

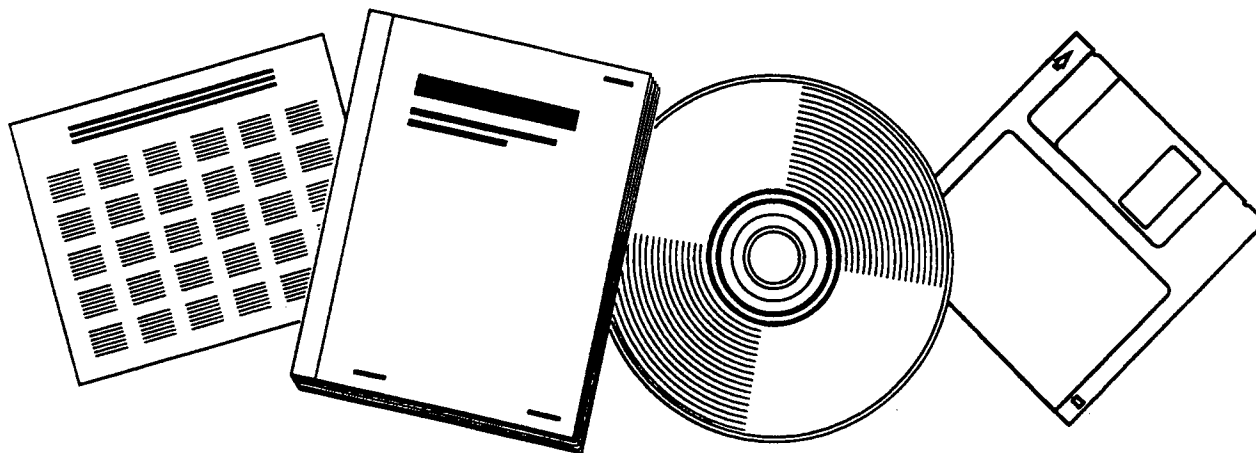


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COSTS OF OCCUPATIONAL INJURIES AND ILLNESSES IN 1992

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Costs of Occupational Injuries and Illnesses in 1992

Final NIOSH Report for Cooperative Agreement with E.R.C, Inc.
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J. Paul Leigh, Ph.D.¹
Steven Markowitz, M.D.²
Marianne Fahs, Ph.D., M.P.H.²
Jared Bernstein Ph.D.³
Lawrence Mishel, Ph.D.³
Chonggak Shin, M.B.A., C.P.A.²
Philip Landrigan, M.D.²

¹ Department of Economics, San Jose State University, San Jose, CA. 95192-0114; and Division of Immunology and Rheumatology, 1000 Welch Road, Suite 203, Stanford University Medical Center, Palo Alto, CA 94304-0146.

² Division of Environmental and Occupational Medicine, Department of Community Medicine, Mt. Sinai School of Medicine, Box 1057, One Gustave L. Levy Place, New York, NY 10029-6574.

³ Economic Policy Institute, 12th Floor, 1660 L St. N.W., Washington D.C. 20036.

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Correspondence: Address to first author. Telephone: 408/924-1368
FAX: 408/924-5406

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16. Abstract (Limit: 200 words) The extent of deaths and injuries occurring among American workers and the cost to the economy were investigated. Estimates were presented of the incidence, prevalence and costs of workplace related injuries, illnesses, and deaths for the entire civilian workforce of the United States in 1992. Roughly 6,500 job related injury deaths occurred, 13.2 million nonfatal injuries, 60,300 job related disease deaths, and 862,200 illnesses in the American workplace in 1992. The total direct and indirect costs associated with these injuries and illnesses were 179.3 billion dollars, or 3% of the Gross Domestic Product. The costs were born by injured workers and their families, by all other workers through lower wages, by firms through lower profits, by consumers through higher prices, and by taxpayers through higher taxes. Workers' compensation covered only slightly more than 30% of all costs. Men were approximately 12 to 13 times more likely than women to suffer a fatal injury, but men were only roughly three times as likely as women to experience a nonfatal injury. Occupations with high mortality rates included lumberjacks, construction laborers, taxi drivers, truck drivers and pilots. Occupations contributing the most to costs included laborers, sanitation workers, warehouse workers, nursing orderlies, and mechanics.				
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List of Abbreviations

1. SDS: Supplementary Data System
2. WC: Workers' Compensation
3. CFI: Census of Fatal Occupational Injuries
4. OSH: Occupational Safety and Health
5. BLS: Bureau of Labor Statistics
6. NIOSH: National Institute for Occupational Safety and Health
7. NTOF: National Traumatic Occupational Fatality Study
8. n.e.c.
and
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Significant Findings

Every year millions of American workers suffer injuries, diseases and deaths in their workplaces. Yet little effort has been made to estimate either the extent of these deaths and injuries or their cost to the economy. Thus, important questions about workplace safety and the economic resources expended due to workplace health problems remain unanswered. In this report, we address to these questions by presenting estimates of the incidence, prevalence and costs of workplace-related injuries, illnesses, and deaths for the entire civilian workforce of the United States in 1992.

Our major findings are:

1. Roughly 6,500 job-related injury deaths, 13.2 million non-fatal injuries, 60,300 disease deaths and 862,200 illnesses occurred in the American workplace in 1992.
2. The total direct and indirect costs associated with these injuries and illnesses were estimated to be \$173.9 billion or 3% of Gross Domestic Product, which was \$5,950.7 billion in 1992. Direct costs included medical expenses on hospitals, physicians, drugs, property damage, and so on, as well as health insurance administrative costs. Direct costs were estimated to be \$66.2 billion.
3. The indirect costs included loss of wages, costs of fringe benefits, and home production (e.g., child care provided by parent and home repairs), as well as insurance administration costs, employer retraining and workplace disruption costs, time delays, and indirect costs of deaths and injuries to innocent bystanders. Indirect costs were estimated to be \$107.7 billion.
4. Total direct and indirect costs for injuries were \$148.4 billion while total direct and indirect costs for diseases were \$25.5353 billion.
5. These costs are large when compared to other diseases. The costs combined are larger than those for AIDS, Alzheimer's disease and back pain and are on a par with those for cancer and for all circulatory (heart and stroke) diseases.
6. Our measures ignored the costs of pain and suffering. Had these been included, using estimates from the willingness-to-pay technique, overall costs would have been estimated to be anywhere from \$568 billion to nearly \$900 billion.
7. These costs were borne by injured workers and their families, by all other workers through lower wages, by firms through lower profits, by consumers through higher prices, and by taxpayers through higher taxes.
8. Workers' Compensation covers only slightly more than 30% of all costs.

9. Our study appears to be the first to use national data to produce estimates on costs for occupational injuries and illnesses. Prior studies have underestimated costs by ignoring non-disabling injuries, deaths, workplace violence, by taking inadequate account of diseases, and, most importantly, by relying only on one or two sources of data.
10. Greater efforts need to be directed toward gathering data on job-related injuries and illnesses. The United States needs better data (a Census of Fatal Occupational Injuries, CFOI) for non-fatal injuries and all illnesses.

Additional findings include these:

11. Many episodes of occupational injuries also involved innocent bystanders. For example, a single pilot death may be associated with scores of deaths to passengers. We estimated 218 deaths and 68,000 non-fatal injuries to innocent bystanders in 1992. The total costs of deaths and injuries to bystanders were \$2.9132 billion.
12. Small firms contributed much higher per capita costs than large firms.
13. The self-employed, persons employed in small firms, and persons over age 65 contributed a high and disproportionate number of injury deaths.
14. Men were approximately 12 to 13 times more likely than women to suffer a fatal injury. But men were only roughly three times as likely as women to experience a non-fatal injury.
15. Occupations with high mortality rates included lumberjacks, construction laborers, taxi drivers, truck drivers and pilots. Occupations contributing high numbers and rates of non-fatal injuries included laborers, truck drivers, nursing orderlies, janitors, and assemblers.
16. Occupations contributing the most to costs included laborers, sanitation workers, warehouse workers, nursing orderlies, and mechanics. On a per capita basis, mechanics, miscellaneous laborers, and drill press workers contributed the most to costs. The most costly industries included trucking, logging, construction, and meat products. On a per capita basis, the costly industries were mining, logging, transport, and sanitary suppliers.
17. Roughly 40% of injury deaths involved transportation accidents and 18% involved murder.
18. Murder was the leading cause of injury deaths among executives, sales, and service workers.

19. Murder and assault at retail stores could be reduced if laws were passed to require stores to post armed guards on duty especially during evening hours.
20. Being at work is not safer than being at home. People who work are more likely to be injured at work than at home. This is especially true for men. Moreover, work-related injuries were more likely to result in hospitalizations than injuries originating outside of work.
21. Non-fatal injuries most frequently involved (in order) the person's back, legs, arms, and fingers. Back injuries alone generated nearly \$50 billion in costs.
22. Any of the major sources of data, such as the Bureau of Labor Statistics, National Institute for Occupational Safety and Health, Workers' Compensation, or National Health Interview Survey, by themselves underestimate the numbers of injuries and illnesses. The National Health Interview Survey especially may not be reliable. Several data sources must be examined and combined to produce overall, national estimates of injuries and illnesses.

These costs are great, but the reason for their size is no mystery. Roughly 120 million Americans worked in 1992. Every job carries some risks (Leigh 1995a). Many people are exposed to job-related safety risks of traffic accidents, falls, murder, electrocution, fire, being struck by objects, explosion, heat, cold, animal attacks, airplane crashes, as well as health risks from radiation, asbestos, silica, benzene, coal dust, tuberculosis, smoke, carbon monoxide, pesticides, benzidine, arsenic, lead, chromium, and stress leading to circulatory disease and cancer.

The estimates presented in this report are the result of an exhaustive compilation of data from a variety of sources.

In developing the estimates, we deliberately selected conservative rather than generous assumptions. The assumptions with greatest consequences are listed near the end of this report. Here, we mention four—all of them conservative.

First, with 7.4% of the workforce unemployed, 1992 was a high unemployment year. When fewer people are employed, fewer job-related injuries and diseases occur.

Second, we did not account for health effects of occupational injuries and illnesses on the relatives of victims or, more importantly, for the cost of caregivers' time and energy. After a serious injury or disease, someone in the family frequently provides care.

Third, we restricted *job-related* circulatory disease deaths to people 65 years old and under. It could be argued that each job has a cumulative effect on circulatory disease that does not become evident

while the person is working but that does become evident during retirement.

Finally, and perhaps most importantly, the direct and indirect methods of estimating costs we relied on ignored costs of pain and suffering. These costs would add an additional \$100 to \$700 billion to our overall \$173.9 billion estimate.

The costs of occupational injuries and illnesses are considerable, both in terms of economic resources and human suffering. Potential victims include anyone of the roughly 120 million Americans who work for a living. Costs are borne by workers, firms, consumers, and taxpayers.

Abstract

Objective: To estimate the direct and indirect costs of occupational injuries and illnesses.

Design and Setting: Aggregation of national and large regional samples collected by the Bureau of Labor Statistics, the National Council on Compensation Insurance and other government bureaus and private firms.

Main Outcomes Measures: Direct and Indirect Costs

Methods Our study relied on the Direct/Indirect (human capital) cost method that decomposes costs into categories such as medical and insurance administration expenses as well as lost earnings, lost home production and lost fringe benefits. We culled the literature for estimates and generated some of our own estimates of the number, severity, and average costs of injuries and illnesses. Total costs were estimated by multiplying average costs by the number of injuries and illnesses defined within Workers' Compensation categories and medical diagnoses.

Results Roughly 6,500 job-related injury deaths, 13.2 million non-fatal injuries, 60,300 disease deaths and 862,200 illnesses occurred in the civilian American workplace in 1992. The total direct (\$66 billion) and indirect (\$108 billion) costs were estimated to be \$174 billion. Injuries cost \$148 billion and illnesses cost \$26 billion. These estimates are conservative for many reasons. For example, we ignored pain and suffering costs, in-home care provided by family members, and general health problems such as reproductive conditions, birth defects, injuries leading to arthritis, and second-hand cigarette smoke. These costs were borne by employees, employers, consumers, and taxpayers.

Conclusion The costs of occupational injuries and illnesses are as high as those for all circulatory diseases or all cancers yet the medical attention these injuries and illnesses receive is small compared to that received by circulatory diseases and cancer.

Body of Report with Conclusions

Costs of Occupational Injuries and Illnesses in 1992

Most people age 22 to 65 spend roughly 40 percent of their waking time at a job. Virtually every job carries at least some risk of injury or illness (Leigh, 1995; Toscano et al., 1995). Everyday some among the over 120 million Americans who work for pay will experience a job-related injury, illness or death. Yet few studies have assessed the national incidence or prevalence of occupational injuries or illnesses (Markowitz et al., 1989; Miller, 1995). Even fewer studies have attempted to calculate the costs of these injuries and illnesses (Miller and Galbraith, 1995; Hoskin et al., 1993; Fahs et al., 1989). This is unfortunate. Costs have become a critical measure in the health care debate. Costs are a Rosetta stone. Costs are a measure that allow comparisons across such disparate conditions as AIDS, circulatory diseases, Alzheimer's disease, and motor vehicle injuries, as well as across all forms of economic activity such as spending on autos, education, prisons, space exploration, weapons, and fishing tackle.

This study reviews estimates of the direct and indirect costs of job-related injuries and illnesses in 1992. Standard epidemiological and economic techniques were applied to estimate incidence, prevalence and costs. Considerable justification exists to support each estimate.

This study appears to be unique in the literature. No prior study with which we are familiar uses *national* data to generate cost estimates of injuries *and* illnesses. In fact, we are aware of only one published study that attempted to estimate these combined costs of injury *and* illness, but it was limited to Pennsylvania (Neumark et al., 1991).

METHODS

Our technique simply involved multiplying average costs by the number of injuries and illnesses defined within Workers' Compensation (WC) and medically diagnosed categories. Given the simplicity of these techniques, our greatest effort was directed toward culling the literature for estimates and generating our own estimates of the numbers of injuries and illnesses, as well as average costs. This effort included attempts to justify assumptions we made to generate these estimates. This Methods section therefore primarily discusses the sources from which we drew our estimates and assumptions. In selecting these assumptions, we erred on the side of conservatism.

Counting Injuries

Our estimate of injuries is incidence-based: we estimated the number of *new* injuries originating in 1992.

Deaths Several primary and secondary sources of data were used to construct our estimate of injury deaths. Primary sources included the Bureau of Labor Statistics'(BLS) Census of Fatal Occupational Injuries (CFOI)(Toscano et al, 1995), the National Institute for Occupational Safety and Health's (NIOSH) National Traumatic Occupational Fatality Study (NTOF)(Jenkins, 1993), BLS Annual Survey of Occupational Injuries and Illnesses (Annual Survey), the National Council on Compensation Insurance's (NCCI) data on Workers' Compensation (WC), and the BLS's Supplementary Data System (SDS). We also consulted several secondary data sources including the National Safety Council's Accident Facts, and the reports by Miller (1995); and Marquis (1992). Each of these sources has strengths and weaknesses.

The CFOI was arguably the most reliable of all data sources we examined. Nevertheless, the CFOI may well result in an undercount since two rather than one document (such as a WC report) was required before the death was counted as job-related. Perhaps due to this undercount, the CFOI fatality rates for African-Americans and whites were nearly identical in 1992. This was unexpected, given that a disproportionate number of African-Americans occupy blue-collar jobs (Gill, 1994).

The NTOF was also a highly reliable source. Yet, the NTOF was limited to death certificates which probably resulted in an even larger undercount than the CFOI. A number of studies have shown that death certificates undercount job-related injury deaths by at least 10 to over 40 percent (Toscano et al, 1995; Ruble, 1993; Kraus, 1990; Davis, 1988; Baker, 1992; Stout and Bell, 1991). We nevertheless judged that the CFOI and the NTOF were the best data on deaths and weighted them more heavily than all of the others estimates in calculating our estimate.

We adjusted all of the death estimates from the literature, except the one for the CFOI. For example, we estimated that by exclusively relying on only death certificates, the NTOF undercounted deaths by 28 percent. Other examples involved adjustments to the NCCI and SDS Workers' Compensation data. We estimated that WC missed roughly 55 percent of deaths (and non-fatal injuries). Five sources were cited to support this estimate of a 55 percent undercount (Toscano et al., 1995; Cone, 1991; Parker, 1994; Hensler et al, 1991; Stout and Bell, 1991; Marquis, 1992).

We also used an econometric forecasting model to update all estimates in the literature to 1992. The model demonstrated a downward secular trend in deaths over time and a negative correlation with the unemployment rate: as unemployment grew, deaths decreased.

Non-fatal Injuries For non-fatal injuries we analyzed three primary sources -- the BLS Annual

Survey, the NCCI Ultimate Reports, and the National Health Interview Survey (NHIS) -- as well as the same secondary sources identified above. Each of the primary sources suffered from serious undercounts. This was especially true of the BLS Annual Survey -- the primary data most frequently cited in the literature.

The 1992 Annual Survey reflects questionnaire data obtained from a stratified random sample of roughly 250,000 private sector firms. The Annual Survey is comprised of summary data provided by employers to the BLS that, in turn, employers derive from their OSHA Log 200. The OSHA Act requires a very high percentage of employers to maintain OSHA Logs. The Annual Survey omits government workers, the self-employed, and farms with fewer than 11 employees. Moreover, the Annual Survey is collected from private firms that face an economic incentive to underreport. That is, firms' WC insurance rates and prospects for an OSHA inspection are high if their reported injury and illness rates are high. We made adjustments for each of these factors as well as others in the other primary and secondary studies. For example, in adjusting Annual Survey estimates, we created one estimate by multiplying the rate per worker found in the Annual Survey by all civilian persons in the labor market including government workers, the self-employed and farm workers. Another estimate was generated by assuming that the percentage undercount of *deaths* in the Annual Survey would be identical to the percentage undercount of *non-fatal* injuries.

We constructed econometric forecasting models to bring all estimates up to 1992. In constructing these models, we discovered that the NHIS estimates do not demonstrate a reliable time series, thus, the NHIS estimates themselves may be less accurate than is commonly believed.

After setting aside duplicating studies and studies that were less than convincing, we weighted the remaining studies equally. (Had we weighted the BLS Annual Survey more heavily than the others, our estimates would have been higher than the ones we ultimately used).

We categorized injuries as follows: deaths, disabling and non-disabling. Disabling means that the injury resulted in at least one day of work loss, while non-disabling means no full days of work loss. Within the disabling category, there are several sub-categories. We relied on the Workers' Compensation (WC) categories: Permanent Total (PT), Permanent Partial (PP), and Temporary Total and Partial (TTP). Permanent Total is the most severe disability category. Although there are a few legal exceptions, it generally means the person will never work again at any job. Permanent Partial is the next most severe category. It means the person will probably never work again at the old job, but, with training, may find a different job. Temporary Total and Partial means temporarily out of work or working at diminished capacity but fully anticipating returning to the old job.

Collateral Injuries A unique aspect of our study was to add collateral injuries. These included non-working, innocent bystanders. For example, an airline crash may kill pilots and flight attendants (employees) but may also kill vacation (non-working) travelers. Our estimate of the number of injuries to innocent bystanders was not great (less than two percent of injuries to workers) but they more frequently than other injuries involved deaths.

