SURVEILLANCE COOPERATIVE AGREEMENT BETWEEN NIOSH AND STATES *(SCANS)* PROGRAM

Rhode Island 1980–1982

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

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PREFACE

Preparation of this report was based on the need to develop feasible and effective occupational health surveillance methods useful at the state level. This need is clear and only continues to grow with the reduced availability of funds, at both the federal and state level, for occupational health personnel and services. It is hoped that the Surveillance Cooperative Agreement between NIOSH and States (SCANS) program will help to expand existing occupational health resources by focusing on populations of workers at increased risk of morbidity, mortality, or disability due to job-related exposures.

This report summarizes SCANS activities undertaken by the Rhode Island Department of Health (RIDH) during the time period September 1980-February 1982. The report is arranged by major activity pursued under the terms of SCANS. Sections will cover the use of population-based measures of mortality in assessing occupational hazards, the use of Sentinel Health Event (SHE) concept in analyzing Rhode Island mortality and hospital discharge data, the dissemination of findings from activities, and recommendations for future occupational health surveillance activities.

ABSTRACT

The purpose of this report is to document the occupational health surveillance activities pursued by the Rhode Island Department of Health (RIDH) in collaboration with the National Institute for Occupational Safety and Health (NIOSH) under the auspices of the Surveillance Cooperative Agreement between NIOSH and States (SCANS) program. The major activities accomplished under this agreement included the coding of the occupational and industrial statements on death certificates for all Rhode Island resident decedents during the years 1973-78, the production of Proportionate Mortality Ratios (PMRs) by age, sex, industry, occupation, and cause of death, and application of the Sentinel Health Event-Occupational Disease (SHE/O) list to both Rhode Island hospital discharge and mortality data. Assessment of the usefulness of these activities is offered along with recommendations for future occupational disease surveillance and control activities.

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INTRODUCTION

The observation that certain disease entities are associated with specific occupations is as old as recorded history. Hunter, in his classic work *The Diseases of Occupations,* related that such records could be traced back to ancient Egypt with the description of the diseases suffered by miners.[1]

The discovery of the association of disease with specific occupational exposures was complicated by many factors. Paramount among these was the lack of reliable and meaningful data regarding occupational exposures and health. This was particularly troublesome as the need for estimates of work-related morbidity and mortality increased. These estimates were required for the various regulatory and programmatic activities of federal, state, and local agencies engaged in the assessment of workplace hazards and in the provision of occupational health services.

The admittedly crude estimates produced have aroused controversy. In 1975 the National Safety Council reported that there were 12,600 deaths due to occupational injuries; and estimated 500,000 cases of occupational disease; and 8.7 million injuries of which 2.2 million resulted in permanent or temporary disability.[2] A federal interdepartmental task force estimated that as many as 100,000 excess deaths occur annually as a result of occupational disease.[3] Possibly the greatest controversy has surrounded the estimates of the component of cancer incidence attributable to occupational exposures. These estimates range from 1 to 5 percent to as high as 23 to 38 percent.[4] [5]

Nationally and statewide, the need for reliable sources of occupational and industrial descriptions linked to health outcome data is a chronic problem. If a comprehensive occupational data base could be constructed, advantages would be accrued. This information source would permit comparisons between states and allow for the monitoring of changes in disease experience over a period of time. The need for state-specific information has only increased with the initiatives presented in *The National Health Planning and Resources Development Act of 1974* (Public Law 93-641), which calls for the development of programs to minimize occupational morbidity and mortality.

In this Law (Section 1501), Congress placed occupational health and safety in the forefront of health planning by requiring health planning agencies to "assemble and analyze data concerning the environmental and occupational exposure factors affecting immediate and long-term health conditions," and by establishing the following National Health Priority:[6]

> The promotion of activities for the prevention of disease, including studies of nutritional and environmental factors affecting health and the provision of preventive health care services.

As a State Health Planning and Development Agency (SHPDA) under this Law, the Rhode Island Department of Health has identified occupational diseases as major health problems of Rhode Islanders. The RIDH has been working during the past eight years (1976-83) to establish a surveillance system and to intervene in major occupational problems.

ALTERNATIVE OCCUPATIONAL HEALTH SURVEILLANCE STRATEGIES

There are many potential sources of information which can contribute positively to a better understanding of occupational morbidity and mortality. Each has attendant strengths and weaknesses in the areas of availability, validity, reliability, and cost of the information. The amalgamation of these sources to offer a more complete picture of morbidity and mortality remains an elusive goal. Various investigative strategies have been used in an attempt to broaden existing knowledge. These range from intensive, analytic investigations of specific industrial and occupational populations to broader, descriptive studies of larger community-based populations. This report's intent is to improve the use of community-based health data systems in occupational health surveillance.

As previously mentioned, there are a wide variety of data sources which could be adapted to or which presently contribute to an improved understanding of occupational morbidity and mortality. These include such common sources as vital records, hospital discharge, reportable disease, health interview survey, workmen's compensation data, and the records of various income replacement programs. Social Security disability information, company and union health records, and health/life insurance records are other sources of useful information; however, they are often less accessible to the researcher or public health professional.

Arrayed against these possible sources of information are various strategies which exist to pursue suspected relationships between occupation and ill health. Monitoring the health outcome experience of defined subpopulations of workers

is the strategy with perhaps the greatest intuitive appeal. Health outcome can be expressed in terms of morbidity, disability, and mortality. For further characterization of aberrant outcome experience, the reliable description of health outcome for defined populations of workers would provide a fruitful entry point. Ideally, morbidity would be the preferable measure of outcome to build into an occupational health surveillance system. As described by Rose, an occupational disease surveillance system would have the following goal, " . . . a basic measurement of the magnitude and potential impact of the problem." Rose also delineated four goals associated with this primary objective for a viable surveillance system:[7]

> "The goals of surveillance may include early identification of known problems in order to provide treatment for those affected and, at the same time, provide protection to others who may be exposed to the hazard. In addition to problem definition, these then become the second and third goals of the system—one being related to the individual already included in the surveillance system and the other being related to preventing a repetition of the same problem among other workers exposed to similar conditions. To approach the optimum end of the range, surveillance programs should have a fourth goal, that of identifying new or previously unsuspected health hazards, so that control measures may be implemented as early as possible."

With the potential of such data for surveillance purposes uppermost in their minds, various authors have discussed the collection and analysis of morbidity data. Discher, Kleinman, and Foster assessed the usefulness of a survey method for obtaining data on occupational diseases. One of the study's salient conclusions was that occupational disease was woefully underreported via the traditional recordkeeping systems—workmen's compensation and the logs of occupational illness and injuries which all employers by law are required to keep (Occupational Safety and Health Act). It was concluded that: "Since existing sources of occupational disease information have many limitations and are generally not carefully analyzed, they may not be useful in planning occupational health control programs."[8]

The study also underscored the continuing need for descriptive epidemiological study in terms of occupational health. Morsch reviewed other alternatives to the study, among them, studies utilizing the Social Security Administration's Disabled Persons' record file.[9] Although morbidity-based measures of a worker's health experience are preferable, there are many difficulties in obtaining valid and reliable estimates of this experience. These difficulties resulted from problems of recognizing the occupational disease by health care professionals, sometimes long latency periods before the disease was prevalent, lack of incentives to record such events, and lack of uniformity in reporting it.

ECOLOGICAL ANALYSES AND CASE CONTROL STUDIES OF OCCUPATIONAL MORTALITY

Faced with these constraints, researchers are using death records as an available source of useful information. Many varied methodologies have been devised to analyze death certificate data. At the National Cancer Institute, Blot and a collaborative group have engaged in pioneering work focusing on descriptive comparisons of age-adjusted cancer mortality with levels of employment by industry for selected U.S. counties. These comparisons have been useful in examining specific cancer sites[10 11] as well as for inquiring into specific patterns of cancer in selected industries.[12 13] These studies represent novel uses of death certificate data and employment statistics. They related age-adjusted cancer mortality rates that were calculated on a county basis for the period 1950-69 to employment levels in specific industries. These rates were then compared to counties without these selected industries. With respect to U.S. counties with significant petroleum industrial involvement, male residents experienced significantly higher rates of cancers of the lung, nasal cavity and sinuses, and skin (including malignant melanoma). In an examination of the shipyard industry, increased rates for respiratory cancer were elevated for both white male and female residents of counties with this industry. These studies represented analysis of readily available data but were subjected to some of the pitfalls of ecological analysis. Blot concisely summarizes some of the caveats:

> "This study of cancer mortality in counties with wartime shipyards represents a preliminary step to evaluate this issue, although correlations based on aggregate population data provide crude estimates that must be interpreted with caution. Information was not available on persons who died in the counties, their occupations, specific residence, duration of residence within the county, smoking habits, or other characteristics."[13]

Because the link between the decedent and the suspected industry is unknown, these caveats must be kept in mind when evaluating any ecological analysis. However, the usefulness of such analysis is apparent. Hypotheses may be developed, and areas for further research may be identified.

Numerous analytic studies have used death certificates as a source of information. The effects of occupation on specific types of cancer have been examined by using two case-control analyses. As identified by death certificate data, Brinton et al. examined cancer of the nasal cavity and sinuses among furniture workers. The analysis revealed a fourfold excess risk linked to this occupation as compared to matched controls.[14] While studying leukemia among Nebraska farmers, Blair and Thomas identified an elevated risk (odds ratio = 1.25) among farmers as compared to matched controls.[15] In both studies, occupational data were derived from the information on the death certificates. No attempt was made to verify the validity of the occupational information which was taken from some other source.

Wegman and Peters, in a study of oat cell carcinoma and selected occupations, assessed the agreement between the occupation reported on the death certificate and that provided through an interview with each patient and family. The study documented the usefulness of investigating cancer by cell type in an occupational population. Another finding was the apparent usefulness of the occupational statement as found on the death certificate. In 75 percent of the cases (N = 91) where occupation was available both by interview and death certificate, the latter statement required no change in classification. The authors concluded, ". . . it appears that death certificates alone may prove useful in a study of this type . . . . This would reduce to a large degree the amount of time necessary to collect occupational histories. There is, however, no alternative to interview or medical record review for smoking histories."[16]

Host specific risk factors can signficantly alter an individual's disease experience. Smoking, one of the most powerful risk factors, can represent an important confounding variable in any consideration of work and disease. Burkhart, Egleston, and Voss proposed an elegant solution to the difficulty of obtaining a smoking history from subjects in a study of farmers and nonfarmers in rural Minnesota.[17] They compared farm and nonfarm populations and identified a rural midwestern county containing one centrally located well-equipped hospital. Such a hospital received a high proportion of all emergent health care needs in that area. They added a question regarding occupation and smoking history to the hospital discharge form in order to assess the impact of these variables on presentation at hospital. Thus, morbidity, occupation, and smoking history were linked on one discharge form. Little overall difference was found between patients with an agricultural background and patients with no agricultural history.

Population-Based Occupational Studies

This portion of the report concentrates on descriptive, population-based approaches which are more applicable to broad surveillance activity. It also examines selected analytic studies.

British Studies

The English were the first to use the death certificate as a data source for analyzing occupational mortality in large populations. Beginning in 1851, studies were routinely conducted during census years. These studies provided risk estimates for specific occupations. These estimates were used to corroborate findings of other more analytic investigations, as well as to formulate hypotheses on which further research was based. The most recent in this series was published in 1978.[18]

The English data have been particularly useful in confirming the relationship between known occupational hazards and increased cancer mortality at many body sites. This work represented the largest body of information relating occupation and mortality and has generally served as a model for other studies of this type. Wisely, the British investigators have included women in the study population. For the first time, a coding system for single women was used in the 1978 study. If the effects of work on women are to be better comprehended, any analysis should be based on the stated occupation of the women decedent, whether married or single.

American Studies

In 1950 Guralnick conducted a study similar to the English studies. The analyses for this study were based on all male deaths between the ages of 20-64 which occurred in the United States in 1950.[19] Estimates of the male population with work experience were derived chiefly from 1950 census data. This allowed the estimation of denominator data for each occupational and industrial group and the calculation of stan-

dardized mortality ratios (SMRs) used in the British design.

As specificed for this census, the occupational data reported and the death records were classified according to a system of 269 occupational categories. Within this system, a three-digit code was used to identify each category. The 269 occupational categories were arranged into 11 major occupational groups. Similarly, industry titles were classified according to 146 categories and arranged into 12 major industrial groups.[20] The occupational data in the death records and census files were analyzed for comparability. The results obtained were similar to those of the British finding with 71 percent of the decedents classified in the same major occupational group by the census and the death records.[21] The comparability or identity rate ranged from a high of 84 percent for farm workers to a low of 52 percent for laborers.

Guralnick's findings were suggestive of the British results. Mortality was observed to vary with both occupational and industrial classifications. The English finding of higher rates of mortality for lower social classes could not be directly assessed, but a strong racial component was evident in the American data with blacks, in general, suffering higher rates of mortality than whites.

Using an age and year of death proportionate mortality ratio (PMR) technique, Milham, in Washington State, analyzed approximately 300,000 white males' (age 20 +) death certificates for the years 1950-71.[22] Due to a lack of estimates of the numbers of the individuals in each occupational group, the PMR was opted. A major weakness of the PMR was that it didn't permit the comparison of the total force of mortality for a given occupational group as each occupation had a total PMR of 100, by definition. The PMR, as employed in this report, was represented in a succeeding section. One hundred ninety-four occupational classes were used as adapted from the *Classified Index of Industries and Occupations.* One hundred sixty causes of death were selected for analysis. To examine specific populations of interest in Washington State, Milham included his own occupational categories. These included workers from both Boeing Aircraft and the Hanford atomic facilities.

He attempted to compare the findings in Washington State with those of previous studies. The level of agreement with previous studies was not addressed with any formal statistical technique. Milham concluded that in the absence of population data, the PMR analysis "yielded the same information as the population-based SMR used in the United States and British studies." No broad assessment was conducted on the accuracy of the occupational data as abstracted from the Washington death records. However, in the analysis of the mortality of three specific cancers through additional follow-up, the identity rates of the occupational data were found to be above 75 percent for the three entities. Milham found that over 97 percent of the death certificates of adult white males contained an occupational statement sufficient to make a classification. The female occupational and industrial statement and the male industrial statement were too poorly recorded to be of use. Nonwhite deaths were not included in the study because of their comparatively small representation (less than 3 percent of total deaths) in the population.

The fact that Milham was unable to code industry could cause problems in the classification of workers by occupation. This resulted from the fact that the method of classification used by the U.S. Bureau of the Census depended, often, on a valid industrial entry so that the occupation could be coded accurately.

Under the auspices of Cooperative Agreements with NIOSH, Rhode Island, New York, Maine, and Utah actively pursued the refinement of methods involving the use of death certificates as a means of occupational health surveillance. Special concern in Rhode Island has been focused on the reliability and validity of the occupational and industrial information contained on the death certificates as compared to alternative sources of information. Gute and Fulton compared the "usual" occupation and industry reported on Rhode Island death certificates for both males and females with information obtained from a panel survey (N = 444) which elicited lifetime occupational information and city directory data (N = 320).[23] The results suggested that there was a similar level of comparability or agreement between death certificate data and the two soures of alternative data (range of 60-77 percent dependent on sex and type of comparison), and that it appeared there may be a bias towards reporting women who worked outside the home in alternative data sources as "housewives" on the death certificates. Such misclassification poses a threat to the accurate estimation of risk for female workers in methods of analysis such as the SMR.

Additionally, certain patterns of inadequate information appearing in the occupational and industrial data on death certificates were present.

Amendments to the interviewing and recording practices of funeral directors would likely serve to improve the quality of data obtained in this area.

The preceding section has outlined methods which pertain to the use of death certificates. Approaches which are more analytic and provide background to the "sentinel health event" perspective are summarized in the next section.

Sentinel Health Event

A further use of available data sources has attracted increasing interest and will represent a major part of this report. This use entails applying the "sentinel health event" concept as developed by Rutstein et al. to health conditions suspected to be of occupational origin.[24] In an exploratory effort, Frazier and Wegman postulated that specific sentinel health events could be selected and analyzed for specific occupational influence.[25] They chose to examine mortality from malignant neoplasm of the trachea, bronchus, and lung, among males age 20-44. The relatively young age was selected to increase the likelihood that an occupational factor was etiologically important. In this analysis, it appeared that men employed in fisheries were at excess risk for lung cancer in the 35-39 year age group. Based upon this finding, the authors suggested further inquiry into the fishing industry as well as the need for further studies aimed at employing death certificate data in this manner.

To further refine the use of this approach, Rutstein and the Working Group on Man Made Diseases in collaboration with the National Institute for Occupational Safety and Health (NIOSH) Surveillance Branch undertook the development of a list of Sentinel Health Events - Occupational Disease (SHE/O).[26] This effort generated a group of 48 conditions thought to be indicative of possible occupational influence based upon review of published epidemiological literature and clinical judgment. These conditions have been field tested in Rhode Island on both mortality (1974-78) and hospital discharge files (1974-78) with satisfactory results. The strength of the SHE/O concept is its ability to screen a large number of health events and focus scrutiny on a relatively small number of these events. This was also true for applications involving mortality and morbidity (hospital discharge files). Based on these files, the ability to meaningfully analyze morbidity data by selecting SHE/O represented a major step forward in arriving at a bona fide occupational health surveillance system.

The bulk of the previous work was concentrated on the use of death certificates to assess occupational mortality. Proportionate mortality ratios (PMRs) and standardized mortality ratios (SMRs) have been extensively used. The advent of the SHE/O approach opens new possibilities in the conducting of occupational health surveillance. This approach has been field tested in Rhode Island on a statewide basis and appears ready for a pilot implementation effort.

THE ASSOCIATION OF OCCUPATION AND INDUSTRY WITH MORTALITY IN RHODE ISLAND

The research hypothesis which provided the impetus for this analysis was deceptively simple. For selected disease entities, this activity seeks to elucidate quantifications of risk for specific occupational populations. The hypothesis offered was that patterns of mortality for selected causes would vary by sex, age, and occupational and industrial groups. The major studies employing death certificate data in the evaluation of occupational health have previously been reviewed (see Introduction Chapter). The Rhode Island mortality analysis sought to contribute to this body of literature in three specific ways.

1. The results were reported by industry and occupation. The most recent U.S. series by Milham lacked results for industry.[22] Such a deficiency could complicate the assignment of occupational codes within the U.S. census coding system.
2. This analysis reported the results for women. In previous studies only the most recent British report contained results for women.[18] Thus, the Rhode Island results represented the first analysis of women in American studies of this type.
3. In addition to presenting occupation- and industry-specific findings of elevated risk, this analysis demonstrated the usefulness of reporting results for occupation *by* industry. This cross-classifying of occupation *and* industry hadn't been utilized in previous studies.

