number of deaths attributed to occupation	California[a] number of deaths attributed to occupation	
				Range	Point
Cancers	517,090	6–10%	31,025–51,709	3,642–6,071	4,856
Cardiovascular and cerebrovascular diseases[b]	101,846	5–10%	5,092–10,185	598–1,196	897
Chronic respiratory diseases	91,541	10%	9,154	1,075	1,075
Pneumoconioses	1,136	100%	1,136	134	134
Nervous system disorders	26,936	1–3%	269–808	32–95	63
Renal disorders	22,957	1–3%	230–689	27–81	54
Total	761,506	Point estimate:	60,290	5,508–8,652	7,079

[a] California contributed 11.74% to national employment in 1992. Therefore, we multiply the U.S. numbers by 0.1174, except the pneumoconioses. The California contribution to pneumonoconioses was 11.8% in 1992 [35].

[b] Age range 25 to 64. All other diseases have age range 25 and above (no upper limit).

and conditions. Estimates are derived from Annual Survey-based data and the PAR model. Table 4 adjusts for the undercounts in the BLS Annual Survey. We estimate a total of 133,201 cases in 1992.

Summary of Costs for Illnesses and Injuries

Summary of costs for illnesses and injuries appears in Table 5.

The California grand total is $20.67 billion. About 14% is derived from illnesses and 86% from injuries. This differs from the U.S. estimate in which 15% derives from illnesses and 85% from disease. The reason for the difference is the relatively high WC total costs in California compared to the rest of the United States and the high prevalence of injuries as opposed to illnesses in WC.

Sensitivity Analysis

Our California estimates as well as the national estimate [8] assume considerably more nonfatal injuries

and illnesses than are reported to the BLS Annual Survey. Whereas the BLS readily acknowledges a serious undercount of illness, the BLS acknowledges only that injuries to government employees, the self-employed, farm workers on farms with fewer than 11 employees, and domestics are not counted in the Annual Survey. We believe the BLS undercount of injuries is more serious than just its lack of coverage of government employees and so on. For example, in 1997, the BLS estimated 27,060 assaults and violent acts that resulted in at least 1 day of work loss [36]. The U.S. Justice Department [37], on the other hand, estimated 2,009,400 annual victims of nonfatal workplace violence in 1996. Nevertheless, suppose we assume that the nonfatal injury rate for persons excluded from the BLS Annual Survey is one-half the rate of those included in the Annual Survey. Further, suppose all firms and all workers never fail to report any injury. Our national estimate would be reduced from 13.337 million to 7.905 million and the California estimate to (7.905 × 0.123) 0.972

TABLE 3

Estimated Occupational Disease Morbidity Attributed to Selected Causes: United States and California, 1992[a]

Cause of Morbidity	U.S. attributable proportion-based data			California[b] estimated number of illnesses attributed to occupation	
	Estimated annual number of new cases in United States	Estimated percentage attributed to occupation	Estimated number of illnesses attributed to occupation	Range	Point
Cancer	1,113,100	6–10%	66,790–111,130	7,841–13,047	10,444
Cardiovascular and cerebrovascular disease[c]	852,500	5–10%	42,625–85,250	5,004–10,008	7,506
Chronic obstructive pulmonary disease	1,500,000	10%	150,000	17,610	17,610
Pneumoconioses	1,136	100%	1,136	134	134
Total			260,551–347,516	30,589–40,799	35,694

[a] Data adapted from Leigh et al. [8].

[b] California number equals U.S. number times 0.1174 (percentage contribution of California to U.S. employment in 1992).

[c] Ages 25 and 64 years, inclusive. All other diseases have age range 25 and above.

TABLE 4

Estimates of Occupational Illnesses: United States and California, 1992

Survey-based data source	United States			California		
	Unadjusted for undercount[a]	Adjusted for undercount[a]	Point estimate, horizontal sum	Unadjusted for undercount[a]	Adjusted for undercount[a]	Point estimate, horizontal sum
BLS Annual Survey	452,415	184,888	637,303	55,517	22,688	78,205
Public employees, self-employed, and all others[b]	162,291[b]	66,323	228,614	13,826	5,650	19,476
Adult blood lead surveillance program[c]	14,250	0	14,250	137[c]	0	137[c]
Subtotal	628,956	251,211	880,167	70,879	28,338	97,818

Proportional attributable risk-based data	United States		California	
	Range	Point	Range	Point
Cancer				
Coronary heart and cerebrovascular disease[d]				
Chronic obstructive lung disease				
Subtotal from Table 3	260,551–347,516	304,033	30,589–40,799	35,694
Total	1,135,733–1,222,998[e]	1,179,215[e]	128,096–138,306[f]	133,201[f]

[a] The "undercount" here refers to the economic incentive by firms in the BLS Annual Survey to underreport.