Counting Illness

Numerous explanations for the difficulty in counting how many cases of illness and death result from occupational exposures have been offered.

One explanation for the under-reporting of occupational illness is the inherent difficulty in diagnosing occupational diseases and in establishing cause and effect relationships. The link between occupation and disease is often elusive, because most occupational diseases are not clinically or pathologically distinct from chronic diseases associated with non-occupational etiologies. For example, the lung cancer caused by asbestos is identical in its clinical and pathological presentation with that caused by cigarette smoking (Selikoff and Lee 1978). Indeed, synergism has been shown to exist between occupational and non-occupational risk factors in the causation of cancer (Hammond et al. 1979). Similarly, solvent-induced encephalopathy may easily be attributed to old age (Landrigan 1983) and lead-induced neuropathy to hypertension or diabetes (Landrigan et al. 1984). Only in rare instances, such as in the association between asbestos and malignant mesothelioma (Selikoff et al. 1964) or in that between vinyl chloride monomer and angiosarcoma of the liver (Creech and Johnson 1974), is the causal association between occupational exposure and disease highly specific.

A second cause of the widespread under-recognition of occupational disease is that the majority of chemicals in commerce have never been fully evaluated with regard to their potential toxicity. A study by the National Research Council in the 1980's found no information available on the toxicity of approximately 80% of the 60,000 chemical substances in commercial use (National Research Council 1984). Even for those groups of substances that are most closely regulated and about which the most information is available—drugs and food additives—reasonably complete information on potential untoward effects is available for only a minority of agents.

This problem of insufficient toxicological data is compounded by the fact that pre-market testing of the toxicity of newly developing chemical substances is inadequate. Pre-market testing is the most effective means of assessing the toxicity of new chemical compounds. However, until the passage of the Toxic Substances Control Act (TSCA) in 1976, there was no legal mechanism in the United States for

prospective evaluation of the toxicity of new industrial compounds. Even since passage of the TSCA, inadequacies in testing requirements remain. Many thousands of potentially toxic compounds whose introduction to commerce antedated passage of TSCA remain untested, and there are no requirements at present for routinely testing such compounds. Also, testing procedures for new industrial compounds have not been standardized, especially for measurement of reproductive, neurological, immunological outcomes. Responsibility for deciding whether or not to test a new chemical and for the development of testing protocols is left almost entirely to the discretion of chemical manufacturers.

The long latency that typically elapses between occupational exposure and onset of illness is a third factor that may obscure the occupational etiology of chronic disease. For example, few occupational cancers appear within 10 or even 20 years of first exposure. Similarly, the chronic neurotoxic effects of solvents may become evident only after many decades of exposure (Landrigan 1983). A worker so affected may well have retired. In such a case, it is unlikely that the workers will be diagnosed as having a disease of occupational origin and even less likely that the employer will learn of this episode of occupational illness.

Lack of awareness among health practitioners about the hazards found at work is a fourth cause of underestimation of occupational disease. This lack of information reflects the fact that most physicians are not adequately trained to suspect work as a cause of disease (Rosenstock 1981). Very little time is devoted in most U.S. medical schools to teaching physicians to take a proper occupational history, to recognize the symptoms of common industrial toxins, or to recall the known associations between occupational exposures and disease. The average American medical student receives only six hours of training in occupational medicine during the four years of medical school (Burststein and Levy 1994). In consequence of this lack of training, most physicians do not routinely obtain histories of occupational exposure from their patients. Surveys indicate that adequate occupational histories are recorded on fewer than 10% of hospital charts (Institute of Medicine 1988).

Compounding this lack of medical awareness is the limited ability of many workers to provide an accurate report of their toxic exposures. Workers may have had multiple toxic exposures in a variety of jobs over a working lifetime. Until recently, they have not been informed of the nature of the hazard of the materials with which they have worked. Employers' reporting requirements remain limited even under the OSHA Hazard Communication Standard and under State and local right-to-know laws (Pollack and Keimig 1987). In many instances, an ill patient will simply not know about his or her past occupational exposures.

Finally, given the potential financial liability associated with the finding that a disease is of occupational origin, employers may be resistant to recognizing the work-relatedness of a disorder,

especially in cases where personal habits (such as cigarette smoking) or non-occupational pursuits are possible contributory factors. Since employers are often in the best position to recognize causal associations between workplace exposures and disease, this unfortunate conflict of interest represents a major obstacle to obtaining accurate estimates of the burden of occupational illness.

Proportional Attributable Risk Model

Given our inability to delineate for nearly all causes of death which individual deaths were due to occupational causes acting alone or in conjunction with other causes, it is necessary to resort to estimating the proportions of diseases and deaths to which occupational exposures have contributed. Such an approach was applied to occupational cancer 15 years ago when it provoked a lively debate (Peto and Schneiderman 1981). Gains in knowledge in the intervening time period can contribute to a more informed discussion of the issues but cannot produce irrefutable, precise proportions of disease attributable to occupational factors for the general population. The aim of this section, then, is to establish reasonable ranges of such proportions for major causes of death, while fully acknowledging the limitations of the approach.

Several seminal issues underlie this approach to estimating occupational morbidity and mortality. First, since most disease is multi-factorial in origin, to attribute a death to an occupational exposure does not exclude a causal role for another factor that is not occupational. Both causes may have actively contributed to a person's death. Indeed, most lung cancers in asbestos-exposed workers who smoke cigarettes occur as a result of the combined action of exposure to asbestos and cigarettes (Hammond et al. 1979). It would be proper, therefore, to assign a lung cancer death in such a person simultaneously to an occupational cause and to a lifestyle factor. This will lead to double-counting as long as categories of causes are considered mutually exclusive. In this chapter, we use the term attributable proportion with reference to an exposure to mean the proportion of disease that would have not occurred in the absence of that exposure.

A deeper problem exists, however. While it is likely that occupational causes frequently interact with non-occupational causes to produce illness and death, the nature of this interaction is largely unknown and unquantified. It is, therefore, difficult to determine, for most occupational exposures, the relative importance of each factor, occupational and non-occupational, acting alone and in concert.

Second, the proportion of disease due to occupational causes (or any other causes) can be expected to vary in time and place. This is due principally to 1) differing relative risks due to variation in type, intensity and duration of exposures and 2) variation in the proportion of the populations exposed to

various occupational toxins. An empirical demonstration of this variation and its sources is provided by the body of case control studies of lung cancer completed in the past 15 years (Milne et al. 1983; Correa et al. 1983; Pastorino et al. 1984; Kjuus et al. 1986; Lerchen et al. 1987; Schoenberg et al. 1987; Damber and Larsson 1987; Benhamou et al. 1988; Levin et al. 1988; Ronco et al. 1988; Vineis et al. 1988; Dambar and Larsson 1988; Morabia et al. 1992).

These considerations determine the type of evidence that would be needed to achieve validity and precision in determining the proportion of categories of diseases due to occupational exposures. Large case-control studies including subjects drawn from a nationally representative sample would yield suitable proportionate attributable risk estimates. Such a study for lung cancer was recommended 15 years ago as part of the occupational cancer debate (Doll and Peto 1981). While many smaller lung cancer case control studies in numerous geographic areas have been completed (Milne et al. 1983; Correa et al. 1983; Pastorino et al. 1984; Kjuus et al. 1986; Lerchen et al. 1987; Schoenberg et al. 1987; Damber and Larsson 1987; Benhamou et al. 1988; Levin et al. 1988; Ronco et al. 1988; Vineis et al. 1988; Dambar and Larsson 1988; Morabia et al. 1992), a truly national study in the United States has not been initiated. Alternatively, a comprehensive set of cohort studies covering many occupations would provide the needed estimates of relative risk and levels of exposure in the relevant populations, though interaction with non-occupational risk factors would remain problematic. Despite increased occupational studies in the past two decades, the database that would allow precise estimates of the proportions of major causes of death due to occupational remains far from complete.

The occupational health research community is unlikely to command the resources in the foreseeable future to undertake the number and kinds of detailed studies that would provide the knowledge base allowing qualitatively better estimates of the occupational contribution to disease than we are able to complete at present. Our approach in this document is to use estimates of ranges of proportions of major categories of diseases that are consonant with current knowledge and thinking. Ranges of estimates of similar magnitudes have been used by numerous groups of occupational health researchers in various states, including New York, Connecticut, Texas and New Jersey, Pennsylvania, and Canada (Markowitz et al. 1989; Fahs et al. 1989; Markowitz and Landrigan 1989; Occupational Health Working Group 1990; Rothstein and Cooper 1993; Pennsylvania Department of Health 1990; Kraut 1994). A summary of our estimates is provided in Table 1.

Table 1

Estimated Percentages of Selected Diseases
Caused by Occupational Factors

<u>Condition</u>	<u>Percentage Attributed to (ICD-9 Codes)</u>	<u>Occupation</u>
Cancer	(140-209)	6%-10%
Coronary heart disease ¹	(410-414,440)	5%-10%
Cerebrovascular disease ¹	(430-438)	5%-10%
Chronic obstructive pulmonary disease	(490-496)	10%
Renal disorders	(580-589)	1%-3%
Nervous System disorders	(323.7, 331, 332, 349.82, 356, 357.7, 359.4)	1%-3%

¹ Only includes new and recurrent cases of coronary heart disease and cerebrovascular disease among people between ages 25 and 64, inclusive. See text for explanation.

Cancer

We estimate that 6% to 10% of all cancers among people aged 25 and older in the United States are caused by occupational exposures.

Previous estimates of the proportion of cancer due to occupational factors range from 4% to 38%. The former number was proposed as the best point estimate by Doll and Peto as part of a major review of the causes of cancer published in 1981 (Doll and Peto 1981). Their report was written in part in response to a 1978 consensus document written by numerous U.S. governmental agencies estimating that 22% to 38% of all cancers in the United States were due to occupational carcinogens (Bridbord et al 1978). The 1978 report was flawed inasmuch as relative risks derived from cohorts heavily exposed to occupational agents were applied to populations with a broad range of exposure to these agents, yielding an overestimate of the number of people likely to develop occupational cancer. On the other hand, a major industry-sponsored review of the 1978 report by Stallones and Downs only mildly criticized the governmental report and estimated that 10% to 33% of cancer in the United States were caused at that time by occupational agents (Stallones and Downs 1978).

The estimate of 6% to 10% is grounded in part on a specific set of studies of selected cancers and in part on general trends in human and animal cancer research. There have been at least a dozen case control studies of lung cancer and occupation completed in the United States and Europe since 1982. After controlling for cigarette smoking, they collectively show that 10% to 33% of all types of lung cancer in

males are attributable to occupational exposures. Applying a narrower range of point estimates, 15% to 20%, to the 91,405 deaths from lung cancer among males in the United States in 1992 yields a total of 13,711 to 18,281 deaths in males from lung cancer due to occupational agents. These lung cancer deaths represent 2.7% to 3.5% of all cancer deaths in the United States in 1992. A similar analysis of deaths from another well-documented occupational cancer, bladder cancer, provides an estimate that 21% to 27% of male bladder cancer deaths are due to occupation in the United States (Silverman et al. 1989a; Silverman et al. 1989b). Since there were 7,123 deaths from bladder cancer among U.S. males in 1992, 1,496 to 1,923 bladder cancer deaths, or approximately 0.3% of all cancer deaths, were due to occupational agents. Together, bladder cancer and lung cancer among males alone accounted for approximately 3% to 4% of all cancer deaths in the United States in 1992. There are an insufficient number of studies of other specific cancer sites to apply point estimates or ranges as the percentages of these cancers attributable to occupation.

Three sets of research findings in occupational cancer in the past 10 to 15 years support the proposition that the percentage of cancer due to occupation is significantly higher than the 3% to 4% specifically due to cancer of the lung and bladder. First, recent studies have increased the likelihood that a number of well-known toxins are human carcinogens. Included in this category are cadmium, fiberglass, silica and lung cancer (Stayner et al. 1992; National Toxicology Program 1994); vinyl chloride and brain cancer (Wong et al. 1991); and orthotoluidine and bladder cancer (Ward et al. 1991; Sellers and Markowitz 1992). For other agents, limited evidence has accumulated to support, though has not yet established, an etiologic role in cancer. Among these agents are formaldehyde, 1,3 butadiene, and perchloroethylene (National Toxicology Program 1994). While the carcinogenicity of some of these agents may be refuted as additional human evidence is accumulated, it is unlikely all will be exonerated as human carcinogens. Notably, industrial exposure to many of these agents is common, increasing the significance of even modest elevations in relative risk.

A second set of findings that is not addressed by the agent by agent approach to identifying occupational cancer is the large number of studies that demonstrate increased risks of cancer for specific occupations without clear identification of the suspect agents. Many occupations have multiple exposures, exposures of uncertain intensity, or no obvious exposures at all. Yet, some of these occupations show consistent elevations on cancer risk. Examples include farmers and lymphoma (Pearce and Reif 1990; Blair et al. 1992) and fire fighters and brain cancer (Demers et al. 1992; Demers et al. 1994; Vena and Fiedler 1987). Undoubtedly, some of these associations are not causal, but it is also likely that many are. Additional research will elucidate the nature of these relationships. Until this is achieved, it is not possible

to ascribe a numeric estimate of the contributions of these jobs to occupational cancer. However, to ignore these findings entirely would be to discard the findings of many well-performed studies.

Third, toxicological assays in animals completed in the past two decades show that a significant number of chemicals tested to date show evidence of carcinogenicity. More than 600 chemical agents have been shown to be carcinogenic in at least one rodent species (Rall et al. 1987). In a review of the experience from the National Toxicology Program (NTP), 130, or one-third, of 404 experiments conducted by the NTP in 105 chemicals showed evidence of carcinogenicity (Rall et al. 1987). Among the more important agents that tested positive in the NTP experiments but for which epidemiologic research is incomplete are methylene chloride, tetrachloroethylene, and propylene oxide (Rall et al. 1987). While there is considerable disagreement about the significance of the results of animal testing for human cancer (Huff and Rall 1992), it is nonetheless considered prudent, given a paucity of human data, to regard chemicals that cause cancer in animal experiments as being reasonably likely of doing so in humans as well. While the results of animal studies certainly do not contribute to the precision of the estimates of the fraction of human cancer attributable to occupational exposures, they nonetheless suggest that the problem of occupational cancer may be larger than is recognized when only established human carcinogens are considered.

Taken together, these lines of evidence—an increased number of epidemiologic studies tying individual agents to specific cancers; the body of literature relating specific occupations to selected cancers even in the absence of identified agents; and the finding that a large proportion of chemicals cause malignancies in animals—exert an upward pressure on the numeric estimates of the proportion of cancer attributable to occupational exposures. They support our notion that no fewer than 6% of cancer deaths have an occupational cause, and, indeed, that the 6% to 10% range may be a conservative estimate of the occupational fraction of cancer deaths.

Cardiovascular and Cerebrovascular Disease

Despite the importance of heart and related large vessel disease as a cause of mortality in the United States, there has been little attention given to the overall burden of cardiovascular disease (CVD) caused by occupational risk factors. Unlike carcinogenesis, relatively few chemical agents have been shown to cause or promote heart disease and hypertension. Carbon disulphide and nitroglycerin have been demonstrated to cause or exacerbate ischemic heart disease. Carbon monoxide displaces oxygen from hemoglobin, reducing oxygen supply to the heart, and worsening symptoms of coronary heart disease. It also appears to promote atherogenesis. Lead raises blood pressure, thereby contributing to the

risk of hypertensive and ischemic heart disease and stroke.

Lead and carbon monoxide are widespread hazards. According to the National Occupational Exposure Survey conducted by NIOSH in the early 1980s, there were 1.4 million people with potential occupational exposure to lead (NIOSH 1992). The number of people exposed to carbon monoxide is less well-described, but is large. The level of excess risk of cardiovascular and cerebrovascular disease experienced by the large numbers of workers exposed to these agents is not known. It is, therefore, not possible to calculate the fraction of CVD caused by these agents.

A large body of scientific literature exists linking a number of non-chemical occupational risk factors to heart disease and stroke or to the antecedent risk factors known to cause these diseases, such as high blood pressure, increased serum lipids, and others. Occupational stress, noise, shiftwork, passive smoking, and the physical inactivity inherent in many occupations have been implicated in excessive rates of heart disease, stroke, and hypertension. It is beyond the scope of this chapter to examine in detail the dozens of studies that have addressed these issues, which have been recently reviewed elsewhere (Kristensen 1989; Olsen and Kristensen 1991; Schnall et al. 1994).

Psychosocial stress in the workplace has been shown to be a probable cause of cardiovascular disease. Empirical support for this relationship is best developed when stress is formulated in the "job strain" model introduced by Karasek 15 years ago (Karasek 1979). This model designates jobs involving high demands and low decision-making latitude as "high strain" jobs. A recent review evaluated 36 studies published between 1981 and 1993 addressing this issue, the majority of which showed a positive association between job strain and cardiovascular disease or known cardiovascular disease risk factors (Schnall et al. 1994). The findings were consistent across populations, study designs, and outcome measures. The authors concluded that available data "strongly suggest" that job strain causes cardiovascular disease.

Olsen and Kristensen use these studies to obtain estimates of the etiologic fraction of cardiovascular disease that is caused by job strain and by other workplace factors in Denmark (Olsen and Kristensen 1991). They restrict their estimates to "premature" cardiovascular disease (i.e., such disease occurring in people under age 70). They estimate that 6% of men and 16% of women have high strain jobs. They use an average relative risk of two for cardiovascular disease associated with job strain to determine that 6% of CVD in men and 14% of CVD among women is due to job strain. The authors note the similarity between their results and those obtained in Sweden, that is, etiologic fractions of 3%-7% for CVD in men and 9%-13% for CVD in women (Olsen and Kristensen 1991).

By a similar method, Olsen and Kristensen obtain etiologic fractions of CVD ascribed to other

non-chemical occupational risk factors: 7% of CVD in both sexes due to shiftwork; 2% of CVD in both sexes due to passive smoking; 1% of CVD in both sexes due to noise; and 42% of CVD in both sexes due to sedentary work. Excluding the risk attributable to sedentary work, the aggregate risk of CVD due to these non-chemical occupational risk factors was 16% in men and 22% in women.

For the present analysis, any risk of cardiovascular disease due to physical inactivity of work is excluded for two reasons. First, there is likely to be much disagreement about whether physical inactivity should be considered an occupational risk factor, much less whether it should be viewed in the same manner as other occupational agents. Second, the etiologic fraction assigned to sedentary work is so large, that, if used, it would become the greatest determinant of our estimates of the number of cases of CVD due to occupational causes. Given the lack of consensus about sedentary work, it seems reasonable to exclude it in order to maintain the integrity of the proportion of CVD due to other occupational factors.