Method

The coding of death certificates by occupation and industry was performed for all white residents of Rhode Island ≥ 16 years of age at the time of

death for the years 1973-78. The death certificates for nonwhites were coded but excluded from the analysis, because their small representation in Rhode Island's population (5.6 percent in 1980)[27] precluded meaningful analysis in a sample of this size. In addition, decedents identified as being institutionalized, students, or members of the armed forces were also excluded.

The coding system was the same as the one used by the U.S. Bureau of the Census in the 1970 census.[28] This system has been amended slightly to provide a more complete description of Rhode Island's workforce through the creation of a small set of additional codes. Coding progressed at the fullest level of specificity under this system which has 417 classifications for occupation and 215 classifications for industry (see appendixes A and B).

The main method of analysis used in this study was the proportionate mortality ratio (PMR) technique. An example of the application of the PMR is provided in Figure 1. The expected values for the PMR analysis were obtained from the mortality experience of all decedents included in the study.

This analysis was tabulated for males in 30 occupational groups (see Appendix C), and for females, it was conducted on 21 occupational groups (see Appendix D). For both males and females, PMR analyses were conducted for 22 industrial groups (see Appendix E).

The results of the PMR analysis were reported by sex, age, occupational group, industrial group, and cause of death. The cause of death categories number 17 and appear as Appendix F. PMRs are displayed for the 16-64 and the ≥ 65 age categories. In general, the number of cross-classified categories (occupation, industry, and cause of death) was kept to a small number because of the relatively small number of death certificates available for this analysis.

The method used to assess the significance of the PMR ratios was taken from the data supplied by Bailer and Ederer.[29] This method expressed 95 and 99 percent significance factors for an observed value of a Poisson variable. This approach was not strictly correct in the sense that an *a priori* test was being made in an *a posteriori* situation. However, it did provide a basis for identifying associations between employment and cause of death. Because the main emphasis of this analysis was to generate hypotheses for further study, it was felt that the use of this test was appropriate.

Data Management Procedures

As previously mentioned, the coding system employed by the U.S. Bureau of the Census for occupation and industry in conjunction with the 1970 census was utilized in this analysis. Training materials received from the Census Bureau were used to help train the coders who were tested for reliability as well as given specific and uniform instructions for the referring of situations in which a coding decision was ambiguous. All such referrals were resolved by one of the authors (DMG) and a record kept of such decisions to insure uniformity.

The coding was carried out by referring to the original death records in the possession of the Division of Vital Statistics, Rhode Island Department of Health. (See Figure 2 for a copy of the death certificate used in Rhode Island.) The codes were entered on coding sheets specifically designed for the mortality analysis. (For a flow diagram of the coding sequence, see Figure 3.)

Because errors in transcription and simple classification errors could plague these studies, all coding was verified at the 20 percent level of review. In an earlier series of occupational coding in Rhode Island (which involved 1968-72 data and over 43,000 death certificates), all coding was verified at the 100 percent level of review.[30] Verification was conducted by a second coder and indicated an error rate of between 5-6 percent. The level of coding errors in the 1973-78 data was consistent with this previous experience.

After verification was completed, the coding sheets were then keypunched by the staff of the Division of Vital Statistics. Here, in accordance with the Division's normal operating procedures, verification was carried out at the 100 percent level.

The coded data were then merged to the existing master file containing all previously computer-accessible mortality data. This was made possible by the unique state file number that each record possessed. Any unmatched records were reported by a special edit procedure and ultimately resolved by the Division's staff.

The editing procedure also identified various illegal codes and entries; thus, it represented a final quality control procedure. Every effort was made to minimize coding and transcription errors. This was viewed as an important goal of the study, and significant resources were expended to successfully attain it.

Figure 1. PMR Calculation — Computation of proportionate mortality ratios for tuberculosis, all forms, for white miners: United States, 1950

AGE	Percent tuberculosis deaths of all deaths all occupations (1)	Deaths from all causes for white miners (2)	Expected deaths from tuberculosis, all forms, for white miners (3) = (1) × (2)	Tabulated deaths from tuberculosis all forms, for white miners (4)
20-24 years	6.28	292	18.34	10
25-29 years	8.30	357	29.63	20
30-34 years	9.01	341	30.72	22
35-44 years	7.78	1,095	85.19	98
45-54 years	5.19	1,784	95.59	174
55-59 years	3.68	1,554	57.19	112
60-64 years	2.77	2,051	56.81	104
Total:				
25-59 years	...	...	295.32	426
20-64 years	...	...	370.47	540

Proportionate mortality ratio 25-59 years = $\frac{426}{295} \times 100 = 146$ 20-64 years = $\frac{540}{370} \times 100 = 144$

$$\text{Proportionate mortality ratio} = \frac{\text{Tabulated deaths for an occupation-cause-color group} \times 100}{\text{Expected deaths for an occupation-cause-color group}}$$

Reference: Guralnick, L. Mortality by Occupation and Cause of Death among Men 20-64 Years of Age: U.S. 1950. Vital Statistics-Special Reports, Vol. 53, No. 3, 1963.

A persistent problem was encountered in the coding of the industrial entries on death certificates. In a large number of cases, the death certificate entry contained only the name of the company. Given the fact that some decedents were quite elderly, the task of ascertaining the type of industry in which the decedent worked proved difficult.

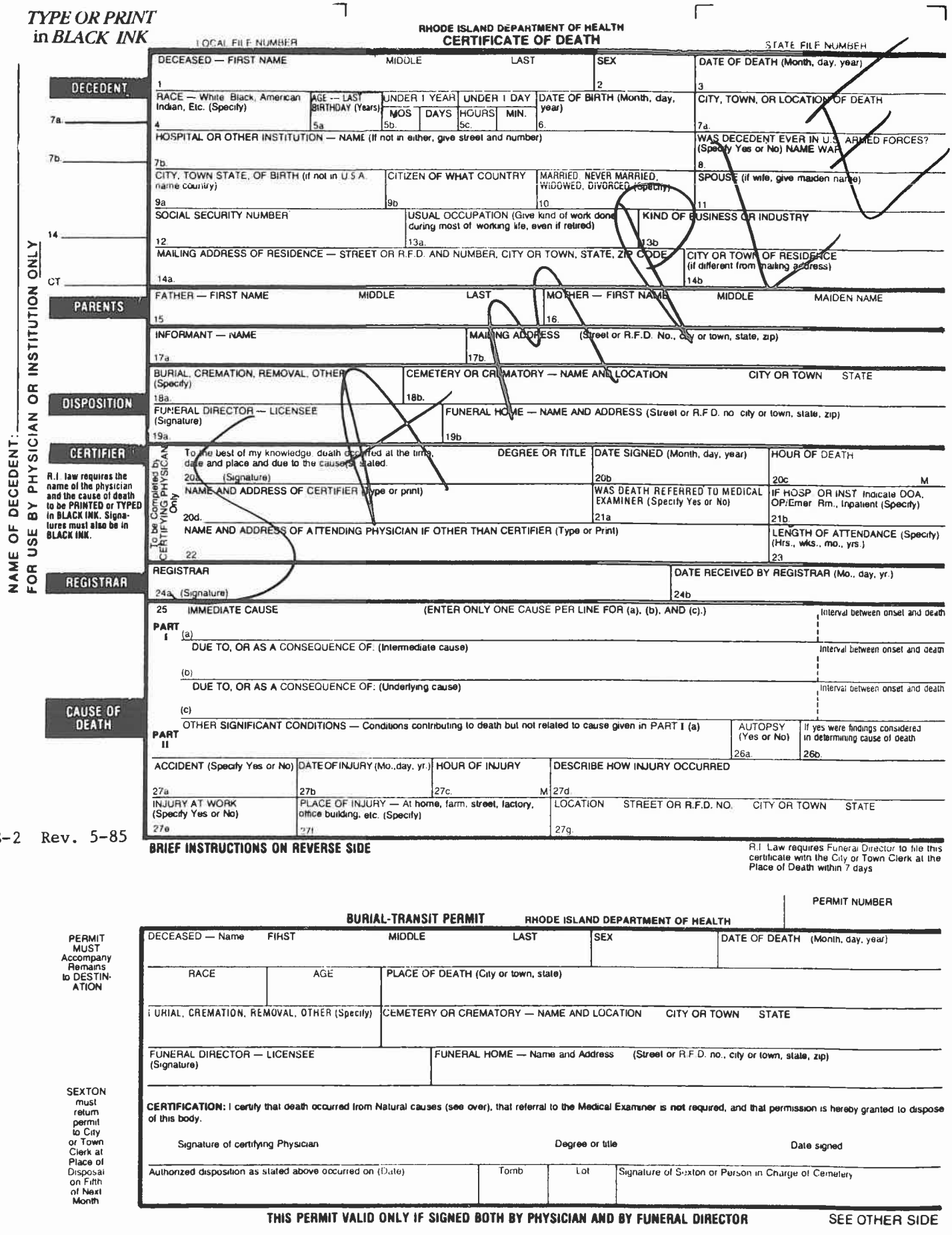
As described above, a successful solution to this dilemma involved the consulting of a variety of informational sources to identify company names. By referring to lists of current Rhode Island employers, past manufacturing guides of the State and surrounding states, and the consultation of city directories, a high percentage of company names were located and identified. The *Thomas Register,* a national compilation of manufacturing firms arranged alphabetically and geographically, also proved valuable in the identification of manufacturing concerns. Codes were assigned and recorded for future reference.[31] In this manner, over 500 companies were identified. This effort was deemed critical in meeting the goals of coding decedents by industry as well as occupation. This effort was also rewarded in that the assignment of the occupational codes with the U.S. census system is often dependent on the industrial code assigned.

One of the advantages of conducting this analysis in Rhode Island was the relatively manageable number of companies the coding staff had to confront. It was also evident that by consulting materials from the bordering states of Massachusetts and Connecticut, almost all Rhode Island residents who worked out-of-state were successfully coded. The urban nature of Rhode Island was also an advantage in that the majority of cities and towns had city directories published, thus allowing investigation into companies in these communities.

Created Codes

Although the coding system used by the Census Bureau offered an exhaustive range of categories, it was necessary to create an additional set of codes to better capture desired information. These codes are evident in Appendix G. The following three codes used in classifying decedents were excluded from the analysis: 991-institutionalized, 992-Student, 993-Armed Forces. The occupational code 400 was created to meet a need discovered after consulting the death certificate data in Rhode Island. With relative frequency, decedents were described as being "jewelry workers." This description was not as specific as other occupational titles for workers in the jewelry

Figure 2. Rhode Island Death Certificate



TYPE OR PRINT in BLACK INK

RHODE ISLAND DEPARTMENT OF HEALTH
CERTIFICATE OF DEATH

LOCAL FILE NUMBER

STATE FILE NUMBER

NAME OF DECEDENT: _____
FOR USE BY PHYSICIAN OR INSTITUTION ONLY

DECEDENT

DECEASED — FIRST NAME (1) | MIDDLE | LAST | SEX (2)

DATE OF DEATH (Month, day, year) (3)

RACE — White, Black, American Indian, Etc. (Specify) (4) | AGE — LAST BIRTHDAY (Years) (5a) | UNDER 1 YEAR: MOS (5b) DAYS | UNDER 1 DAY: HOURS (5c) MIN. | DATE OF BIRTH (Month, day, year) (6)

CITY, TOWN, OR LOCATION OF DEATH (7a)

HOSPITAL OR OTHER INSTITUTION — NAME (If not in either, give street and number) (7b)

WAS DECEDENT EVER IN U.S. ARMED FORCES? (Specify Yes or No) NAME WAR (8)

CITY, TOWN STATE, OF BIRTH (If not in U.S.A. name country) (9a) | CITIZEN OF WHAT COUNTRY (9b) | MARRIED, NEVER MARRIED, WIDOWED, DIVORCED (Specify) (10)

SPOUSE (If wife, give maiden name) (11)

SOCIAL SECURITY NUMBER (12) | USUAL OCCUPATION (Give kind of work done during most of working life, even if retired) (13a) | KIND OF BUSINESS OR INDUSTRY (13b)

MAILING ADDRESS OF RESIDENCE — STREET OR R.F.D. AND NUMBER, CITY OR TOWN, STATE, ZIP CODE (14a) | CITY OR TOWN OF RESIDENCE (If different from mailing address) (14b)

PARENTS

FATHER — FIRST NAME (15) | MIDDLE | LAST

MOTHER — FIRST NAME (16) | MIDDLE | MAIDEN NAME

INFORMANT — NAME (17a) | MAILING ADDRESS (Street or R.F.D. No., City or town, state, zip) (17b)

DISPOSITION

BURIAL, CREMATION, REMOVAL, OTHER (Specify) (18a) | CEMETERY OR CREMATORY — NAME AND LOCATION (18b) | CITY OR TOWN | STATE

FUNERAL DIRECTOR — LICENSEE (Signature) (19a) | FUNERAL HOME — NAME AND ADDRESS (Street or R.F.D. no. city or town, state, zip) (19b)

CERTIFIER

R.I. law requires the name of the physician and the cause of death to be PRINTED or TYPED in BLACK INK. Signatures must also be in BLACK INK.

To be Completed by CERTIFYING PHYSICIAN Only

To the best of my knowledge, death occurred at the time, date and place and due to the cause(s) stated.

DEGREE OR TITLE | DATE SIGNED (Month, day, year) (20b) | HOUR OF DEATH (20c) M

(20a) (Signature)

NAME AND ADDRESS OF CERTIFIER (Type or print) (20d) | WAS DEATH REFERRED TO MEDICAL EXAMINER (Specify Yes or No) (21a) | IF HOSP OR INST Indicate DOA, OP/Emer Rm., Inpatient (Specify) (21b)

NAME AND ADDRESS OF ATTENDING PHYSICIAN IF OTHER THAN CERTIFIER (Type or Print) (22) | LENGTH OF ATTENDANCE (Specify) (Hrs., wks., mo., yrs.) (23)

REGISTRAR

REGISTRAR (24a) (Signature) | DATE RECEIVED BY REGISTRAR (Mo., day, yr.) (24b)

CAUSE OF DEATH

PART I

25 IMMEDIATE CAUSE (ENTER ONLY ONE CAUSE PER LINE FOR (a), (b), AND (c).) — Interval between onset and death

(a)

DUE TO, OR AS A CONSEQUENCE OF: (Intermediate cause) — Interval between onset and death

(b)

DUE TO, OR AS A CONSEQUENCE OF: (Underlying cause) — Interval between onset and death

(c)

PART II

OTHER SIGNIFICANT CONDITIONS — Conditions contributing to death but not related to cause given in PART I (a) | AUTOPSY (Yes or No) (26a) | If yes were findings considered in determining cause of death (26b)

ACCIDENT (Specify Yes or No) (27a) | DATE OF INJURY (Mo., day, yr.) (27b) | HOUR OF INJURY (27c) M | DESCRIBE HOW INJURY OCCURRED (27d)

INJURY AT WORK (Specify Yes or No) (27e) | PLACE OF INJURY — At home, farm, street, factory, office building, etc. (Specify) (27f) | LOCATION STREET OR R.F.D. NO. CITY OR TOWN STATE (27g)

VS-2 Rev. 5-85

BRIEF INSTRUCTIONS ON REVERSE SIDE

R.I. Law requires Funeral Director to file this certificate with the City or Town Clerk at the Place of Death within 7 days

PERMIT NUMBER

BURIAL-TRANSIT PERMIT — RHODE ISLAND DEPARTMENT OF HEALTH

PERMIT MUST Accompany Remains to DESTINATION

DECEASED — Name FIRST | MIDDLE | LAST | SEX | DATE OF DEATH (Month, day, year)

RACE | AGE | PLACE OF DEATH (City or town, state)

BURIAL, CREMATION, REMOVAL, OTHER (Specify) | CEMETERY OR CREMATORY — NAME AND LOCATION | CITY OR TOWN | STATE

FUNERAL DIRECTOR — LICENSEE (Signature) | FUNERAL HOME — Name and Address (Street or R.F.D. no., city or town, state, zip)

SEXTON must return permit to City or Town Clerk at Place of Disposal on Fifth of Next Month

CERTIFICATION: I certify that death occurred from Natural causes (see over), that referral to the Medical Examiner is not required, and that permission is hereby granted to dispose of this body.

Signature of certifying Physician | Degree or title | Date signed

Authorized disposition as stated above occurred on (Date) | Tomb | Lot | Signature of Sexton or Person in Charge of Cemetery

THIS PERMIT VALID ONLY IF SIGNED BOTH BY PHYSICIAN AND BY FUNERAL DIRECTOR

SEE OTHER SIDE

Figure 3. Occupational and industrial coding procedures.