[b] First numbers in this row (162,291; 13,826) are estimates by the authors, assuming that the illness rate that applies to private firm employees also applies to government workers, the self-employed, and all others.

[c] U.S. estimate assumes that blood lead level of 25 μg/dl is a poisoning case. Barbara Materna, Ph.D., Chief of Lead Poisoning Prevention Program at the California Department of Health Services states that 50 μg/dl is a more accurate limit (Feb. 7, 2000; e-mail). We therefore use 50 μg/dl and estimate 137 cases in California in 1992. This 137 is the actual number from 1993. We assume it as an estimate for 1992.

[d] Ages 25 and 64 years, inclusive.

[e] Total excludes estimated overlap among data sources. This includes 1,485 cases of cancer, heart disease, stroke, and COPD that were recorded in the 1992 BLS Annual Survey and an estimated 3,500 cases of elevated blood lead level that were included in the 1992 BLS Annual Survey. For example, 880,167 + 260,551 − 1,485 − 3,500 = 1,135,733.

[f] Similar to footnote e. Total excludes 1485 × 0.1174 = 174 and 137 overlap for cancer, heart disease, stroke, COPD, and lead poisoning. For example, 128,096 = 97,818 + 30,589 − 174 − 137.

million. This represents a 40.9% reduction from our estimate of 1.6454 million. Since nonfatal injuries comprise 97.4% of injury costs, this represents a 39.8% reduction in injury costs: $7.07 billion. These alternative assumptions would lead to a total cost estimate of $13.59 billion.

DISCUSSION

California's injury and illness contribution ($20.67 billion) to the U.S. total ($155.5 billion [8]) is 13.3%; injury costs alone are 13.39% of U.S. injury costs. These 13% figures lie within the range of California's contribution to a variety of indicators. For example, California's contribution to private sector, nonfarm civilian employment in 1992 was 11.74%, to Gross Domestic Product—13.47%, to the CFOI—10.36%, to the BLS Annual Survey of injuries only—12.3%, to total medical expenditures—12.29%, to WC benefits paid (not incurred)—16.1%.

Comparison with Other Studies

We are not familiar with any other study on the aggregate cost of occupational injuries and illnesses in California. We are aware of only one study of costs for any other state—Pennsylvania. Neumark et al. [38] estimated a cost of roughly $2.4 billion for 1988. But there are several limitations to the Pennsylvania study. (1) The deficiencies of the BLS's Annual Survey were never mentioned or accounted for. (2) The deficiencies of WC were mentioned but no adjustments were made. (3) The results for direct and indirect costs for injuries are difficult to accept. Generally, indirect costs exceed direct costs for injuries by factors of 2 or 3 or more [8, 20]. In the Neumark et al. [38] estimates, the opposite occurs: direct costs exceed indirect costs by threefold. (4) They ignore fringe benefits and recruitment and retraining expenses. (5) Their injury estimate, if extrapolated to the United States, is far less than WC costs, nationwide [21]. (6) The initial epidemiological study that formed the basis of the Neumark et al. [38] study is not available for public review nor has it been published.

There have been some important studies of WC costs in California. These include a study already mentioned in the text, Telles and Fox [9], as well as studies by Stern et al. [39], Mont et al. [40], and Shor [41].

The Telles and Fox [9] study of the WC system in California reaches a number of conclusions. First, they conclude that there are a greater number of persons

TABLE 5

Total Cost for Injuries and Illnesses in California ($ Billions)