The age groups for inclusion in the estimates of occupational disease is of crucial importance for cardiovascular disease. In 1991, 84% of all deaths due to cardiovascular diseases in the United States occurred among people aged 65 and over (National Center for Health Statistics 1993). This skewed age distribution is less true for cancer. In 1991, 69% of deaths from cancer in the United States occurred among people aged 65 and over (National Center for Health Statistics 1993). For our estimates of the number of cancers caused by occupational factors, we apply a range of proportions to cancers in all age groups, because the well-known phenomenon of latency dictates that occupational exposures experienced during the working years, ages 40 to 60, may not be expressed until well after retirement age. Whether such a latent period applies to the non-chemical occupational risk factors for CVD is not known. We, therefore, restrict our estimates of occupational cardiovascular disease to people aged 64 and below. This is close to the age range used by Olsen and Kristensen (Olsen and Kristensen 1991).

We estimate that 5% to 10% of all ischemic and hypertensive heart disease and cerebrovascular disease among people below age 65 in the United States is due to occupational causes. We employ lower percentages than those cited above in an attempt to be conservative and in recognition of the uncertainty of the underlying data.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is the principal occupational cause of respiratory mortality and morbidity other than the pneumoconioses. COPD also constitutes the primary cause of deaths due to chronic respiratory disease in the United States. While cigarette smoking is undoubtedly the major cause of COPD at present, studies have demonstrated a role for occupational exposures in the

etiology of COPD. The best quantitative data exist for a limited number of exposures, principally coal, silica, grain dust, cadmium and others (U.S. Department of Health and Human Services 1985). Other studies have related specific occupations to excess COPD mortality (Becklake 1989; Oxman et al. 1993). The literature relating to this topic is extensive and has been reviewed recently elsewhere (Becklake 1989; Oxman et al. 1993).

Recent studies clearly support a role for occupational exposures in COPD mortality (Korn et al. 1987; Lebowitz 1977; Krzyzanowski and Kauffman 1988; Viegi et al. 1991; Xu et al. 1992). These large population-based studies consistently show that exposure to a wide variety of occupational dusts, and, to a lesser extent, gases and fumes, is associated with a 30% to 50% increase in symptoms and pulmonary function deficits characteristic of COPD. In order to recognize the likelihood that occupational exposures play a limited but definite role in the cause of death from COPD, we assign an estimate of 10% to the proportion of COPD caused by occupational exposures, acknowledging that this estimate should be regarded as provisional until better data exist.

Pneumoconioses

That all deaths and most illness caused by pneumoconioses are due to occupational exposures to pathogenic dusts is obvious and deserves little comment. Exposure to asbestos, coal, silica and other dusts occurs outside of the workplace, especially in the homes of workers and in the neighborhoods of dust-producing facilities. However, the intensity of these non-occupational exposures is unlikely to cause death.

A more important issue is the extent to which pneumoconioses may be under-diagnosed and, therefore, missing from death certificates. The most extensive analysis of the under-diagnosis of mortality from a pneumoconiosis has been performed among insulators in the United States and Canada by Selikoff and colleagues (Selikoff and Seidman 1991). Between 1977 and 1986, there were 123 insulator deaths ascribed to asbestosis on the death certificates in this cohort. After investigators reviewed medical records, chest radiographs, and tissue pathology when available ("best evidence"), they ascribed 259 insulator deaths occurring between 1977 and 1986 to asbestosis (Selikoff and Seidman 1991). Over one-half of pneumoconiosis deaths were, thus, missed in this group well-known to have heavy asbestos exposure. Unfortunately, there are not a sufficient number of other studies of the under-diagnosis of pneumoconioses on death certificates to allow a reliable correction of the mortality statistics available from the National Center for Health Statistics.

Renal and Neurologic Disease

The extent of research documenting the occupational causes of renal and neurologic disease is considerably less extensive than that supporting the relationships between occupational agents and cancer and chronic respiratory disease. Examples of exposure-response relationships for these outcomes abound, even if the accumulated research has not been sufficiently comprehensive or appropriately designed to support precise estimates of the occupational etiologic fraction. Both categories of disease can be caused by exposure to common occupational toxins. Renal toxicity has been associated with occupational exposure to lead and mercury, glycol ethers, and other organic solvents (Landrigan et al. 1984; Daniell 1994). Neurological disorders stemming from the workplace exposures have been caused by pesticides, heavy metals, many organic solvents, and other organic agents (National Research Council 1992; Landrigan et al. 1994; Office of Technology Assessment 1990). Because the exposure-response relationships have not been well characterized for these disease categories, estimates of the etiologic fraction due to occupation can only be crudely estimated. We employ a range of 1% to 3% for the occupational proportion of these diseases in order to ascribe a limited role for the contribution of occupational agents to deaths from diseases of these organ systems. This range may represent an under-estimate, but data do not exist to support a higher attributable percentage with any degree of confidence.

Costs

Theory Economists have developed two methods for estimating the costs of injuries and illnesses: the Direct and Indirect cost method and the Willingness-to-Pay (WTP) method. The Direct/Indirect method, alternatively called the Human Capital method, is the most widely used method in medical and legal settings. It is practical, intuitive, and easy to implement (i.e., estimates are available and reliable). The WTP method is more widely used in the economics literature. Most, but not all (Robinson, 1986), economists believe it is theoretically more compelling than the Direct/Indirect method, but they acknowledge that it is difficult to implement (i.e. only a few estimates are available and their reliability is questioned). Finally, WTP estimates represent marginal rather than average or total costs. Marginal costs are the more relevant costs for assessing, for example, the benefit to cost ratio of a proposed change in OSHA regulations. They may not be appropriate for measuring the overall national cost burden of all occupational injuries and illness.

Direct costs represent actual dollars spent or anticipated to be spent on providing medical care to an injured or ill person as well as property damage, police and fire services, administrative costs for

delivering indemnity benefits and direct costs to innocent third parties. Medical costs include doctors' and nurses' services, hospital charges, drug costs, rehabilitation services, ambulance fees, payments for medical equipment and supplies. Indemnity benefit costs do *not* include the benefits themselves, these we implicitly accounted for in the indirect costs (lost wages). Indemnity benefit costs include the administration costs associated with providing Workers' Compensation indemnity or Social Security disability payments to injured or sick workers and their families. Property damage includes costs of damage to vehicles, machines, buildings and so on, directly associated with the injuries and illness.

The largest indirect costs include the injured or sick workers' lost earnings, fringe benefits and home production. Other indirect costs include employer costs associated with retraining and restaffing, co-worker costs of lost productivity, time delays, and indirect costs to innocent bystanders.

The WTP method attempts to value injuries and illnesses based on prices generated in private market transactions. The presumption behind WTP is that individual workers themselves are in the best position to evaluate the true value of medical costs, lost earnings, family hardship, pain and suffering, and so on, than researchers analyzing statistical data. These prices, theoretically, may be observed through market transactions. But there are criticisms of the WTP method and especially the estimates as we note in the Final Report. For example, we are not aware of any WTP estimates for occupational illnesses.

We present estimates derived from both methods. We prefer the estimates based upon the Direct/Indirect method, since 1) these are more widely accepted in the medical and legal literature; 2) since these are more conservative estimates (WTP estimates tend to be two to five times the size of the Direct/Indirect method estimates); 3) and since the estimates are more reliable for what they are designed to measure than the WTP estimates are for what WTP estimates are designed to measure; 4) WTP estimates represent marginal costs.

Two approaches can be used in estimating the costs of injury or illness by the Direct/Indirect (or 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 costs of the base year manifestations of injury or disease which may have had their onset in the base year or any time prior to the base year.

Incidence-based costs represent the lifetime costs resulting from a *new* injury, disease or illness originating in the base year. In the aggregate, incidence costs in a given base year refer to the likely course of an injury or a disease and its duration, including survival rates since onset, medical care that will be used and costs for the duration of the injury or disease.

We used the incidence method for all injuries and morbidity estimates of disease. We used the

prevalence method for disease deaths.

Direct/Indirect Cost Application -- Injuries To estimate the costs of injuries, we needed to estimate the number of categories of workplace-related injuries and multiply these by the average costs of such injuries. The data allowed us to specify three broad categories of injuries: deaths, disabling and non-disabling. The disabling injuries were, in turn, split into the Workers' Compensation (WC) categories so that we could match them with WC cost figures from the National Council on Compensation Insurance (NCCI) Ultimate Reports.

Direct average costs for medical care were drawn from the NCCI Ultimate Reports. Lifetime medical costs (1992 dollars) for deaths were valued at \$20,120; for Permanent Total at \$132,419; for Permanent Partial at \$17,920; for Temporary Total and Partial at \$3,250; and for no work loss at \$275. The medical expenses were drawn from WC accounts and did not require adjustment since WC paid virtually 100 percent of medical bills in 1992, i.e. no copayments or deductibles were charged to clients.

The calculation of the indirect costs was based upon a variety of sources including indemnity data in the NCCI and national government data on employment, earnings, and mortality. Home production, as well as hiring, training and workplace disruption costs, were priced in accord with estimates in the literature (Douglas and Kenney; Barron, Black, Lowenstein; Oi).

Indirect costs for fatalities required a present value calculation. We took a similar approach to calculating the present value as was taken by Rice et al. (1989), and Miller and Galbraith (1995). We assumed that persons who died would have earned what others of the same age and gender earned.

The age and sex data on the deaths were estimated with information from the CFOI. These age and sex data were combined with information on wages (U.S. Dept. of Commerce, 1993); probabilities that persons will survive to age 75 (U.S. Bureau of the Census, 1993); as well as the employment within those categories (U.S. Bureau of Census, 1993).

The present value formula we used was similar to the one in Rice et al. (1989).

$$PV_{\text{death}} = \sum_{n=y}^{75} P_{y,s,n} \times \frac{[M_{s,n} + H_{s,n} + F_{s,n}] \times LFPR \times (1+g)^{n-y}}{(1+r)^{n-y}}$$

where PV_{death} = present discounted value of loss due to injury death per person;

$P_{y,s,n}$ = probability that a person of sex s and age y will survive to age n;

y = age at which person was injured;

s = sex of person;

n = age of person;

$M_{s,n}$ = mean annual earnings of employed persons of sex s and age n ;

$H_{s,n}$ = annual value of household production for person of sex s and age n ;

$LFPR_{s,n}$ = labor force participation rate: proportion of the population of sex s and age n that are employed in the labor market, i.e., the labor force participation rate. The $LFPR = 1$ for injured (not ill) persons who were working and older than 65.

$F_{s,n}$ = fringe benefits for sex s and age n ;

g = rate of increase of labor productivity, assumed to be 1%;

r = real discount rate, assumed to be 4%.

The LFPR above deserves comment. Most people retire at or before age 65. We assumed that persons who died prior to 65 would have a LFPR of typical persons now over age 65, e.g., .161 for men and .083 for women. However, some of our injury decedents, prior to death, were over 65 and still working. For these people, we assumed a LFPR of 1.0, i.e., we assumed that they would have continued working until age 75. We assumed no one would work beyond age 75.

M represents average annual earnings for full-time and part-time employees (U.S. Department of Commerce, 1993). H represents the annual value of household production. The contribution of the individual to economic and social output should include home production. Home production included changing diapers, reading to children, home repairs, building cabinets, plumbing repairs, and so on (and on!). Home production can take place anytime of the day. Estimates on home production were drawn from Douglas, Kenney and Miller (1990) and updated to 1992 using the CPI-U-X1. These Douglas et al. (1990) estimates assume: 1) higher productivity in the labor market implies higher productivity at home; 2) women, because of socialization and job market discrimination, have more home production than men; 3) women of child-rearing age provide the greatest amount of home production; and 4) women are more likely than men to work for pay part-time and work at home more hours than men.

Fringe benefits are indicated with an F . A 22 percent rate was assumed for men and a 16 percent rate for women. The disparity reflects the greater likelihood that men were employed full-time.

The NCCI figures also provided us with indemnity benefits. The indemnity benefits were adjusted assuming WC paid to clients the following rates: 40 percent of before tax wages for Permanent Total (PT) conditions; 50 percent for Permanent Partial (PP) conditions; and 60 percent for Temporary Total and Partial (TTP) conditions. Fringe benefits were assumed to be 21 percent of the before tax wage for men and women combined. (We did not conduct separate cost analyses for men and women for non-fatal injuries.)

Insurance administrative costs were assumed to be 31 percent of *medical* expenses for WC and

16 percent for the combined expenses from private insurance, Medicaid, welfare and Medicare. Another 31 percent for WC and 10 percent for administrative expenses, for the combined amount from private insurance, welfare, and Social Security was assumed for *indemnity* benefits. The 16 and 10 percents were justified given that a high and disproportionate amount of medical expense comes from private firms and a high and disproportionate amount of indemnity expense comes from the government.

Cost estimates for workplace training, restaffing and disruption were based on studies by Barron, Black, Lowenstein, Smart and Oi. Estimates on the cost of property damage, time delays, and police and fire services were drawn from Blincoc and Faigin.

We applied the same average cost estimates to innocent third party bystander deaths and injuries as we applied to job-related deaths and injuries.

Direct/Indirect Cost Application -- Disease

Two approaches can be used in estimating the costs of illness by the human capital method. Prevalence-based costs provide an estimate of the direct and indirect economic burden in a period of time (the base period) as a result of the prevalence of disease, a period most often a year. Included are the costs of the base year manifestations of sequelae of disease which may have had its onset in the base year of any time prior to the base year. Prevalence costs measure the value of resources used or lost during a specified period of time, regardless of the time of disease onset.

Incidence-based costs represent the lifetime costs resulting from the disease or illness. In the aggregate, incidence costs in a given base year refer to the likely course of a disease and its duration, including survival rates since onset, medical care that will be used and its cost during the duration of the disease, and the impact of the disease on employment, housekeeping, and earnings.

Relatively few incidence-based studies exist, but the state of the art is illustrated by three studies. Hartunian, Smart, and Thompson (1981) estimated the lifetime costs of cancer, coronary heart disease, stroke, and motor vehicle injuries. Policy Analysis, Inc. conducted a study for the National Center for Health Statistics entitled "Evaluation of Cost of Illness Ascertainment Methodology." Final Report, DHHS Pub. No. 233-79-2048, December 1981. This report examines the incidence-based costs of breast cancer, diabetes mellitus, rheumatoid arthritis, stroke, and acute lymphocytic leukemia. Oster, Colditz, and Kelly (1984) estimated the costs of smoking and the benefits of quitting in their book, *The Economic Costs of Smoking and Benefits to Quitting*. Lexington Books, D.C. Heath and Company 1984.

These studies investigate direct and indirect costs by modeling the disease process from onset until cure or death, including the trends of important parameters such as incidence, survival, use and cost

of medical care, and time lost from work and housekeeping. In each of these studies, a great deal of effort was expended in locating and making the most of available data, which often were originally gathered for other purposes, were incomplete, and had to be modified to meet the needs of incidence costs analysis. These studies are impressive in their demonstration that incidence-based costs are methodologically feasible, and in their use of extensive sensitivity analysis to reveal the impact of alternative assumptions and parameter values on estimated costs.

For the incidence-based lifetime costs of occupational disease, data are needed on the number of *new* cases of cancer, heart disease, respiratory disease, renal disorders and so on, that are caused by or associated with various unhealthy occupations. To obtain estimates of lifetime costs of these *new* cases, one must have information on the severity of disease from onset, the direct medical costs incurred from onset to death, the productive time lost during this period and the lag time between diagnosis and death. Owing to idiosyncrasies in the manner by which most occupational diseases are managed and recorded, accurate data both on incidence and cost are difficult to secure. Without substantial primary data collection and analysis, which is outside the resource constraints of this project, the current data limitations for age-specific and sex-specific incidence rates and severity of occupational disease preclude the development of an incidence-based cost of illness estimate. The purpose of this chapter is to develop a reasonable appreciation for the potential magnitude of the economic cost of occupational disease in the US in the face of less than optimal data.

The prevalence-based methodology estimates the direct and indirect costs of occupational disease using a step-down accounting strategy and available national data. The prevalence method is the more commonly used accounting strategy due to the less extensive data requirements. This method is primarily concerned with costs during a fixed period of time, normally a calendar year. The economic costs associated with occupational disease are estimated in this analysis using a prevalence-based methodology, following the work of Rice and colleagues (Rice 1966; Rice, Hogson, and Kopstein 1985; Hodgson and Rice 1976; Hodgson 1982). The cost of disease is measured by the cost of resources consumed as the result of the disease during one year, and by the value of the lost productivity resulting from morbidity and premature mortality caused by the disease during that year. In estimating the economic burden resulting from the prevalence of disease, the conventional prevalence methodology attributes the future costs of premature mortality to the year in question, using discounting techniques to estimate the present value of future losses.

Following the prevalence-based method, we apply cost of illness accounting techniques to calculate the present value of the direct and indirect costs associated with occupational disease. Using the

national hospital discharge survey , we calculated the total number of days spent in the hospital by patients with a primary diagnosis for each of the attributable occupational illness groups defined by specific ICD9 codes for the occupational diseases most responsible for worker mortality presented above. Total days of hospitalization by disease group were transformed to obtain standardized proportions of national hospital utilization attributable to occupational disease. We applied these proportions to the national health expenditure accounts (minus nursing home costs), estimated by the Health Care Financing Agency, to obtain an estimate of medical direct costs. The direct costs of nursing home care for occupationally-related disease were estimated using the National Nursing Home Survey (1985). These cost estimates, using diagnosis-specific nursing home length-of-stay data, were added to medical expenditure estimates to obtain an estimate of total direct costs.

Indirect costs were estimated using present value formula applied to injuries. Unlike the injury application, however, no one was assumed to have a labor force participation rate of 1.0 beyond age 65. Information applied to age-specific, sex-specific, and disease-specific mortality data from the National Center for Health Statistics, Vital Statistics Division (U.S. National Center for Health Statistics 1993; U.S. Department of Health and Human Services 1993 and 1994), as well as life table estimates, and expected earnings and labor force participation data from the Bureau of Labor Statistics. By applying the attributable risk proportions, presented above, to the total estimates of individual costs by disease, the present value of the indirect costs of premature mortality due to occupational disease is estimated for the base year 1992. Finally, we calculated national disease-specific trends over time in the ratios of morbidity costs to direct costs, and morbidity costs to mortality costs (Rice 1985; Rice 1989) to obtain an estimate of the morbidity costs for the occupational diseases that comprise the major causes of death from occupational disease.

In addition to estimating the economic costs associated with the occupational diseases responsible for major causes of death in the United States we investigated the costs of specific nonfatal occupational diseases, including skin diseases, and carpal tunnel syndrome, as reported to the Bureau of Labor Statistics. Industry-specific wage rates were applied to lost work time to obtain a conservative estimate of indirect costs. Direct costs were based on estimates obtained from published data from the National Council on Compensation Insurance (Neumark et al, 1991).

Method for -- Who Pays?

Our analysis of who pays for occupational injuries and illnesses was split into two parts. In the first part, the *nominal* aspects of costs were considered and in the second the actual (or "true" or what

economists refer to as *incidence*) aspects of costs were considered. In the *nominal* view, the origin of funds was presumed to be with the agent that actually wrote the check or signed the credit form or paid the cash.

In the second part, the actual or *incidence* aspects of costs were considered. The actual payer may or may not be the nominal payer. Economic theory and empirical studies were reviewed pertaining to who actually bears the burden of occupational injury and illness costs. For example, the Social Security Administration writes the checks to cover Medicare bills. But Medicare is financed through payroll taxes on employers and employees. The employers may try to pass on some of the payroll taxes to consumers in the form of higher prices or to workers in the form of lower wages. Medicare costs, therefore, may actually be paid by consumers and workers, not employers.