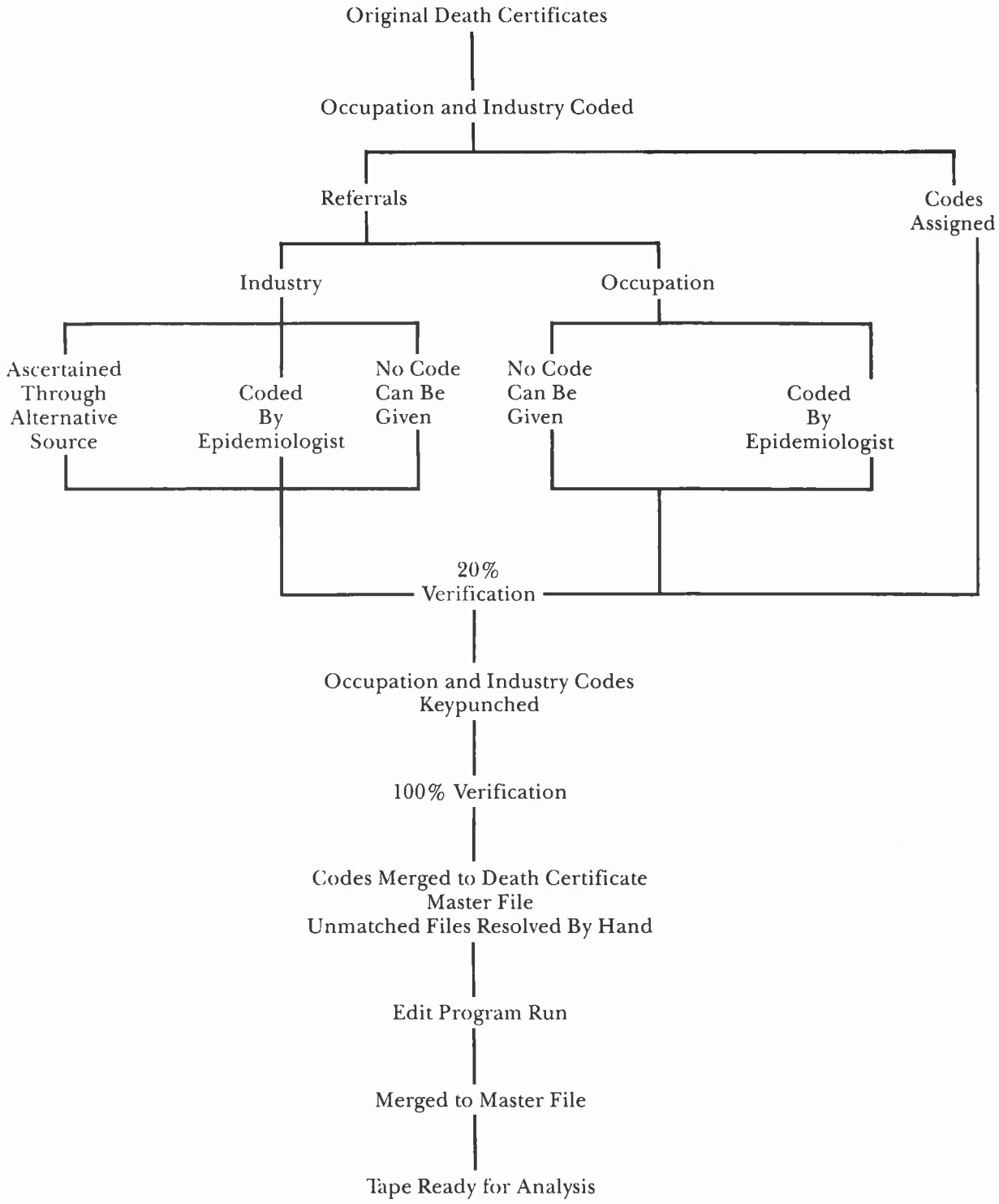


Table 1. Percentage Distribution of Incompleteness Of Occupational And Industrial Statement On Death Certificates: Rhode Island 1973-78

MALES

Created Code	Occupation	Industry
994 (Never Worked)	.5%	.5%
995 (Occupation-blank)	.5%	—
996,997 (Unknown, Retired)	1.2%	1.2%
998 (Incomplete entry)	4.1%	3.9%
999 (Industry blank)	—	2.7%
	6.3%	8.3%

FEMALES

Created Code	Occupation	Industry
994 (Never Worked)	1.5%	1.4%
995 (Occupation-blank)	1.4%	—
996,997 (Unknown, retired)	1.4%	1.2%
998 (Incomplete entry)	2.5%	2.6%
999 (Industry-blank)	—	2.6%
	6.8%	7.8%

industry. For this reason, the group was coded separately along with other workers engaged in jewelry manufacturing who proved difficult to classify. However, the code 400 does not represent all jewelry workers as polishers, dippers, carders, etc. were coded successfully into the existing U.S. census system. Thus, the occupational code 400 is a partial listing of a variety of jewelry workers.

The industrial code 399 was created to delineate all jewelry manufacturing and was necessary in order to preserve jewelry manufacturing as a discrete category. Under the U.S. census sytem, jewelry manufacturing is included in category 259 with other miscellaneous manufacturing industries.

The methodology adopted for the mortality analysis represents an active synthesis of previous work in the area of occupational mortality. The primary constraint to be confronted is the relatively small sample of decedents. Efforts have been expanded to account for this through the parsimonious choice of occupational, industrial, and disease descriptors. It is probable that such a parsimony might possibly obscure significant relationships which would have surfaced if analysis had progressed at a more disaggregated level. However, this eventuality is preferred to conducting analyses on cross-classified cells of insufficient size.

Results

A total of 51,127 death records were coded for this analysis which includes all white Rhode Island resident deaths for the years 1973-78. The completeness of the individual records with respect to the occupation and industry statement was encouraging. As is evident in Table 1, the completeness of the occupational statement is superior to the completeness of the industrial statement for both males and females. Looking over the various components in Table 1 for males, 6.3 percent of all occupational statements were to some extent incomplete or vague as compared to 8.3 percent for the industrial statements. For females, similar findings are 6.8 and 7.8 percent. These figures of incompleteness represent improvements over the results achieved in the previously reported 1968-72 Rhode Island series. In these earlier data, 6.2 percent of all occupational statements for males were incomplete or vague as compared to 9.2 percent for the industrial responses. The results for females were 8.9 percent for the occupational data and 11 percent for industry. It was evident that completeness for male industry responses and female responses for both occupation and industry improved when comparing the 1973-78 data to the earlier series. It is likely that these improvements reflect the impact of programs instituted by the Division of Vital Statistics in the middle 1970's which, among other approaches, began to institute a querying process for blank occupational and industrial statements. Another helpful influence was the increased ability to identify named companies entered in the industry section of the death certificate.

Findings for PMR Analyses

The findings for the PMR analyses are presented in the following section. Comparisons will be made to four previously published studies similar in design to this analysis as well as to selected other papers. The four studies referred to for general comparison are the British PMR and Standardized Mortality Ratio (SMR) analysis for 1970-72,[18] the 1950 Guralnick SMR analyses,[19 20] Milham's 1950-71 PMR analysis in Washington,[22] and Rhode Island results for the 1968-72 time period.[30]

You should be aware that the strict comparison of the results of these studies is not entirely justifi-

able given the differences in the choice of standard populations, occupational coding systems, and method of analysis. For example. Guralnick's study utilized SMRs. These differences also include the age of subjects in each of the respective studies with Guralnick's being comprised of only men 20-64 years in age. In certain cases the industry, occupation, and cause of death categories were also unique to the Rhode Island analysis. The residual cause of death category is the most frequent example. The findings for the occupational categories appear in Tables 2 and 3. Appendixes C and D contain explication of the codes for the male and female occupational categories. The respective ratios (rounded to the nearest whole number) for each occupational category by sex and cause of death are reported in Tables 2 and 3. As an aid in interpreting the stability of these results, the number of observed deaths for the study period (1973-78) in each cause of death category is also displayed. The findings for the industrial categories appear in Tables 4 and 5. The detailed listing of which industry codes comprise the specific categories appear in Appendix E.

Due to the sheer volume of results, only statistically significant increased ratios are presented. The finding of a statistically elevated PMR for a particular occupational or industrial group does not constitute a causal relationship. However, such associations can represent fertile areas for further analytic epidemiological study. Thus, lacking any additional analytic data which would bear upon personal risk factors which could confound the relationship between a cause of death and a particular industry or occupation, it is premature to conclude that a PMR association is indeed a causal one. What should be stressed is that, at all times, you should be conscious of the number of observed deaths in any cell, thereby, gaining a relative understanding of the reliability of the association. As a rule, small numbers can give rise to unreliable estimates of an increased mortality experience. Further, relationships which do not quite meet the critical value for statistical significance could prove to be as meaningful or more so than those that do.

Specific Findings

Category-specific findings are reported below, and comparisons are made with selected previously published findings. Due to the sheer volume of the results, only statistically significant ratios ($p < .05$) and those with five or more observed deaths are commented on.

Male Workers By Occupation (Table 2)

Professional, Technical, and Kindred Workers—

Deaths due to crebrovascular disease exhibited a (65+) PMR of 131 which was significantly elevated for the study period (130 observed, 99 expected). This result was not observed in the British report nor by Milham or Guralnick.

Managers and Administrators, except farm—

For the study period (51 observed, 33 expected), malignant neoplasms of the colon showed a (16-64) PMR of 154. A similar result was reported in the earlier Rhode Island report.

Guralnick identified a similar significant excess for malignant neoplasms of the intestine and rectum among an equivalent occupational category. The British report indicated an excess PMR for cancers of the large intestine (except rectum). Colorectal cancer is not viewed as an occupational disease, generally, and in both Guralnick's work and the British reports, occupational groups composed of primarily white collar workers appeared to predominate. This lends credence to the hypothesis that individual risk factors may be important in the expression of this disease.

Managers and Administrators, NEC—

This occupational group displayed an excess (16-64) PMR of 148 (34 observed, 22 expected) for malignant neoplasms of the colon. The commentary for this finding was similar to the commentary for the previous group of workers.

Jewelry Workers (Partial)—

This category only included those identified as jewelry workers on the death certificate. Specific job titles such as polisher, dipper, etc. were coded to their respective categories. As such, it gives a partial view of the mortality experience of workers engaged in the manufacturing of jewelry.

For this category the (65+) PMR for malignant neoplasms of the colon was significantly elevated at 401 based on 9 observed deaths and 2 expected. Although not generally thought to be occupationally related, some excesses have been previously noted in occupations which involved exposure to metal work and chemicals including cleansing solvents.[32] The jewelry industry does entail exposure to such materials, but the etiological importance of such exposure cannot be accurately assessed

Table 2

Mortality by occupation for which the PMRs were significantly raised ($p < .05$). Men aged ≥ 16 Rhode Island 1973-78.

Occupation Title Cause (ICD Code)	Age Group	PMR	Observed Deaths
Professional, Technical, and Kindred Workers			
Cerebrovascular Disease (430-438)	65 +	131	130
Managers and Administrators, except farm			
Colon Cancer (153)	16-64	154	51
Managers & Administrators, n.e.c.			
Colon Cancer (153)	16-64	148	34
Jewelry Workers (Partial)			
Colon Cancer (153)	65 +	401	9
Construction Craftsmen			
Trachea, Bronchus, & Lung Cancer (162)	65 +	151	78
Bladder Cancer	16-64	285	7
Plumbers			
Trachea, Bronchus, & Lung Cancer (162)	65 +	179	21
Foremen, n.e.c.			
Chronic Ischemic Heart Disease (412)	16-64	136	59
Textile Operatives			
Chronic Ischemic Heart Disease (412)	65 +	113	303
Diabetes (250)	16-64	233	8
Transport Equipment Operatives			
Trachea, Bronchus, & Lung Cancer (162)	16-64	142	81
Stomach Cancer (151)	65 +	174	17
Accidents (800-949)	16-64	139	51
Policemen and Detectives			
Acute Myocardial Infarction (410)	16-64	147	33
Other Service Workers			
Cirrhosis (571)	16-64	176	24
	65 +	246	14
Residual: All Others (001-799)	65 +	132	106
Never Worked			
Residual: All Others (001-799)	16-64	148	37

Table 3

Mortality by industry for which the PMRs were significantly raised ($p. < .05$). Men aged ≥ 16 Rhode Island 1973-78.

Industry Title Cause (ICD Code)	Age Group	PMR	Observed Deaths
Construction			
Trachea, Bronchus & Lung Cancer (162)	65 +	123	117
Jewelry Manufacturing			
Colon Cancer (153)	65 +	186	27
Personal Services			
Residual: All Others (001-799)	16-64	152	38
Professional and Related Services			
Cerebrovascular Disease (430-438)	65 +	135	125
Federal Public Administration			
Residual Cancer: All Others (140-209)	65 +	131	66
Never Worked			
Influenza and Pneumonia (470-438, 480-486)	16-64	536	5
Residual: All Others (001-799)	16-64	154	38
Unknown, Retired			
Chronic Ischemic Heart Disease (412)	65 +	129	78
Incomplete entry			
Residual Cancer: All Others (140-209)	16-64	131	59
Industry not reported			
Trachea, Bronchus, & Lung Cancer (162)	16-64	155	41
Residual: All Others (001-799)	16-64	145	89

with these data. Comparable occupational categories were not present in the British study or those conducted by Milham and Guralnick.

Construction Craftsmen—

Trachea, bronchus, and lung cancer in the 65 + age group and bladder cancer in the 16-64 age group both exhibited significant PMR excesses. The lung cancer excess was supported in the 1968-72 Rhode Island survey and in the British data for construction workers, a category which we feel was generally comparable to the category construction craftsmen used here. The finding of excess lung cancer probably reflected higher than average smoking patterns among these workers, although social class standardization within the British data did not fully account for the excess. No comparable group existed to enable comparison with either Milham's or Gurlanick's work. Exposure to asbestos must also be considered etiologically important for this group of workers.

Plumbers—

For plumbers, a significant (65 +) PMR of 179 was observed for cancer of the trachea, bronchus, and lung based on 21 observed and 11 expected deaths. This finding was corroborated by Milham and Guralnick as well as by the English study. This excess was also found in an earlier California study in which smoking was controlled.[33] Asbestos exposure is potentially common to this occupational group as well.

Foremen—

Chronic ischemic heart disease showed an excess PMR in the 16-64 age group which was not seen in the two American studies and the earlier Rhode Island data. No comparable category existed in the British Study.

Textile Operatives—

Textile operatives displayed significantly raised PMRs for diabetes in the 16-64 age group and for chronic ischemic heart disease in the 65 + age group. No comparable findings were identified in the three major studies used for comparison. A raised (16-64) PMR was reported for the 1968-72 Rhode Island series for chronic ischemic heart disease for textile operatives.

Transport Operatives—

A PMR of 174 (17 observed, 9 expected) in the 16-64 age range was found for stomach cancer in this occupational category. A similar significant

finding was reported by British investigators for the roughly comparable category of "Drivers of road goods vehicles." An excess (16-64) PMR of 142 for trachea, bronchus, and lung cancer was exhibited (81 observed, 57 expected). This finding was consistent with all three of the comparison studies for similar occupational categories. Exposure to diesel exhaust and other contaminants could well be an etiologically important influence. Another factor of interest was obviously related to personal health behaviors. Truck drivers as an occupational group have exhibited higher smoking rates than other occupational groups.[34] Such behavior could be operating synergistically with other risk factors for this group in the expression of lung neoplasms.

Transport operatives also suffered a raised (16-64) PMR for accidental deaths. This was in agreement with the British results and the finding of excess motor vehicle accidents for truck and tractor drivers by Milham.

Policemen—

An increased (16-64) PMR of 147 due to acute myocardial infarction for the 16-64 group was reported (33 observed, 22 expected). This finding was consistent with the Guralnick, Milham, British, and the earlier Rhode Island data.

Other Service Workers—

For this occupational category, significant 16-64 and 65 + PMRs were reported for cirrhosis. Guralnick and the British data supported this finding. In addition, the PMR for the residual cause of death category was raised in the 65 + age group. No comparison with the other studies was possible, as this cause of death category was unique to this present study.

Never Worked—

The PMR for the residual cause of death category was raised for this occupational category for the 16-64 group.

Male Workers: Industry (Table 3)

Direct comparisons for the industry portion of this report are only possible for the Guralnick and 1968-72 Rhode Island data. This method of aggregation is not identical to the industry groupings in the American studies. The British did analyze by occupational orders or grouped occupational units. Where appropriate, comparisons with British data are reported.

Construction—

The construction industry category was found to exhibit an excess PMR of 123 for trachea, bronchus, and lung cancer (117 observed, 95 expected). The results were consistent with the previous Rhode Island analysis and with the Guralnick and British data. Similar to the raised lung cancer experience of construction craftsmen, the influence of smoking and job-related hazards which include exposure to asbestos are likely to be etiologically important.

Jewelry Manufacturing—

A significant PMR of 186 was reported for colon cancer in the 65 + age group. No corroborative results were available from either the British or previous Rhode Island analyses.

Personal Services—

A raised PMR of 152 was exhibited by this industrial category for the 16-64 age group for the residual cause of death category. In a like manner, the industry categories "Never Worked" and "Industry Not Reported" also produced raised 16-64 PMRs for this disease category.

Professional and Related Services—

For this industry category, the results for the 65 + PMR for cerebrovascular disease was statistically elevated. No equivalent results were evident in the studies employed for comparison.

Federal Public Administration—

For the 65 + age group, a raised PMR experience was exhibited for the residual cancer cause of death category. The earlier Rhode Island analysis did not support this finding.

Never Worked—

Based on 5 observed and 1 expected, this group experienced a raised 16-64 PMR finding for influenza and pneumonia. The results were similar to the previous Rhode Island analysis and to the British data.

Unknown, Retired—

For the 65 + age group, an increased experience of chronic ischemic heart disease was reported. No equivalent finding was reported by any of the studies used for comparison.

Incomplete Entry—

The results for the 16-64 PMR for residual can-

Table 4

Mortality by occupation for which the PMRs were significantly raised ($p < .05$). Women aged ≥ 16 Rhode Island 1973-78.

Occupational Title Cause (ICD Code)	Age Group	PMR	Observed Deaths
Teachers			
Breast Cancer (174)	65 +	153	26
Cerebrovascular Disease (430-438)	65 +	143	93
Manager and Administrators, except farm			
Breast Cancer (174)	16-64	158	27
Salesworkers			
Colon Cancer (153)	65 +	159	23
Clerical and Kindred Workers			
Trachea, Bronchus, & Lung Cancer (162)	65 +	171	26
Breast Cancer (174)	65 +	150	47
Craftsmen & Kindred Workers			
Chronic Ischemic Heart Disease (412)	65 +	145	58
Jewelry Workers (Partial)			
Influenza & Pneumonia (470-474, 480-486)	16-64	387	6
Operatives, except transport			
Chronic Ischemic Heart Disease (412)	65 +	109	587
Laundry and Dry Cleaning Operatives, n.e.c.			
Chronic Ischemic Heart Disease (412)	16-64	322	9
Sewers and Stitchers			
Acute Myocardial Infarction (410)	16-64	203	25
Textiles Operatives			
Chronic Ischemic Heart Disease (412)	65 +	112	353
Housewives			
Acute Myocardial Infarction (410)	16-64	112	322
Occupation not reported			
Influenza & Pneumonia (470-474, 480-486)	16-64	806	4
Residual: All Others (001-799)	16-64	190	18
Unknown, Retired			
Accidents (800-949)	16-64	367	5

cer were elevated. This finding was not supported by any of the studies used for comparison.

Industry Not Reported—

For this industrial category, an increase in the (16-64) PMR for trachea, bronchus, and lung cancer was identified. For this category, an increased (65 +) PMR was reported in the 1968-72 Rhode Island findings.

Female Workers: Occupation (Table 4)

The findings for women were more difficult to evaluate since the only existing comparable results were found in the British data. Neither Guralnick nor Milham examined women workers. Because of greater movement in and out of the labor force and smaller samples of women in each occupational and industrial category, analysis and interpretation were complicated further. The results for female occupational groups follow below. For all analyses, both single and married women were included.

Teachers—

For both breast cancer and cerebrovascular diseases, raised PMRs were reported in the 65 + age group. The breast cancer results were also found in the earlier Rhode Island analysis and the British data and were likely due to life-style factors rather than occupational influences.

Managers and Administrators—

For breast cancer, an excess (16-64) PMR was reported for this occupational category, which was not consistent with the British or Rhode Island data. Breast cancer was shown to be positively cor-

Table 5

Mortality by industry for which the PMRs were significantly raised ($p < .05$). Women aged ≥ 16 Rhode Island 1973-78.