	Injuries, illnesses, and percentages					
	Injuries	Selected percentages	Illnesses	Selected percentages	Total	Selected percentages
I. Direct costs	$5.4004	30%[a]	$1.6409	57%[b]	$7.0413	34%[c]
A. Medical only	$3.6845	68%[d]	$1.3604	83%[e]	$5.0449	72%[f]
1. Mortality	$0.0189		$0.8949		$0.9138	
2. Morbidity	$3.6656		$0.4655		$4.1311	
B. Medical administration	$0.8150	15%[d]	$0.1925	12%[e]	$1.0075	14%[f]
1. Mortality	$0.0042		$0.1267		$0.1309	
2. Morbidity	$0.8108		$0.0658		$0.8766	
C. Indemnity administration	$0.9009	17%[d]	$0.0880	5%[e]	$0.9889	14%[f]
1. Mortality	$0.0046		$0.0583		$0.0629	
2. Morbidity	$0.8963		$0.0297		$0.9260	
II. Indirect costs	$12.3667	70%[a]	$1.2573	43%[b]	$13.6240	66%[c]
A. Lost earnings	$8.9846	73%[g]	$0.9204	73%[h]	$9.9050	73%[i]
1. Mortality	$0.3200		$0.6050		$0.9250	
2. Morbidity	$8.6646		$0.3154		$8.9800	
B. Fringe benefits	$1.8927	15%[g]	$0.2125	17%[h]	$2.1052	15%[i]
1. Mortality	$0.0750		$0.1544		$0.2294	
2. Morbidity	$1.8177		$0.0581		$1.8758	
C. Home production	$1.1957	10%[g]	$0.1244	10%[h]	$1.3201	10%[i]
1. Mortality	$0.0440		$0.0818		$0.1258	
2. Morbidity	$1.1517		$0.0426		$1.1943	
D. Workplace training, restaffing, disruption	$0.2937	2%[g]	0	0%[h]	$0.2937	2%[i]
1. Mortality	$0.0008		0		$0.0008	
2. Morbidity	$0.2929		0		$0.2929	
III. Grand total	$17.7671	86%[c]	$2.8982	14%[c]	$20.6653[j]	100%[c]

[a] Percentage of injury total costs.
[b] Percentage of illness total costs.
[c] Percentage of grand total.
[d] Percentage of injury direct costs.
[e] Percentage of illness direct costs.
[f] Percentage of injury and illness direct costs.
[g] Percentage of injury indirect costs.
[h] Percentage of illness indirect costs.
[i] Percentage of injury and illness indirect costs.
[j] California's total 13.3% of the U.S. total (20.670/155.5).

receiving permanent partial disability benefits per capita in California compared with the rest of the United States. Second, they conclude that there are lower average benefits for these persons, compared with the average of other WC systems in the United States. They also conclude that California's adjustment system for WC is cumbersome and difficult to understand and "may drive the worker to an attorney."

Stern et al. [39] offer some general WC statistics, but focus on permanent partial claims. They note that in the 1990s, insurance premiums ran between $6 billion and $9 billion for non-self-insuring firms. Self-insuring firms account for approximately 30% of the California market. An important conclusion of the study is that the indemnity benefits-to-wages ratios for permanent partial disabilities are especially low in California compared with other states.

Mont et al. [40] is an annual review of national and state payments from WC insurers. They do not have data on self-insuring firms. In 1996, they estimate total benefits paid (not incurred) to be $42 billion for the United States and $6.8 billion for California. California thus accounted for 16.1% of the 1996 national total. Mont et al. [40] also find that California pays relatively more than the rest of the United States for medical expenses but relatively less than the United States for indemnity expenses.

Shor's [41] study explored the WC mechanisms for paying for occupational diseases. Shor points out that in the mid-1980s only roughly half of the cost of WC premiums to employers was being paid to injured workers. Shor argues that most of the costs of occupational diseases are not covered by WC. He suggests taxes on specific industries to "internalize" those costs.

A 1996 NIOSH publication [35] reports on a number of pneumoconioses deaths in California in 1992. There were 134 such deaths. The U.S. count was 1,136. The

California number thus represents an 11.8% contribution. This 11.8% is remarkably close to our assumed percentage (11.74%) of California's contribution for all other occupational mortality. This lends credence to our use of the 11.74%.

In a nationwide study [8], costs of other diseases are compared with costs for occupational injuries and illnesses. These other diseases include the costs of AIDS ($30 billion), of Alzheimer's disease ($67 billion), of all musculoskeletal conditions (mostly arthritis) ($149 billion), of cancer ($171 billion), and of circulatory disease ($189 billion), all for 1992. To convert these to California figures, we multiply by 0.121, which is California's contribution to the U.S. population in 1992 [27]. The population percentage is most appropriate here because these are calculations of costs for these diseases regardless of occupational factors. The California figures would be $3.6 billion for AIDS, $8.1 billion for Alzheimer's, $18.0 billion for all musculoskeletal diseases, $20.7 billion for all cancers, and $22.9 billion for all circulatory diseases. It is likely that the California contribution to AIDS is higher than this $3.6 estimate. The *U.S. Statistical Abstract* indicates that 14.4% of all AIDS cases were in California in 1996 [42] (0.144 × $30 billion = $4.3 billion in cost). A better California estimate for AIDS would therefore be $4.3 billion.