RESULTS

Results for Counting Injuries

We estimated that 6,529 workers died from workplace-related injuries in 1992. As with any point estimate, our estimate of 6,529 represents a point between an upper (7567) and lower bound (6063). Our point estimate is closer to the lower than upper bound because we have more confidence in the studies that generated low estimates of deaths. These bounds are presented in Table 2. These bounds are not confidence intervals. Bound estimates were suggested by at least one study or our own analysis. The lower bound estimates we obtained were presumed to be extreme minimums. For example, our lower bound on deaths (6063) was drawn directly from the Census on Fatal Occupational Injuries (CFOI). The CFOI required that at least two documents (e.g., a death certificate and a Workers' Compensation claim) attest to the fact that a given injury fatality was job-related, hence we have great confidence that the true number of injury deaths to civilians was more than 6063.

Table 2

Estimates of Injury Deaths and Non-fatal Injuries^a

			Lower and Upper Bound for Deaths and Total <u>Non-fatal Injuries</u>	
Deaths	6,529 ^b		6063 ^b to 7567 ^b	
Total non-fatal injuries	13.247	million	10.786 to 17.210	million
Non-disabling (54% of Total)	7.1534	million		
Disabling (46% of Total)	6.0936	million		
Permanent Total (.176% of Disabling)	10,725 ^b			
Permanent Partial (12.497% of Disabling)	.761517	million		
Temporary Total and Partial (30.983% of Disabling)	1.88798	million		
One to seven days lost (56.344% of Disabling)	3.43338	million		

^a Excludes injuries to innocent third parties

^b Deaths and Permanent Totals are not expressed in millions

A disproportionate share of injuries, especially injury deaths (40%), were caused by transportation accidents including aircraft crashes, boat and rail accidents, but most importantly, vehicle collisions. Other causes of deaths were assaults and violent acts (20%), falls (10%), electrocutions (5%), fires, and explosions (3%).

We estimated 13.247 million non-fatal injuries in the workplace in 1992. Disabling injuries accounted for 6.09 million and non-disabling accounted for 7.15 million injuries. We estimated the percentages of disabling injuries in each WC category: 0.176% for PT, 12.497% for PP, 30.983% for TTP, and 56.344% for One to Seven days of disability. This last category was necessary because WC requires at least three days and sometimes seven days of work loss before any of the three categories -- PT, PP, and TTP -- apply.

Another unique aspect of our study involves a collection of data from various sources pertaining to the demographic and job characteristics of persons injured. We found, for example, that men were far more likely than women (11:1) to be killed on the job but only slightly (2:1) more likely to experience a nonfatal injury.

Results for Counting Illnesses

BLS Annual Survey

The federal Bureau of Labor Statistics has conducted the Annual Survey of Occupational Injuries and Illnesses (BLS Annual Survey) since 1972 under a mandate established by the Occupational Safety and Health Act of 1970. The goal of the survey is to obtain the numbers and the rates of illnesses recorded by the employers as being occupational in origin. The 1992 survey reflects questionnaire data obtained from a stratified random sample of approximately 250,000 establishments in the private sector. The survey completed by the employer is principally a distillation of data that employers are required to maintain by OSHA (OSHA Log 200). The most recent year for which detailed data are available is calendar year 1992.

The BLS Annual Survey has several important exclusions. It excludes farms with fewer than 11 employees, the self-employed, and employees of the federal, state, and local governments. In order to include information on miners and railroad workers, the BLS Annual Survey reports data collected by the Mine Safety and Health Administration and the Federal Railroad Administration.

It is noteworthy that BLS requires employers to record all occupational illnesses on the annual survey, regardless of whether the illness led to work restriction or lost work time. This is in contradistinction to occupational injuries, which are only recorded on the survey if there is loss of consciousness, restriction of work or motion, job transfer, or medical treatment other than first aid.

Some well-recognized weaknesses severely limit the ability of the BLS survey to provide a full and accurate count of occupational illnesses in the United States. Data are employer-derived. Any illness that the employee does not report to the employer as being work-related is not likely to be reported by the employer on the annual survey. Among active workers, such a failure to report may be due to fear of consequences by the employee. A second major obstacle to reporting is the failure of the employee's physician to diagnose the illness as being work-related. Occupational disease occurring among retired workers are not subject to the BLS reporting requirement. Indeed, it is unlikely that the employer would be aware of the onset of a work-related illness in a retiree. Since many cases of chronic occupational illnesses with long latency, including cancer and lung disease, are likely to have their onset following retirement, a large proportion of such cases would not be included in the data collected by the BLS.

These limitations are recognized by BLS in its report on its annual survey. In the published report on the 1991 survey, BLS states: "Some conditions, for example, long-term latent illnesses caused by exposure to carcinogens, are difficult to relate to the workplace and are not recognized and reported. These long-term latent illnesses are believed to be understated in the survey's illness measures " (Bureau of Labor Statistics 1993).

Nonetheless, the BLS annual survey has some important strengths. It has been conducted consistently over the past 20 years, and therefore, time trends can be expected to be reasonably reliable. Furthermore, the illnesses recorded by employers as being work-related would be generally accepted as being work-related. Hence, the numbers provided by the annual survey can be viewed as a lower limit to the number of illnesses that actually occur. Although it is generally accepted that chronic occupational illnesses are under-recorded in the BLS Annual Survey, whether significant under-reporting of the more easily recognized acute occupational illnesses also occurs in the BLS annual survey is less clear.

Table 3

Numbers of Occupational Illnesses in the United States, 1992
Bureau of Labor Statistics Annual Survey

<u>Category of Illness</u>	<u>Number of Cases</u>	<u>(%)</u>
Skin diseases	62,900	(13.8)
Dust diseases of the lungs	2,800	(0.6)
Respiratory conditions due to toxic agents	23,500	(5.1)
Poisonings	7,000	(1.5)
Disorders due to physical agents	22,200	(4.9)
Disorders associated with repeated trauma	281,800	(61.6)
All other occupational illnesses	<u>57,300</u>	<u>(12.5)</u>
Total	457,400	(100.0)

Source: Bureau of Labor Statistics, Department of Labor, December, 1994.

In 1992, there were 457,400 occupational illnesses in the private industry in the United States, according to the BLS Annual Survey (Table 3). This is an increase of 89,100 cases, or 24%, over the 368,300 illnesses recorded in the 1991 BLS Annual Survey. Expressed as rates, the incidence of new occupational illnesses was 49.0 per 10,000 full-time workers in 1991 and 59.8 per 10,000 such workers in 1992, a 22% increase.

Disorders associated with repeated trauma, such as carpal tunnel syndrome, tendinitis of the wrist and elbow, and hearing loss, dominate the occupational illnesses recorded in the annual survey and have done so since 1987 (Table 3). In 1992, they accounted for 62% of all illness cases recorded on the annual survey. Other important categories of disease were skin disorders, pulmonary diseases, and disorders associated with physical trauma (Table 3).

Table 4

Occupational Illnesses in the United States, 1973-1992
Bureau of Labor Statistics Annual Survey

Year	Dust diseases of the lungs	Respiratory conditions due to toxic agents	Poisoning	Skin diseases or disorders	Disorders due to physical agents	Associated with repeated trauma	Other occupational illness	TOTAL
1973	1,500	11,500	6,800	89,200	27,500	23,600	40,400	200,500
1974	1,700	12,700	7,400	89,400	27,100	24,600	37,400	200,400
1975	1,000	11,900	6,200	74,400	21,200	23,700	24,900	163,300
1976	1,200	13,100	6,100	71,600	24,200	23,000	28,800	167,900
1977	2,000	13,100	5,700	73,000	23,600	23,400	21,100	161,900
1978	1,600	13,600	5,600	65,900	16,700	20,200	19,600	143,500
1979	1,700	13,100	5,800	67,900	15,100	21,900	23,200	148,900
1980	2,300	11,400	4,700	56,100	13,200	23,100	19,200	130,200
1981	2,100	10,800	5,600	51,200	11,900	22,900	21,500	126,100
1982	2,000	8,800	3,400	41,900	8,300	22,600	18,600	105,600
1983	1,700	7,900	3,000	39,500	8,800	26,700	18,400	106,100
1984	1,800	10,600	4,500	42,500	9,000	34,700	21,400	124,800
1985	1,700	11,600	4,200	41,800	9,000	37,000	20,100	125,400
1986	3,200	12,300	4,300	41,900	9,200	46,000	20,400	136,800
1987	3,400	14,300	4,800	54,200	13,800	72,900	26,800	190,200
1988	2,900	16,100	5,500	57,900	17,300	115,400	25,600	240,700
1989	2,600	18,900	5,800	62,100	17,700	146,900	29,700	283,700
1990	3,000	20,500	6,100	60,900	18,200	185,400	37,300	331,600
1991	2,500	18,300	6,700	58,200	18,200	223,600	40,800	368,300
1992	2,800	23,500	7,000	62,900	22,200	281,800	57,300	457,400

Source: Occupational Injuries and Illnesses in the United States by Industry, 1991. Bureau of Labor Statistics, United States Department of Labor, May 1993. Unpublished data, Bureau of Labor Statistics, United States Department of Labor, December, 1994.

The time trend of occupational illnesses recorded in the annual survey since its inception is remarkable. Table 4 shows the numbers of occupational illnesses by disease category from 1973 to 1992. Recorded occupational illnesses decrease sharply through the 1970's and reached a nadir in 1982 when 105,600 such illnesses were reported in the private sector. The numbers of occupational illnesses increased thereafter, especially after 1986. The 1992 total, 457,400 cases, represents an increase of 333%, or 351,000 cases per year, compared to 1982. Indeed, most of this increase has occurred over a shorter time period (i.e., since 1986). Comparing 1986 and 1992, there has been an increase of 234%, or 320,600 occupational illness cases per year (Table 5).

Table 5

Number of New Cases of Occupational Illnesses by Category of Illness
BLS Annual Survey, 1982, 1986 and 1992

<u>Category of Illness</u>	<u>1982</u>	<u>1986</u>	<u>1992</u>	<u>% Change 1982-1992</u>	<u>% Change 1986-1992</u>
Skin diseases	41,900	41,900	62,900	+50.1%	+50.1%
Dust diseases of the lungs	2,000	3,200	2,800	+40.0%	-12.5%
Respiratory conditions due to toxic agents	8,800	12,300	23,500	+167.0%	+91.1%
Poisoning	3,400	4,300	7,000	+105.9%	+62.8%
Disorder due to physical agents	8,300	9,200	22,200	+167.5%	+141.3%
Disorders associated with repeated trauma	22,600	45,500	281,800	+1,146.9%	+519.3%
All other occupational illnesses	18,600	20,400	57,300	+208.1%	+180.9%
Total	105,600	136,800	457,400	+333.1%	+234.4%
(Total excluding repeated trauma)	83,000	91,300	175,600	+111.6%	+92.3%
Average annual employment, private sector	73,729,000	83,291,200	90,459,600	+22.8%	+8.7%

Source: *Occupational Injuries and Illnesses in the United States by Industry*, 1991. U.S. Department of Labor. Bureau of Labor Statistics, May 1993.

Bureau of Labor Statistics, United States Department of Labor, December, 1994.

Table 5 compares the number of new cases of occupational illnesses and percent changes according to the BLS Annual Surveys for selected years, 1982, 1986 and 1992. Table 6 shows the comparable data by incidence rates for 1986 and 1992. Because the average annual employment in the private sector rose only 23% between 1982 and 1992 and 9% between 1986 and 1992, the percent changes in the rates are only slightly less than the percent changes in the numbers of new cases.

Disorders associated with repeated trauma clearly account for the largest proportion of the

increment in cases of occupational illness. This rise is well-known. Whereas repeated trauma disorders were associated with 45,500 cases of occupational illness in 1986, or 32% of all illnesses recorded by the BLS, they increased to 281,800 by 1992, or 62% of all BLS-recorded occupational illnesses. Of the 320,600 additional cases of all occupational illness that occurred in 1992 compared to 1986, 236,300, or 74%, were disorders associated with repeated trauma (Table 5).

Table 6

Incidence of Occupational Illness BLS Annual Survey, 1986 versus 1992 (Rate per 10,000 full-time workers)			
<u>Category of Illness</u>	<u>1986</u>	<u>1992</u>	<u>% Change</u>
Skin diseases	5.9	8.2	+39.0%
Dust diseases of the lung	0.5	0.3	-40.0%
Respiratory conditions due to toxic agents	1.7	3.1	+82.4%
Poisonings	0.6	0.9	+50.0%
Disorders due to physical agents	1.3	2.9	+123.1%
Disorders associated with repeated trauma	6.4	36.8	+475.0%
All other occupational illnesses	<u>2.9</u>	<u>7.5</u>	<u>+158.6%</u>
Total	19.2	59.8	+211.5%
(Total excluding repeated trauma)	12.8	23.0	+79.7%

Source: 1) Occupational Injuries and Illnesses in the United States by Industry, 1991. U.S. Department of Labor. Bureau of Labor Statistics, May 1993.
2) Bureau of Labor Statistics, United States Department of Labor, December, 1994.

This epidemic rise in disorders associated with repeated trauma, however, cannot be allowed to obscure the significant increases that have occurred in other categories of occupational illness. Overall, there was an 80% increase in the recorded incidence in these occupational illnesses in the five years between 1986 and 1992 (Table 6). Excluding disorders associated with repeated trauma, there were an

additional 84,300 cases of occupational disease recorded in the BLS Survey in 1992 compared to 1986 (Table 5). Indeed, the total number of reported occupational illnesses other than those due to repeated trauma in 1992, 175,600 cases, exceeds the *total* number of recorded occupational illnesses (including those associated with repeated trauma) in 1986, when 136,800 cases of occupational illness were reported by employers. With the exception of dust diseases of the lungs, all other categories of occupational diseases experienced 50% to 180% increases in the numbers of cases and 40% to 160% increases in case rates reported by employers on the BLS survey between 1986 and 1992. Of the specific categories, the category showing the greatest increase is that of disorders due to physical agents, which increased by 141% in cases between 1986 and 1992. The breadth of the increase is also shown by the 181% increase in the rate of diseases in the category of "all other occupational illnesses" between 1986 and 1992.

These increases in the numbers and rates of occupational diseases recorded by employers and reported to the BLS in recent years are remarkable. During the same time period, 1986 to 1992, the rate of occupational injuries per 100 full time workers recorded by the BLS increased from 7.7 in 1986 to 8.3 in 1992, a 7.8% increase. The number of recorded fatalities in the workplace has likewise not increased dramatically in the past five years. This suggests that, if the increase in occupational diseases reflects an increase in the prevalence of workplace hazards, these hazards must be quite specific. Yet, the breadth of the categories of diseases showing an increase in rates of illness argues against such specificity.

The change in the recording of occupational illnesses may be due to a change in the underlying occurrence of disease or to a change in the recognition and reporting of these conditions. The latter may reflect increased awareness of occupational diseases among workers, improved diagnosis by physicians, improved reporting by workers to employers, enhanced recording of occupational illnesses by employers, or a combination of all of these factors. In the case of disorders associated with repeated trauma, it is likely that rapid changes in the workplace have altered the nature and prevalence of hazards leading to repeated trauma. Most of the increase in the disorders associated with repeated trauma between 1986 and 1992 would, therefore, represent a frank increase in the underlying incidence of disease. On the other hand, with respect to the other occupational illnesses, while one cannot rule out that workplace conditions in the private sector have changed between 1986 and 1992 such that the likelihood of occupational illness has increased, it is more likely that the recognition of occupational illnesses has significantly changed in this five-year time period. This would imply that workers, employers, and/or health care professionals have significantly improved their ability to recognize, report, and/or record occupational illnesses. While this explanation is the most plausible one with respect to the occupational illnesses other than those involving

repeated trauma, it is nonetheless striking that the recognition of occupational disease would change in such a short time period.

In response to recommendations by the National Academy of Sciences (Pollack and Keimig 1987), the BLS re-designed its annual survey in the early 1990s (U.S. Bureau of Labor Statistics 1994a). In addition to previous information collected, the new survey includes specific information on workers with occupational illnesses and injuries that are considered serious (i.e., involve 1 or more lost work days). Newly collected information includes occupation, age, gender, race, length of service, nature of illness/injury, part of body affected, event or exposure, and primary and secondary sources of illness and injury. This re-designed survey was first conducted in 1992.

Preliminary data from the re-designed 1992 BLS Annual Survey are now available (U.S. Bureau of Labor Statistics 1995). In 1992, one-third (34%), or 2.33 million, of the 6.80 million occupational illnesses and injuries recorded in the 1992 BLS Annual Survey were of a serious nature. Of these 2.3 million serious occupational illnesses and injuries, 2.29 million were classified into either injuries or illnesses.

Occupational illnesses were more likely to be serious than occupational injuries. Occupational illnesses represented 6.7% (457,400) of the total 6.8 million occupational illnesses and injuries in 1992, yet they comprised 8.0% (182,862) of the 2.29 million serious occupational illnesses and injuries in 1992, an excess of 19%. Occupational illnesses also disproportionately accounted for the most serious cases (i.e., involving more than 30 days away from work). Nearly one-third (31%), or 56,883, of the 182,862 occupational illnesses led to greater than 30 lost work days, compared to 19% (392,389) of the 2.1 million occupational injuries.

The re-design of the BLS Annual Survey in 1992 provides an unprecedented opportunity to examine the extent to which employers record specific chronic diseases as occupational in origin. Categories of disease used in previous BLS Annual survey were too broad and few to identify diseases of interest such as cancer and heart disease. Table 7 shows numbers of selected occupational illnesses in the BLS survey in 1992. For coronary heart disease, stroke, cancer and chronic respiratory disease combined, there were 1,485 cases, or 0.8% of all serious occupational illnesses. While the nature of non-serious occupational illnesses recorded in the BLS survey is unknown, they are unlikely to consist of a significant number of cases of coronary heart disease, stroke, cancer and chronic respiratory disease, given the severity of morbidity that usually accompanies these diseases. Thus, even with the well-demonstrated increase in occupational diseases recorded by the BLS, especially from 1986 to 1992, including diseases other than those involving repeated trauma, the four leading causes of death and

disease in the United States are still not recorded in large numbers by the occupational disease surveillance system of the Bureau of Labor Statistics.

Table 7

Number of Occupational Illnesses Involving Days Away from Work
BLS Annual Survey, 1992

Systemic diseases and disorders	148,834
Nervous system and sense organs diseases	49,474
Carpal tunnel syndrome	33,042
Circulatory system diseases	1,462
Ischemic heart disease	591
Stroke	75
Respiratory system diseases	3,892
COPD	716
Asthma	272
Pneumoconioses	188
Digestive system disease and disorders	32,987
Musculoskeletal system and connective tissue disease and disorders	46,148
Rheumatism (incl. tendinitis, synovitis, ganglia and others)	40,324
Skin diseases	13,845
Infectious diseases	3,237
Neoplasms 103	
Symptoms, signs and ill-defined conditions	21,274
Other conditions	6,992
Mental disorders or syndromes	6,765
Multiple disorders and conditions	2,385

Source: Bureau of Labor Statistics, U.S. Department of Labor, 1995

The most important exclusion from the BLS Annual Survey for which data exist on occupational illnesses and injuries are workers in the public sector. In 1992, there were a total of 18,644,000 workers employed by public agencies including 2,969,000 Federal employees, 4,408,000 state employees, and 11,267,000 employees of local governments (Green and Becker 1994). There were 90,459,600 private sector workers covered by the BLS annual survey in 1992. Public workers represented approximately

17% of the total work force in the United States in 1992.

