Current Magnitude of Occupational Disease in the United States

Estimates from New York State

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Occupational diseases encompass a broad range of human illness. They include lung cancer and mesothelioma in asbestos workers, cancer of the bladder in dye workers, leukemia in workers exposed to benzene, chronic bronchitis in workers exposed to dust, disorders of the nervous system in workers exposed to solvents, chronic kidney disease in workers exposed to lead, heart disease in workers exposed to carbon monoxide, impairment of reproductive function in men and women exposed to lead and pesticides, and chronic disease of the musculoskeletal system in workers who suffer repetitive trauma.

Occupational exposures have been estimated to cause 100,000 deaths and 400,000 cases of illness each year in the United States.[1] However, no empirical data exist on the current incidence or prevalence of occupational disease in the United States. Currently available surveillance systems for occupational illness have been described as "fragmented, unreliable and 70 years behind the times."[2]

Effective prevention of occupational disease requires accurate data on incidence, prevalence, and time trends. Long experience with the communicable diseases has demonstrated the value of effective, sensitive disease surveillance systems. Data from such systems have been essential for the global eradication of smallpox[3] and for the control of measles in the United States.[4] If occupational diseases are to be similarly controlled, similar data will be required.

In an initial effort to obtain more accurate data on the incidence and prevalence of occupational disease in one large state—New York—our group from the Mount Sinai School of Medicine, with support from the New York State Departments of Health and Labor and the New York State Legislature, has undertaken a statewide survey of occupational disease. This study made use of data from the New York State Workers' Compensation Board, the U.S. Occupational Safety and Health Administration (OSHA), disease registries maintained by the New York State Department of Health, and physicians' reports.

This report presents the results of our evaluation[b] and suggests approaches for extrapolating these data to derive improved national estimates of the incidence and prevalence of occupational disease in the United States.

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[b] The full presentation of these data is included in a report entitled "Occupational Disease in New York State: Proposal for a Statewide Network of Occupational Disease Diagnosis and Prevention Centers," Mount Sinai School of Medicine, New York City, 1987. This report is available from the authors at no cost.

MORTALITY

Accurate data on mortality from occupational disease are largely lacking. In the absence of such data, we used a proportionate attributable risk approach to estimate occupational disease mortality in New York State.

Estimated percentages of each disease attributable to occupation were applied to disease-specific mortality totals to obtain estimates of total numbers of deaths due to occupational exposures; 10% of all cancer, 100% of all pneumoconioses, and 1–3% of all chronic respiratory, cardiovascular, neurologic, and renal disease deaths were ascribed to occupational causes[5–14] (TABLE 1). Application of these percentages leads to the conclusion that between 4,686 and 6,592 deaths each year in New York State are the result of occupational exposures.

TABLE 1. Annual Estimates of Occupational Disease Mortality, New York State

Cause of Death	Average Total Annual Mortality, NYS 1979–1982	Estimated Proportion and Number of Deaths Associated with Occupation		Average Annual Occupational Disease Deaths Reported by Workers' Compensation
		%	*n*	
Cancer	37,081	10	3,708	3
Pneumoconioses	25	100	25	34
Chronic respiratory disease	4,104[a]	1–3	41–123	3[b]
Cardiovascular disease, renal disease, and neurologic disorders	91,213	1-3	912–2,736	176
Other conditions	34,631	—	—	17
Total	167,054	—	4,686–6,592	233

SOURCES: Vital Statistics of New York State, 1979–1982; Compensated Cases Closed, State of New York Workers' Compensation Board Division of Research and Statistics, Bulletins Nos. 40–43, 1979–1982.

[a]Includes emphysema, asthma, bronchitis, bronchiectasis, and allergic alveolitis (ICD 490–496).

[b]Includes all nontoxic respiratory system conditions.

This range is probably a low estimate of total occupational disease mortality in New York State. A low estimate is generated, because proportional risks were applied to deaths from only six conditions: cancer, pneumoconioses, cardiovascular disease, chronic respiratory disease, neurologic illness, and renal disease. Furthermore, in each instance, conservative proportional risk estimates were selected from the range of figures available.

It is important to consider these results in the context of overall mortality data. There are 167,000 deaths in New York State each year. The estimated 5,000–7,000 deaths attributable to work-related exposures therefore constitute 3–4% of total deaths. Every year, twice as many people die from work-associated diseases as die from homicide and suicide combined, 1.5 times as from accidents, and more than twice as many have died of occupational diseases in New York State each year as have died from AIDS since that disease was first identified in 1981.

TABLE 1 also provides data on the average number of occupational disease deaths reported annually by the New York State Workers' Compensation Board between 1979 and 1982. Although the worker's compensation system provides an intuitively appealing and widely employed resource for occupational disease surveillance, its records are not accurate; they produce a significant underestimate of the number of persons affected by occupational disease, as well as misleading information on the pattern of occupational illness. Of the 233[c] occupational disease deaths reported on average each year by the Workers' Compensation Board, only 3 were cancer deaths. By contrast, data from other sources indicate that in 1979, nearly 80 deaths in New York State resulted from mesothelioma, a single relatively rare type of cancer that is nearly always caused by occupational exposure to asbestos.[15] Hospital discharge data, to be discussed herein, also indicate that Workers' Compensation data are incomplete.