Our occupational injury and illness costs for California are nearly 5 times the cost of AIDS in the state, 2.6 times the cost of Alzheimer's disease, 16% larger than the costs of all musculoskeletal conditions, almost identical to the costs of cancer, and roughly 10% less than the costs of heart disease and stroke combined. Our $20.7 billion estimate for job-related injuries and illnesses is also more than the California-specific studies mentioned in the Introduction: indirect cost for cardiovascular disease ($6.4 billion) ([2] $6.4 billion, 1991 indirect only) and medical spending for all smoking-related diseases ($8.7 billion in 1993) ([3] medical costs only).

Can the Results be Generalized?

The approach here could easily be applied to other states. First, the particular state's contributions to U.S. population, labor force, BLS Annual Survey, BLS Census of Fatal Occupational Injuries, and so on, need to be calculated. Second, a search of WC records specific to the state needs to be conducted. Many states have a state-run WC insurer. Other states have a rating bureau similar to the Workers' Compensation Insurance Rating Bureau of California (WCIRB). Most states provide data to the National Council on Compensation Insurance, which, in turn, produces state-specific data. The Workers' Compensation Research Institute in Boston frequently produces reports on a state-by-state basis. Third, a search through state OSHA agencies or Labor or Industrial Relations offices needs to be conducted to produce unique studies within the state. Fourth, NIOSH has a number of documents with state data, including the one relied on here for pneumoconioses [35]. Every effort should be made to obtain state-specific data. Extrapolation from national data should be used only as a last resort.

Strengths and Weaknesses

Injuries.   There are many strengths and weaknesses to our approach of multiplying WC/Telles and Fox [9] average cost estimates times the number of injuries. We first consider the strengths.

First, theoretically, medical costs should include all customary costs for ambulances, emergency rooms, physicians, therapists, nurses, hospitals, rehabilitation, and so on. By relying on the WC data, we avoid problems associated with creating our own estimates of costs for ambulances, therapists, and so on.

Second, in the year we relied on, 1992, WC almost always paid for 100% of medical expenses. Few, if any, copayments or deductibles occurred. We therefore avoid questionable assumptions about deductibles and copayments that would have to be made using private health insurance data.

Third, the WC data are incidence based and follow each case for at least 2 years. Moreover, insurance company actuaries (not us) make the forecast for future expenses.

Fourth, these are simple calculations. They do not require that we match cost data to hospitalizations to injuries based on the part of the body affected. There is a serious difficulty associated with cost measurements based on body parts. Perhaps as many as 40% of all injuries affect more than one body part [43, 44].

Fifth, the Telles and Fox [9] WC cost data are drawn from the WCIRB of California, a bureau that services the entire third party WC market in California and must stand accountable to legal challenges. Their numbers are reliable.

Sixth, the Telles and Fox data are specific to California. We did not rely on an extrapolation based on national data.

Seventh, and perhaps most importantly, we are not aware of any other credible attempts to estimate the costs of workplace injuries that did not rely heavily on WC data and ultimately multiply WC costs by numbers of injuries. There is great precedent in the literature for our approach.

The first weakness is that we must assume that the large self-insured firms (excluded from the California Rating Bureau) have average costs similar to those of the firms included in the Telles and Fox [9] numbers. It could be that large firms have in-house medical staff

that can reliably treat injuries at costs less than WC providers. This assumption suggests that we may have overestimated costs.

The second weakness is that the Telles and Fox [9] average cost data are for injuries and illnesses. This assumption is not terribly problematic given that illnesses comprise less than 3% of total WC costs [45]. This assumption does not result in an obvious under- or overestimate of costs.

Third, we omitted collateral damage to innocent third parties as a result of an accident. For example, when an airplane crashes the pilot and crew may die. These would be recorded as injury deaths. But 100 or so passengers may also die. Many injury accidents have collateral damage: car and truck crashes, police gun battles in which third parties are wounded, firefighters hosing down blazes, and so on. This omission results in an underestimate of injury costs.