Data on occupational illnesses among Federal employees are collected by the Federal Occupational Workers' Compensation Program (OWCP). In 1993, there were 24,500 claims filed for occupational illnesses, and 15,500 of these claims were approved (Office of Workers' Compensation Program, 1994). There were approximately 2.9 million Federal employees in 1993, yielding a rate of 51.7 cases of occupational illnesses per 10,000 full-time workers. Data for 1991 and 1992, the most recent years for which data from the BLS Annual Survey could be obtained, are not available from the OWCP. The OWCP does not categorize approved claims by category of illness. The 24,500 claims filed during 1993 have been so categorized, but 17,257 (70%) of these claims are categorized as "other occupational diseases," making the disease profile by category uninformative (Office of Workers' Compensation Program 1994).

Data on the rates and numbers of illnesses due to occupation among state and local employees are also available for selected states. States collect these data in relation to occupational safety and health plans that have been adopted for public employees. Such plans usually meet or exceed the regulations promulgated and enforced by federal OSHA. A recent study of state and local employees in New Jersey documented 1,700 occupational illnesses among state and local employees in 1990, yielding an incidence of 50 per 10,000 public sector workers (Roche 1993). Similar rates were obtained for 1988 and 1989. The profile of disease category differed significantly from the profile recorded in the BLS Annual Survey. Two-thirds of the illnesses among New Jersey public employees were skin diseases or respiratory conditions due to toxic agents. Only 3% of illness episodes were due to repeated trauma.

The rates of occupational disease among Federal and non-federal public workers are remarkably congruent with each other and with the rates of such illness among private sector workers as recorded in the BLS Annual Survey. It is reasonable to apply an occupational illness rate of 50 per 10,000 full-time workers to the 18,644,000 Federal, state and local workers employed in 1992. This yields a total of 92,010 illnesses among public workers occurring in 1992. This total should be added to the number of occupational illnesses recorded in the BLS survey to obtain a more complete picture of the number of occupational illness occurring among American workers (Table 3.12). Data for illnesses among state and local employees are not available for 1992. Since the illness rate in the public sector probably increased in 1992, as it did in the private sector, using 92,010 as the number of occupational illnesses in the public sector in 1992 would be a conservative estimate.

Heavy Metal Poisoning

Numerous states require that clinical laboratories report the results of selected categories of specimens to the state health department. Among the agents relevant to the occupational setting are lead, arsenic, cadmium, and mercury as well as measures reflecting pesticide exposure. Since 1992, NIOSH has compiled the results of adult blood lead testing in the Adult Blood Lead Epidemiology and Surveillance (ABLES) program (Chowdhury et al. 1994). By the end of 1993, 20 states were reporting elevated blood lead levels to NIOSH and an additional 10 states are developing the capacity to collect and report blood lead data ((Chowdhury et al. 1994). In 1993, there were 11,240 individuals with blood lead levels that equalled or exceeded 25 micrograms per deciliter (ug/dl) of blood in the 20 reporting states (Chowdhury et al. 1994) (Table 8). These 20 states contain 60% of the U.S. population. Since among these states are the most heavily industrial states in the United States (e.g., California, Illinois, New Jersey, New York, Pennsylvania, and Michigan), it may be reasonably estimated that they contain 75% of all individuals in the United States who have elevated blood lead levels. Using this adjustment, it can be estimated that approximately 15,000 individuals had elevated blood lead levels in the entire United States in 1993.

Assuming that 95% of adults with elevated blood lead levels have an occupational source of lead exposure (Chowdhury et al. 1994), then an estimated 14,250 individuals had elevated blood lead values as a result of occupational lead exposure in 1993. This number well exceeds 7,000, the total number of poisonings that were reported by employers to BLS in the annual survey in 1992. (BLS data from the 1992 survey are used, because 1993 data are not yet available). The BLS category of poisonings includes illnesses with systemic effects due to heavy metals, solvents, pesticides, toxic gases, and other chemical agents. It should be noted that we assume that the numbers of adults with excessive occupational lead exposure in 1992 and in 1993 were not appreciably different. If 3,500, or one-half, of the 7,000 cases of poisonings reported by the BLS in 1992, were due to elevated body lead burden secondary to occupational exposure, then 10,750 adults with such workplace lead exposure were not reported to the BLS in the annual survey. This represents three-quarters of the estimated number of adults with excessive blood levels due to occupational exposure. Indeed, even if all of the 7,000 poisonings reported by employers to BLS in 1992 represented individuals with excessive blood lead levels, over one-half (51%) of the such individuals recorded by the NIOSH ABLES program would not have been reported by employers to BLS.

With regard to severity of blood lead elevation, 3,199 (28%) of the individuals with elevated blood lead levels in 1993 had blood leads greater than or equal to 40 ug/dl, which is the level which OSHA requires actions to protect workers from lead exposure in the workplace. 906 (8%) of the cases reported in

the ABLES program had blood lead levels ≥ 50 ug/dl, which is the level at which OSHA mandates the removal of the individual from lead exposure (Table 8) (Chowdhury et al. 1994).

Table 8

Numbers of Adults with Elevated Blood Lead Levels,
20 States, 1993*

<u>High Blood Lead Level</u> <u>(μg/dl)</u>	<u>Numbers of Persons</u>	<u>(%)</u>
25-39	8,041	71.5%
40-49	2,293	20.4%
50-59	627	5.6%
≥ 60	<u>279</u>	<u>2.5%</u>
Total	11,240	100.0%

*Source: National Adult Blood Lead Epidemiology and Surveillance, NIOSH
Adapted from MMWR Vol. 43:26, July 8, 1994

National Health Interview Survey

The National Health Interview Survey (NHIS) is a household survey conducted by the National Center for Health Statistics in order to obtain estimates of the prevalence of health conditions from a representative sample of households reflecting the civilian non-institutionalized population of the United States. In 1988, an Occupational Health Supplement (NHIS-OHS) was included in order to obtain population-based estimates of the prevalence of selected conditions that may be associated with work (Centers for Disease Control and Prevention 1993). Approximately 50,000 households were sampled in 1988, and 27,408 currently employed individuals were interviewed. The results of the NHIS reflect the reporting of health problems by participating individuals. No medical or workplace verification of the reported information is performed. Despite this limitation, the NHIS Occupational Health Supplement is uniquely able to provide valid estimates of the perceptions of potentially work-related illnesses for the United States as a whole (Centers for Disease Control and Prevention 1993).

Among the health conditions addressed by the NHIS-OHS are work-related injuries, dermatologic conditions, cumulative trauma disorders, eye, nose and throat irritation, hearing loss, and low back pain (Centers for Disease Control and Prevention 1993). NHIS-OHS data on injuries and low back pain are

addressed in Chapter 2 of this report describing workplace injuries. To date, the only other fully analyzed condition is carpal tunnel syndrome (Tanaka et al. 1995). Carpal tunnel syndrome, or entrapment of the median nerve in the wrist, is one of the cumulative trauma disorders of the upper extremity.

Tanaka and colleagues from NIOSH recently reported that, based on the 1988 NHIS-OHS data (Tanaka et al. 1995), 1.1 million people in the United States who have worked at least part of the past 12 months reported "prolonged hand discomfort" that they referred to as "carpal tunnel syndrome." "Prolonged hand discomfort" was defined as discomfort for seven consecutive days or 20 or more days in total during the previous 12 months. Of these 1.1 million people, 675,000 people also reported that their health care providers had told them that they had carpal tunnel syndrome. This corresponds to approximately one of every 200 workers who have worked at least part of the previous 12 months. Of the 675,000 people who report that their health care providers had diagnosed carpal tunnel syndrome, Tanaka et al. report that 52.8% also state that their health care providers has said that the carpal tunnel syndrome is work-related (Tanaka et al. 1995). Thus, by this method, Tanaka and colleagues estimate that the national prevalence of work-related carpal tunnel syndrome in 1988 was 356,000 cases (Tanaka et al. 1995). This estimate does not include workers who had not worked in the 12 months prior to the survey and who may have been disabled due to work-related carpal tunnel syndrome.

Comparison between the results of the NHIS-OHS and the BLS Annual Survey are difficult, because the former measures prevalence of disease during a specified interval and the latter includes reports of new episodes of illness. In 1988, 115,000 individuals had disorders associated with repeated trauma, according to the BLS Annual Survey (Bureau of Labor Statistics 1993). The BLS includes in this category noise-induced hearing loss, Raynaud's phenomenon, tenosynovitis, and bursitis in addition to carpal tunnel syndrome. While it is not known what proportion of these 15,000 illnesses were carpal tunnel syndrome, it is unlikely to represent the most common diagnosis. In a recent study of workers' compensation claims in Ohio, Tanaka and NIOSH colleagues reported that less than 50% of cases with disorders associated with repeated trauma involved the wrist. The diagnosis in the majority of these cases was tenosynovitis of the wrist (Tanaka et al. 1988). The NHIS-OHS analysis completed to date suggests, however, that the BLS annual survey is under-estimating the incidence of work-related carpal tunnel syndrome.

Tanaka and others at NIOSH continue to analyze NHIS-OHS data for conditions other than carpal tunnel syndrome, but the resultant analyses are not yet available.

National Hospital Discharge Survey

A unique source of information about medical care utilization for occupationally specific diseases is provided by the National Hospital Discharge Survey maintained by the National Center for Health Statistics. This database provides summary information about inpatient admissions at non-federal hospitals in the United States, including primary and other diagnoses, patient gender and age, hospital charges, payment sources and other variables. A full description of the database and its use are available elsewhere (Graves 1994).

A fundamental problem with the National Hospital Discharge Survey is that the unit of measurement is hospitalizations or discharges, not individuals. To the extent that individual patients have more than one hospitalization per year, the number of discharges will be discrepant from the number of people with a given diagnosis. It is, therefore, not possible to obtain a count of the number of unique individuals who are hospitalized per year for a particular health problem. In addition, since individuals hospitalized in any particular year will have been first diagnosed as having the disorder of interest during any of a number of years, including the year of hospitalization and preceding years, the incidence of disease for any specific year cannot be obtained. While prevalence of occupational disease is of interest, the focus of this chapter so far has been on the number of new cases or episodes of occupational illness per year in the United States.

The hospital discharge survey has another obvious liability. Only individuals with disease sufficiently severe to require hospitalization will be included in the database. For many chronic diseases, the majority of patients will not become so ill as to require hospitalization, especially given the increasing breadth and depth of outpatient treatments available. These patients may nonetheless suffer significant morbidity, incur costly medical care and lose substantial numbers of days from work. Thus, even if the data of the discharge survey were suitably organized and evaluated to yield disease incidence and prevalence, it would only reflect part of the spectrum of morbidity associated with any specific disease.

Table 9 gives numbers of hospitalizations incurred as a result of diseases that are specific to occupational exposures (National Hospital Discharge Survey 1991). For the primary diagnosis associated with the hospital stay, there were 2,360 hospitalizations for pneumoconioses, principally coal workers pneumoconiosis (1,646 hospitalizations) and asbestosis (479 hospitalizations), and 857 hospitalizations for malignant neoplasm of the pleura, most of which are malignant mesothelioma of the pleura.

Table 9

Numbers of Hospital Discharges for Primary and Secondary Diagnoses for
Pneumoconioses and Malignancies of the Pleura, United States, 1991

<u>Diagnosis (ICD-9 code)</u>	<u>Number of Discharges with Pneumoconiosis or Malignancies of the Pleura as Primary Diagnosis</u>	<u>Number of Discharges with Pneumoconiosis or Malignancies of the Pleura as Secondary Diagnosis</u>
<u>Pneumoconioses</u>		
Asbestosis (501)	479	6,456
Silicosis (502)	---	3,704
Coal Workers Pneumoconioses (500)	1,646	10,825
Pneumoconioses due to other inorganic dust (503)	---	46
Pneumopathy due to inhalation of other dust (504) (byssinosis)	235	475
Pneumoconioses, unspecified (505)	---	801
Total	<u>2,360</u>	<u>22,307</u>
<u>Malignancies of the Pleura</u> (163.0, 163.1, 163.9)	857	1,843

Source: National Hospital Discharge Survey 1991

Table 9 also provides the numbers of hospitalizations for which pneumoconioses and malignancy of the pleura were not the primary diagnoses, but were among the multiple diagnoses listed for hospitalizations in the National Hospital Discharge Survey (National Hospital Discharge Survey 1991). These are primary and secondary diagnoses. The National Hospital Discharge Survey allows up to seven diagnoses per hospital discharge, including the primary diagnosis. The numbers of discharges with occupationally-specific diseases among the secondary diagnoses is considerably higher than those with

such diseases constituting the primary diagnoses. This is less true for malignancy of the pleura than for the pneumoconioses, since malignant mesothelioma is highly lethal and can be expected to be the dominating diagnosis on most hospitalizations of patients with this cancer. While the secondary diagnoses can be considered as illnesses that are active medical concerns at the time of hospitalization, the degree to which they are contributing factors to the hospitalization is uncertain.

Attributable risk-based estimates of morbidity

Cancer

Among the major causes of morbidity and mortality in the United States, cancer represents the group of chronic diseases for which occupational etiology is best documented. Nevertheless, cancers are scarcely recorded in the BLS Annual Survey or in workers' compensation data. Prior to 1992, it was not possible to identify the numbers of cancers recorded in the BLS Annual Survey, because only broad diagnostic categories of disease were utilized. Revision of the BLS Annual Survey beginning in 1992 allows identification of numbers of specific diseases that were considered serious (i.e., involve 1 or more days of lost work time). According to the 1992 Annual Survey, among these serious cases, employers reported 103 employees with occupational neoplasms, most of which were malignant (U.S. Bureau of Labor Statistics 1995). Since it is likely that virtually all cancers that are identified as occupational by employers would involve lost work time, it is unlikely that many additional cancers would be recorded among the non-serious cases identified in the BLS survey.

Workers' compensation is another potential source of data for enumerating occupational cancers. Like the BLS Annual Survey, many states do not use a specific category for occupational cancers (e.g., California and Washington). By contrast, New York and New Jersey do report the number of cancers identified by the workers' compensation systems as being work-related. In New York State, eight people had occupational cancer claims accepted for workers' compensation in 1988 (New York Workers' Compensation Board 1993). In New Jersey, an annual average of 131 individuals were recognized as having occupational cancer by the workers' compensation system between 1988 and 1991, whereas the average annual total number of occupational disease awards was 6,340 (New Jersey Workers' Compensation Board 1990). There were 36,896 individuals newly diagnosed as having cancer (excluding basal cell cancer of the skin) and 17,285 deaths from cancer in New Jersey in 1988 (New Jersey Department of Health 1992). While acknowledging that the cases of cancer awarded workers' compensation in 1988 reflects incident cancer cases from previous years, it is nonetheless clear that a small proportion (i.e., less than 1%, of cancers are recognized as being occupational by selected workers'

compensation systems).

In order to obtain a more accurate count of the number of cases of occupational illness per year in the United States, we use the proportional attributable risk model to estimate the number of cancers in the United States that are likely to be occupational in origin. The American Cancer Society (ACS) publishes estimates of the numbers of cases of cancer that occur annually in the United States based on the data collected under the Surveillance, Epidemiology, and End Results (SEER) program of the National Cancer Institute. According to these ACS estimates, there were 1,113,100 malignancies (excluding basal cell cancer of the skin) newly diagnosed among adults 25 years and over in the U.S. in 1992 (American Cancer Society 1995). Assuming that 6% to 10% of these cancer are occupational in origin, then 66,790 to 111,310 new cases of cancer were caused by workplace factors in 1992 (Table 10).

Table 10

Estimated Incidence of Occupational Illness for
Major Causes of Death, United States

<u>Condition¹</u>	<u>Estimated annual number of new cases in United States</u>	<u>Percentage attributed to occupation</u>	<u>Estimated number of cases due to occupation</u>
Cancer	1,113,100	6%-10%	66,790-111,130
Coronary heart disease ²	730,000	5%-10%	36,500-73,000
Cerebrovascular disease ²	101,000-144,000	5%-10%	5,050-14,400
Chronic obstructive pulmonary disease	1,500,000	10%	<u>150,000</u>
	Total		258,340-348,710

¹ See Appendix to Table 3.11 for listing of ICD codes included in these conditions.

² Only includes new and recurrent cases of coronary heart disease and cerebrovascular disease among people between ages 25 and 64, inclusive.

Sources: See text

Cardiovascular and Cerebrovascular Disease

As described above, we use an estimate of 5% to 10% of cases of cardiovascular and cerebrovascular disease among people aged 25 to 64, inclusive, as caused by occupational factors. The rationale for attribution of this range of proportions to occupational etiology is presented above. For accounting of occupational morbidity due to heart disease, the focus is restricted to coronary heart disease, since it is the major cause of heart disease, and current studies support a causal role of occupational factors in the etiology of coronary heart disease.

National incidence data for coronary heart disease are less than optimal, since they are extrapolated from the Framingham heart disease sample of approximately 5,000 people. Nonetheless, these data have been used to determine that there are approximately 1.25 million new or recurrent

myocardial infarctions each year in the United States, including 530,000 myocardial infarctions among individuals between the ages of 25 and 64, inclusive (Kannel and Thom 1994; American Heart Association 1994; National Heart, Lung, and Blood Institute 1995). Approximately 78,000 of these one-half million heart attacks are fatal. The Framingham database has also allowed an estimation of approximately 200,000 new cases of uncomplicated angina pectoris each year in the United States among people less than 65 years old (American Heart Association 1994; National Heart, Lung, and Blood Institute 1995).

Applying the proportional range cited above, there are 36,500 to 73,000 new or recurrent cases of coronary heart disease (including new or recurrent myocardial infarctions and new cases of uncomplicated angina) each year in the United States due to occupational risk factors (Table 10).

Data from the Framingham study also allow estimation that an estimated 101,000 to 144,000 strokes and transient ischemic attacks annually in the United States occur among people less than 65 years of age (Kannel and Thom 1994; American Heart Association 1994). Since most coronary heart disease and cerebrovascular disease result from the same underlying disease process, atherosclerosis, we use the same range of percentages (5% to 10%) as caused by occupational factors. Hence, it is estimated that 5,050 to 14,400 strokes and transient ischemic attacks among people less than 65 years of age are associated with occupational exposures (job stress; shiftwork; noise; and occupational exposures) each year in the United States (Table 10).

By contrast, the revised BLS Annual Survey recorded 591 work-related cases of ischemic heart disease and 76 people with cerebrovascular disease in 1992. Even given the provisional nature of the estimates obtained using the proportional attributable risk approach, there is an obvious and large discrepancy between the BLS data and the estimates derived above.