MORBIDITY

Estimates of the incidence of nonfatal occupational illness are inherently less precise than are those of mortality. Estimates of the occurrence of work-related illness in New York State, however, are facilitated by the existence of several data sources in New York, in other states, and nationally. These data allow crude estimates of disease incidence and prevalence despite their weaknesses. TABLES 2 through 7 present the results of several approaches to the estimation of occupational disease morbidity in New York State, based on Workers' Compensation data, hospital discharge records, state disease registries, employers' OSHA reports, and California physicians' reports.

New York State-Specific Data

TABLE 2 shows the distribution of disease and the average number of new cases of nonfatal occupational illness reported annually by the New York State Workers' Compensation Board. These figures represent only closed cases of occupational disease—cases in which benefits have been awarded by the Workers' Compensation Board—not all claims submitted to the Board. These estimates are almost certainly too low.

Easily recognized, acute conditions, such as skin disease and musculoskeletal conditions, are relatively overrepresented; chronic disease is underreported. Only six cases of work-related cancer were compensated annually. The total of 3,765 new cases reported by Workers' Compensation is the lowest of the three illness estimates developed in the study.

Data from the New York State Department of Health's Heavy Metals Registry is useful for assessing the completeness of the workers' compensation data. Physicians, medical laboratories, and health care facilities are required to report excessive urine and blood levels of lead, cadmium, mercury, and arsenic to the Heavy Metals Registry. As shown in TABLE 3, in 1985, the registry reported 575 cases with elevated blood lead levels alone in 1985 and a total of 1,061 cases of excessive absorption of all four metals requiring reporting to the registry in that

[c] All nontraumatic accidental conditions have been incorporated into the disease category (e.g., heart attacks and infectious diseases are included under "diseases").

TABLE 2. Occupational Disease Morbidity Reported by the New York State Workers' Compensation Board, 1979–1982 Annual Averages

Condition	Average Annual Workers' Compensation Awards, NYS 1979–1982
Infectious and parasitic diseases	156
Cancer	6
Mental disorders	67
Nervous system and sensory organ conditions	
Hearing loss	627
Eye disease	20
Other	168
Circulatory system diseases	
Heart attacks	446
Stroke and other	34
Respiratory system diseases	
Pneumoconioses	
Asbestosis	14
Silicosis	28
Other	10
Other respiratory conditions	93
Musculoskeletal system conditions	968
Accidental poisonings	447
Skin diseases	639
Other	42
Total	3,765

SOURCES: Compensated Cases Closed, State of New York Workers' Compensation Board, Division of Research and Statistics Bulletins Nos. 40–43, 1979–1982.

year. The Workers' Compensation Board, however, recorded an average of 446 cases of all "systemic poisonings," including other causes besides heavy metal exposure, during the years 1979–1982.

Hospital discharge data, compiled by the Statewide Planning and Research Cooperative System (SPARCS) of the State Department of Health, provide an-

TABLE 3. Comparative Frequency of Occupational Heavy Metals Poisonings Reported by the Workers' Compensation Board and the NYS Heavy Metals Registry

Metal	NYS Heavy Metals Registry Reports 1985	Average Annual Workers' Compensation Awards for Systemic Poisonings, 1979–1982
Lead	575	—
Mercury	454	—
Arsenic	30	—
Cadmium	2	—
Total	1,061	446

SOURCES: New York State Heavy Metals Registry 1985; Compensated Cases Closed, State of New York Workers' Compensation Board, Division of Research and Statistics Bulletins Nos. 40–43, 1979–1982.

other means of judging the completeness of the information collected by the Workers' Compensation Board. According to the SPARCS data base, 599 hospital discharges for pneumoconioses were reported in New York State (TABLE 4). By contrast, workers' compensation benefits were initiated for an average of 52 individuals with pneumoconioses each year between 1979 and 1982. Clearly, the number of hospital discharges is not equivalent to the number of individuals with pneumoconioses. However, the likelihood that hospital discharges may overestimate the numbers of workers with pneumoconioses is counterbalanced by the fact that only the more severe cases of pneumoconioses require hospitalization, and thus represent only a small proportion of all cases of the disease. Hence, it is likely that workers' compensation data significantly underestimate the burden of pneumoconiosis in the State of New York.

TABLE 4. Pneumoconioses Cases Reported by the Statewide Planning and Research Cooperatiave System and the NYS Workers' Compensation Board

Pneumoconiosis	Average Annual Hospital Discharges 1980–1985	Average Annual Workers' Compensation Awards, 1979–1982
Asbestosis	210	14
Silicosis	298	28
Other	91	10
Total	599	52

SOURCES: Statewide and Research Cooperative System data; Compensated Cases Closed, State of New York Workers' Compensation Board, Division of Research and Statistics, Bulletins Nos. 40–43, 1979–1982.