Industry Title Cause (ICD Code)	Age Group	PMR	Observed Deaths
Manufacturing			
Stomach Cancer (151)	65 +	183	16
Bladder Cancer (188)	65 +	253	8
Transport, Communications, & Other Public Utilities			
Breast Cancer (174)	16-64	236	20
Wholesale & Retail Trade			
Colon Cancer (153)	65 +	143	52
Finance, Insurance, and Real Estate			
Breast Cancer (174)	16-64	203	24
	65 +	189	15
Business & Repair Services			
Colon Cancer (153)	16-64	585	6
Entertainment and Recreation Services			
Accidents (800-949)	16-64	545	4
Professional and Related Services			
Cerebrovascular Disease (430-438)	65 +	121	239
Never Worked			
Influenza & Pneumonia (470-474, 480-486)	16-64	548	5
Industry Not Reported			
Colon Cancer (153)	16-64	286	7
Influenza & Pneumonia (470-474, 480-486)	16-64	468	4

related with socioeconomic status, and this may have partially accounted for this excess.

Sales Workers—

For this occupational category, excess (65 +) PMRs were reported for colon and breast cancer. These excesses were not consistent with either the British or Rhode Island data.

Clerical and Kindred Workers—

For trachea, bronchus, lung, and breast cancer, excess (65 +) PMRs were identified. For breast cancer, a similar British result was evident. In the Rhode Island series, a significant (16-64) PMR for breast cancer was found for this occupational group.

Jewelry Workers (Partial)—

For influenza and pneumonia in the 16-64 age category, a PMR of 387 (6 observed, 2 expected) was identified. This finding was not supported by any of the previous studies.

Craftsmen and Kindred Workers—

For chronic ischemic heart disease, a (65 +) PMR of 145 was noted in this occupational category. This finding was unsupported by the comparable studies.

Sewers—

For acute myocardial infarction in the 16-64 age category, an excess PMR was reported.

Laundry and Dry Cleaning Workers—

For chronic ischemic heart disease, an increased PMR (16-64) of 322 (9 observed, 3 expected) was identified. No comparable results were obtained in the other analyses.

Operatives, Not Transport—

In this category, a raised PMR for chronic ischemic heart disease was found for the 65 + age group.

Textile Operatives—

For chronic ischemic heart disease, a raised (65 +) PMR was identified. This was consistent with an increase in ischemic heart disease in British women in a comparable occupational category.

Housewives—

For housewives dying of acute myocardial infarction, an elevated (16-64) PMR experience was detected.

Occupation Not Reported—

For this occupational category, the residual cause of death was significantly elevated for the (16-64) PMR.

Female Workers: Industry (Table 5)

The British data did not report results in a manner which aided the comparison of industry results. The Rhode Island results from the earlier 1968-72 analysis which agreed with the present findings were for the following two industrial groups.

Transportation, Communications, and Public Utilities—

For breast cancer, a raised (16-64) PMR was found in this category. In the earlier Rhode Island analysis, this increase was identified for the 65 + age group.

Industry Not Reported—

For influenza and pneumonia, an excess (16-64) PMR was evidenced in this occupational category.

All other findings for female industrial categories were not supported by any of the British data in the few instances where comparable categories existed, or by the 1968-72 Rhode Island analysis.

However, one other female industrial category deserves further comment. This is the Finance, Insurance, and Real Estate category in which excess PMRs were reported for breast cancer in both the 16-64 and the 65 + age groups. As previously stated, breast cancer is known to be positively correlated with socioeconomic status. Employment in this industry could well favor selection of women from the upper strata of the socioeconomic continuum.

CROSS CLASSIFICATION OF DEATHS BY OCCUPATION AND INDUSTRY

Having reported results by either occupation or industry, it was decided to analyze the joint distribution of occupation *and* industry. The following section utilizes Rhode Island death certificate data from the years 1968-72 as previously published.[30] For the decedents, it includes codes such as institutionalized, students, and members of the Armed Forces in the analysis. To demonstrate this approach, two causes of death will serve as examples: accidents and bladder cancer. In Tables 6 and 7, the PMRs are displayed for accidents in males aged 16-64. In Table 6, it is evident that the industrial categories with the highest PMR experience are mining and construction and the created category. This created category, to review, is a heterogeneous mixture containing those "900" categories listed in Appendix G, such as students, uncodable entries, etc. Within the occupation categories in Table 7, the created and craftsmen classifications appeared to have suffered the higher PMRs. Because of the young age of this group and the attendant rise in risk of accidental death, the inclusion of students among the created category for both the industrial and occupational PMRs most likely accounted for the mortality excess noted here.

The risk of accidental death for those workers engaged in a specific industry or occupation was reported in Tables 6 and 7. This is another example of the traditional approach of analysis which does not take into account the joint effects of industry *and* occupation. To display the advantages of a method of analysis which utilizes both occupation *and* industry, let us examine the risk of accidental death among white male decedents aged 16-64 employed within the mining and construction industry. This industrial category has already been determined to have an excess experience of accidental deaths; what was lacking was a further clarification of which occupational categories within this industry contributed to this excess.

The PMRs for the white male decedents aged 16-64 in the major occupational categories who were employed in the mining and construction industries are displayed in Table 8. They are in order of magnitude, with a PMR of 100 indicating no difference from the accident mortality

experience of all white male decedents aged 16-64 included in the study. In Table 7, it is evident that the occupational categories most heavily involved with actual exposure to construction activity; transport operatives, craftsmen, kindred workers, and operatives except transport have relatively high PMRs. The findings for salesworkers do not fit this pattern but are based only on a single death. Thus, the method of calculating cause-specific PMRs allows for the identification of the specific occupational groups within industrial groupings at elevated levels of risk. This type of resolution is vital to epidemiological inquiry. When categorized by industrial affiliation, another example of the method demonstrated the range of risk which could be detected for an occupational group. As displayed in Table 9, the accident PMRs for white male decedents aged 16-64 who were craftsmen and kindred workers ranged from a high of 147 (mining and construction industries) to a low of 34 (personal and professional services). As in Table 8, a PMR of 100 indicated no difference from the accident mortality experience of all white male decedents aged 16-64 who were included in the study. To recapitulate, the accident PMR for males employed as craftsmen and kindred workers *within* the mining and construction industries was 147. This is to be contrasted with an accident PMR of 128 for all male workers in the mining and construction industry (see Table 6) and a PMR of 109 for all craftsmen and kindred workers in any industry (see Table 7). Thus, the risk experienced by those craftsmen and kindred workers *in* the mining and construction industry exceeded that suffered by both the industry and occupational categories of which they are a part. This increase in risk would not have been detected by methods which analyze only occupation or industry.

As a further example of this approach, bladder cancer mortality in males will be examined. For male decedents aged 16-64, there were 48 deaths attributed to bladder cancer for all occupational and industrial categories. Six of these 48 deaths occurred in the occupational category "Operatives, Not Transport." This category primarily consisted of skilled workmen. The PMR for bladder cancer in this category was well below the levels expected. In contrast, when industry was taken into account, five of the six deaths within the "Operatives, Not Transport" occupation category occurred in men working in the textile industry. For the "Operatives, Not Transport" workers employed *within* the textile industry, the PMR for bladder cancer was elevated at 193. This increase in risk for bladder cancer among textile workers has been documented by previous authors with the suspected etiological agent presumed to be exposure to α and β-naphthylamine, benzidine, and aromatic nitro, amino, and azo-compounds.[4]

There has been no documentation in more recent investigations of increased risk to textile workers.[3,5] This finding was attributable to the removal of the dyes and materials containing carcinogens. Due to the prolonged latency period of industrial carcinogenesis, the finding of an elevated number of bladder cancer cases for textile workers in Rhode Island could well reflect exposures that are just becoming evident.

Alternatively, these cases could have resulted from continued threats to workers posed by newly developed agents or as yet possibly unknown synergisms, which existed between bladder carcinogens and such deleterious practices as cigarette smoking. In any event, the group of Rhode Island bladder cancer cases within the textile industry was perhaps cause for investigation to ascertain possible current exposure to harmful agents and to arrive at better and more effective work practices. Only looking at broad occupational and industrial groups with no concern for the possible joint influence of these categories, this result would have gone unnoticed within a conventional analysis. This exercise, we think, demonstrates the utility of stratifying on industry if you are confronted with nonspecific occupational titles and of stratifying on occupation in situations where nonspecific industry titles predominate.

SENTINEL HEALTH EVENTS OF OCCUPATIONAL ORIGIN (SHE/O)

Taken one at a time, health or medical records generally have little value to the public health professional; however, in the aggregate they are invaluable tools for protecting the health and welfare of the citizenries. Deaths, or cases of disability and disease due (in part or in whole) to occupational exposures, are identified by surveillance of the occupational disease. Like other health records, individual reports of occupational disease are rarely important to the occupational health specialist. If these records are used effectively to ascertain risk of ill health due to occupational exposure, in the aggregate, they could be invaluable. Occupational health resources could then be allocated in proportion to risk to assure that existing cases are identified, treated, and rehabilitated and that future cases are prevented or minimized.

Table 6

All accident PMRs for industry category for males aged 16-64

	PMR	Observed Deaths
Mining and Construction	128	77
Created*	126	210
Business and Repair Services	112	14
Transportation, Communications, and Public Utilities	103	38
Manufacturing	89	158
Personal Services, Entertainment, Recreational Services and Professional and Related Services	83	43
Public Administration	82	35
Wholesale and Retail	79	67
Finance, Insurance, and Real Estate	30	4

*Created category contains "900" codes.

Table 7

All accident PMRs for occupation category for males aged 16-64

	PMR	Observed Deaths
Created*	137	190
Craftsmen and Kindred Workers	109	138
Operatives, Except Transport	104	90
Transport Operatives	104	35
Laborers	93	37
Service Workers	89	46
Professional, Technical, and Kindred Workers	79	38
Managers and Administrators	61	36
Sales Workers	57	17
Clerical and Kindred Workers	57	19

*Created category contains "900" codes.

Table 8

All accident PMRs for the mining and construction industry category by occupation for males aged 16-64

Occupational Category	PMR	Observed Deaths
Sales Workers	286	1
Transport Operatives	159	5
Craftsmen and Kindred Workers	147	52
Laborers	126	15
Operatives, Except Transport	64	1
Managers and Administrators	56	3
Professional, Technical, and Kindred Workers	—	0
Clerical and Kindred Workers	—	0
Service Workers	—	0
Created*	—	0
Mining and Construction Industry (All Occupations)	128	77

*Created category contains "900" codes.

Table 9

All accident PMRs for the craftsmen and kindred worker occupation category by industry for males aged 16-64

Industry Category	PMR	Observed Deaths
Mining and Construction	147	52
Public Administration	137	8
Transportation, Communications, and Public Utilities	134	11
Business and Repair Services	134	6
Finance, Insurance, and Real Estate	127	1
Wholesale and Retail Trade	96	11
Manufacturing	91	43
Created*	53	5
Personal and Professional Services	34	1
Craftsmen and Kindred Workers (All Industries)	109	138

*Created category contains "900" codes.

The sentinel health event (SHE) approach was based upon the principle that carefully controlled scientific study of unnecessary health events as defined by the SHE list yields crucial information on the medical, social, and personal factors that could lead to better health.[24] To prepare this list of conditions, which enumerates causes of potentially unnecessary or avoidable disease, disability, or untimely death, the professional judgment of scientists and clinicians has been combined with the literature on descriptive and analytic epidemiological studies. The rate of occurrence of SHE cases, as well as information on severity of the condition and social concern, can be used to establish priorities for the allocation of health system resources. As higher priority cases are selected for intensive investigation and as the evidence accumulates, failures in the chain of responsibility for preventing such cases should become increasingly understood. Eventually, it should be possible to correct these failures and prevent further cases of illness.

The SHE approach has been adapted for use in the surveillance of diseases of occupational origin. When one examines the characteristics or assumptions upon which the approach is based, the usefulness to occupational disease surveillance of the SHE approach becomes evident. First, as is true in other parts of the health system, occupational health resources are scarce, because they are far from commensurate with the magnitude of the occupational health problem. Secondly, negative indexes of health (e.g., disease, disability, and death rates) are measures of outcome which are appropriate for use in setting priorities among health problems. Thirdly, unnecessary diseases, disabilities, and untimely deaths can be counted and can serve as SHEs or warning signals for the health system. Fourthly, the occurrence of unnecessary diseases, disabilities, or untimely deaths justifies carefully controlled scientific search for remediable underlying causes. Lastly, understanding the etiology of health problems may make possible the design of cost-effective programs and services to prevent these problems. Factors, such as relative effectiveness, economic cost, social acceptability, and feasibility can then be assessed to establish priorities for health system interventions.

Development of the SHE Approach

Because of the characteristics of the SHE approach, it offers significant potential in applications to occupational disease surveillance. In addition, it has been suspected for some time that many deaths and cases of disability and disease occur each year that are, in fact, attributable to occupational exposure.[3] In reality, however, the occupational source of these deaths and cases is frequently not recognized. These events of unrecognized occupational origin are nonetheless regularly recorded in our vital records systems and such other health-related data sources as hospital discharge, health insurance, disability insurance data systems, ambulatory medical care utilization surveys, health interview surveys of the general population, and employees' medical records maintained by employers, etc. These data systems can generally be adapted at a relatively low cost to produce information that is needed to establish associations, which may exist between health events and the occupational/industrial experiences of workers.

Due to the potential usefulness of the SHE approach in occupational disease surveillance and the plethora of available data sources, the staff within the NIOSH Surveillance Branch began, several years ago, to develop methods of surveillance which would utilize data systems available throughout the United States to capture sentinel health events of occupational origin (SHE/O). Initially, they began to enhance their own staff expertise in the SHE approach and worked collaboratively with David D. Rutstein, M.D. and his associates toward the development of a list of SHEs of occupational origin. In April 1980, the Surveillance Branch issued a Request for Application for a "Cooperative Agreement Demonstration of a State Occupational Health Surveillance System." The Rhode Island Department of Health (RIDH) applied for and was awarded a Cooperative Agreement. During the past two years, the RIDH has been collaborating with NIOSH's Surveillance Branch to develop and test a SHE/O list. The RIDH and its subcontractor, Rhode Island Health Services Research, Inc. (SEARCH), have provided data for evaluating the problems associated with using the SHE/O list in occupational disease surveillance on a statewide basis.

Development of SHE/O List

In January 1982, NIOSH's Surveillance Branch produced a SHE/O list entitled "Sentinel Health Events-Occupational Disease" (see Appendix H). The list included 49 disease entities and 6 groupings of external causes of injury and poisoning, which were coded as occurring to workers or in the workplace. Within each disease rubric, there

is a specific listing of industries and/or occupations where an occurrence of occupational exposure was suspected. Thus, SHE/O are those events for which people have had both a particular disease and have been employed in a given occupation and/or industry. The SHE/O disease list also indicates whether the condition contains an unnecessary disease, case of disability, or death. Finally, the list indicates the agent(s) that are suspected of playing an etiological role in each disease rubric. It should be noted that the lists of agents and industries/occupations are not all inclusive and should be considered open-ended.

Testing the SHE/O List

In 1982, the RIDH and SEARCH produced data from the Rhode Island vital records and hospital discharge abstracts systems to conduct initial testing of the SHE/O disease list. Specifically, deaths and hospital discharges experienced by Rhode Island residents during the years 1974-78 were tabulated by SHE/O diagnosis by age and sex. All of Rhode Island's acute care hospitals participate in the same hospital discharge abstract report system. This facilitated the summarizing of this experience. In Table 10, these data appear in a summary form with tabulations for deaths and hospital episodes of care attributed to SHE/O diagnoses per year and for the 5 year period.

The Data

The data in Table 10 have a number of limitations. It should be noted that these are preliminary tabulations, which have been produced for the purpose of discovering problems associated with the use of existing data systems for occupational disease surveillance. With this caveat in mind, however, the data in Table 10 are of some interest. During the 5 year period 1974-78, more than 3,400 deaths and 11,450 hospitalizations were discovered by diagnoses, which were classified as SHE/O occurrences. Table 11 (on page 25), presents the number of SHE/O diagnoses, other diagnoses, and total deaths and hospitalizations in Rhode Island between 1974-78. Although SHE/O diagnoses represented only 7.5 percent of all deaths and 1.6 percent of all hospitalizations during the period, the direct and indirect costs to society are very large.

Referring again to Table 10, 91 percent of the SHE/O deaths were attributable to the following six diagnoses: 1) malignant neoplasms of the trachea, bronchus, and lung 2) malignant neoplasms of the bladder 3) acute or chronic renal failure; 4) malignant neoplasms of the kidney and other urinary organs; 5) acute myeloid leukemia; and 6) malignant neoplasms of the larynx. Eighty-eight percent of the hospitalizations were attributable to the following eight diagnoses: 1) malignant neoplasms of the trachea, bronchus, and lung; 2) malignant neoplasms of the bladder; 3) acute or chronic renal failure; 4) malignant neoplasms of the kidney and other urinary organs; 5) malignant neoplasms of the larynx; 6) contact and allergic dermatitis; 7) acute myeloid leukemia; and 8) hepatitis A.

Use of SHE/O Data

How could one use such a tabulation of sentinel health events of occupational origin? On face value, it would appear that the infrequently reported SHE/O diagnoses are being prevented. Therefore, maintenance of the efforts which are preventing these conditions should be all that is required. Because a small number of diagnoses account for approximately nine of ten deaths and hospitalizations identified by the disease surveillance protocol, the SHE/O diagnoses of greater concern are readily apparent in the tabulation.