Fourth, in calculating the costs to the firm, we excluded the workplace disruption costs associated with (a) experiencing anxiety with the death of a co-worker and (b) increasing strike frequencies [46], absences, or sabotage rates that are associated with high injury rates [47].

Fifth, we ignored property damage, police and fire services, and time delays. Property damage can result from an injury accident when, for example, the car, truck, van, train, or plane is destroyed. Police and fire services are a municipal government expense when, for example, a truck overturns and kills a driver or a fire burns down a factory. Time delays can result to innocent third parties stuck in a traffic jam caused by a delivery truck explosion. These omissions result in an underestimate.

Sixth, we assumed 55 and 45% of all injuries would be nondisabling and disabling, respectively, in California. The corresponding percentages for the nation were 60 and 40%. Evidence suggests that California is more generous than other states in allowing disability injuries to qualify for WC [9]. For example, the ratio of medical-only claims (most are nondisability) to all claims nationwide was roughly 75% in the early 1990s [8]. The same ratio in California was 68% [9]. Now 68 is roughly 9% less than 75 (68/75 = 0.91). Similarly, 55 is roughly 9% less than 60 (55/60 = 0.917).

Seventh, injury numbers apply only to 1992. If present trends continue, numbers of injuries will continue to decline while average length of time away from work for any given injury will continue to expand. The net effect of these two trends results in an unknown bias.

Eighth, we used 0.35, 0.45, and 0.55 for pretax replacement rates for PPs, PTs, and TTPs. Our national estimates assumed 0.40, 0.50, and 0.60. Again, we relied on evidence in Telles and Fox [9] and Nelson [21] that indicating California was among the most generous of states in level of benefits. All of these rates fare well in comparison to the literature. Berkowitz and Burton [48], in a national survey, found that PP rates across the states ranged from 75 to 25%. In their extensive analysis of three states' average PPs, they found rates of 75% for Wisconsin, 51% for Florida, and 46% for California (again, we assumed 45% for PPs in California). DeVol [49] found that workers' compensation benefits provided most workers with 80–100% of their *after*-tax income for temporary disabilities. But *after*-tax replacement rates depend significantly on the person's wages or salary. Moreover, temporary disabilities compromise roughly only 30 to 40% of WC benefits nationwide [48] and even less in California [39]. In addition, replacement rates for permanent disabilities are considerably less than those for short-term disabilities.

Two recent studies have been conducted on California rates. Using early 1990s data, Stern et al. [39] found *before*-tax rates at just under 40% for PPs. Using more recent data, Reville et al. [50] found 45 to 50% for the self-insured firms and 50 to 55% for the non-self-insured firms for PPs.

Finally, it is generally accepted that replacement rates for government indemnity plans—including WC—are roughly 50% of *before*-tax wages [24] across the nation.

Ninth, our nonfatal injury estimate is over twice that of the BLS. There are a number of reasons for this that are discussed in the book with the national estimate (pp. 213–17, 263) [8]. We assume that the private industry injury rate applies to all of these omitted groups such as government workers, the self-employed, and so on. Whereas this may not be correct on a group-by-group basis, there may be some support for the same rate applying to all groups combined. Whereas nonfatal injury rates for all farmers and self-employed persons are not available, fatality rates are. To the extent that fatality rates are correlated with nonfatal injury rates, especially serious nonfatal injury rates, these fatality rates are relevant and lend support to our assumption. Farmers and persons who are self-employed have especially high fatality rates. In 1997, the fatality rates for the self-employed (who comprise 9–10% of the workforce) were nearly two and a half times the rate for all wage and salary workers [51]. Government workers, on the other hand, have fatality rates that are lower than those in private industry [51]. Again, whereas nonfatal rates are not available for all farmers and farm workers, a study of a representative sample of the United States indicated that persons who worked on farms reported among the worst disability scores on an Activities of Daily Living scale [52]. This high score for farmers and farm workers was attributed to the dangerous nature of farm work [52]. The BLS numbers also ignore firms' economic incentives to underreport. These issues are addressed in the Sensitivity Analysis above.