National Data Extrapolated to New York

TABLE 5 provides an estimate of the occupational disease burden in New York State based on reports made by nongovernmental employers to the U.S. Department of Labor, Bureau of Labor Statistics (BLS) in 1984. The estimate of 11,687 new occupational illnesses in New York State was obtained by multiplying the U.S. incidence rate for each industry by the number of workers employed in that industry in New York State in 1984.

TABLE 6 illustrates the distribution of new cases of occupational disease in New York State by health condition. The two conditions reported most frequently by employers were skin diseases and musculoskeletal conditions. The Bureau of Labor Statistics data on which this estimate is based are limited almost entirely to easily recognizable, acute conditions and include virtually no cases of cancer or of other chronic or long latency occupational diseases.

California Physicians' Reports Extrapolated to New York State

California is unusual among the states in requiring physicians to report all cases of occupational disease treated and in publishing the resulting information. The "Doctors' First Report of Injury or Illness," from which the California

TABLE 5. Estimates of Occupational Disease Incidence by Industry Based on 1984 Bureau of Labor Statistics Data

Industry	U.S. Rate of New Cases Per 10,000 Workers 1984	New York State Employees, 1984	Estimated Number of New Cases of Occupational Disease in NYS, 1984
Agriculture, forestry, and fishing	43.8	95,000	416
Manufacturing			
Durable goods	38.6	736,400	2,843
Nondurable goods	38.4	589,900	2,265
Construction	16.3	255,200	416
Services	14.1	1,966,100	2,772
Mining	13.0	6,800	9
Transportation and public utilities	11.8	418,500	494
Government	9.0[a]	1,318,200	1,186
Wholesale and retail trade	6.5	1,576,900	1,025
Finance, insurance, and real estate	3.7	704,400	261
Total	15.2	7,667,400	11,687

SOURCE: Occupational Injuries and Illnesses in the United States by Industry, 1984. U.S. Dept. of Labor, Bureau of Labor Statistics, Bulletin 2259, May 1986.

[a]BLS data exclude government employees. This rate is the average of the rates for employees in the following industries: transportation and public utilities; wholesale and retail trade; finance, insurance, and real estate; and services.

incidence rates were calculated, encompasses first treatments given for all work-related conditions.[16] TABLE 7 uses data from California physicians' reports to estimate the frequency of occurrence of occupational illness in New York State.

Using this approach, it is estimated that 27,985 new cases of occupational disease occur each year in New York State. To develop this estimate, disease-specific California incidence rates were multiplied by the total number of workers

TABLE 6. Estimates of Occupational Disease Incidence by Illness Category Based on 1984 Bureau of Labor Statistics Data

Condition	Estimated Number of New Cases in New York State, 1984
Skin disease or disorders	4,056
Disorders associated with repeated trauma	2,675
Respiratory conditions due to toxic agents	1,052
Disorders due to physical agents	832
Poisoning	465
Dust diseases of the lung	139
All other occupational illnesses	2,468
Total	11,687

SOURCE: Occupational Injuries and Illnesses in the United States by Industry, 1984. U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2259, May 1986.

in New York State. The distribution of new cases of disease reported by physicians (TABLE 7) is similar to that of diseases reported by employers (TABLE 6). The almost 28,000 illnesses estimated on the basis of physicians' reports include primarily acute conditions, especially skin diseases, and almost no cases of cancer.

The morbidity estimates presented in TABLES 2 to 7 range from a low of 3,765 cases to a high of 27,985 cases. Because all of these estimates exclude occupational cancer, the range should more properly extend from 10,345–34,565 new cases of work-related disease each year, assuming that 10% of all new cases of cancer are due to occupational factors. The resulting figure of 34,565 cases annually is probably the most accurate estimate currently available on the incidence of work-related illness in New York State. Nevertheless, because the occupational origin of work-related illness is so often overlooked by both physicians and other medical providers, even this figure may represent a conservative estimate.

TABLE 7. Occupational Disease Incidence Estimates Based on California "Doctors' First Report" Data, 1983

Condition	New Disease Rate per 10,000 California Workers[a]	Estimated Number of New Cases, New York State, 1984[b]
Skin conditions	12.2	9,354
Eye conditions	11.2	8,587
Systemic poisonings	3.0	2,300
Respiratory conditions	3.0	2,300
Chemical burns	2.4	1,840
Exposure to toxic materials	0.7	537
Ear conditions	0.6	460
Circulatory system conditions	0.6	460
Other	2.8	2,147
Total		27,985

[a]Occupational Disease in California, 1983. State of California Department of Industrial Relations, Division of Labor Statistics and Research, San Francisco, California, September 1985.

[b]There were 7,667,300 workers in New York State in 1984 (NYS Department of Labor).