Again assuming for the moment that these data are SHE/O cases, they could be used to focus efforts upon the development of means to prevent the high priority occupational diseases. Formal criteria[35] (e.g., magnitude, severity, economic cost, and the social concern associated with each problem) could be utilized to allocate proportionately more of the supply of occupational safety and health resources to investigate and ultimately to prevent these high priority SHE/O cases. Once the high priority SHE/O conditions have been selected, the following activities could be undertaken:

1. Consult tabulations of SHE/O cases to determine the relative frequency of occupational groups and industries in which the SHE/O cases were reported to have worked. A representative sample of firms, in which the cases were employed, could be drawn.
2. Occupational safety and health service personnel could be deployed to the firms where the samples were taken to investigate whether or not the agent(s) hypothesized to have caused the SHE/O cases did exist or continues to exist in the firms. A team approach to surveillance would be needed, and additional information (e.g., toxicological, environmental, medical, etc.) should be collected.[37] Prior to field investigation, the accuracy of the

Table 10

Deaths and Hospital Episodes of Care Attributed To Sentinel Health Events of Occupational Origin: Rhode Island 1974-78

		DEATHS						HOSPITAL EPISODES					
ICD-9	CONDITION	1974	1975	1976	1977	1978	Total	1974	1975	1976	1977	1978	Total
011, 502	Pulmonary Tuberculosis, Silicotuberculosis	9	8	7	4	5	33	58	45	47	54	40	244
020	Plague	0	0	0	0	0	0	0	0	0	0	1	1
021	Tularemia	0	0	0	0	0	0	0	0	0	0	0	0
022	Anthrax	0	0	0	0	0	0	0	0	0	0	0	0
023	Brucellosis	0	0	0	0	0	0	1	0	1	0	0	2
037	Tetanus	0	0	0	0	0	0	0	0	0	1	1	2
056	Rubella	0	0	0	0	0	0	21	17	8	7	7	60
070.0-.1	Hepatitis A	3	4	4	3	2	16	114	75	50	45	31	315
070.2-.3	Hepatitis B							36	37	30	47	29	179
071	Rabies	0	0	0	0	0	0	0	0	0	0	0	0
073	Ornithosis	0	0	0	0	0	0	0	0	0	0	1	1
160.0	MN Nasal Cavities	0	3	1	1	2	7	11	12	10	11	12	56
161	MN Larynx	18	23	21	16	18	96	136	88	84	140	109	557
162	MN Trachea, Bronchus, Lung	376	417	460	484	485	2222	687	776	749	904	989	4105
158, 163	MN Peritoneum, Pleura	6	4	10	10	8	38	17	16	24	22	21	100
170	MN Bone	13	6	7	19	9	54	36	32	36	32	18	154
187.7	MN Scrotum	1	0	0	0	0	1	1	2	2	1	1	7
188	MN Bladder	61	54	71	56	74	316	437	423	499	543	575	2477
189	MN Kidney & Other Urinary Organs	41	33	33	42	42	191	113	104	109	127	135	588
204	Lymphoid Leukemia, Acute	9	7	8	8	2	34	58	43	53	52	39	245
205	Myeloid Leukemia, Acute	15	20	24	24	18	101	72	60	53	60	88	333
207.0	Erythroleukemia	1	3	1	0	6	11	2	4	7	6	19	38
283.1	Hemolytic Anemia, Non-autoimmune	0	2	0	0	0	2	2	1	0	5	1	9
284.8	Aplastic Anemia	4	9	6	2	4	25	8	10	7	14	20	59
288.0	Agranulocytosis of Neutropenia	1	1	1	2	0	5	CCP	CCP	CCP	CCP	CCP	CCP
366.4	Cataract	NA	NA	NA	NA	NA	NA	6	2	0	7	9	24
443.0	Raynaud's Syndrome (Secondary)	NA	NA	NA	NA	NA	NA	16	12	10	9	13	60
500	Coalworker's Pneumoconiosis	1	0	0	0	0	1	4	1	3	2	0	10
501	Asbestosis	1	0	0	1	1	3	2	0	0	0	0	2
502	Silicosis Talcosis	3	0	2	1	1	7	1	3	5	1	3	13
503	Berylliosis	0	0	0	0	0	0	0	0	0	0	1	1
504	Byssinosis	0	0	0	0	0	0	0	0	0	0	0	0
570, 573.3	Toxic Hepatitis	5	0	0	2	2	9	19	24	19	12	12	86
584, 585	Acute or Chronic Renal Failure	28	48	43	45	35	199	181	239	216	279	392	1307
606	Infertility Male	NA	NA	NA	NA	NA	NA	15	11	10	10	9	55
692	Contact and Allergic Dermatitis	NA	NA	NA	NA	NA	NA	75	69	63	76	81	364
E800-807	Railway Accident	0	0	0	0	0	0						NC
E830-838	Water Transport Accident	2	0	0	2	1	5						NC
E840-845	Air Transport Accident	0	2	0	1	1	4						NC
E860-869	Accidental Poisoning	0	0	1	1	2	4						NC
E880-888	Accidental Fall	4	5	1	3	2	15						NC
E891	Accidental Fire in Building	0	0	3	1	0	4						NC
E894	Accidental Ignition of Material	0	0	0	0	1	1						NC
E902	High or Low Air Pressure	0	0	0	0	0	0						NC
E914	Foreign Body in Eye	0	0	0	0	0	0						NC
E915	Foreign Body in Other Orifice	1	0	0	0	0	1						NC
E916-928	Other Accidents	1	8	4	3	8	24						NC
	TOTAL	604	657	708	731	729	3429	2129	2106	2095	2467	2657	11454

NA: Not Applicable NC: No Code Exists CCP: Code Conversion Problem

reported usual occupation of the SHE/O case should be verified to eliminate the possibility of wasting resources on the study of current jobs which are unimportant in the etiology of the SHE/O condition.

3. SHE/O cases which cannot be explained by use of the suspected agents contained in the SHE/O listing should be referred for further more analytic epidemiological investigation.
4. Because of the latency periods between exposure and health effects, investigation is likely for some SHE/O cases for which agents are no longer present, because they have been withdrawn from industrial processes. Estimates could be prepared for the medical care expenditures and social welfare payments that would be incurred by cases which become evident for a period of years after exposure has ceased. Further, secondary and tertiary prevention techniques should be improved for these conditions so that effective efforts are made to intervene early, to provide curative and/or palliative clinical care, to rehabilitate, and to monitor these cases.
5. Last, SHE/O cases, where agents continued to be used in industrial processes, should be aggressively investigated. The occupational health surveillance team should first attempt to determine the natural history of each SHE/O condition. Thereafter, efforts should be focused upon developing a means of establishing a barrier between the agent and the worker, and where this cannot be fully effective, minimize the health effects of such exposures through the development of alternative production processes. Thus, determination must be made of the range of occupational services required (e.g., accident analysis, hazard monitoring, development and enforcement of regulatory standards, plant health and safety programs, record-keeping, medical monitoring, health education, emergency, clinical, and rehabilitative care, etc.); the effectiveness of such services should be maximized; and the availability of required services should be assured to the occupational groups and industries in which high priority SHE/O cases occur.

It is expected that the SHE/O approach to occupational disease surveillance will identify a high priority subset of all deaths and illnesses possibly due to continuing occupational exposures. Of course, due to false positives, a somewhat larger number of cases will have to be investigated. Once the high priority SHE/O cases are identified, the supply of occupational health services and manpower could be concentrated upon these conditions rather than being spread throughout the economy over the whole matrix of occupations and industries. Allocating these resources according to risk could tend to enhance greatly the impact of scarce resources upon occupational injury and illness.

DISSEMINATION STRATEGY

In any surveillance activity, the importance of the dissemination of findings should be self-evident. To promote effective intervention strategies, the employees, employers, occupational health professionals, and relevant organizations should be well informed of the major occupational health problems, the principal etiological factors associated with the problems, and the effective means of resolving or preventing these problems.

This is especially true knowing that the RIDH desires to fashion an epidemiological model to guide the allocation of occupational health resources. This epidemiological approach will produce a set of statistical associations between specific health outcomes and occupation and industry. These associations would be used as a means of establishing priorities for the allocation of occupational health resources and in the development of hypotheses for further epidemiological investigation. It is evident that such a system would function effectively only if the results obtained from the statistical analyses, such as the PMR analysis, are made available and disseminated in an effective and appropriate manner.

The activities pursued to accomplish this task are listed as follows.

1. The presentation of relevant information, findings, and methodologies developed under the Cooperative Agreement at professional conferences, university lectures, and public forums by the RIDH staff. Such presentations are appropriate at either the national, regional, or state level. One of the more successful presentations involved participation in a Grand Rounds series at a prominent Rhode Island hospital. This provided the opportunity to emphasize the importance of occupational factors to a variety of clinicians. Such an activity is especially important given the historical resistance of physicians to include occupational questions as part of a routine patient history. (See Appendix I.)

2. The anticipation of the RIDH is that

appropriate material developed under the terms of the Cooperative Agreement will be published as part of a continuing series of Technical Reports. These reports are routinely distributed to approximately 175 health-related agencies by the RIDH on topics of public health interest. They are widely distributed throughout the state, to health planning agencies around the country, and are routinely listed in both the National Technical Information Service (NTIS) and with the National Health Planning Information Center (NHPIC).

3. The distributing of information emanating from the Cooperative Agreement to principal actors in occupational health and related areas both within Rhode Island and the surrounding region would utilize available media with particular emphasis being placed upon RIDH press releases to newspapers. Abstracts and summaries of findings would also be designed to encourage their incorporation in the newsletters of appropriate organizations (i.e., Blue Cross/Blue Shield of Rhode Island, voluntary health organizations, industry, unions, etc.). In this way, relevant information could be targeted at the leadership of appropriate statewide organizations.

4. The submission of articles by RIDH staff to relevant professional journals which summarized the products and policy conclusions of the SCANS project. (See Appendix I.)

5. Information developed under the Cooperative Agreement was included in the first and second Rhode Island Health Plans. Heavy emphasis was placed on the area of occupational health within the health status portions of the *Rhode Island State Health Plans,* and many of the proposed solutions were endorsed by the Statewide Health Coordinating Council.

CONCLUSIONS AND RECOMMENDATIONS

The SCANS project in Rhode Island represented a surveillance effort in its initial stages of development. Although the program has not reached maturity, certain positive effects have already been detected.

These effects were most evident in activities of the RIDH and in the increased consciousness of the larger Rhode Island community concerning occupational health problems. The perceived value of participating in the SCANS project was reflected by the Health Department's decision to support the coding of occupation and industry on all Rhode Island death certificates. This state initiative began in February 1982 and can be directly traced to the success of coding the 1968-78 mortality data. In a time of fiscal austerity, this investment represents a positive statement of the importance accorded to this type of activity by the RIDH. In addition, the RIDH is currently reorganizing personnel and enhancing its ability to assist employer and employee groups in identifying and intervening in life-style and occupational risk factors.

The impact of SCANS activities was clearly seen in the reaction of the larger Rhode Island community to the Technical Report released in June 1981 by the RIDH concerning an analysis of 1968-72 death certificates coded for occupation and industry.[29] The report was prominently featured in both the electronic and print media. The publication of the report was followed by a substantial number of inquiries and served to provide a focus for groups concerned about occupational health within the state.

The publishing of this report and the subsequent initiatives pursued under the Cooperative Agreement have vastly increased the visibility of occupational health problems in Rhode Island and the support for quantifying the possible effects of occupational illness occurring in Rhode Island. The primary advance has been achieved in the building of a state-specific data base, which can be utilized to generate epidemiological hypotheses linking work and health suitable for further analytic inquiry.

The Sentinel Health Event Approach

Initial testing of the SHE/O protocol in Rhode Island has produced some useful information which merits further investigation and which may lead to occupational disease control activities. However, the principal product of the SHE/O pilot has been the identification of the limitations of the SHE/O which remain to be resolved. These limitations will be delineated below, and potential solutions will be outlined.

Limitations Of The Preliminary SHE/O Data

A number of problems are evident within the tabulations of SHE/O data. The use of retrospective data to test a list, which was developed and specified in the context of the 9th Revision of the ICD, created problems which consumed considerable time and resources. First, due to code conversion problems, some of the SHE/O conditions could not be included in Table 10. In converting death record codes from ICDA-9 to ICDA-8, some

Table 11

Total SHE/O and Non-SHE/O deaths and hospital episodes of Care: Rhode Island, 1974-78.

Deaths

	1974	1975	1976	1977	1978	Total
SHE/O	604	657	708	731	729	3,429
Other	8,551	8,380	8,607	8,475	8,374	42,387
Total	9,155	9,037	9,315	9,206	9,103	45,816
% SHE/O	6.6	7.3	7.6	7.9	8.0	7.5

Hospital Episodes

	1974	1975	1976	1977	1978	Total
SHE/O	2,129	2,106	2,095	2,467	2,657	11,454
Other	136,633	137,397	136,286	137,981	135,482	683,779
Total	138,762	139,503	138,381	140,448	138,139	695,233
% SHE/O	1.5	1.5	1.5	1.8	1.9	1.6

diagnostic categories were either broader in ICDA-8 or did not exist in ICDA-8. Therefore, sufficiently accurate conversions were not possible for the following SHE/O rubrics: hepatitis A (070.0,.1), hepatitis B (070.2,.3), non-A, non-B hepatitis (070.4), hemangiosarcoma of the liver (155M), methemoglobinemia (289.7), toxic encephalitis (323.7), inflammatory and toxic neuropathy (357.7), extrinsic allergic alveolitis (495.0-495.6), extrinsic asthma (493.0, 507.8), acute bronchitis, pneumonitis, and pulmonary edema due to fumes and vapors (506.0,.1), excessive heat of man-made origin (E900.1), excessive cold of man-made origin (E901.1), accidental drowning (E901.3), and accidental mechanical suffocation by falling earth or other substances (E913.3). In converting from ICDA-9 to ICD-9-CM to H-ICDA-2, the following additional SHE/O rubrics did not match adequately for the hospitalization data: agranulocytosis or neutropenia (288.0), Parkinson's disease, secondary (322.1), cerebellar ataxia (334.3), noise effects on inner ear (388.1), and all of the external causes of injury and poisoning (E800-E928). Because H-ICDA-2 does not include a fifth digit which identifies occupational occurrences of these external causes of injury, the last must be excluded.

Secondly, these data represented SHE/O *diagnoses,* not the joint product of diagnosis and occupational exposure. Neither the death nor the hospital discharge data were screened for occupational/industrial experience, to select decedents or patients having both a SHE/O diagnosis and experience in one of the listed occupations or industries. The hospital discharge data didn't include information on occupational or industrial experience. Thus, such screening was not possible. Therefore, the events in Table 10 are a superset of SHE/Os, because they also include people with occupational and/or industrial experiences other than those hypothesized to be involved in the etiology of true SHE/Os. To estimate the proportion of SHE/O diagnoses that may be cases, death certificates were manually screened to select decedents reported as having both a SHE/O diagnosis as the underlying cause of death and an experience in one of the listed occupations and/or industries (see Table 12). For several of the SHE/O diagnoses, none of the decedents were reported as having worked in one of the listed occupations and/or industries. With regard to the other selected SHE/O diagnoses, from 2 to 6 percent of the decedents worked in one of the listed occupations and/or industries. Because the occupational experiences with and exposures to agents on the list of SHE/O diseases are sometimes poorly specified, it should be noted that the proportion of SHE/O diagnoses that are cases was underestimated.

Thirdly, the figures for hospital discharges represented care given to unknown individuals. They do not represent individual *cases.* Therefore, incidence rates of hospitalization and hospital case fatality rates couldn't be computed. Data systems, which don't allow the unique identification of individuals, were of limited value in occupational disease surveillance.

Fourthly, confounding etiological factors have been hypothesized for many of the SHE/O conditions. For a number of them, an occupational exposure was probably not the principal etiological factor. For example, deaths and hospitalizations due to malignant neoplasms of the trachea, bronchus, and lung are more likely caused by the independent effects of cigarette smoking than by the independent effects of occupational exposures (see Table 10).

Fifthly, not all SHE/O diagnoses which appeared on the death certificates or on the hospital discharge abstracts were shown in Table 10. In Rhode Island, only the underlying cause of death was coded in machine-readable form. Thus, the mortality data in Table 10 showed only SHE/O diagnoses which appeared as underlying causes of death. The Rhode Island hospital discharge data system (PAS) included coded data for multiple causes of hospitalization. However, computer

Table 12

Sentinel Health Events-Occupational Disease (SHE/O):
Deaths to Rhode Island Residents: 1974-78.

Cause of Death (ICDA codes)	SHE/O Diagnoses	SHE/O Cases*	% SHE/O Cases*
Pulmonary Tuberculosis	33	2	6.1
Cancer of Nasal Cavities	7	0	0.0
Cancer of Larynx	96	0	0.0
Cancer of Trachea, Bronchus	2,222	42	1.9
Cancer of Bladder	316	7	2.2
Lymphoid Leukemia, Acute	34	1	2.9
Myeloid Leukemia, Acute	101	0	0.0

*Case status indicates the decedent was listed as working in either an occupation or industry which was identified as being associated with particular SHE/O diagnoses.

software was not developed to scan all diagnoses per hospitalization and to select one most meaningful SHE/O diagnosis. For consistency with the mortality data, only primary diagnosis was scanned.

Last, the number of deaths and, particularly, the number of hospitalizations attributed to a diagnosis were influenced by the medical resources available to a population. In one situation, the overdevelopment of hospital services or the overabundance of particular types of physicians in subspecialty fields, may result in the identification of conditions that wouldn't have been diagnosed in earlier years or in areas with fewer medical resources. In another situation, it has long been suspected that practicing physicians frequently lack the training or the interest needed to identify the occupational origins of many conditions that are presented to them. Hopefully, one of the by-products of occupational disease surveillance activities will be to improve recognition and reporting of conditions of occupational origin by physicians. Whether occupational diseases are underreported or thoroughly reported, time-trend analysis or generalization from the occupational disease experience of a particular population will have to take into consideration the subtle effects of the level of development that medical resources have upon case identification.

Improvement of the SHE/O Protocol And Approach

Although these problems appear formidable, most can be resolved or minimized with sufficient additional research and further development of the SHE/O protocol. First, in order to apply the SHE/O list to retrospective data, researchers will have to be careful when using such retrospective data to examine time trends; and code conversion problems in future refinements of the SHE/O list should be taken into account. Secondly, data systems to which the SHE/O protocol is applied, in the future, should include necessary information on occupational experience. Only the events having the required diagnosis and occupational or industrial exposure should be selected. In this manner, identifying excessive numbers of events for which there are no known occupational exposures can be avoided. Thirdly, the SHE/O protocol should be applied to data systems which include a unique identifier for individuals. This is necessary to allow identification of SHE/O cases as opposed to episodes of care attributed to SHE/O diagnoses. Adapting some data systems could be costly; thus, wise choices of data sources are important. Fourthly, within the limits of the state of the art in epidemiology, the confounding effects of nonoccupational etiological factors in SHE/O cases can be determined. However, to analyze relationships among etiological factors, the data systems used in SHE/O-type surveillance will have to encompass all variables concerned or special studies will be required. Fifthly, to capture all SHE/O events in a data system, multiple diagnoses will have to be coded, and computer software must be developed to scan all diagnoses and, in the instance where more than one SHE/O diagnosis

occurs per case, select the most appropriate from a predetermined hierarchy. Lastly, it will be difficult to assess the influence of the relative availability of medical resources in an area upon the reporting rates of SHE/Os. Thus, generalization of findings through time within an area and from area to area must be done cautiously. However, because the SHE/O list contains a limited number of frequently occurring conditions, it may be possible to educate physicians across the country on how to appropriately diagnose conditions of occupational origin.

Once these problems are resolved or minimized, the great potential for using the SHE/O approach would be realized. This approach could be applied to many existing data systems, which would require relatively minor modification. The cost would be only a fraction of the expenditures that would be required if the data or the reporting systems were specially designed and implemented in order to identify cases of ill health due to occupational exposures.