Chronic Obstructive Lung Disease

Despite the fact that chronic obstructive lung disease (COPD) is the fourth leading overall cause of mortality in the United States and increased during the 1980s (American Lung Association 1995), national data on the incidence of COPD are virtually non-existent. Given the chronic nature of COPD, the impact of this set of diseases has traditionally been measured by its mortality rate and prevalence. The American Lung Association estimates that 15.4 million Americans suffered from COPD in 1992 (American Lung Association 1995). One estimate of the number of new cases of COPD in the United States was 1.5 million in 1984 (Farer and Schieffelbein 1987). Recognizing the dearth of well-founded data in this area, we use this estimate of 1.5 million new cases. Given the rise in COPD mortality from 27.7 per 100,000 in the United States in 1984 to 34.1 per 100,000 in 1992, the estimate of 1.5 million, if accurate, would be an underestimate of the annual number of new cases of COPD in the 1990s. Applying the estimated percentage of COPD attributable to occupational exposures, 10%, yields an estimate of 150,000 new cases of COPD each year occurring as a result of exposure to airborne contaminants in the workplace (Table 10).

In the 1992 BLS survey, 717 cases of work-related COPD were recorded among the "serious" illness cases (i.e., cases where 1 or more days of work was missed).

Specific Occupational Diseases

As discussed previously, though the spectrum of diseases associated with occupations is broad, the diseases uniquely caused by occupational exposures are very limited. Included in this group are the pneumoconioses and one type of cancer, malignant mesothelioma of the pleura and peritoneum. Table 11 shows the numbers of deaths attributed to these diagnoses as the underlying cause of death and as one of multiple causes of death listed on the death certificate (National Center for Health Statistics 1992). In 1992, there were 1,236 deaths due to the dust diseases of the lung as the underlying cause, including 631 deaths due to coal workers pneumoconiosis and 285 deaths due to asbestosis. For malignancies of the pleura, most of which are malignant mesothelioma, there was a total of 476 deaths (National Center for Health Statistics 1992). Because there is no ICD code specific for malignant mesothelioma of the peritoneum, it is not possible to identify the number of peritoneal mesotheliomas that occurred in 1992.

Table 11

Deaths due to Pneumoconioses and Malignancy of the Pleura
Underlying Cause and Multiple Causes
United States, 1990 and 1992

<u>Cause of Death (ICD-9 Code)</u>	<u>1992</u>	<u>Number of deaths</u>	
	<u>Underlying Cause</u>	<u>1991</u>	<u>1990</u>
	<u>Underlying Cause</u>	<u>Underlying Cause</u>	<u>Multiple Causes</u>
Coal workers' pneumoconiosis (500)	631	693	1990
Asbestosis (501)	285	269	948
Silicosis (502)	117	153	308
Other pneumoconioses (503-505)	<u>103</u>	<u>122</u>	<u>413</u>
Total	1,136	1,237	3,656
Malignancy of the pleura (163.0, 163.1, 163.9)	477	452	553

Source: National Center for Health Statistics

Table 11 also shows the numbers of deaths due to pneumoconioses and malignancies of the pleura when they appear as one of multiple causes of death on the death certificate for the most recent year available, 1990. As expected, the numbers of such deaths are higher than the numbers of death where underlying cause is specified. Citation of a disease among multiple causes can be reasonably interpreted as signifying that it was a contributing factor in death. In 1990, there were 3,659 deaths in which one of the pneumoconioses was a contributing factor and 553 deaths in which malignancy of the pleura was a factor contributing to death (NIOSH, 1994; National Center for Health Statistics 1992).

Attributable Risk-based Estimates of Mortality

Table 12 provides the results of applying the proportional attributable risk model as described above to the major causes of death in the United States in 1992. With the exception of pneumoconioses, all causes of death are associated with an occupational etiology in no more than an estimated 10% of cases. Nonetheless, this analysis yields an estimate of 46,899 to 73,681 deaths as a result of occupational risk factors in the United States in 1992. Cancer dominates these estimates due to its high overall incidence and to the restriction of occupationally-associated cardiovascular and cerebrovascular deaths to persons under 65 years of age. For each of the three major causes of death, however, the number of deaths, ranging between 5,000 and 52,000, is significant.

Table 12

Estimated Occupational Disease Mortality due to Selected Causes
United States, 1992

<u>Selected causes of death¹</u>	<u>Number of deaths U.S., ages 25 and over²</u>	<u>Estimated percentage due to occupation</u>	<u>Number of deaths due to occupation U.S., 1992</u>
Cancer	517,090	6%-10%	31,025-51,709
Cardiovascular and cerebrovascular disease ³	101,846 ³	5-10%	5,092-10,185
Chronic respiratory disease	91,541	10%	9,154
Pneumoconioses	1,136	100%	1,136
Nervous system disorders	26,936	1%-3%	269 - 808
Renal disorders	<u>22,957</u>	1%-3%	<u>223 - 689</u>
Total	713,506		46,899-73,681

¹ See Appendix to Table 11 for listing of ICD codes used for selected causes of death

² Source: National Center for Health Statistics

³ Only includes deaths between ages 25 and 64 years, inclusive

Appendix to Table 12

Codes of ICD, 9th revision used in Table 9

Cancer: 140-209 (malignant neoplasms)

Cardiovascular and cerebrovascular disease:

401-404 (hypertension, hypertensive heart and renal disease)

410-414 (ischemic heart disease)

430-438 (cerebrovascular disease)

440 (atherosclerosis)

Chronic respiratory disease:

490-496 (chronic obstructive pulmonary disease 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)

To provide a population perspective on this overall estimate of occupational mortality, comparisons to other diseases may be instructive. In 1992, there were 25,488 deaths from homicides, 30,484 deaths from suicides, and 33,566 deaths from AIDS in the United States. The number of deaths that occurred in 1992 as a result of tobacco consumption is far higher. The latter is well-recognized, even if resources to end the epidemic of cigarette-associated diseases have not yet been mobilized. By contrast, the likely toll from occupational mortality, though highly preventable, has not yet been recognized. Table 13 summarizes our results.

Table 13

Numbers of Occupational Illnesses Based on Current Surveys and Proportional Attributable Risk Estimates United States, 1992	
Survey-based Data Source	Number of Occupational Illnesses
BLS Annual Survey	457,400
Adult blood lead surveillance program	14,250
Public employees	92,010
Sub-total	563,660
<u>Proportional Attributable Risk-based Data</u>	
Cancer	
Coronary heart disease	
Cerebral disease	
Chronic obstructive lung disease	
Sub-total	258,340-348,710
Total	817,015-907,385*

* 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 are included in the 1992 BLS Annual Survey.

Estimates of Direct and Indirect Costs of Injuries

In 1992, injuries in the workplace generated a total direct and indirect cost to our economy of \$148.3883 billion (see Table 1.3). Our lower and upper bounds (\$120.53 to \$192.98) are not formal confidence intervals. They are average costs estimates multiplied by the lower and upper bounds for the number of injuries.

Direct costs of fatal and non-fatal injuries in the workplace were \$50.1046 billion in 1992. While these costs were clearly substantial, they represented only roughly 34% of total costs, with indirect costs contributing 66%.

Table 14

Total Direct and Indirect Costs for Injuries in 1992
(1992 dollars)

	<u>Billions of Dollars</u>
I. Total Costs	\$148.3883
A. Direct	\$ 50.1046
1. Medical	\$ 25.0739
2. Administrative costs on WC (31%), private insurance, Medicaid, Welfare, Medicare (16%)	\$ 5.7012
3. Indemnity administration costs for WC (31%), Social Security and private insurance (10%)	\$ 8.8645
4. Property damage	\$ 8.7497
5. Police and fire services	\$.7801
6. Injuries to innocent third parties	\$.9322
B. Indirect	\$ 98.1837
1. Lost Earnings	\$ 68.1559
a. Fatalities	2.5481
b. Non-fatalities	65.6078
2. Fringe Benefits	\$ 14.3332
a. Fatalities	.5556
b. Non-fatalities	13.7776
3. Home Production	\$ 8.2059
a. Fatalities	.3067
b. Non-fatalities	7.8992
4. Workplace training, restaffing, disruption	\$ 5.1986
a. Fatalities	.0397
b. Non-fatalities	5.1589
5. Time delays	\$.3091
a. Fatalities	.0114
b. Non-fatalities	.2977
6. Injuries to innocent third parties	\$ 1.9810
a. Fatalities	.0733
b. Non-fatalities	1.9077
II. Lower and upper bounds for total costs	\$120.5346 to \$192.9806

Costs can be further described within the broad direct and indirect categories, shown in Table 14. Of the \$50 billion in direct costs, \$25.1 billion went to doctors, hospitals, drug companies, nursing homes, rehabilitation providers, and so on; \$5.7 and \$8.9 billion went to cover medical and indemnity insurance administration expenses, respectively; \$8.7 billion covered property damage; \$.78 billion went for police and fire services; and \$.9 billion went for direct costs to innocent third parties. The \$.9 for direct costs represents 32% rather than 34% of the total for innocent third parties. We assumed a smaller percentage because third party injuries were heavily concentrated among fatalities that have high indirect costs.

The \$98.1837 billion of indirect costs can also be disaggregated (Table 14): \$68 billion in wage losses; \$14 billion in fringe benefits; \$8 billion in home production losses; \$5.2 billion for workplace training; \$.3 for time delays; and \$2.0 billion for injuries to third parties.

Much prior estimation has ignored the value of home production, administrative costs, especially for indemnity benefits, police and fire services, property damage, and injuries to third parties.

Costs of Illnesses

The economic cost of occupational disease in the United States is greater than \$25.5 billion in 1992 dollars. Fatalities due to occupational diseases comprise 77% of the total. Of the \$19.7 billion losses due to deaths from occupational disease in 1992, 54% are direct costs, 36% are mortality costs, and 10% are morbidity costs. Direct costs comprise 92% of total losses for reported nonfatal occupational illness. These results are summarized in Table 15.

Table 15

Summary of Costs of Selected Occupationally-Related Diseases - 1992
(Costs in 000s)

Economic Cost	Cost of Fatal Occupational Diseases	Cost of Non-Fatal Occupational Diseases	Total Cost of Occupational Diseases
Direct	\$10,699,670	\$5,370,452	\$16,070,122
Indirect	\$8,992,864	\$472,336	\$9,465,200
Mortality	\$7,003,204	--	
Morbidity	\$1,989,661	\$472,336	
TOTAL	\$19,692,534	\$5,842,788	\$25,535,322

SOURCES: U.S. Health Care Financing Administration, Health Care Financing Review (Fall 1994); National Hospital Discharge Survey, National Center for Health Statistics (1992); National Nursing Home Survey, National Center for Health Statistics (1985); Medical Care Component, Consumer Price Index, Bureau of Labor Statistics, Department of Labor (1995); Money Income of Households, Families and Persons in the United States (1992); U.S. Bureau of the Census (1993); and, Tables 2-6, Chapter 6: National costs of occupationally-related disease. In Costs of Occupational Injuries and Illnesses. NIOSH Final Report. Contract #U60CCU902886-07. Internal Document (1995).

The distribution by diagnosis of total economic costs for fatal occupational disease shows the greatest losses are caused by diseases of the circulatory system, and chronic respiratory disease, accounting for \$9.4 billion, \$5.8 billion, and \$3.9 billion. Together these three diseases accounted for 97% of the economic costs of fatal occupational illness.

Table 16 presents the range of total costs of occupational illness by disease, for fatal occupational illness, estimated at \$19.7 billion dollars, with a high estimate of \$24.2 billion and a low estimate of \$15.2 billion. Total estimated costs for cancer amount to \$9.4 billion, with a high estimate of \$11.7 billion to a low estimate of \$7.0 billion. Total estimated costs for nervous system disorders amount to \$286 million, with a high estimate of \$429 million to a low estimate of \$143 million.

Table 16

Range of Total Costs of Occupational Fatalities, by Disease
(Costs in 000s)

<u>Disease²</u>	<u>Estimated Proportion Due to Occupation³</u>	<u>Total Cost Range¹ Low Estimate</u>	<u>High Estimate</u>	<u>Midpoint Estimate</u>
Cancer	6 - 10%	\$7,030,400	\$11,717,334	\$9,373,867
Nervous System Disorders	1 - 3%	143,060	429,180	286,120
Pneumoconioses	100%	201,654	201,654	201,654
Chronic Respiratory Disease	10%	3,904,621	3,904,621	3,904,621
Cardiovascular & Cerebrovascular Disease	5 - 10%	3,850,293	7,700,586	5,775,439
Renal Disorders	1 - 3%	<u>75,416</u>	<u>226,249</u>	<u>150,833</u>
TOTAL		\$15,205,444	\$24,179,623	\$19,692,533

¹All cost estimates are in 1992 dollars.

²Specific ICD9 codes used to define diseases are listed in Appendix to Table 12.

³Estimated proportions are from Markowitz and Landrigan, 1995.

SOURCE: U.S. Health Care Financing Administration, Health Care Financing Review (Fall 1994); National Hospital Discharge Survey, National Center for Health Statistics (1992); National Nursing Home Survey, National Center for Health Statistics (1985); Medical Care Component, Consumer Price Index, Bureau of Labor Statistics, Department of Labor (1995); Money Income of Households, Families and Persons in the United States (1992); U.S. Bureau of the Census (1993).

Total estimated costs for pneumoconioses amount to \$202 million. Total estimated costs for chronic respiratory disease amount to \$3.9 billion. Total estimated costs for cardiovascular and cerebrovascular diseases amount to \$5.8 billion, with a high estimate of \$7.7 billion to a low estimate of \$3.9 billion. Total estimated costs for renal disorders amount to \$151 million, with a high estimate of \$226 million to a low estimate of \$15 million.

Table 17 presents the breakdown of direct and indirect costs for fatal occupational illness disease. Total direct costs amount to \$10.7 billion, and indirect costs are \$9.0 billion. The total mortality costs amount to \$7.0 billion, and total morbidity costs amount to \$2.0 billion.

Table 17

Range of Total Costs of Occupational Fatalities by
Direct and Indirect Costs by Disease (Midpoint estimates)
(Costs in 000s)

	<u>Cancer</u>	<u>Nervous System Disorders</u>	<u>Pneumoconioses</u>	<u>Chronic Respiratory Disease</u>	<u>Cerebrovascular & Cardiovascular Disease</u>	<u>Renal Disorders</u>	<u>TOTAL</u>
Direct Cost	\$4,521,965	\$241,740	\$8,585	\$2,634,150	\$3,214,237	\$78,993	\$10,699,670
Indirect Cost	\$4,851,902	\$44,380	\$193,069	\$1,270,471	\$2,561,202	\$71,839	\$8,992,863
Mortality	\$4,160,602	\$25,393	\$77,470	\$511,019	\$2,196,282	\$32,438	\$7,003,204
Morbidity	\$691,300	\$18,987	\$115,599	\$759,452	\$364,921	\$39,402	\$1,989,661
TOTAL	\$9,373,867	\$286,120	\$201,654	\$3,904,621	\$5,775,439	\$150,833	\$19,692,534

SOURCE: U.S. Health Care Financing Administration, Health Care Financing Review, Fall 1994; National Hospital Discharge Survey, National Center for Health Statistics, 1992; National Nursing Home Survey, National Center for Health Statistics, 1985; Medical Care Component, Consumer Price Index, Bureau of Labor Statistics, Department of Labor, 1995; Money Income of Households, Families and Persons in the United States, 1992; U.S. Bureau of the Census, 1993.

The range of estimates for the total direct and indirect costs for fatal occupational illness is \$25.6 billion, with a high estimate of \$32.3 billion and a low estimate of \$18.8 billion. The midpoint estimate for total direct costs is \$10.7 billion, and for total indirect costs is \$9.0 billion. The midpoint estimate for mortality is \$7.0 billion, and for morbidity is \$2.0 billion. These results are presented in Table 18.

Table 18

Range of Direct and Indirect Costs of Occupational Disease Fatalities
(Costs in 000s)

	<u>Low Estimate</u>	<u>High Estimate</u>	<u>Midpoint Estimate</u>
Direct Cost	\$8,337,400	\$13,061,940	\$10,699,670
Indirect Cost	6,868,044	11,117,682	8,992,864
Mortality	5,202,044	8,804,364	7,003,204
Morbidity	1,666,000	2,313,319	1,989,660
TOTAL	\$15,205,444	\$24,179,623	\$19,692,533

SOURCE: U.S. Health Care Financing Administration, Health Care Financing Review (Fall 1994); National Hospital Discharge Survey, National Center for Health Statistics (1992); National Nursing Home Survey, National Center for Health Statistics (1985); Medical Care Component, Consumer Price Index, Bureau of Labor Statistics, Department of Labor (1995); Money Income of Households, Families and Persons in the United States (1992); U.S. Bureau of the Census (1993).

Table 19 presents the number of new cases of occupational illnesses and morbidity costs by industry and category of illness in 1992. The total costs for morbidity are \$472 million. Table 20 presents the number and estimated total medical costs of new cases of occupational illnesses by industry and category of illness. These costs amount to over \$5 billion.

Table 19

Number of New Cases of Occupational Illnesses and Morbidity Costs by Industry and Category of Illness, 1992 (000s)

	Agriculture, forestry, and fishing	Mining	Construct.	Manufact.	Transport. and public utilities	Wholesale and retail trade	Finance, insurance, real estate	Private industry, services	all
Total illnesses	6.2	1.9	10.5	292.3	16.7	43.9	16.1	69.8	457.4
Skin diseases or disorders	2.7	0.2	2.4	31.2	2.9	5.6	1.1	16.9	63.0
Dust diseases of the lungs	0.0	0.6	0.1	1.0	0.0	0.2	0.5	0.5	2.4
Respiratory conditions due to toxic agents	0.4	0.1	1.0	10.0	1.1	3.3	0.9	6.8	23.6
Poisoning	0.1	0.0	0.5	3.5	0.4	1.0	0.9	1.4	7.0
Disorders due to physical agents	0.4	0.1	1.2	11.1	0.9	0.0	0.8	3.7	18.2
Disorders associated with repeated trauma	1.5	0.7	2.2	219.9	8.7	20.2	11.4	17.3	281.9
All other occupational diseases	1.1	0.2	3.2	15.7	2.5	9.6	1.9	23.3	57.5
Lost workday cases ⁽¹⁾									
Total (including restricted works)	1.8	0.5	3.6	119.9	6.6	16.2	6.7	22.1	177.4
Average lost workdays per lost workday case	19	27	28	34	30	39	39	27	33
Average hourly earnings ⁽²⁾	10.6	11.5	14.5	14.1	13.5	9.3	10.8	10.5	10.6
Total morbidity costs ⁽³⁾	\$2,787,321	\$1,215,330	\$12,473,121	\$314,954,299	\$21,061,235	\$46,698,107	\$20,459,615	\$52,687,368	\$472,336,400

Assumption: Average lost workdays come from BLS 1991 data. ⁽¹⁾ We assume that restricted work days are 20 percent of a workday. ⁽²⁾ Includes 17% administrative cost. ⁽³⁾ Agricultural industries' wages come from average hourly earnings. Source: US Bureau of Labor Statistics, Bulletin 2370, supplement to Employment and Earnings, July 1991; and Employment and Earnings, monthly.