In New York State, as elsewhere, there is little or no coordination among data sources on occupational disease, and the information they provide is fragmentary and unreliable. The occurrence of occupational disease is underreported for a variety of reasons, including workers' fears of losing their jobs, employers' fears of legal and financial liability, lack of recognition by physicians of the occupational origin of a patient's condition, the fact that workers are often unaware of or unable to recall their exposure to dangerous materials, and the frequently long latency period that elapses between exposure and the development of recognizable symptoms of disease.

Although the available data on occupational disease are limited, they are sufficient to demonstrate that occupational disease is a serious problem in New York State.

HAZARDOUS WORKPLACE EXPOSURES IN NEW YORK STATE

The identification and characterization of hazardous workplace exposures are necessary for understanding patterns of occupational disease in New York State and for formulating prevention strategies. Hazard surveillance complements occupational disease surveillance. Indeed, given the general underdiagnosis of occupational disease, systematic examination of work-related hazards in industries and occupations across the state can provide an important guide as to the location and nature of possible work-related illness.

In 1985, approximately 7.9 million people were employed in New York State—8% of the total United States workforce. Of these 7.9 million people, 1.3 million (16%) were employed in the manufacturing sector and another 285,000 (4%) in construction. Many fewer people were employed in other economic sectors important in terms of occupational health: 99,000 in agriculture and 6,700 in mining. The most populous economic sectors in New York in 1985 were the service industry, with 2.0 million workers, and wholesale and retail trade, with 1.6 million workers.

A total of 158,804 New Yorkers were employed in the 50 most hazardous industries (identified by 4-digit Standard Industrial Classification code) in 1985 according to the Inspection-Based Exposure Rating (IBER) system.[17] The limitation of the list to 50 industries is arbitrary and is not meant to imply that other industries do not present hazards. Over 75% of the workers in these industries are concentrated in 14 of New York State's 62 counties. In descending order, the counties with the highest employment in hazardous industries are: New York City (includes five counties), 32,900 workers; Erie, 23,700 workers; Niagara, 10,200 workers; Suffolk, 9,100 workers; and Onondaga, 9,100 workers.

A second hazard ranking scheme was proposed in 1983 by Pederson, Young, and Sundin of the National Institute for Occupational Safety and Health (NIOSH). This was the Industry Risk Index (IRI).[19] In contrast to the IBER approach, the IRI is based on the National Occupational Hazard Survey. Conducted by NIOSH between 1972 and 1974, the National Occupational Hazard Survey (NOHS) was a walk-through survey of a national sample of over 4,600 workplaces. Trained surveyors visited each of these 4,600 employment sites and described the chemical, physical, and biological hazards present in each workplace.[20] Over 8,000 potentially hazardous chemical agents and 86,000 trade-name products were observed to be in use in the workplaces visited. Because no actual measurements of exposures were performed as part of the survey, the extent of worker exposure to the inventoried hazards was not determined. Hence, the NOHS considered only "potential exposure." The term "potential exposure" indicates that a worker is situated in proximity to a hazardous material for a minimum number of hours per week. Despite this limitation, NOHS represented a landmark achievement in the creation of a national data base describing the magnitude and distribution of hazardous agents in the workplace. The survey was repeated during 1981 to 1983 as the National Occupational Exposure Survey, but those results are not expected to be available before 1990.

The IRI combines the industry-specific exposure profile provided by NOHS with a judgment on the toxicity of specific chemical agents as well as with information about the number of potentially exposed workers to create a ranking of industries according to the degree of hazard. The level of toxicity of a given agent was determined by its ability to cause cancer, mutations, birth defects, and acute

harm as recorded in the Registry of Toxic Effects of Chemical Substances.[21] Distribution of workers by industry was obtained from County Business Patterns data. One of the main strengths of the IRI is its attempt to incorporate comprehensive toxicologic information on a vast array of agents into a hazard-ranking scheme.

A total of 746,806 workers in New York State were employed in the 50 most hazardous specific industries according to a modified IRI. Selected industries were deleted from the original IRI list, because they were judged to involve relatively minor actual hazards and distorted the overall employment figures because of large numbers of employees in these industries in New York State. The deleted industries include accounting and auditing, real estate, and legal services, which employed over 150,000 workers in 1985.

Hospitals and health care facilities (Standard Industrial Classification codes 8062 and 8099) employed the largest numbers of workers on the IRI list with a combined total of 405,000 workers, or 54% of all workers on the list. Other common hazardous industries are building maintenance, car repair, and pharmaceutical manufacture. Counties with the largest numbers of workers in hazardous industries include New York City, Suffolk, Nassau, and Erie. Nearly half of all workers employed in the IRI's 50 most hazardous industries reside in these counties.