Finally, the SHE/O approach could be complemented with other approaches to occupational disease surveillance, which would obviate one enduring limitation of the SHE/O approach. That is, it could not "discover" previously unknown health events of occupational origin. This is obvious, because the SHE/O protocol applies to data systems a predetermined list of conditions, which have been found or judged to be of occupational origin by analytic studies and clinical experience. Other types of occupational disease surveillance protocols, such as those based upon measures of relative risk (e.g., PMRs or SMRs), search for associations between health events and occupational exposures. Because the latter types of protocol have the potential to identify new associations, they complement the SHE/O approach. Therefore, consideration should be given to simultaneous application of complementary occupational disease surveillance protocols.

Proportionate Mortality Ratio Conclusions

The interpretation of mortality analyses such as the PMR findings in this publication was complicated by certain difficulties. These difficulties include that the PMR makes no use of the population at risk and is subject to variability based on the distribution of competing causes in the study population. It is also important to note that certain key elements (occupational and industrial data, cause of death, and personal risk factors) could be missing or hampered by uneven validity and reliability for any PMR analysis using the death certificate as a primary source of information. In interpreting PMR analyses, every effort must be made to keep in mind the caveats of this type of investigation. Balanced against these caveats is the desire to use the results of the PMR analyses as one part of an occupational health surveillance system, in an attempt to define hypotheses for occupational disease research and identify hazards amenable to control technologies. In setting such agendas, attention must be given to the following factors: the magnitude of the association of the occupation with a given disease, the consistency of the association with previous studies, the biological plausibility of the association, the presence or absence of a dose-response relationship, and the presence of suspected etiological agents in the occupations or industries at excess risk.

An additional perspective must be added in the formulation of priorities for further control and research activities. This is the public health significance of the suspected association between work and health. The public health significance of any association could be thought of as encompassing the following attributes:

1. The size of the population of affected workers.
2. The magnitude of excess risk suffered by exposed workers.
3. The relative distribution of the suspected etiological agent.
4. The degree to which the insult could be prevented.

Having considered the magnitude and quality of the evidence supporting the association and by assessing the overall public health significance, policymakers could begin to translate the expressions of risk generated by occupational health surveillance systems into meaningful actions. These actions could be translated into either a more accurate characterization of the excess risk borne by workers in certain occupations, or into initiatives which go beyond analytic responses and consider control techniques which seek to minimize the risk to workers.

Based upon the results of the mortality analyses carried out in Rhode Island, the associations listed in Table 13 represent those that are the most in need of further research or control. Only findings for males are summarized in Table 13. Because the Rhode Island analysis was the first U.S. study to include women, it was thought to be too premature to summarize the findings as

Table 13

Priorities for Control and Further Study by Occupation and Industry and Cause of Death.*

Male Occupation Title Cause (ICD code)	16-64 Age Group	≥65 Age Group
Managers and Administrators		
Acute Myocardial Infarction (410)	3	2
Construction Craftsmen		
Trachea, Bronchus, and Lung Cancer (162)	0	3
Transport Operatives		
Trachea, Bronchus, and Lung Cancer (162)	3	1
Policemen		
Acute Myocardial Infarction	3	0
Industry Title Cause (ICD code)		
Construction		
Trachea, Bronchus, and Lung Cancer (162)	2	2
Accidents (800-949)	3	0

*Found to be significant ($p < .05$) in at least 3 of the following assessments of Rhode Island mortality data. 1. SMR ages 16-64 (1968-72),[1] 2. PMR ages 16-64 and ≥65 (1968-72),[2] 3. PMR ages 16-64 and ≥65 (1973-78), and 4. PMR ages 16-64 and ≥65 (1968-78).[3]

Sources: 1,2 Technical Report No. 23 The Association of Occupation and Industry with Mortality in Rhode Island (1968-72).
3 Available from authors.

shown in Table 13.

Table 13 synthesizes the findings from four different analyses of the Rhode Island data set. They are as follows:

1. PMR analysis 1968-72 (16-64, ≥65)
2. SMR analysis 1968-72 (16-64)
3. PMR analysis 1973-78 (16-64, ≥65)
4. PMR analysis 1968-78 (16-64, ≥65)

The four occupational associations and the single industrial association in Table 13 were each found to be significantly elevated ($p < .05$) in at least 3 of the analyses. They also were generally consistent with previously published findings of similar studies. The finding of an increased colon cancer experience among the professional and technical worker occupational and industrial categories also satisfied these criteria, but this relationship was judged to be confounded by a social class gradient stronger than any occupational risk factor. In addition, causes of death associated with amorphous occupational and industrial categories (e.g., Never Worked) were dropped from this summary.

The associations reported in Table 13 could have partially resulted from the influence of personal risk factors. Given the constellation of conditions, the differential patterns of smoking by occupational group were perhaps the most salient to address.

It was evident from inspecting the smoking rates of the occupational and industrial groups listed in Table 13 that two of the groups, Transport Operatives and Construction Craftsmen, have been documented as exhibiting excess prevalence of cigarette smoking.[34] Although no attempt was made in the Rhode Island analysis to adjust for smoking, the attempts made in the Third National Cancer Survey and Roswell Park studies to do similar adjustments left the association between occupation and lung cancer unaffected.[38] It is also important to note that in the case of Transport Operatives, Construction Craftsmen, and the Construction industry, important job-related exposures (diesel exhaust, asbestos) must be evaluated, by disease. The possibility of these exposures acting in concert (either in an additive or a multiplicative fashion) with personal risk factors such as smoking must be monitored.

From what is already known about the influence of asbestos in the expression of lung cancer and mesothelioma, the further intensification of control measures or substitution of less hazardous substances is warranted. To better understand this association and given the lack of firm evidence with regard to the relationship between diesel exhaust and other petroleum products and lung cancer, the emphasis for further activity should be placed on the sharpening of epidemiological analyses.

The two findings of increased acute myocardial infarction among Managers and Administrators and Policemen would also benefit from further study. In the previous example, rigorous adjustment for social class could well account for the increased experience of this population. In the case of Policemen, the association between this form of employment could well be tied to the personal risk factors which recruits bring with them rather than explicit occupational risk factors. Further study is necessary in pursuing both associations.

The other conclusion, which can be gleaned from the mortality analyses, is the high probability of positive benefit which could be attained in the aggressive mounting of health promotion programs at the worksite. The importance of personal risk factors in contributing to increased risk of

mortality can be clearly seen. Although these personal risk factors cannot be thought of as the primary etiological influence, attempts at minimizing their impact can be beneficial.

In summary, the use of mortality analyses could, with proper respect of the caveats and weaknesses of such analysis, contribute to a better identification of associations which could benefit from either control techniques or that represent fertile areas for further research.

The Surveillance System

The NIOSH Request for Application (RFA) for the SCANS projects described a surveillance strategy which has two main elements:

1. The development of a national information base would identify potential health hazards in the workplace. Its main goals would be the identification of types of industries, occupational groups, and trade name and generic hazards found in the workplace. Also involved would be the dissemination of information about these hazards to government agencies, researchers, workers and their representatives, employers, and medical care providers.

2. The development of nationwide information systems would have, as their goal, the early detection of occupational disease. Such systems would *detect trends and possible determinants of occupationally related disease,* and would *develop, maintain, and analyze the information, adapting existing national, state, and other health-data systems.*

Though the positive effects of the SCANS projects to date are evident, weaknesses in the disease surveillance protocols delineated above must be resolved. Further, to implement the NIOSH surveillance strategy, weaknesses in the overall surveillance system, must also be addressed. These weaknesses include the following:

1. The present surveillance system is overly dependent on mortality data. Mortality data suffers from a variety of deficiencies, but the major drawback is the number of events available for study, as well as the limited possibilities of discovering associations in view of the long latency periods and the inability to intervene effectively because of death.

2. The PMR and SMR usually employed in population-based mortality analyses could only be effective if used in the generation of epidemiological hypotheses. They cannot be appropriately used in the rigorous testing of existing hypotheses.

3. The use of hospital discharge data in the SHE/O analysis addresses some of the limitations of mortality data but is compromised by the fact that it only addresses the portion of morbidity that is treated in hospitals. Further, at this time, hospital discharge abstracts do not contain information about patients' work experiences.

4. The SHE/O approach functions by selection of cases from a predetermined list and is, therefore, a static system. It will not be especially useful in uncovering new relationships between work and health.

5. One main weakness of the existing occupational disease surveillance system is that it has not been wedded to a subsequent analytic system which would seek additional epidemiological data that examines, more rigorously, possible associations between work and health. Presently, associations found to exist by population-based analyses can only be followed up on an ad hoc basis.

6. In addition to further analytic investigation, the capacity is inadequate for investigative follow-up of cases of likely occupational origin. Not only SHE/O cases, but also PMR and SMR associations confirmed by previous analytic investigations should be reviewed by groups of experts. Such review groups should select cases or associations for further investigation which have a high probability of being of occupational origin. Multidisciplinary teams (i.e., epidemiologists, practitioners of occupational medicine, industrial hygienists, etc.) could then be deployed to investigate the cases selected.

7. A final major weakness of the surveillance system is that it is fragmented. Disease surveillance has not been integrated with analytic or investigative follow-up, priority setting, the provision of preventive, curative, and rehabilitative occupational health, and with dissemination of information. In short, an occupational disease surveillance and control system does not exist. The SCANS project represents a pilot effort to improve surveillance, intervention, and dissemination activities in a systematic manner.

Given these caveats, the existence of the SCANS project has been a positive influence on improving the prominence of occupational health as a major health problem in Rhode Island. These advantages begin with the accumulation of a state-specific body of data, which is useful for planning purposes and for the generation of epidemiological hypotheses linking work and health. Additionally, surveillance efforts at the state level allow for the investigation of possibly unique industries

which occur only in some states. Although these industries on the national level may not be sizable, they may be quite large in specific states. The other main advantage offered by the SCANS approach is a highly valuable return of useful data for relatively modest expenditure of personnel time and funds. Such efficiencies are best attained through the adaptation of existing data sources for occupational disease surveillance.

Recommendations And Future Activities

Participation in the SCANS project has produced various beneficial effects in Rhode Island. These serve as justification for the continued participation in the SCANS effort by the Rhode Island Department of Health. Planned future activities presently include the following:

1. The coding of death records for the years 1979-81 to permit the computation of SMRs and PMRs by occupation, industry, age, sex, and cause of death for the time period during the 1980 census.

2. For use on a statewide basis with both mortality and hospital discharge data, the continued refinement of the SHE/O methodology. Many problems in the initial SHE/O protocol have been identified, and solutions have been proposed in the Sentinel Health Event section of this report.

3. The field testing of a hospital-based SHE/O surveillance system. In this pilot demonstration, attempts would be made to identify true SHE/O cases through the selection based on the patient's diagnosis and employment history. A major item of interest would be to gauge the impact of the introduction of a SHE/O surveillance system into a hospital on the practice of clinical medicine.

These future activities are consistent with the perceived weaknesses of existing surveillance systems. First, the proposed activities seek to augment the ability to use morbidity data for surveillance purposes. The pilot test of a SHE/O list protocol in a hospital is a key component of this effort. Secondly, this agenda attempts to provide a better mechanism for translating increased expressions of risk in working populations into appropriate and effective intervention activities. The lack of an effective intervention capacity could reduce a surveillance system to a sterile and hollow exercise. Such development takes time and must be done in a competent and effective manner. Thirdly, this prescription for the future is predicated on the belief that the need for state-based surveillance efforts in the area of occupational health has only increased, given the reduced availability of funds, for ensuring the health and safety of working populations. Occupational health resources should ideally be allocated on a sound epidemiological data base. Lacking a data base, such allocation decisions are impossible. The SCANS approach, in its most basic sense, attempts to provide the necessary data to foster such decision making.

The maturation of the Rhode Island SCANS effort has been encouraging. In the coming years, it will be possible to build upon the data base already assembled and continue to improve the ability of the statewide occupational health surveillance system to gather new information on the effects of work on health.

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APPENDIX A
INDUSTRIAL CLASSIFICATION SYSTEM

Equivalent alphabetic codes follow some codes. Either code may be utilized, depending upon the processing method. Numbers in parentheses following the industry categories are the SIC definitions. "N.e.c." means "not elsewhere classified."

Industry Code	AGRICULTURE, FORESTRY, AND FISHERIES
017 (A)	Agricultural production (01)
018	Agricultural services, except horticultural (07 except 0713 and 073)
019	Horticultural services (073)
027	Forestry (08)
028	Fisheries (09)
	MINING
047	Metal mining (10)
048	Coal mining (11, 12)
049	Crude petroleum and natural gas extractions (13)
057	Nonmetallic mining and quarrying, except fuel (14)
	CONSTRUCTION
067	General building contractors (15)
068	General contractors, except building (16)
069 (B)	Special trade contractors (17)
077	Not specified construction
	MANUFACTURING
	Durable goods
	Lumber and wood products, except furniture
107	Logging (241)
108	Sawmills, planing mills, and mill work (242, 243)
109	Miscellaneous wood products (244, 249)
118	Furniture and fixtures (25)
	Stone, clay, and glass products
119	Glass and glass products (321-323)
127	Cement, concrete, gypsum, and plaster products (324, 327)
128	Structural clay products (325)
137	Pottery and related products (326)
138	Miscellaneous nonmetallic mineral and stone products (328, 329)
	Metal industries
139	Blast furnaces, steel works, rolling and finishing mills (3312, 3313)
147	Other primary iron and steel industries (3315-3317, 332, 3391, part 3399)
148	Primary aluminum industries (3334, part 334, 3352, 3361, part 3392, part 3399)
149	Other primary nonferrous industries (3331-3333, 3339, part 334, 3351, 3356, 3357, 3362, 3369, part 3392, part 3399)
157	Cutlery, hand tools, and other hardware (342)
158	Fabricated structural metal products (344)
159	Screw machine products (345)
167	Metal stamping (346)
168	Miscellaneous fabricated metal products (341, 343, 347, 348, 349)
169	Not specified metal industries
	Machinery, except electrical
177	Engines and turbines (351)
178	Farm machinery and equipment (352)
179	Construction and material handling machines (353)
187	Metalworking machinery (354)
188	Office and accounting machines (357 except 3573)
189	Electronic computing equipment (3573)
197	Machinery, except electrical, n.e.c. (355, 356, 358, 359)
198	Not specified machinery
	Electrical machinery, equipment, and supplies
199	Household appliances (363)
207	Radio, T.V., and communication equipment (365, 366)
208	Electrical machinery, equipment, and supplies, n.e.c. (361, 362, 364, 367, 369)
209	Not specified electrical machinery, equipment, and supplies
	Transportation equipment
219	Motor vehicles and motor vehicle equipment (371)
227	Aircraft and parts (372)
228	Ship and boat building and repairing (373)
229	Railroad locomotives and equipment (374)
237	Mobile dwellings and campers (3791)
238	Cycles and miscellaneous transportation equipment (375, 3799)
	Professional and photographic equipment, and watches
239	Scientific and controlling instruments (381, 382)
247	Optical and health services supplies (383, 384, 385)
248	Photographic equipment and supplies (386)
249	Watches, clocks, and clockwork-operated devices (387)
257	Not specified professional equipment
258	Ordnance (19)
259	Miscellaneous manufacturing industries (39)

Industry Code	MANUFACTURING—Continued
	Nondurable goods
	Food and kindred products
268	Meat products (201)
269	Dairy products (202)
278	Canning and preserving fruits, vegetables, and sea foods (203)
279	Grain-mill products (204, 0713)
287	Bakery products (205)
288	Confectionery and related products (207)
289	Beverage industries (208)
297	Miscellaneous food preparation and kindred products (206, 209)
298	Not specified food industries
299	Tobacco manufacturers (21)
	Textile mill products
307	Knitting mills (225)
308	Dyeing and finishing textiles, except wool and knit goods (226)
309	Floor coverings, except hard surface (227)
317	Yarn, thread, and fabric mills (221-224, 228)
318	Miscellaneous textile mill products (229)
	Apparel and other fabricated textile products
319 (C)	Apparel and accessories (231-238)
327	Miscellaneous fabricated textile products (239)
	Paper and allied products
328	Pulp, paper, and paperboard mills (261-263, 266)
329	Miscellaneous paper and pulp products (264)
337	Paperboard containers and boxes (265)
	Printing, publishing and allied industries
338	Newspaper publishing and printing (271)
339	Printing, publishing, and allied industries, except newspapers (272-279)
	Chemicals and allied products
347	Industrial chemicals (281)
348	Plastics, synthetics and resins, except fibers (282, except 2823 and 2824)
349	Synthetic fibers (2823, 2824)
357	Drugs and medicines (283)
358	Soaps and cosmetics (284)
359	Paints, varnishes, and related products (285)
367	Agricultural chemicals (287)
368	Miscellaneous chemicals (286, 289)
369	Not specified chemicals and allied products
	Petroleum and coal products
377	Petroleum refining (291)
378	Miscellaneous petroleum and coal products (295, 299)
	Rubber and miscellaneous plastic products
379	Rubber products (301-303, 306)
387	Miscellaneous plastic products (307)
	Leather and leather products
388	Tanned, curried, and finished leather (311)
389	Footwear, except rubber (313, 314)
397	Leather products, except footwear (312, 315-317, 319)
398	*Not specified manufacturing industries*

Industry Code	TRANSPORTATION, COMMUNICATIONS, AND OTHER PUBLIC UTILITIES
	Transportation
407 (D)	Railroads and railway express service (40)
408	Street railways and bus lines (411, 413-415, 417)
409	Taxicab service (412)
417	Trucking service (421, 423)
418	Warehousing and storage (422)
419	Water transportation (44)
427	Air transportation (45)
428	Pipe lines, except natural gas (46)
429	Services incidental to transportation (47)
	Communications
447	Radio broadcasting and television (483)
448	Telephone (wire and radio) (481)
449	Telegraph and miscellaneous communication services (482, 489)
	Utilities and sanitary services
467	Electric light and power (491)
468	Electric-gas utilities (493)
469	Gas and steam supply systems (492, 496)
477	Water supply (494)
478	Sanitary services (495)
479	Other and not specified utilities (497)

Industry Code	WHOLESALE AND RETAIL TRADE
	Wholesale trade
507	Motor vehicles and equipment (501)
508	Drugs, chemicals, and allied products (502)
509	Dry goods and apparel (503)
527	Food and related products (504)
528	Farm products — raw materials (505)
529	Electrical goods (506)
537	Hardware, plumbing, and heating supplies (507)
538	Not specified electrical and hardware products
539	Machinery equipment and supplies (508)
557	Metals and minerals, n.e.c. (5091)
558	Petroleum products (5092)
559	Scrap and waste materials (5093)