Illnesses. First, possible job-related reproductive problems were omitted from our disease and illness calculations [*53*]. Second, the full extent of hearing loss was underestimated with BLS Annual Survey data because the losses are gradual and may not become serious until retirement. Third, we did not assume that any deaths or illnesses resulted from workers who worry about layoffs. As corporate restructuring continues, so do feelings of job insecurity that, in turn, could lead to increased colds, flus, cancers, and circulatory disease [*54, 55*]. We do not have reliable national estimates for any of these. Fourth, small proportions (PARs) (1 to 3 to 10%) were used when we attempted to estimate morbidity and mortality from the major diseases. Fifth, occupational circulatory morbidity and mortality was limited to events among people less than 65 years of age because the extent of the occupational impact on circulatory disease after retirement is uncertain. Sixth, no diseases were allowed for persons less than 25 years of age. We also disallowed any consequences of workers bringing carcinogens home with them (on clothing, for example) and exposing children [*56*]. Seventh, we did not account for sick-building syndrome, which may cause eye irritations, headaches, fatigue, cough, colds, dizziness, and flus [*57*]. No reliable cost estimates are available for this syndrome. Each of these seven factors results in a downward bias, i.e., our estimates are likely to be low.

One limitation that has drawn sharp criticism concerns the assumptions about circulatory diseases [*14*]. The assumptions used in this study (one-third of recorded deaths from circulatory diseases omitted and an upper age limit of age 65) result in our attributing, on average, less than 1% of all circulatory disease to job exposures. Given the voluminous literature on job strain and circulatory disease [*58*] this less than 1% attribution appears small.

Both injuries and illnesses. First, we did not add any damage costs for injuries that would eventually produce arthritis [*59, 60*]. Second, we did not account for the effect of dull, repetitive work on producing dementia. Adam Smith [*61*] warned of the deleterious effects of repetitive work on the intellectual capacity of workers. He argued for government intervention to improve working conditions in the *Wealth of Nations*, Vol. 2, Book 5, p. 302 [*61*]. Third, we used a 31% WC administrative cost estimate using Nelson's [*21*] data. Burton and Schmidle's [*62*] statistics indicated a 38% rate. All three of these imply we underestimated costs.

Fourth, we ignored pain and suffering costs. Lawsuits involving nonfatal injuries almost always involve some payment for pain and suffering [*63*]. A rule of thumb frequently cited is that pain and suffering equal three to four times the nonadministrative medical expenses, medical expenses plus lost wages [*63*]. This would mean

adding another roughly $52.5 ($15 × 3.5 = $52.5) billion to our costs.

Fifth, we did not include the costs of a family caregiver's time nor the health problems that occur among caregivers. These costs are undoubtedly large but are difficult to estimate [*64*]. One estimate suggests that they are roughly 20% of the medical costs [*64*].

Sixth, children reared in families in which one parent is disabled or missing acquire less education and consequently earn less lifetime income than children whose parents are not disabled or are present in the household [*65*]. Children who experience the sudden loss of a parent frequently exhibit lifelong psychological disorders [*66*].

CONCLUSION

We rely on conventional methods to estimate the costs of occupational injuries and illnesses for California. Since no published study has attempted to make these estimates, we feel justified in using conventional methods. Future researchers may wish to take a more novel approach. We estimate costs at $20.7 billion in 1992 dollars. This is a large amount in part because so many people hold jobs and virtually all jobs carry some degree of risk [*67*]. Roughly 66% is due to indirect costs, and 34% is due to direct costs. These costs are on a par with the California cost for either cancer or heart disease and stroke. Workers' compensation estimates proved most useful in generating our estimates. We nevertheless estimated that the California WC system covers significantly less than 50% of our estimated costs of occupational injuries and illnesses.

APPENDIX TO TABLE 2

Codes of ICD, 9th Revision Used in Table 9

Cancer: 140–209 (malignant neoplasms)
Cardiovascular and cerebrovascular diseases
    401–404 (hypertension, hypertensive heart, and renal diseases)
    410–414 (ischemic heart diseases)
    430–438 (cerebrovascular diseases)
    440 (atherosclerosis)
Chronic respiratory diseases
    490–496 (chronic obstructive pulmonary diseases and allied conditions)
    500–505 (pneumoconioses)
Nervous system disorders
    323.7 (toxic encephalitis)
    331 (other cerebral degenerations)
    332 (Parkinson's disease)
    349.82 (toxic encephalopathy)
    356 (hereditary and idiopathic peripheral neuropathy)

357.7 (polyneuropathy due to other toxic agents)

359.4 (toxic myopathy)

Renal disorders: 580–589 (nephrotis, nephrotic syndrome, and nephrosis)

ACKNOWLEDGMENT

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