There is a lack of overlap between the two lists of most hazardous industries, a difference that reflects the different methods used to create the two indexes. Each method has different strengths and weaknesses; they can be used in complementary fashion to gain a broad view of the relative hazards present in different industries. Both indexes demonstrate that a significant number of workers in New York State are employed in hazardous trades. Furthermore, the distribution of workers in hazardous industries throughout the state is similar, regardless of the index used. Use of either index would lead to similar conclusions about the need for and optimal location of occupational health services across the state.

COSTS OF OCCUPATIONAL DISEASE IN NEW YORK STATE

Estimates of the costs of illness and death associated with certain occupationally related conditions were made using the human capital approach to the calculation of the costs of illness.[22–28]

The human capital method divides costs into two categories: direct and indirect. *Direct costs* are the value of resources that could be allocated to other uses in the absence of disease. They include expenditures for hospitalization, physicians' services, nursing home care, drugs, medical appliances, and related expenses. *Indirect costs* are the value of the lost output of workers and retirees suffering premature death or disability, measured in terms of the wages they would have earned if they had not contracted occupational diseases. In addition to earnings loss, indirect costs include the lost value of household production services caused by disability and death from occupational disease, measured according to the market wages that would be paid to outsiders for those services.

The human capital approach can be used to estimate the costs of illness and death associated with occupationally related cancer and, to a more limited extent, stroke, heart disease, pneumoconioses, chronic respiratory disease, and renal failure.

Cancer

The estimates of occupational cancer discussed earlier were used to obtain an estimate of the annual direct costs of occupational cancer in New York State. Cost estimates were averaged over specific cancer diagnostic categories to obtain average direct costs by age and sex. National medical care cost data in 1975 dollars[29] were adjusted to account for the higher costs of medical care in New York State. These adjusted cost estimates were then applied to the New York incidence estimates and adjusted to 1985 dollars, using the medical care price index specific to the New York region.[30] Future costs were discounted at 6%. As shown in TABLE 8, the average direct cost per case of occupational cancer was $31,255 in New York State in 1985.

Additional costs of occupational cancer—foregone earnings—were ascertained by measuring lost productivity owing to cancer morbidity over the patient's expected life span, and comparing this to expected productivity and life expectancy of a matched cancer-free population.[29] These estimates were adjusted to take into account the 12.3% difference in average annual pay between New York State and U.S. workers. Future lost earnings were discounted at 6%. Total annual foregone earnings were $44,272 per cancer victim, as shown in TABLE 8.

Adding together direct costs and foregone earnings for all workers diagnosed with occupationally related cancer during a 12-month period, the total annual cost of occupational cancer in New York State was approximately $497 million in the early 1980s (TABLE 9).

Coronary Heart Disease and Stroke

Because incidence rates for coronary heart disease (CHD) and stroke were not available by age and sex in New York State, it was impossible to conduct as comprehensive an analysis for these diseases as for occupational cancer. Nevertheless, mean per-capita direct and indirect cost estimates,[29] averaged over age and sex categories, can be adjusted to New York 1985 dollars; it is therefore possible to obtain an approximate lower-bound indication of the costs of occupational deaths in New York State attributable to the major diagnostic categories that constitute cardiovascular disease. These cost estimates were applied to the work-related CHD and stroke mortality estimates discussed earlier. The resultant

TABLE 8. Direct and Indirect Costs per Person of Various Occupational Disease Diagnostic Categories in 1985

Diagnosis	Indirect Cost[a]	Direct Cost	Total Cost
Cancer[b]	$44,272	$31,255	$75,527
Coronary heart disease[c]	36,062	11,219	47,281
Stroke[c]	34,105	24,413	58,518
End-stage renal disease[c]	—	33,000	33,000[d]
Chronic respiratory disease[c]	—	8,058	8,058[d]
Pneumoconiosis	—	6,009[e]	6,009[d]

[a]Present value of future costs, discounted at 6%.
[b]Cases.
[c]Deaths.
[d]Direct costs only.
[e]Cost per hospital admission only.

TABLE 9. Cost of Occupational Diseases in New York State by Diagnostic Category

Diagnosis	Number of Cases/Deaths	Costs per Case	Total Costs
Cancer[a]	6580	75,527[b]	$496,960,000
Coronary heart disease[c]	600–1800	47,281[b]	28,368,600–85,105,800
Stroke[c]	102–306	58,518[b]	5,968,836–17,906,508
End-stage renal disease[c]	18–56	33,000[d]	594,000–1,848,000
Chronic respiratory disease[c]	120–400	8,058[e]	966,960–3,23,200
Pneumoconiosis	599[f]	6,009[g]	3,599,384
Total			$536,457,780–$605,043,508

[a]All cases.
[b]Indirect and direct costs.
[c]Deaths only.
[d]Direct costs only; indirect cost estimates are not available.
[e]Hospitalization cost only.
[f]Number of hospital admissions for pneumoconioses.
[g]Average cost per hospital admission.

summary cost figures do not fully account for costs of these illnesses, however, because more people suffer from these diseases than actually die from them.