Industry Code	WHOLESALE AND RETAIL TRADE — Continued
567	Alcoholic beverages (5095)
568	Paper and its products (5096)
569	Lumber and construction materials (5098)
587	Wholesalers, n.e.c. (5094, 5097, 5099)
588	Not specified wholesale trade
	Retail trade
607	Lumber and building material retailing (521-524)
608	Hardware and farm equipment stores (525)
609 (E)	Department and mail order establishments (531, 532)
617	Limited price variety stores (533)
618	Vending machine operators (534)
619	Direct selling establishments (535)
627	Miscellaneous general merchandise stores (539)
628 (F)	Grocery stores (541)
629	Dairy products stores (545)
637	Retail bakeries (546)
638	Food stores, n.e.c. (542-544, 549)
639	Motor vehicle dealers (551, 552)
647	Tire, battery, and accessory dealers (553)
648	Gasoline service stations (554)
649	Miscellaneous vehicle dealers (559)
657	Apparel and accessories stores, except shoe stores (56 except 566)
658	Shoe stores (566)
667	Furniture and home furnishings stores (571)
668	Household appliances, TV, and radio stores (572, 573)
669 (G)	Eating and drinking places (58)
677	Drug stores (591)
678	Liquor stores (592)
679	Farm and garden supply stores (596)
687	Jewlery stores (597)
688	Fuel and ice dealers (598)
689	Retail florists (5992)
697	Miscellaneous retail stores (593-595, 599 exc. 5992)
698	Not specified retail trade
	FINANCE, INSURANCE, AND REAL ESTATE
707	Banking (60)
708	Credit agencies (61)
709	Security, commodity brokerage, and investment companies (62, 67)
717	Insurance (63, 64)
718	Real estate, incl. real estate-insurance-law offices (65, 66)
	BUSINESS AND REPAIR SERVICES
727	Advertising (731)
728	Services to dwellings and other buildings (734)

Industry Code	BUSINESS AND REPAIR SERVICES—Continued
729	Commercial research, development, and testing labs (7391, 7397)
737	Employment and temporary help agencies (736, 7398)
738	Business management and consulting services (part 7392)
739	Computer programming services (part 7392)
747	Detective and protective services (7393)
748	Business services, n.e.c. (732, 733, 735, 7394, 7395, 7396, 7399)
749	Automobile services, except repair (751, 752, 754)
757	Automobile repair and related services (753)
758	Electrical repair shops (762, 7694)
759	Miscellaneous repair services (763, 764, 769, except 7694)
	PERSONAL SERVICES
769(H)	Private households (88)
777	Hotels and motels (701)
778	Lodging places, except hotels and motels (702, 703, 704)
779	Laundering, cleaning, and other garment services (721, 727)
787	Beauty shops (723)
788	Barber shops (724)
789	Shoe repair shops (725)
797	Dressmaking shops (part 729)
798	Miscellaneous personal services (722, 726, part 729)
	ENTERTAINMENT AND RECREATION SERVICES
807	Theaters and motion pictures (78, 792)
808	Bowling alleys, billiard and pool parlors (793)
809	Miscellaneous entertainment and recreation services (791, 794)
	PROFESSIONAL AND RELATED SERVICES
828	Offices of physicians (801, 803)
829	Offices of dentists (802)
837	Offices of chiropractors (804)
838 (J)	Hospitals (806)
839	Convalescent institutions (8092)
847	Offices of health practitioners, n.e.c. (part 8099)
848	Health services, n.e.c. (807, part 8099)
849	Legal services (81)
857 (K)	Elementary and secondary schools (821)
858	Colleges and universities (822)
859	Libraries (823)
867	Educational services, n.e.c. (824, 829)
868	Not specified educational services

869	Museums, art galleries, and zoos (84)
877	Religious organizations (866)
878	Welfare services (part 867)
879	Residential welfare facilities (part 867)
887	Nonprofit membership organizations (861-865, 869)
888	Engineering and architectural services (891)
889	Accounting, auditing, and bookkeeping services (893)
897	Miscellaneous professional and related services (892, 899)

PUBLIC ADMINISTRATION

907	Postal service (part 9190)
917 (L)	Federal public administration (part 9190, 9490)
927	State public administration (9290)
937 (M)	Local public administration (9390)

999 **INDUSTRY NOT REPORTED**[1]

ALLOCATION CATEGORIES[2]

029	Agriculture, forestry, and fisheries—allocated
058	Mining—allocated
078	Construction—allocated
267	Manufacturing, durable goods—allocated
399	Jewelry
499	Transportation, communications, and other public utilities—allocated
599	Wholesale trade—allocated
699	Retail trade—allocated
719	Finance, insurance, and real estate—allocated
767	Business and repair services—allocated
799	Personal services—allocated
817	Entertainment and recreation services—allocated
899	Professional and related services—allocated
947	Public administration—allocated

[1]This code is used to identify not reported industries in surveys where the not reported cases are not allocated.

[2]Those returns from the Population Census which do not have an industry entry are allocated among the major industry groups during computer processing. These cases are labeled with the code for the "allocation" category to which they are assigned. (See text, page VI).

APPENDIX B
OCCUPATIONAL CLASSIFICATION SYSTEM

Equivalent alphabetic codes follow some codes. Either code may be utilized, depending on the processing method. "N.e.c." means "not elsewhere classified."

Occupation Code	PROFESSIONAL, TECHNICAL, AND KINDRED WORKERS
001	Accountants
002	Architects
	Computer specialists
003	Computer programmers
004	Computer systems analysts
005	Computer specialists, n.e.c.
	Engineers
006	Aeronautical and astronautical engineers
010	Chemical engineers
011	Civil engineers
012	Electrical and electronic engineers
013	Industrial engineers
014	Mechanical engineers
015	Metallurgical and materials engineers
020	Mining engineers
021	Petroleum engineers
022	Sales engineers
023	Engineers, n.e.c.
024	Farm management advisors
025	Foresters and conservationists
026	Home management advisors
	Lawyers and judges
030	Judges
031	Lawyers
	Librarians, archivists, and curators
032	Librarians
033	Archivists and curators
	Mathematical specialists
034	Actuaries
035	Mathematicians
036	Statisticians
	Life and physical scientists
042	Agricultural scientists
043	Atmospheric and space scientists
044	Biological scientists
045	Chemists
051	Geologists
052	Marine scientists
053	Physicists and astronomers
054	Life and physical scientists, n.e.c.
055	Operations and systems researchers and analysts
056	Personnel and labor relations workers
	Physicians, dentists, and related practitioners
061	Chiropractors
062	Dentists
063	Optometrists
064	Pharmacists
065	Physicians, medical and osteopathic
071	Podiatrists
072	Veterinarians
073	Health practitioners, n.e.c.

Occupation Code	PROFESSIONAL, TECHNICAL AND KINDRED WORKERS—Continued
	Nurses, dietitians, and therapists
074	Dietitians
075	Registered nurses
076	Therapists
	Health technologists and technicians
080	Clinical laboratory technologists and technicians
081	Dental hygienists
082	Health record technologists and technicians
083	Radiologic technologists and technicians
084	Therapy assistants
085	Health technologists and technicians, n.e.c.
	Religious workers
086	Clergymen
090	Religious workers, n.e.c.
	Social scientists
091	Economists
092	Political scientists
093	Psychologists
094	Sociologists
095	Urban and regional planners
096	Social scientists, n.e.c.
	Social and recreation workers
100	Social workers
101	Recreation workers
	Teachers, college and university
102	Agriculture teachers
103	Atmospheric, earth, marine, and space teachers
104	Biology teachers
105	Chemistry teachers
110	Physics teachers
111	Engineering teachers
112	Mathematics teachers
113	Health specialites teachers
114	Psychology teachers
115	Business and commerce teachers
116	Economics teachers
120	History teachers
121	Sociology teachers
122	Social science teachers, n.e.c.
123	Art, drama, and music teachers
124	Coaches and physical education teachers
125	Education teachers
126	English teachers
130	Foreign language teachers
131	Home economics teachers
132	Law teachers
133	Theology teachers
134	Trade, industrial, and technical teachers
135	Miscellaneous teachers, college and university

Occupation Code	PROFESSIONAL, TECHNICAL, AND KINDRED WORKERS—Continued
140	Teachers, college and university, subject not specified
	Teachers, except college and university
141	Adult education teachers
142 (N)	Elementary school teachers
143	Prekindergarten and kindergarten teachers
144	Secondary school teachers
145	Teachers, except college and university, n.e.c.
	Engineering and science technicians
150	Agriculture and biological technicians, except health
151	Chemical technicians
152	Draftsmen
153	Electrical and electronic engineering technicians
154	Industrial engineering technicians
155	Mechanical engineering technicians
156	Mathematical technicians
161	Surveyors
162	Engineering and science technicians, n.e.c.
	Technicians, except health, and engineering and science
163	Airplane pilots
164	Air traffic controllers
165	Embalmers
170	Flight engineers
171	Radio operators
172	Tool programmers, numerical control
173	Technicians, n.e.c.
174	Vocational and educational counselors
	Writers, artists, and entertainers
175	Actors
180	Athletes and kindred workers
181	Authors
182	Dancers
183	Designers
184	Editors and reporters
185	Musicians and composers
190	Painters and sculptors
191	Photographers
192	Public relations men and publicity writers
193	Radio and television announcers
194	Writers, artists, and entertainers, n.e.c.
195	Research workers, not specified
	MANAGERS AND ADMINISTRATORS, EXCEPT FARM
201	Assessors, controllers, and treasurers; local public administration
202	Bank officers and financial managers
203	Buyers and shippers, farm products
205	Buyers, wholesale and retail trade
210	Credit men
211	Funeral directors
212	Health administrators

Occupation Code	MANAGERS AND ADMINISTRATORS, EXCEPT FARM—Continued
213	Construction inspectors, public administration
215	Inspectors, except construction, public administration
216	Managers and superintendents, building
220	Office managers, n.e.c.
221	Officers, pilots, and pursers; ship
222	Officials and administrators; public administration, n.e.c.
223	Officials of lodges, societies, and unions
224	Postmasters and mail superintendents
225	Purchasing agents and buyers, n.e.c.
226	Railroad conductors
230	Restaurant, cafeteria, and bar managers
231	Sales managers and department heads, retail trade
233	Sales managers, except retail trade
235	School administrators, college
240	School administrators, elementary and secondary
245	Managers and administrators, n.e.c.
	SALES WORKERS
260	Advertising agents and salesmen
261	Auctioneers
262	Demonstrators
264	Hucksters and peddlers
265	Insurance agents, brokers, and underwriters
266	Newsboys
270	Real estate agents and brokers
271	Stock and bond salesmen
280	Salesmen and sales clerks, n.e.c.[1]
	CLERICAL AND KINDRED WORKERS
301	Bank tellers
303	Billing clerks
305 (P)	Bookkeepers
310	Cashiers
311	Clerical assistants, social welfare
312	Clerical supervisors, n.e.c.
313	Collectors, bill and account
314	Counter clerks, except food
315	Dispatchers and starters, vehicle
320	Enumerators and interviewers
321	Estimators and investigators, n.e.c.
323	Expediters and production controllers
325	File clerks
326	Insurance adjusters, examiners, and investigators
330	Library attendants and assistants
331	Mail carriers, post office
332	Mail handlers, except post office
333	Messengers and office boys
334	Meter readers, utilities
	Office machine operators
341	Bookkeeping and billing machine operators

Occupation Code	CLERICAL AND KINDRED WORKERS—Continued
	Office machine operators—Continued
342	Calculating machine operators
343	Computer and peripheral equipment operators
344	Duplicating machine operators

[1]Category "280 Salesmen and sales clerks, n.e.c." was subdivided in the Census into 5 occupation groups dependent on industry. The industry codes are shown in parentheses.

Occ. Code	
281	Sales representatives, manufacturing industries (Ind. 107-399)
282	Sales representatives, wholesale trade (Ind. 017-058, 507-599)
283	Sales clerks, retail trade (Ind. 608-699 except 618, 639, 649, 667, 668, 688)
284	Salesmen, retail trade (Ind. 607, 618, 639, 649, 667, 668, 688)
285	Salesmen of services and construction (Ind. 067-078, 407-499, 707-947)
345	Key punch operators
350	Tabulating machine operators
355	Office machine operators, n.e.c.
360	Payroll and timekeeping clerks
361	Postal clerks
362	Proofreaders
363	Real estate appraisers
364	Receptionists
	Secretaries
370	Secretaries, legal
371	Secretaries, medical
372 (Q)	Secretaries, n.e.c.
374	Shipping and receiving clerks
375	Statistical clerks
376	Stenographers
381	Stock clerks and storekeepers
382	Teacher aides, exc. school monitors
383	Telegraph messengers
384	Telegraph operators
385	Telephone operators
390	Ticket, station, and express agents
391	Typists
392	Weighers
394	Miscellaneous clerical workers
395	Not specified clerical workers

CRAFTSMEN AND KINDRED WORKERS

401	Automobile accessories installers
402	Bakers
403	Blacksmiths
404	Boilermakers
405	Bookbinders
410	Brickmasons and stonemasons
411	Brickmasons and stonemasons, apprentices

Occupation Code	CRAFTSMEN AND KINDRED WORKERS—Continued
412	Bulldozer operators
413	Cabinetmakers
415 (R)	Carpenters
416	Carpenter apprentices
420	Carpet installers
421	Cement and concrete finishers
422	Compositors and typesetters
423	Printing trades apprentices, exc. pressmen
424	Cranemen, derrickmen, and hoistmen
425	Decorators and window dressers
426	Dental laboratory technicians
430	Electricians
431	Electrician apprentices
433	Electric power linemen and cablemen
434	Electrotypers and stereotypers
435	Engravers, exc. photoengravers
436	Excavating, grading, and road machine operators; exc. bulldozers
440	Floor layers, exc. tile setters
441	Foremen, n.e.c.
442	Forgemen and hammermen
443	Furniture and wood finishers
444	Furriers
445	Glaziers
446	Heat treaters, annealers, and temperers
450	Inspectors, scalers, and graders; log and lumber
452	Inspectors, n.e.c.
453	Jewelers and watchmakers
454	Job and die setters, metal
455	Locomotive engineers
456	Locomotive firemen
461	Machinists
462	Machinist apprentices
	Mechanics and repairmen
470	Air conditioning, heating, and refrigeration
471	Aircraft
472	Automobile body repairmen
473 (S)	Automobile mechanics
474	Automobile mechanic apprentices
475	Data processing machine repairmen
480	Farm implement
481	Heavy equipment mechanics, incl. diesel
482	Household applicance and accessory installers and mechanics
483	Loom fixers
484	Office machine
485	Radio and television
486	Railroad and car shop
491	Mechanic, exc. auto, apprentices
492	Miscellaneous mechanics and repairmen
495	Not specified mechanics and repairmen
501	Millers; grain, flour, and feed
502	Millwrights
503	Molders, metal
504	Molder apprentices
505	Motion picture projectionists
506	Opticians, and lens grinders and polishers

Occupation Code	CRAFTSMEN AND KINDRED WORKERS—Continued
510	Painters, construction and maintenance
511	Painter apprentices
512	Paperhangers
514	Pattern and model makers, exc. paper
515	Photoengravers and lithographers
516	Piano and organ tuners and repairmen
520	Plasterers
521	Plasterer apprentices
522	Plumbers and pipe fitters
523	Plumber and pipe fitter apprentices
525	Power station operators
530	Pressmen and plate printers, printing
531	Pressman apprentices
533	Rollers and finishers, metal
534	Roofers and slaters
535	Sheetmetal workers and tinsmiths
536	Sheetmetal apprentices
540	Shipfitters
542	Shoe repairmen
543	Sign painters and letterers
545	Stationary engineers
546	Stone cutters and stone carvers
550	Structural metal craftsmen
551	Tailors
552	Telephone installers and repairmen
554	Telephone linemen and splicers
560	Tile setters
561	Tool and die makers
562	Tool and die maker apprentices
563	Upholsterers
571	Specified craft apprentices, n.e.c.
572	Not specified apprentices
575	Craftsmen and kindred workers, n.e.c.
580	Former members of the Armed Forces

	OPERATIVES, EXCEPT TRANSPORT
601	Asbestos and insulation workers
602 (T)	Assemblers
603	Blasters and powdermen
604	Bottling and canning operatives
605	Chainmen, rodmen, and axmen; surveying
610	Checkers, examiners, and inspectors; manufacturing
611	Clothing ironers and pressers
612	Cutting operatives, n.e.c.
613	Dressmakers and seamstresses, except factory
614	Drillers, earth
615	Dry wall installers and lathers
620	Dyers
621	Filers, polishers, sanders, and buffers
622	Furnacemen, smeltermen, and pourers
623	Garage workers and gas station attendants
624	Graders and sorters, manufacturing
625	Produce graders and packers, except factory and farm
626	Heaters, metal
630	Laundry and dry cleaning operatives, n.e.c.

Occupation Code	OPERATIVES, EXCEPT TRANSPORT—Continued
631	Meat cutters and butchers, exc. manufacturing
633	Meat cutters and butchers, manufacturing
634	Meat wrappers, retail trade
635	Metal platers
636	Milliners
640	Mine operatives, n.e.c.
641	Mixing operatives
642	Oilers and greasers, exc. auto
643	Packers and wrappers, except meat and produce
644	Painters, manufactured articles
645	Photographic process workers
	Precision machine operatives
650	Drill press operatives
651	Grinding machine operatives
652	Lathe and milling machine operatives
653	Precision machine operatives, n.e.c.
656	Punch and stamping press operatives
660	Riveters and fasteners
661	Sailors and deckhands
662	Sawyers
663	Sewers and stitchers
664	Shoemaking machine operatives
665	Solderers
666	Stationary firemen
	Textile operatives
670	Carding, lapping, and combing operatives
671	Knitters, loopers, and toppers
672	Spinners, twisters, and winders
673	Weavers
674	Textile operatives, n.e.c.
680	Welders and flame-cutters
681	Winding operatives, n.e.c.
690	Machine operatives, miscellaneous specified
692	Machine operators, not specified
694	Miscellaneous operatives
695	Not specified operatives

	TRANSPORT EQUIPMENT OPERATIVES
701	Boatmen and canalmen
703	Bus drivers
704	Conductors and motormen, urban rail transit
705	Deliverymen and routemen
706	Fork lift and tow motor operatives
710	Motormen; mine, factory, logging camp, etc.
711	Parking attendants
712	Railroad brakemen
713	Railroad switchmen
714	Taxicab drivers and chauffeurs
715 (U)	Truck drivers

Occupation Code	TRANSPORT EQUIPMENT OPERATIVES—Continued
	LABORERS, EXCEPT FARM
740	Animal caretakers, exc. farm
750	Carpenters' helpers
751 (V)	Construction laborers, exc. carpenters' helpers
752	Fishermen and oystermen
753	Freight and material handlers
754	Garbage collectors
755	Gardeners and groundskeepers, exc. farm
760	Longshoremen and stevedores
761	Lumbermen, raftsmen, and woodchoppers
762	Stock handlers
763	Teamsters
764	Vehicle washers and equipment cleaners
770	Warehousemen, n.e.c.
780	Miscellaneous laborers
785	Not specified laborers
	FARMERS AND FARM MANAGERS
801 (W)	Farmers (owners and tenants)
802	Farm managers
	FARM LABORERS AND FARM FOREMEN
821	Farm foremen
822	Farm laborers, wage workers
823	Farm laborers, unpaid family workers
824	Farm service laborers, self-employed
	SERVICE WORKERS, EXC. PRIVATE HOUSEHOLD
	Cleaning service workers
901	Chambermaids and maids, except private household
902	Cleaners and charwomen
903 (X)	Janitors and sextons
	Food service workers
910	Bartenders
911	Busboys
912	Cooks, except private household
913	Dishwashers
914	Food counter and fountain workers
915 (Y)	Waiters
916	Food service workers, n.e.c., except private household
	Health service workers
921	Dental assistants
922	Health aides, exc. nursing
923	Health trainees
924	Lay midwives
925	Nursing aides, orderlies, and attendants
926	Practical nurses
	Personal service workers
931	Airline stewardesses
932	Attendants, recreation and amusement
933	Attendants, personal service, n.e.c.