Table 20

Number and Estimated Total Medical Costs of New Cases
of Occupational Illnesses by Industry and Category of Illness
(Costs in 000s)

<u>Industry Division</u>	<u>Total Illnesses</u>	<u>Skin Diseases or Disorders</u>	<u>Dust Diseases of the Lungs</u>	<u>Respiratory Conditions due to Toxic Agents</u>	<u>Poisoning</u>	<u>Disorders due to Physical Agents</u>	<u>Disorders Associated with Repeated Trauma</u>	<u>All other Occupational Illnesses</u>
Private Industry, All Cases	457.40	63.00	2.40	23.60	7.00	18.20	281.90	57.50
Mean Medical Cost using Ohio Worker's Compensation	--	\$0.40	\$5.70	\$5.70	\$5.70	\$5.70	\$5.15	\$5.70
Mean Medical Cost using NCCI	--	\$8.75	\$8.75	\$8.75	\$8.75	\$8.75	\$8.75	\$8.75
Total Medical Cost using Worker's Compensation	\$2,838,576	\$34,187	\$18,516	\$182,072	\$54,004	\$140,411	\$1,965,779	\$443,607
Total Medical Cost using NCCI	\$5,370,452	\$745,896	\$28,415	\$279,415	\$82,877	\$215,481	\$3,337,589	\$680,778

Sources:

U.S. Bureau of Labor Statistics, Occupational Injuries and Illnesses in the U.S. by Industry, Washington D.C.: Govt. Printing Office, 1993, Bulletin 2424.
 Neumark D, et.al. Cost of occupational injury and illness in Pennsylvania. Journal of Occupational Medicine Sept 1991; 33(9):
 Webster BS and Snook SH. The cost of compensable upper extremity cumulative trauma disorders. Journal of Occupational Medicine, forthcoming.
 The Industrial Commission of Ohio and Division of Safety and Hygiene, Average Costs of Occupational Injuries and Illnesses 1980-1983, State of Ohio. March 1986.
 Notes: Medical costs are updated from the base years using medical portion of the consumer price index.

In many ways, the methodological challenges researchers must face in estimating the economic costs of occupationally-related disease mirror the challenges of industrial regulation policy where fragmented information systems diffuse and obscure the predictable health effects of occupational hazards. Occupational health policy analysis, that is, the ability to analyze the effect of disease prevention technologies and clinical detection and treatment systems on health outcomes, cost of resources, and ultimately on productivity, is severely hampered by the fragmented information systems that are associated with the over 1500 employer-based health insurance plans for working populations. In addition, the loss of continuous medical history and follow-up data due to the separation of Medicare, the insurer for the population 65 years and older, from private employer-based insurance information systems further limits the data accessibility that is necessary to understand the full spectrum of the costs of occupationally-related disease, over the life-span.

In order to assess the reliability of our estimates, we performed a sensitivity analysis. We analyzed the effect of our results on the assumptions used to estimate morbidity costs. To perform the sensitivity analysis, we calculated morbidity costs two ways. In Tables 16-18, we presented estimates based on the calculation of morbidity costs as a ratio of mortality costs. Tables 21-23 present estimates based on the calculation of morbidity costs as a ratio of direct costs. We estimated the ratio as a linear function of 1980 and 1985 ratios, calculated by Rice and colleagues (Rice et al. 1985; Rice et al. 1989). We find the method used does not substantially affect the final estimate of the total costs of occupational disease. The total economic cost estimates vary by less than 10% at midpoint.

Table 21

Range of Total Costs of Occupational Fatalities, by Disease
Sensitivity Analysis: Assumptions for Morbidity Costs Based on
Estimated Direct Costs
(Costs in 000s)

<u>Disease²</u>	<u>Estimated Proportion Due to Occupation³</u>	<u>Total Cost Range¹</u>		<u>Midpoint Estimate</u>
		<u>Low Estimate</u>	<u>High Estimate</u>	
Cancer	6 - 10%	\$7,464,566	\$12,440,943	\$9,952,754
Nervous System Disorders	1 - 3%	145,141	435,423	290,282
Pneumoconioses	100%	89,794	89,794	89,794
Chronic Respiratory Disease	10%	4,170,959	4,170,959	4,170,959
Cardiovascular & Cerebrovascular Disease	5 - 10%	4,085,800	8,171,60	6,128,700
Renal Disorders	1 - 3%	59,246	177,737	118,491
TOTAL		\$16,015,505	\$25,486,455	\$20,750,980

¹All cost estimates are in 1992 dollars.

²Specific ICD9 codes used to define diseases are listed in Appendix to Table 12.

³Estimated proportions are from Markowitz and Landrigan, 1995.

SOURCE: U.S. Health Care Financing Administration, Health Care Financing Review, (Fall 1994); National Hospital Discharge Survey, National Center for Health Statistics (1992); National Nursing Home Survey, National Center for Health Statistics (1985); Medical Care Component, Consumer Price Index, Bureau of Labor Statistics, Department of Labor (1995); Money Income of Households, Families and Persons in the United States (1992); U.S. Bureau of the Census (1993).

Table 22

Total Costs of Occupational Fatalities by
Direct and Indirect Costs by Disease (Midpoint estimates)
Sensitivity Analysis: Assumptions for Morbidity Costs Based on Estimated Direct Costs
(Costs in 000s)

	<u>Cancer</u>	<u>Nervous System Disorders</u>	<u>Pneumoconioses</u>	<u>Chronic Respiratory Disease</u>	<u>Cerebrovascular & Cardiovascular Disease</u>	<u>Renal Disorders</u>	<u>TOTAL</u>
Direct Cost	\$4,521,965	\$241,740	\$8,585	\$2,634,150	\$3,214,237	\$78,993	\$10,699,670
Indirect Cost	\$5,430,790	\$48,542	\$81,209	\$1,536,809	\$2,914,463	\$39,498	\$10,051,311
Mortality	\$4,160,602	\$25,393	\$77,470	\$511,019	\$2,196,282	\$32,438	\$7,003,204
Morbidity	<u>\$1,270,188</u>	<u>\$23,149</u>	<u>\$3,739</u>	<u>\$1,025,790</u>	<u>\$718,181</u>	<u>\$7,060</u>	<u>\$3,048,107</u>
TOTAL	\$9,952,754	\$290,282	\$89,794	\$4,170,959	\$6,128,700	\$118,491	\$20,720,981

SOURCE: U.S. Health Care Financing Administration, Health Care Financing Review, Fall 1994; National Hospital Discharge Survey, National Center for Health Statistics, 1992; National Nursing Home Survey, National Center for Health Statistics, 1985; Medical Care Component, Consumer Price Index, Bureau of Labor Statistics, Department of Labor, 1995; Money Income of Households, Families and Persons in the United States, 1992; U.S. Bureau of the Census, 1993.

Table 23

Range of Total Direct and Indirect Costs of Occupational Disease Fatalities
Sensitivity Analysis: Assumptions for Morbidity Costs
Based on Estimated Direct Costs
(Costs in 000s)

	<u>Low Estimate</u>	<u>High Estimate</u>	<u>Midpoint Estimate</u>
Direct Cost	\$8,337,400	\$13,061,940	\$10,699,670
Indirect Cost			\$10,051,310
Mortality	5,202,044	8,804,364	7,003,204
Morbidity	2,476,061	3,620,151	3,048,106
TOTAL	\$16,015,505	\$25,486,455	\$20,750,980

SOURCE: U.S. Health Care Financing Administration, Health Care Financing Review, (Fall 1994); National Hospital Discharge Survey, National Center for Health Statistics (1992); National Nursing Home Survey, National Center for Health Statistics (1985); Medical Care Component, Consumer Price Index, Bureau of Labor Statistics, Department of Labor (1995); Money Income of Households, Families and Persons in the United States (1992); U.S. Bureau of the Census (1993).

Estimates by disease will vary according to the relationship between direct costs and mortality costs within disease categories. For some diseases such as cancer, using a ratio for morbidity costs that is based on mortality costs, the total estimate of the costs of cancer is slightly lower. This is due to the high relative proportion of direct costs to mortality costs for cancer patients. This relationship is not true for pneumoconioses, which have much higher ratios of mortality costs to direct costs. Therefore, the estimate of total costs for pneumoconioses, using morbidity cost based on mortality cost, is substantially higher than the estimate for pneumoconioses using morbidity costs based on direct costs. Overall, in the estimates presented, there appears to be a balancing out of these effects, so that the total estimate appears stable.

There are other assumptions that should be tested in future research. Specifically, the assumptions regarding homogeneity of occupational disease death rates with national average age-specific death rates of the diseases under study should be examined. If, for instance, workers with occupationally-acquired cancer die at an earlier age than patients whose cancers are caused by non-occupational factors, our economic cost estimates are likely to be biased downwards.

National surveys and data sets for describing medical care utilization patterns for the general population should be explored further for measures and data regarding costs and outcomes of occupationally-related disease. These rich sources of clinical and socio-economic data have not been examined, for the most part, for model building and testing of hypotheses regarding health status, medical expenditure, and occupational status. Research diverted toward the sources of knowledge in data sets (such as the National Medical Expenditure Survey, U.S. Department of Health and Human Services 1994) would be a productive use of health policy research dollars.

In summary, the estimates presented in this report are conservative. The economic cost estimates associated with deaths due to occupational disease include morbidity costs, but do not include costs for persons diagnosed with these potentially fatal occupationally-related diseases who did not die during 1992. In addition, no economic costs were attributed to deaths due to occupationally-related heart disease after age 65. Our supplement to the costs of fatal illness, the BLS report of occupationally-related chronic disease (U.S. Bureau of Labor Statistics 1991), is widely criticized to be under-reported. Estimates from the literature indicate the under-reporting may be as much as three-fold (Oleinick 1993).

Cost Summary

Our most important findings are summarized in Table 24. We found roughly 6,500 injury deaths, 13.2 million non-fatal injuries, 60,300 disease deaths and 857,500 illnesses. Total costs were estimated to be \$174 billion in 1992.

Table 24

Number and Costs of Injuries and Illnesses in 1992

Category	Costs		Direct	Indirect
	Number	Total		
Injuries*	13,253,529	\$148.3883	\$50.1046	\$98.1837
Deaths	6,529	3.7974	.2626	3.5348
Non-fatal	13,247,000	144.5904	49.8420	94.6489
Illnesses**		\$ 25.5353	\$16.0701	\$ 9.4652
Deaths	60,293	19.6925	10.6997	8.9929
Morbidity	858,165	5.8428	5.3705	.4723

* Innocent bystanders excluded from counts of injuries but included in dollar estimates.

** The number of deaths and illnesses cannot be summed.

In addition to these major findings we also found: many episodes of occupational injuries also involved innocent bystanders. For example, a single pilot death may be associated with scores of deaths to passengers. Workers' compensation covers only slightly more than 30 percent of all costs. Being at work is not safer than being at home. People who work are more likely to be injured at work than at home. This is especially true for men. Moreover, work-related injuries were more likely to result in hospitalizations than injuries originating outside of work. Non-fatal injuries most frequently involved (in order) the person's back, legs, arms, and fingers. Back injuries alone generated nearly \$50 billion in costs.

WTP Results

As noted above, an alternative method for determining the cost of injuries and illnesses is the Willingness-to-Pay method (WTP). The WTP method is designed to be comprehensive, i.e., it does not split costs into direct and indirect groups and it is designed to include people's evaluations of the costs of pain and suffering.

We used the summary of WTP estimates in Viscusi (1993) to price our deaths, injuries and illnesses. We used \$4 million for each death and \$40,000 for each non-fatal injury and disease. These WTP estimates apply to everyone regardless of age or gender.

Our WTP estimates range from \$527 to \$831 billion. Since GDP in 1992 was \$5.9507 trillion, these \$527 to \$831 billion represent roughly 9 to 14 percent of GDP. These high WTP numbers suggest that using the WTP approach to calculate *total* as opposed to *marginal* costs may not be credible. They

nevertheless suggest that the costs of pain and suffering are likely to be substantial.

Results for -- Who Pays?

We all pay. This is the conclusion from both the *nominal* and *incidence* analysis of who pays. The *nominal* analysis suggests that roughly 25 percent is paid by WC, 10 percent by private health insurance, 50 percent by the victim and family, 10 percent by federal programs, and 5 percent by state and local programs. The *incidence* method suggests that employers bear 11 percent, consumers 9 percent, and all employees 80 percent. These *incidence* costs are experienced by employers through lower profits, consumers through higher prices, and all employees (whether or not injured) through lower wages.

Comment

This Comment Section is split into three parts: Assumptions; Limitations and Issues; and Literature Review.

Assumptions

In this Assumption section, we mention 14 of the major assumptions of the study. A word precedes our list of each assumption below. The word "Low" indicates that this assumption would result in a lower estimate than would otherwise be obtained with alternative assumptions. The word "High" indicates the opposite. We invoked high estimate assumptions only when we believed there was overwhelming evidence to support them or when no other defensible assumption was available.

List of Consequential Assumptions

1. Low. We selected our year of analysis to be 1992, a high unemployment year.
2. Low. We omitted injuries and illnesses among military personnel.
3. Low. We used NCCI average medical cost data that excluded California and New York. But California and New York had higher average medical costs than the rest of the nation.
4. Low. We did not include costs of health problems in caregivers providing care to injured or sick workers. The constant stress of providing care may produce illness in the caregivers. Even more importantly, we did not include the costs of caregivers' time.
5. Low. We chose a 55 percent rather than a 60 percent undercount for WC even though most studies showed a 60 percent undercount was more plausible.
6. High. We added 1500 deaths to the NSC injury death estimate to account for violent deaths. The NSC explicitly ignores violent deaths.
7. Low. Reproductive problems, injuries leading to arthritis and any possible transmission of disease (e.g. dust) from parent to child, were omitted from our disease and illness calculations (Olsham, 1991). Moreover, we did not assume 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 (Heaney et al., 1993; Marriot et al., 1994).
8. Low. Small proportions (1 to 3 to 10 percent) were used when we attempted to estimate morbidity and mortality from the major diseases.
9. Low. Occupational cardiovascular morbidity and mortality were limited to events among people less than 65 years old.
10. Low. We ignored pain and suffering costs. Lawsuits involving non-fatal injuries almost always involve some payment for pain and suffering. A rule of thumb frequently cited in lawsuits is that pain and suffering equal three times the non-administrative medical expenses (Ferguson, 1995). In our case, this would mean adding another roughly \$100 billion to our costs. In addition, the WTP estimates suggest that pain and suffering would add an additional \$300 billion to \$700 billion.
11. Low. In calculating workdays lost due to disease (not injuries) we used the BLS Annual Survey data that ignores as much as 70 percent of total days lost (Oleinick et al.) This is due to the BLS restrictions that days lost only be counted in one calendar year. Many of the especially serious disease cases force a person to miss more than 12 months of work.
12. Low. We relied heavily on the CFOI data that documented the amount of undercounting in the death certificate, WC and Annual Survey data. It is likely that the CFOI itself underestimates injury

deaths, hence all of our undercount estimates for death certificates, WC and the Annual Report would be higher if we accounted for the CFOI undercount.

13. Low. We assumed that once the injured or ill worker was re-employed, no more lost wages would need to be accounted for. However, most permanently impaired workers do not earn their old wage if they find work at a firm other than the one where they experienced the injury. They experience permanent wage losses for the rest of their working lives (Berkowitz, 1990; Jacobson, Lalonde and Sullivan, 1993; Bound, 1989).

14. Low. Children reared in families where one parent is disabled acquire less education and consequently earn less lifetime income than children whose parents are not disabled (Haveman and Wolfe, 1994). We did not count these costs.

Limitations and Issues

Data Sets Our most serious limitation was that there was no single source of data available to provide all of the information we required. We had to analyze data from a variety of sources. In all, we considered 14 primary sources and over 200 secondary sources. Each source had limitations and numerous assumptions had to be made in calculating our final estimates. This limitation has been singled out as the most serious of all limitations in a variety of cost studies (Rice et al., 1989; Hoskin et al., 1993; Miller, 1995).

Fraudulent Claims A popular perception is that many job-related injuries and illnesses are fraudulent. This perception is especially strong when a WC claim is involved. For example, some people fake back pain or exaggerate the pain they feel, hoping to qualify for WC benefits. It is, nevertheless, fair to say that the extent of the WC fraud, whether big or small, has never been carefully documented. In the Final Report, we review the (few) studies on fraudulent claims in WC as well as in the Social Security Disability Insurance program (Burton, 1988; Bound, 1989; Boaz and Muller, 1990; Smith, 1992).

But there are also reasons to expect WC to undercount legitimate cases. Some employees may not report injuries or illnesses for fear of employer recriminations. Moreover, many especially minor but nevertheless costly (in terms of lost work time) injuries and illnesses do not qualify for WC (e.g., first aid incidents, smashed toe, and so on). In the Final Report we also review studies on the tendency for WC to undercount incidents (Horwitz, 1994; Rejda, 1991; O'Coughlin, 1993; Toscano and Windau, 1993; Parker et al. 1994; National Health Interview Study-Occupational Health Supplement, 1988; Hensler et al. 1991; Marquis, 1992; Cone et al. 1991; Stout and Bell, 1990).

We conclude that these are limitations of our study, but that additional research needs to be conducted to determine the extent of the fraud, fear, and undercount problems.

Generous WC Benefits Increase Injuries Some investigators have maintained that generous WC benefits would, ironically, result in more injuries occurring. Presumably, workers are aware of the WC benefits they qualify for in the event of an injury. If those benefits are sufficiently generous, some workers may not take as much precaution at work than if the benefits were stingy. This is the so-called Moral Hazard problem identified in the insurance literature. We review the literature on Moral Hazard as it applies to WC in the Final Report (Ruser, 1993; Cheadle et al., 1994; Leigh, 1985b). We acknowledge the problem but note that regardless of the motivation or care of the employee, these injuries and illnesses were nevertheless job-related.

WC Medical Costs Exaggerate True Medical Costs In calculating medical expenses for injuries, we relied heavily on WC costs. WC costs are readily available (NCCI). Moreover, WC pays virtually 100 percent of the medical bill. Injured or ill workers do not pay a co-payment or have a deductible.

But there may be a disadvantage to using WC cost data. In recent years, WC medical costs were estimated to have increased one and one-half times faster than general medical costs (Nelson, 1992). Thus, some investigators have argued that this evidence suggests that WC pays more than the true medical costs associated with an injury or illness (Durbin, Corro and Helvacian, 1993).

In the Final Report, we review reasons for the increase in WC costs such as expanding employment from 1982 to 1990; increasing numbers of cases involving carpal tunnel syndrome; increasing expensive non-fatal injuries while decreasing relatively inexpensive fatal injuries. On balance, we do not believe WC medical costs exaggerate true costs.

Total and Average Costs Versus Marginal Costs Our study, like all studies on direct and indirect costs, calculates total and average costs, not marginal costs. Our attention to total and average costs rather than marginal costs is appropriate. We seek to generate overall cost figures which then may be compared to overall cost figures for other diseases, injuries and other economic activities.