Total economic costs of work-related CHD were obtained by combining and averaging the direct and indirect costs for the three major categories of CHD for which economic data are available: myocardial infarction, coronary insufficiency, and uncomplicated angina pectoris. The total cost per patient in New York State was estimated to be $47,281 in 1985 dollars, adjusted for differentials in New York State wages, hospital costs, physician fees, and other medical prices (TABLE 8). Approximately 25% of these costs, or $11,281, were direct costs, with the remaining 75%, or $36,062, due to earnings foregone as a result of heart disease, using a discount rate of 6% for lost future earnings. The total lower-bound estimate of the costs of occupational CHD in New York thus ranges from $28,368,600 to $85,105,800 (TABLE 9).

Average total per capita costs for completed strokes (including hemorrhagic and infarctive events, but excluding transient ischemic attacks) were estimated to be approximately $58,518 (1985 dollars) in New York State, using an adjustment methodology similar to that detailed earlier. This per capita cost included $24,413 in direct costs and $34,105 in indirect costs (TABLE 8). The lower bound range of costs due to occupationally related stroke deaths in New York in 1985 is thus conservatively estimated to be between $6 million and $18 million.

In summary, the total annual economic costs of occupational heart disease and stroke in New York State are estimated to be between $34 million and $103 million.

End-Stage Renal Disease

The annual cost of medical care for end-stage renal disease (ESRD) was estimated in 1982 to be approximately $26,000 per patient.[31] Adjusting this figure to 1985 dollars and using the medical care component of the Consumer Price Index for the New York region, the average estimated cost of direct medical care for patients with ESRD was approximately $33,000 per year. Accurate data on the

etiology of ESRD are available for fewer than 50% of cases.[14] Epidemiologic estimates in an earlier section of this presentation, however, attribute 18 to 56 deaths caused by kidney disease per year in New York State to occupational causes. Thus, estimates of the medical cost of ESRD due to occupational exposures range between $594,000 and $1,848,000. Indirect costs cannot be calculated.

Pneumoconioses and Other Chronic Respiratory Diseases

Between 1980 and 1985 in New York State, the average annual number of hospital discharges for the pneumoconioses (ICD codes 500–505) was 599 (TABLE 4), accounting for approximately 7,724 annual inpatient days. At a cost of $466 per day, hospitalizations for pneumoconioses cost $3,599,384 in 1985.

Between 120 and 400 deaths per year in New York State are attributable to occupationally related chronic respiratory disease. In a recent study of the cost of care for patients with chronic lung disease, investigators found that the average patient used a total of $6,979 in health care resources during a 12-month period.[32] There were an average of 10.1 hospital days per patient year, which accounted for approximately one half the health care costs. Adjusting these data to New York State prices, the estimate of direct medical care expenses for deaths from occupationally related chronic lung disease in New York State was between $996,000 and $3,223,000.

In summary, the total estimated cost of occupational disease in New York State is between 540 and 604 million dollars per year.

SUPPLY OF OCCUPATIONAL HEALTH SERVICES AND PERSONNEL IN NEW YORK STATE

Trained Personnel

Clinical occupational health services concentrating on the detection and prevention of occupational disease are in short supply in New York State. In 1985, only 73 of the more than 52,000 licensed physicians in New York State were board certified in occupational medicine.[33,34] Thus, there is one occupational medicine physician for every 108,000 workers in the state.

The distribution of occupational medicine physicians throughout the state further accentuates their inaccessibility. Nearly two thirds, or 46, of the board-certified occupational medicine physicians in New York State are located in three counties: 23 in New York County, 16 in Monroe County, and 7 in Westchester County. Furthermore, at least two thirds of occupational medicine physicians are not involved in direct patient care. Most of these physicians work in administrative, research, or teaching positions. Important industrial counties such as Nassau, Onondaga, and Steuben have no occupational medicine specialists who provide direct patient care.

A larger number of physicians identify occupational medicine as their primary specialty than are board certified in the field. In New York State, 121 physicians involved in direct patient care list their primary speciality as occupational medicine.[35] The majority are not board certified in occupational medicine. Regardless of whether they are qualified to diagnose occupational disease, many self-designated occupational medicine physicians spend most of their time performing pre-employment physical examinations or periodic evaluations, treating acute occu-

pational injuries, or delivering general medical care in an occupational setting or to identified occupational groups. Although these activities are necessary, they provide only limited sources for the diagnosis and treatment of chronic occupational diseases. Hence, it is unlikely that this larger group of occupational medicine physicians significantly increases the availability of services established specifically for the diagnosis and treatment of occupational disease.

Industrial hygienists are more common than are occupational physicians in New York State. The American Industrial Hygiene Association (AIHA), the major professional organization of industrial hygienists, lists 292 active industrial hygienists as members in New York State, including 91 who are certified.[36] Since 85% to 90% of all industrial hygienists are members of AIHA,[37] the estimated number of industrial hygienists in New York is 325 to 345.

Despite their greater numbers, however, industrial hygienists are not much more accessible than are occupational medicine physicians. TABLE 10 shows the type of employer or professional activity of industrial hygienists in New York. Two thirds, or 176, of the industrial hygienists in New York State are employed by corporations, mostly large companies such as IBM, which employs 22 industrial hygienists, Kodak, which employs 19, and General Electric, which employs 7. Various levels of government employ another 15% of the industrial hygienists

TABLE 10. Type of Employer or Professional Activity of Industrial Hygienists in New York State, 1985–1986

Affiliation	Number	Percent
Private corporation	176	63
Government	42	15
Private consultant	35	13
University	35	9
Total	278	100

SOURCE: American Industrial Hygiene Association Membership Directory, 1985–1986; excludes 14 industrial hygienists who did not indicate professional activity.

in New York State; universities employ 9%, especially New York University, which employs 10, the University of Rochester, which employs 7, and Columbia University, which employs 5. Only 35 industrial hygienists are primarily consultants.

Hence, large institutions employ the majority of industrial hygienists in New York State. Few industrial hygienists are available to the vast majority of employers, unions, occupational health programs, and community groups, who have an intermittent need for industrial hygiene services.

Institutional Resources

New York State has only one fully functioning hospital-based center specializing in the diagnosis and treatment of occupational disease. This facility is located at Mt. Sinai Medical Center in New York City. Specialty clinics at other medical centers in Rochester, Buffalo, and Long Island are being initiated, but currently they offer only limited services.

The extent to which company-based health services are currently available in New York State is unknown. However, a nationwide study conducted by NIOSH in 1981–1983 indicated that 24% of all industries sampled had inplant health services, an increase of 10% since the early 1970s. For small (1–99 employees) and medium-size (100–499 employees) industries, rates of established health facilities were approximately 5% and 35%, respectively.[38] Although access to some type of health services within the plant has improved overall, most workers are still employed in plants without on-site health services. It is unlikely that industries in New York State have established inplant health facilities significantly more frequently than have industries in the remainder of the country.

The growing interest in occupational disease and the increasing need to screen groups of workers with known hazardous exposures, such as exposure to asbestos, have led to the rise of for-profit health care corporations that specialize in periodic medical examinations. Their previous emphasis on providing general preventive evaluations for occupational groups such as executives and selected blue collar workers is being broadened to include a focus on occupational diseases. The quality of such services may, however, be limited.[39,40]

Various unions have developed health care centers for their membership that provide general services as well as selected specialty care. Unions in New York State with such facilities include the International Ladies' Garment Workers Union, the International Brotherhood of Teamsters, and the Service Employees International Union. Although these facilities do care for large numbers of workers with hazardous occupational exposures, they have not obtained expertise in occupational medicine and do not focus on the possible occupational diseases for which their members are at risk.

Local and county health departments throughout New York State do not offer diagnostic services in occupational medicine.

Training of Occupational Health Professionals

Given the present inadequate supply and lack of availability of occupational medicine physicians and industrial hygienists in New York, what are the prospects for the future? Only two occupational medicine residency programs exist in New York State, both in New York City. Columbia University School of Public Health graduates an average of 1.5 occupational medicine physicians per year. The Mount Sinai School of Medicine program averages 3 new occupational medicine physicians annually. Thus, 4.5 new occupational medicine physicians enter the workforce each year. Although this number is small, it represents approximately 10% of all new occupational medicine physicians trained each year in the United States.[41] Clearly, occupational medicine is an underserved specialty.

DISCUSSION AND RECOMMENDATIONS

The major finding of this study is that occupational disease is a major problem in New York State despite the fact that 18 years have now elapsed since passage of the Occupational Safety and Health Act in 1970. We estimate that each year in New York State occupational exposures are responsible for 5,000 to 7,000 deaths and for at least 35,000 new cases of illness.

Nationally, as well as in New York State, success in reducing work-related illness has remained elusive. Cancer mortality appears to be increasing, and occu-

pational exposures may account for at least part of this trend.[42] Death rates in underground miners have increased.[42] Asbestos, although used less frequently than in the past, remains widely dispersed; approximately 10,000 asbestos-related deaths are expected to occur in the United States each year for the remainder of the century.[44] Silicosis, a disease recognized since antiquity, is still common among miners and foundry workers;[45] a recent review of OSHA inspection records indicates that the level of silica exposure in 43% of American foundries remains above legally mandated standards.[46] These factors led the American Public Health Association to conclude in 1984 that "occupational disease is at epidemic proportions in the United States."[47]

Prevention of occupational disease both in New York State and nationally requires a comprehensive and unified plan. Appropriate medical diagnostic and industrial hygiene services need to be made available. Physicians and other health providers must be trained adequately to recognize work-related problems. Surveillance efforts, although praiseworthy at present, are limited in scope and resources and need urgently to be expanded and made more effective. Comprehensive plans must be made available for providing information to workers on the nature of the exposures that they encounter at work and on the work relatedness of the diseases that they suffer as the result of those exposures.