If our study had been concerned with, for example, evaluating OSH engineering standards, the appropriate cost would be marginal, not average or total. Presumably, few standards eliminate risk altogether. A standard might cut risk by a tenth or a quarter, but rarely, if ever, by 100 percent. The total and average cost concepts most appropriately apply to cutting risk by 100 percent. The marginal cost most appropriately applies to marginal cuts of 5, 10 or 20 percent.

Full Employment The largest component of indirect costs are lost wages. But whether lost wages

represent a true cost depends upon economic conditions. If there is a substantial amount of unemployment, then the worker sustaining the injury or illness might be easily replaced with someone currently unemployed. Since the unemployed replacement had no wages prior to acquiring the job, the loss to the economy from the injured workers' production may be zero.

There are three responses to this point. First, the point confuses marginal with average and total costs. It may be true that for some injured or ill workers, unemployed replacements are immediately available. The *marginal* worker might be easily replaced. But all workers (*total*) could not be replaced simply because the number of injured or ill workers in 1992 exceeded the number of people looking for work.

Second, we are consistent with all prior direct/indirect studies. The implicit assumptions in all prior studies on the lost wages component of indirect costs, and the explicit assumption here, is that the economy is operating at full employment. This means that no direct, easy replacement of the injured or ill worker is readily available. The replacement must come from a different sector in the economy, necessitating a drop in output from that sector.

Third, our assumption underpins the common sense idea that people are a valuable resource. If this were not true, then a number of counter-intuitive conclusions could be drawn about costs in the economy. For example, business groups often complain about the overall costs of environmental and OSHA regulations. Businesses must spend more than they otherwise would, for example, on machinery in a cotton mill that reduces the amount of cotton fiber circulating in the plant. These new machines are costly. The manufacturers of the machines must pay people to produce the machines. Presumably, without the added spending on the new machines, these people would have been employed elsewhere in the economy. The fact that they are induced into building new cotton mill machinery presumably means that output elsewhere in the economy must have decreased. But if these workers had been unemployed, then the cost to the economy would be zero. We would have the perverse result that environmental and OSHA standards create jobs and therefore do not result in any cost to the economy. We, therefore, invoke the same Full Employment assumption used by business groups who point out the costs of OSHA regulations.

Incidence versus Prevalence Our injury estimates are incidence-based. Our illness estimates are a mixture of the two, incidence for morbidity; prevalence for mortality. As is evident in the Literature Review section of the Final Report, the incidence method is preferred for measuring injury and short-term episodes of disease. The prevalence method is preferred for measuring mortality costs of disease.

The reason for the split is simple: injuries and episodes of non-fatal illnesses tend to be immediate

and chronic diseases resulting in death tend to be long-term. An incidence study of chronic disease deaths would be difficult, especially in our case. We would be forced to estimate how many, for example, cancer deaths would occur over the next 50 years due to job-related exposure in 1992. Such an estimate would be difficult to defend. First, 50 years is far into the future. Second, and perhaps most importantly, job exposures to chemicals for just one year is not the relevant standard. The relevant standard should be the likely exposure for a typical worker in a job, i.e. a person who stayed in the job for the typical amount of time. We believe a prevalence measure is more likely to capture the experience of the typical worker than an incidence measure.

There is some minor controversy over whether the incidence or prevalence cost method generates the largest estimates (Miller and Galbraith, (1995)(versus Hensler et al (1991)). We side with Hensler et al (1991) who assert that because of discounting at more than the inflation rate, incidence estimates will appear to be smaller than prevalence estimates. But as we demonstrated in the Final Report, these differences are minor. Much more significant are the assumptions leading to the estimate for the numbers of injuries or illnesses and the average costs for the injuries or illnesses.

Proportional Attributable Risk Model Several seminal issues underlie this attributable risk model. First, since most disease is multi-factorial in origin, to attribute a death to an occupational exposure does not exclude a causal role for another factor that is not occupational. Both causes may have actively contributed to a person's death. Most lung cancers in asbestos-exposed workers who smoke cigarettes occur as a result of the combined action of exposure to asbestos and cigarettes (Hammond et al, 1979). It would be proper, therefore, to assign a lung cancer death in such a person simultaneously to an occupational cause and to an unhealthy habit. This will lead to double-counting as long as categories of causes are considered mutually exclusive. In our analysis we use the term attributable proportion with reference to an exposure to mean the proportion of disease that would have not occurred in the absence of that exposure.

Other problems exist, however. While it is likely that occupational causes frequently interact with non-occupational causes to produce illness and death, the nature of this interaction is largely unknown. It is, therefore, difficult to determine the relative importance of each factor acting alone or in concert. Finally, the proportion of disease due to occupational causes (or any other causes) can be expected to vary in time and place and across different types of people. Our approach was to use estimates of ranges of proportions of major categories that were consonant with current knowledge. Ranges of estimates of similar magnitudes have been used by numerous groups of occupational health researchers in studying disease in New York, Connecticut, Texas, New Jersey, Pennsylvania, and Canada (Markowitz et al.,

1989, Fahs et al., 1989; Markowitz and Landigan 1989 ; Occupational Health Working Group, 1990; Rothstein and Cooper, 1933; Penn Dept of Health, 1990; Kraut, 1994.)

Literature Review

Neumark et al. 1991 Neumark et al. (1991) estimated the incidence cost of occupational injuries and diseases in Pennsylvania in 1987, 1988 and 1989. They extrapolated to the U.S. and found a mean estimate of \$54.5 billion for illnesses *and* injuries. In the Final Report we show that \$17 billion would be their estimate of direct and indirect costs for all occupational injuries in the U.S. in 1989.

The Neumark et al. (1991) study is useful for several reasons. 1) Their approach to the NCCI data was essentially the same as ours. To estimate medical costs, they simply multiplied the number of injuries and diseases by the corresponding NCCI medical costs. 2) They ignored Willingness-To-Pay estimates. Neumark et al. (1991) were skeptical of the existing WTP estimates that were available in the literature. The most popular WTP estimate requires widespread information on job hazards. Neumark et al. explicitly state that they do not believe information is widespread.

The Neumark et al. study suffers flaws, however. Here we note two. First, they assumed that average age of death would be the same for injuries and illnesses. This is not true. Second, their total cost estimate for injuries -- \$17 billion for the late 1980's -- is alarmingly low. National WC costs alone were more than double that in the same years (Nelson, 1992).

National Safety Council The National Safety Council collects and presents more data on accidents, injuries and their costs than any other private firm or federal agency. Hoskin et al. (1993) estimate the total cost for job-related injuries to be \$115.9 billion in 1992. This \$115.9 billion estimate, like our \$148 billion estimate for injuries, is an incidence, not a prevalence estimate. The largest portion of job-related costs came from wage and productivity losses (\$62.5 billion) and medical expenses (\$22.0 billion). The other categories of expenses are itemized as administrative expenses (\$14.5 billion), employer costs (\$10.2 billion), motor vehicle damage (\$3.4 billion), and fire losses (\$3.3 billion). Our approach is similar to the NSC. We include all of their cost categories in our analysis. For administrative expenses, we both include legal costs. The NSC, like us, use the difference between premiums paid to insurance companies and claims paid out by those companies to estimate administrative costs. We also concur with the NSC inclusion of costs to uninjured workers' and firms' production slowdowns, training of replacement workers and extra cost of overtime for non-injured workers. We differ in that our fire losses are combined with motor vehicle damage in the general property damage category. Unlike the NSC, we attempt to estimate the costs of administration for indemnity benefits, police and fire services, and harm to

innocent third parties.

Our \$148 billion injury estimate is larger than the NSC's \$115.9 billion estimate. The disparity is largely the result of two factors: 1) the NSC explicitly ignored violent incidents (assault, murder, suicide) and more importantly, 2) the NSC relied on the NHIS estimate of non-fatal work injuries. As we argued in Chapter 2 of the Final Report, the NHIS only captures roughly 50 to 60 percent of all non-fatal injuries.

It is nevertheless reassuring that our percentage estimates of direct and indirect costs are similar. The NSC direct costs were roughly \$43 billion or 37 percent of total costs and the indirect costs were roughly \$73 billion or 63 percent of total costs. Our percentages are roughly 34 percent and 66 percent, respectively.

Marquis The Hensler et al. (1991) and Marquis (1992) studies at Rand Corporation were prevalence-based, unlike the great majority of the other injury studies we reviewed. Hensler et al. looked at all injuries whether on or off the job. Marquis looked only at job-related injuries.

Marquis (1992) presented testimony to Congress on the costs of workplace injuries using the Hensler et al. study (1991) as her database. The Marquis study has been widely cited.

Marquis' estimates applied to non-fatal traumatic injuries. Fatalities and all occupational diseases -- including carpal tunnel syndrome -- were excluded. She estimated that 7 million Americans suffered on-the-job injuries in 1989. Another 4 million suffered in 1989 as a result of an injury that occurred prior to 1989. Her 11 million estimate was a prevalence estimate.

She estimated a total cost of \$83 billion in 1989 -- almost two percent of GNP. Roughly 40 percent of that amount was spent on direct (medical) costs, and 60 percent resulted from work loss costs.

Marquis (1992) did not place a dollar value on the loss in home production. She looked at who paid the costs. She estimated that 45 percent of medical and wage losses were born by the individuals and their families. The remaining 55 percent was split among a variety of payers: WC (27.5%), private insurance (11%), employer provided benefits (5.5%), Medicare, Supplemental Security Income and Social Security Disability Insurance (5.5%), and, finally, tort liability (5.5%).

The Hensler et al. (1991) and especially the Marquis (1992) studies are limited. First, fatalities were excluded. Second, given the nature of the questions on their questionnaires about accidents and injuries, a considerable number of assaults, attempted murders and suicides were excluded. Third, a great number of minor injuries, involving one to four days of work loss, were excluded. A fourth limitation is that they underrepresented minorities and the poor -- groups that are more likely than other groups to experience injuries on- and off-the-job (Graham, Chung and Evans, 1992; Wildarsky, 1980).

Despite these limitations, which Hensler et al. and Marquis readily acknowledge, their studies

were exceptional. No other cost study we reviewed conducted such an independent extensive household survey of injuries.

An additional finding in the Hensler et al. (1991) study was relevant for us: On average, injured persons reported 1.4 injuries per incident (p. 37). The word "injury" here refers to the type and body part affected. "Types" include strains, sprains, cuts, fractures, broken bones, bruises, pain, burns, and so on. Body parts include head, foot, ankle, back, hand, arm, and so on.

Any costing procedure constructed around type of injury and body part affected will be confounded by this simple fact: some percent, Hensler et al. suggest 40%, of incidents result in more than one body part affected. This is one reason we believe injuries are better classified by the WC categories than body part categories. Another reason is that medical cost and especially wage loss data are difficult to find for body parts.

Miller and Galbraith Miller and Galbraith's study (1995) used injury statistics from 1989 and produced cost estimates for December 1990. They estimated 10,958,600 injuries (disabling and non-disabling) in 1989. The total amount of their estimated expenses, including insurance liability and insurance overhead, was \$96.6 billion. They also estimated an additional \$61.8 billion based on WTP estimates. These \$96.6 billion applied to 1990. Assuming a 7.345 inflation rate between 1990 and 1992, Miller and Galbraith's (1995) estimate would be \$103.7 billion in 1992. This estimate is only roughly 11 percent less than the NSC estimate for 1992.

Miller and Galbraith's medical costs, like ours, were drawn from an NCCI Ultimate Report covering policies in years 1985 and 1986. Miller and Galbraith (1994) used the same Rice et al. (1989) method we used to estimate wage losses for fatalities. Men and women who died were assumed to have lost the earnings of men and women of the same age who lived and earned wages until age 65. Wage losses for fatalities were discounted at a 4 percent rate. Miller and Galbraith also estimated wage losses for non-fatal injuries using techniques similar to ours. They relied on NCCI indemnity data and assumed that WC compensated 60.3 percent of the before-tax wage-loss and none of the fringe benefit loss. Our assumed percentages -- 40, 50 and 60 -- on average resulted in more conservative estimates than those in Miller and Galbraith.

Miller and Galbraith also added an estimate for fringe benefits which were valued at 20 percent of wages. This 20 percent figure was the value of supplements to wages reported in the National Income Accounts by the Council of Economic Advisors (1992). This is close to our assumed percentage of 21 percent.

The chief reasons our overall injury estimate was bigger than theirs was that we estimated over

13 million injuries while they estimated less than 11 million and we assumed higher administrative costs.

Nelson Nelson (1992, 1993) estimated total WC premium costs of \$55.2 billion in 1991. Roughly \$42.1 billion of this was spent on benefits and \$13.1 billion was retained for administration expense. Of the \$42.1 billion, roughly \$16.8 went for medical costs and \$25.3 went for indemnity costs.

A simple approach to estimating costs for all injuries (WC and non-WC) takes the national WC estimates in Nelson (1992, 1993), adjusts for federal and state differences in WC, adjusts for illnesses, multiplies by 2.22, and adjusts fringe benefits, home production, lost earnings for the deceased, workplace disruption, property damage, time delays, emergency services, collateral damages, and for the inflation. The 2.22 multiplier results from assuming that WC only covers 45 percent of all injuries or costs.

In the Final Report, our Nelson-adjusted estimate for injuries only is \$194 billion. This \$194 billion is probably an overestimate. The WC data includes death benefits and the relatively high WC administrative costs (31%). Nevertheless, it is useful to note that our \$148 billion estimate for injuries only is not the highest estimate available in the literature.

Compare with Other Diseases Our costs are large when compared to other diseases. The medical costs of AIDS were estimated to be roughly \$7.0 billion in 1992 (Hellinger, 1992). These AIDS costs did not include insurance administration costs. Our medical only direct costs for injuries and illnesses were \$47 billion -- nearly seven times the costs for AIDS. We are not familiar with any recent estimates of indirect costs for AIDS, but these are likely to be large for the same reason that job-related injury indirect costs are large: people die at relatively young ages.

Alzheimer's disease was recently estimated to cost \$20.6 billion in direct costs and \$46.7 billion in indirect costs (Ernst and Hay, 1994).

Circulatory diseases -- heart attack, stroke, and high blood pressure -- are responsible for more deaths than any other disease or injury. Unfortunately, the most reliable estimate of the costs of all circulatory diseases dates to 1980. Rice et al. (1985) estimated \$32.5 billion in direct costs and \$47.1 billion in indirect costs in 1980. To bring these 1980 estimates up to 1992 requires several assumptions, involving inflation, changes in the incidence of circulatory diseases and so on. With these assumptions we calculated that the total costs for all circulatory diseases would be \$164.28 billion in 1992.

Similar calculations can be carried out for the costs of cancer (Rice et al. 1985). We estimated a \$170.71 billion cost in 1992.

Conclusion of Literature Review The first point of our review of the existing literature is to affirm that our methods and assumptions are reasonable. In as many cases as possible, we relied on the literature to support our methods and assumptions. We did not seek to create new methods.

The literature review is also useful in allowing us to compare our estimates with those elsewhere. The most reliable *national* estimate in the review applied to injuries: NSC, Marquis, Miller and Galbraith and Nelson. The National Safety Council (NSC) (1993) estimated \$116 billion of costs for injuries only in 1992. But the NSC ignored assault, murder, suicide and other acts of violence. Marquis (1992) estimated the direct and indirect costs of injuries only (not illness) to be roughly \$83.2 billion in 1989. But the Marquis study greatly underestimated non-disabling injuries, ignored deaths, ignored assaults and acts of violence, and the dollars applied to 1989, not 1992. Miller and Galbraith estimated a cost of \$96.6 billion in 1990. We differ because there was inflation between 1990 and 1992 and most importantly, we estimated 25 percent more injuries. We believe Miller and Galbraith too heavily relied on the NHIS. Finally, our adjustments to Nelson's (1990, 1993) WC data would suggest roughly a \$194 billion estimate. We believe \$194 is too high since Nelson included death benefits and the very high WC administration rate of 31% out of benefits.

Finally, the literature review enables us to draw cost comparisons among a variety of diseases, conditions and injuries.

Conclusion

Identifying the costs of occupational injury and disease in the United States has been an elusive goal. Our study represents the first attempt to estimate the national cost of occupational injury and illness using national data. But even with our study, this goal remains unattained. Nevertheless, improvements in national data systems such as the Census of Fatal Occupational Injuries and the BLS Annual Survey provide increasing confidence that the overall magnitude of the problem can be approximated. Proper interpretation of national surveys, recognition of the deficiencies of WC reports and OSHA Log 200 form reports to the BLS, extensive examination of NCCI cost data, and prudent application of a proportional attributable risk model to major causes of disease, provided the foundation for our study of the civilian workforce in 1992. Any of the major sources of data, such as the Bureau of Labor Statistics, National Institute for Occupational Safety and Health, Workers' Compensation, or National Health Interview Survey, by themselves, underestimate the numbers of injuries and illnesses. Several data sources must be examined and combined to produce overall, national estimates. One of our most important conclusions is this: Greater efforts need to be directed toward gathering data on job-related injuries and illnesses. The United States needs better data (a Census of Fatal Occupational Injuries, CFOI) for non-fatal injuries and all illnesses.

We found that roughly 6,500 job-related injury deaths, 13.2 million non-fatal injuries, 60,300

disease deaths and 857,500 illnesses occurred in the American workplace in 1992 (see Table 1.5). The total direct and indirect costs associated with these injuries and illnesses were estimated to be \$173.9236 billion or 3 percent of Gross Domestic Product in 1992. Direct costs were estimated to be roughly \$66 billion and indirect costs, roughly \$108 billion. These are conservative estimates. They ignore pain and suffering, the value of time and care provided to victims by loved ones, the effect on children of now having a disabled or absent parent, among other costs. These costs are large when compared to other diseases. The costs combined are larger than those for AIDS, Alzheimer's disease and back pain and are on a par with those for cancer and for all circulatory (heart and stroke) diseases.

The costs are high because so many people are at risk. One hundred twenty (120) million people held jobs in 1992. Any of the 120 million could have suffered a job-related injury or illness.

While the lion's share of costs are experienced by the injured or ill workers and their families, all Americans share in these costs. Firms experience them as premiums for WC and health insurance, as workplace disruptions, and as property damage. Consumers experience them as higher prices. Workers experience them as lower wages. Taxpayers experience them as high taxes for Medicare and Medicaid.

Despite the high cost, the great numbers of people at risk, and the fact that so many of us must pay, occupational injuries and illnesses do not receive the attention they deserve. The NIOSH receives one of the lowest levels of funding of any of the health research institutes in the country. No private charities are available to fund research on OSH. Heart disease has the American Heart Association; Cancer has the American Cancer Society; AIDS has the Ryan White institute; and so on. Occupational injuries and illnesses do not have a corresponding charitable foundation.

The federal government's flagship health statistics publication Advanced Data on injury-related data visits (Schapport, 1994), hospitalizations (Hall and Owings, 1994) and emergency room visits (Burt, 1995), for example, do not include any categories for occupational injuries.

A cursory view of medical articles in newspapers, stories on television, best-selling medical self-help books and so on, reveals far more attention to AIDS, heart disease and cancer than to job-related injuries and illnesses.

The 120 million Americans who work for a living and the nearly 20 million firms, charities, hospitals, and governments that employ them deserve greater attention to the cost of occupational injuries and illnesses.

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