In order that a start be made toward accomplishing these goals, we recommended that New York State strengthen its efforts to protect the health and safety of its workforce by expanding the capacity of the health care system to diagnose and treat workers with occupational diseases. Complementary efforts to enhance professional training and to strengthen ongoing surveillance, evaluation, and planning with respect to occupational disease are also vital.

1. We recommend that the State of New York initiate and fund a demonstration project to establish a statewide network of occupational health clinical centers coordinated through a network office.

The central goal of these centers is to provide accessible diagnostic, preventive, and treatment services for all workers in New York State with occupational diseases or with exposure to occupational hazards. Introduction of this network in New York State will entail: (1) transformation of existing facilities with limited programs into comprehensive occupational health centers; (2) establishment of additional centers in those parts of the State that currently lack even limited occupational health services; and (3) creation of a network office to coordinate network activities. The resulting integrated system will make occupational health care services available to all workers and employers in the state.

The proposed occupational health clinical centers will concentrate on the diagnosis and treatment of occupational diseases. However, a commitment to prevention at primary, secondary, and tertiary levels additionally requires the integration of industrial hygiene, educational, and social work services into a traditional medical model. The diagnosis of occupational disease in an individual can be exploited to ameliorate unsafe conditions in the workplace, to prevent coworkers from becoming ill, and to detect disease early in exposed coworkers.

Development of a clinical center network might best be accomplished by a 5-year demonstration project financed primarily by the State. The 5-year demonstration period would consist of two major components: a planning phase and an implementation and evaluation phase. The length of the planning process would vary among network components. Expansion of existing facilities will require 6–12 months of planning, depending on the present level of development of each

center. Twelve months of planning will be needed before new centers in currently unserved regions of the State can reasonably be expected to be operational. Organization of the network office will also require a 12-month planning period.

Funding of the demonstration project should be provided by the State. One appropriate source of funds for the provision of medical services for patients with occupational diseases could be the workers' compensation system, that is, insurance premiums. The need for funding during the later years of the operation of the clinical centers will be partially decreased by revenues from patient care and consultations.

The total costs estimated for the demonstration project as currently envisioned will be approximately 2 million dollars for the first year and 4–5 million dollars for each of the subsequent 4 years. These figures represent the ceiling funding levels that will be required. The total funds needed will in fact be lower by the amount of revenues generated by the project's operations. These revenues can be estimated to increase from 10% of the operating expenses of the clinical centers in year 2, to 20–30% of operating expenses in years 3 and 4, to 40–50% of expenses by year 5 of the demonstration project. These figures represent, at a maximum, 0.8% of the annual costs of occupational disease in New York State.

In April 1987, the New York State Legislature appropriated 1 million dollars for the planning and partial implementation of six occupational health clinical centers in New York State. Six institutions, including four medical schools, a health maintenance organization, and a free-standing clinic, received grants ranging from $100,000 to $225,000 in 1987 to establish the clinic network suggested by this study. The program is being administered by the New York State Department of Health. Three million dollars has been requested for funding of this network in the second year, when all centers will become fully operational.

2. We recommend that the State Departments of Health, Labor and Environmental Conservation coordinate and expand existing occupational disease and hazard information systems in order to create a comprehensive, coordinated surveillance system.

In New York State as well as at the federal level there is an urgent need for the various agencies with responsibilities in occupational health and safety, including the Department of Health and Human Services, the Department of Labor, and the Environmental Protection Agency, to work together in a coordinated fashion to improve disease and hazard surveillance, environmental health research, and regulation.

3. We recommend that the State Board of Regents and the State University of New York establish requirements mandating that all schools of health professions such as schools of medicine and nursing enhance the training of all health professionals in occupational and environmental health.

Health professional schools throughout the nation are sorely lacking in appropriate and ample instruction in occupational health and safety. The average medical student in the United States receives only a few hours of instruction in occupational medicine.[48] This lack of training occurs despite the recognized need for and lack of qualified professionals in all of the disciplines encompassed by the field. An expansion of the funding for NIOSH-supported Educational Resource Centers and an incentive program for health professional schools to introduce occupa-

tional health and safety in the curriculum are effective ways to begin to increase the supply of occupational health professionals.

SUMMARY

The data from our study indicate that the magnitude of occupational disease in New York State is considerable, and that a detailed and comprehensive plan must be initiated and implemented if occupational disease is to be controlled. New York State contains slightly less than 10% of the nation's workforce. A direct linear extrapolation of findings in New York State cannot be made to derive estimates of the national burden of work-related illness. Nevertheless, a crude estimate of the national magnitude of occupational disease can be derived from the New York experience. Such extrapolation provides a crude estimate of 50,000–70,000 deaths each year from occupational disease and of 350,000 new cases of occupational illness. These numbers are distressingly similar to the annual estimates of 100,000 deaths and 400,000 cases of occupational illness developed almost 15 years ago by Ashford.[1] Clearly substantial progress remains to be made.

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