Occupation Code	SERVICE WORKERS, EXC. PRIVATE HOUSEHOLD—Continued
934	Baggage porters and bellhops
935	Barbers
940	Boarding and lodging house keepers
941	Bootblacks
942	Child care workers, exc. private household
943	Elevator operators
944	Hairdressers and cosmetologists
945	Personal service apprentices
950	Housekeepers, exc. private household
952	School monitors
953	Ushers, recreation and amusement
954	Welfare service aides
	Protective service workers
960	Crossing guards and bridge tenders
961	Firemen, fire protection
962	Guards and watchmen
963	Marshals and constables
964	Policemen and detectives
965	Sheriffs and bailiffs
	PRIVATE HOUSEHOLD WORKERS
980	Child care workers, private household
981	Cooks, private household
982	Housekeepers, private household
983	Laundresses, private household
984 (Z)	Maids and servants, private household
995	OCCUPATION NOT REPORTED[2]
	ALLOCATION CATEGORIES[3]
196	Professional, technical, and kindred workers—allocated
246	Managers and administrators, except farm—allocated
296	Sales workers—allocated
396	Clerical and kindred workers—allocated
586	Craftsmen and kindred workers—allocated
696	Operatives, except transport—allocated
726	Transport equipment operatives—allocated
796	Laborers, except farm—allocated
806	Farmers and farm managers—allocated
846	Farm laborers and farm foremen—allocated
976	Service workers, exc. private household—allocated
986	Private household workers—allocated

[2]This code is used to identify not reported occupations in surveys where the not reported cases are not allocated.

[3]Those returns from the Population Census which do not have an occupation entry are allocated among the major occupation groups during computer processing. These cases are labeled with the code for the "allocation" category to which they are assigned. (See text, page VI.)

APPENDIX C

Occupations (Male) — PMR

	Census Occupation Codes	Labels
1.	000-196	Professional, technical, and kindred workers
2.	201-246	Managers and administrators, except farm
3.	245	Managers and administrators
4.	260-296	Salesworkers
5.	301-396	Clerical workers
6.	374	Shipping and receiving clerk
7.	400*	Jewelry workers (partial)
8.	410-412,421,430,431,436,440, 510-512,520-523,534,550,560	Construction craftsmen, except carpenters
9.	522,523	Plumbers
10.	461,462,403,404,442,446,454, 502-504,514,533,535-540, 561,562	Metal craftsmen, except mechanics
	——— ———	Other craftsmen and kindred workers
11.	453	Jewelers
12.	415,416	Carpenters
13.	441	Foremen
14.	All other 400's + 500's	
15.	670-674	Operatives except transport
16.	680	Textile operatives
17.	All other 600's	Welders and Flame Cutters
18.	701-715,726	Transport equipment operatives
19.	750,751	Construction laborers
20.	753,754,760,762,770	Material handlers
21.	740,752,755,761,763,764, 780-796	Other laborers, except farm
22.	801-806,821-846	Farm workers
23.	960-965	Protective service workers
24.	964	Policemen and detectives
25.	901-903	Cleaning service workers
26.	910-916,921-926,931-954,976, 980-986	Other service workers
27.	994*	Never worked
28.	995*	Occupation not reported
29.	996*,997*	Unknown, retired
30.	998*	Incomplete entry

*created code by investigator

APPENDIX D

Occupations (Female) — PMR

	Census Occupation Codes	Labels
1.	075	Registered nurses
2.	142-144	Teachers
3.	001-074,076-141,150-196	Other professional, technical, and kindred workers
4.	201-246	Managers and administrators, except farm
5.	245	Managers and administrators, NEC
6.	260-296	Sales workers
7.	370-372,376,391	Secretaries
8.	301-364,374,375,381-390, 392-396	Other clerical and kindred workers
9.	400*	Jewelry workers (partial)
10.	All other 400's All 500's not specified	Craftsmen and kindred workers
11.	663	Sewers
12.	611,630	Laundry and dry cleaning workers
13.	601-610,612-626,631-662, 664-696	Other operatives, except transport
14.	670-674	Textile operatives
15.	701-726,740-796,801-806, 821-846	Transport, laborers and farmers
16.	901-986	Service workers
17.	990*	Housewives

*created code by investigator

APPENDIX E

Industrial Categories — PMR
Male and Female

Codes Industry Codes	Labels
1. 017-019,029	Agriculture
2. 027, 028	Forestry and fisheries
3. 047-058	Mining
4. 067-078	Construction
5. 307-309,317,318	Textile products
6. 399*	Jewelry manufacturing
7. 107-298,319-398	Other Manufacturing
8. 407-499	Transportation, communications, and public utilities
9. 507-699	Wholesale and retail trade
10. 707-719	Finance, insurance, and real estate
11. 727-767	Business and repair services
12. 769-799	Personal services
13. 807-817	Entertainment
14. 828-899	Professional and related services
15. 907	Postal service
16. 917	Federal public administration
17. 927,937,947	State and local public administration
18. 990*	At home
19. 994*	Never worked
20. 996*,997*	Unknown, retired
21. 998*	Incomplete entry
22. 999*	Industry not reported

*created code by investigator

APPENDIX F

Cause of Death Categories

	ICDA Codes	Label
1.	140-209 (All Other)	Residual Cancer
2.	151	Stomach Cancer
3.	153	Colon Cancer
4.	162	Trachea, Bronchus, and Lung Cancer
5.	174	Breast Cancer
6.	188	Bladder Cancer
7.	250	Diabetes
8.	410	Acute Myocardial Infarction
9.	412	Chronic Ischemic Heart Disease (CIHD)
10.	430-438	Cerebrovascular Disease
11.	440	Arteriosclerosis
12.	470-474, 480-486	Influenza and Pneumonia
13.	490-493	Chronic Obstructive Lung Disease (COLD)
14.	571	Cirrhosis
15.	800-949	Accidents
16.	(All Other Causes)	Residual
17.	000-999	All Causes (SMR Only)

APPENDIX G

Created Codes

Death Certificate Entry	Code
Housewife, Home, At Home	990
Institutionalized, Name of State Facility	991
Student	992
Armed Forces (Active Duty or Retired)	993
Never worked, None	994
Unknown	996
Retired	997
Incomplete entry (insufficient to obtain valid code)	998
Jewelry, Jewelry manufacturing (Industry)	399
Jewelry worker (Occupation)	400

APPENDIX H

SENTINEL HEALTH EVENTS — OCCUPATIONAL DISEASE

TABLE A-(O)
OCCUPATIONALLY RELATED UNNECESSARY DISEASE, DISABILITY, AND UNTIMELY DEATH

ICD-9	CONDITION	A[1]	B[2]	C[3]	INDUSTRY/OCCUPATION[4]	AGENT
011	Pulmonary Tuberculosis (0)[5]	P*	P,T*	P,T	School teachers, medical personnel, dental personnel, med lab workers.	*Mycobacterium tuberculosis.*
011, 502	Silicotuberculosis	P	P,T	P,T	Quarrymen, sandblasters, silica processors, mining, metal foundries, ceramic industry.	SiO_2 + *Mycobacterium tuberculosis.*
020	Plague (0)	P	—	P,T	Shepherds, farmers, ranchers, hunters, field geologists.	*Yersinia pestis.*
021	Tularemia (0)	P	—	P,T	Hunters, fur handlers, sheep industry workers, cooks, vets, ranchers, vet pathologists.	*Francisella tularensis.*
022	Anthrax (0)	P	—	P,T	Shepherds, farmers, butchers, handlers of imported hides or fibers, vets, vet pathologists, weavers, gelatin workers, artisans.	*Bacillus anthracis.*
023	Brucellosis (0)	P	P	P,T	Farmers, shepherds, veterinarians, lab workers, slaughterhouse workers.	*Brucella abortus, suis.*
037	Tetanus (0)	P	—	P,T	Farmers, ranchers	*Clostridium tetani.*
056	Rubella (0)	P	P	P	Medical personnel and teachers.	Rubella virus.
070.0 .1	Hepatitis A (0)	P	P	P	Day care center staff, orphanage staff, mental retardation institution staff.	Hepatitis A virus.
070.2 .3	Hepatitis B (0)	P	P	P	Medical and dental personnel, orphanage and mental institution staff, dialysis personnel, med lab personnel.	Hepatits B virus.
070.4	Non-A, Non-B Hepatitis(0)	P	P	P	As above for hepatitis A and B.	? Agent.
071	Rabies (0)	P	—	P	Vets, animal and game wardens, lab researchers, farmers, ranchers, trappers.	Rabies virus.
073	Ornithosis (0)	P	—	P,T	Psittacine bird breeders, pet shop staff, poultry producers, vets, zoo employees.	*Chlamydia psittaci.*

[1]Unnecessary disease [2]Unnecessary disability [3]Unnecessary untimely death
[4]INDUSTRY/OCCUPATION listings are examples only [5](0) = Only where an occupational exposure can be established
*P denotes prevention, T treatment

APPENDIX H

ICD-9	CONDITION	A[1]	B[2]	C[3]	INDUSTRY/OCCUPATION[4]	AGENT
155.1	Hemangiosarcoma of the Liver	P	P	P	Polyvinyl chloride polymerization industry. Vintners.	Vinyl chloride monomer. Arsenical pesticides.
160.0	Malignant Neoplasm (MN) of Nasal Cavities (0)	P	P,T	P,T	Woodworkers, cabinet and furniture makers. Boot and shoe industry. Radium chemists and processors. Chromium producers, processors, users. Nickel smelting and refining.	Hardwood dusts. ? Agent. Radium. Chromium VI compounds. Nickel.
161	MN of Larynx (0)	P	P,T	P,T	Asbestos industries and utilizers.	Asbestos.
162	MN of Trachea, Bronchus, and Lung (0)	P	P	P	Asbestos industry and utilizers. Topside coke oven workers. Uranium and fluorspar miners. Chromium producers, processors, users. Nickel smelters, processors, users. Ion exchange resin makers, chemists Smelters, pesticide industry, vintners. Mustard gas formulators.	Asbestos. Coke oven emissions. Radon daughters. Chromates. Nickel. BCME and CMME.[6] Arsenic. Mustard gas.
158, 163	Mesothelioma (MN of Peritoneum) (MN of Pleura)	P	—	P	Asbestos mining and production; insulators, textile, and shipbuilding industries.	Asbestos.
170	MN of Bone (0)	P	—	P	Radium chemists and processors, dial painters.	Radium.
187.7	MN of Scrotum	P	—	P,T	Automatic lathe operators. Coke oven workers, petroleum refiners, tar distillers.	Mineral/cutting oils. Soots and tars, tar distillates.
188	MN of Bladder (0)	P	—	P	Rubber and dye workers. Gas retort workers.	Benzidine, alpha and beta naphthylamine, auramine, magenta, 4-aminobiphenyl, 4-nitrophenyl. ? Agent.
189	MN of Kidney, Other, and Unspecified Urinary Organs (0)	P	P	P	Coke oven workers.	Coke oven emissions.
204	Lymphoid Leukemia, Acute (0)	P	—	P	Rubber industry. Radiologists.	? Agent. Ionizing radiation.
205	Myeloid Leukemia, Acute (0)	P	—	P	Occupations with exposure to benzene. Radiologists.	Benzene. Ionizing radiation.
207.0	Erythroleukemia (0)	P	—	P	Occupations with exposure to benzene.	Benzene.

#Modified ICD rubric.

[6]Bis(chloromethyl) ether (BCME) and chloromethyl methyl ether (CMME)

continued

APPENDIX H

ICD-9	CONDITION	A[1]	B[2]	C[3]	INDUSTRY/OCCUPATION[4]	AGENT
283.1	Hemolytic Anemia, Non-autoimmune (0)	P	—	P,T	Whitewashing and leather industry. Occupations with exposure to arsine or stibine. Plastics industry. Dye, celluloid, resin industry. Explosives and dye industry.	Copper sulfate. Arsine, stibine. Trimellitic anhydride. Naphthalene. Nitrobenzene.
284.8	Aplastic Anemia (0)	P	—	P	Explosives manufacture. Occupations with exposure to benzene. Occupations with exposure to ionizing radiation.	TNT Benzene. Ionizing radiation.
288.0	Agranulocytosis or Neutropenia (0)	P	—	P	Occupations with exposure to benzene. Explosives and pesticide industries. Pesticides, pigments, pharmaceuticals.	Benzene. Phosphorus. Inorganic arsenic.
289.7	Methemoglobinemia (0)	P	—	P,T	Explosives and dye industries.	Aromatic amino and nitro compounds (eg. aniline, TNT, nitroglycerin).
323.7	Toxic Encephalitis (0)	P	P	P	Battery, smelter, and foundry workers. Electrolytic chlorine production, dentists, battery makers, fungicide formulators.	Lead. Inorganic and organic mercury.
332.1	Parkinson's Disease (Secondary) (0)	P		—	Manganese processing, battery makers, welders. Metallurgic industries, acetylene welding, Internal combustion engine industries.	Manganese. Carbon monoxide.
334.3	Cerebellar Ataxia (0)	P	P	—	Chemical industry using toluene. Electrolytic chlorine production, battery makers, fungicide formulators.	Toluene. Organic mercury.
357.7	Inflammatory and Toxic Toxic Neuropathy (0)	P	P,T	P,T	Pesticides, pigments, pharmaceuticals. Shoe manufacturing and degreasing operations. Explosives industry. Rayon, ammonium salt, varnish makers. Plastics, hydraulics, coke industries. Battery, smelter, and foundry workers. Pesticide formulators and applicators.	Arsenic and arsenic compounds. Hexane, MBK, TCE.[7] TNT. CS_2. Tricresyl phosphates. Inorganic lead. Organophosphate pesticides.
366.4	Cataract (0)	P	P,T	—	Microwave and radar technicians. Explosives and dye industries. Radiologists. Blacksmiths, glass blowers, bakers. Moth repellant formulators, fumigators. Explosives, dye, herbicide and pesticide industries.	Microwaves. DNT, TNT. Ionizing radiation. Infrared radiation. Naphthalene. Dinitrophenol, dinitro-o-cresol.
388.1	Noise Effects on Inner Ear (0)	P	P	—	Exposure.	Excessive noise.
443.0	Raynaud's Phenomenon (Secondary) (0)	P	—	—	Lumberjacks, chain sawyers, grinders, chippers. Polyvinyl chloride polymerization industry.	Whole body or segmental vibration. Vinyl chloride monomer.

[7]Methyl n-butyl ketone (MBK), trichlorethylene (TCE)

continued

APPENDIX H

ICD-9	CONDITION	A[1]	B[2]	C[3]	INDUSTRY/OCCUPATION[4]	AGENT
495.0 to 495.6, .8	Extrinsic Allergic Alveolitis	P	P	P,T	Farmer's lung, baggassosis, bird fancier's lung, suberosis, malt worker's lung, mushroom worker's lung, maple bark disease, cheese washer's lung, coffee worker's lung, fish-meal worker's lung, furrier's lung, sequoiosis, wood worker's lung, miller's lung.	Various agents.
493.0, 507.8	Extrinsic Asthma (0)	P	P,T	P,T	Jewelry, alloy and catalyst makers.	Platinum.
					Polyurethane, adhesive, paint workers.	Isocyanates.
					Alloy, catalyst, refinery workers.	Chromium and cobalt.
					Solderers.	Aluminum soldering flux.
					Plastic, dye, insecticide makers.	Phthalic anhydride.
					Foam workers, latex makers, biologists.	Formaldehyde.
					Printing industry.	Gum arabic.
					Nickel platers.	$NISO_4$.
					Bakers.	Flour.
					Plastics industry.	Trimellitic anhydride.
					Woodworkers, furniture makers.	Red cedar and other wood dusts.
					Detergent formulators.	*Bacillus subtilus.*
500	Coalworkers' Pneumoconiosis	P	P	P	Coal miners.	Coal dust.
501	Asbestosis	P	P	P	Asbestos mining and production; insulators, textile, and shipbuilding industries.	Asbestos.
502	Silicosis,	P	P	P	Quarrymen, sandblasters, silica processors, mining, metal, and ceramic industries.	Silica.
	Talcosis[8]				Talc processors.	Talc.
503	Berylliosis[9]	P	P	P	Beryllium alloy workers, ceramic and cathode ray tube makers, nuclear reactor workers.	Beryllium.
504	Byssinosis[10]	P	P	P	Cotton industry workers (spinning, weaving, carding, mixing).	Cotton, flax, hemp, and cotton-synthetic dusts.
506.0	Acute Bronchitis,	P,T	P,T	P	Refrigeration, fertilizer, oil refining industries.	Ammonia.
506.1	Pneumonitis, and Pulmonary Edema Due to Fumes and Vapors(0)				Alkali and bleach industries.	Chlorine.
					Silo fillers, arc welders, nitric acid industry.	Nitrogen oxides.
					Paper and refrigeration industries, oil refining.	Sulfur dioxide.
					Cadmium smelters, processors.	Cadmium.
570, 573.3	Toxic Hepatitis (0)	P	P	P	Solvent utilizers, dry cleaners.	Carbon tetrachloride, chloroform. tetrachlorethane, TCE.[7]
					Explosives and dye industries.	Phosphorus, TNT.
					Fire and waterproofing additive formulators.	Chloronaphthalenes.
					Plastic formulators.	Methylenedianiline.
					Fumigators, gasoline and fire extinquisher formulators.	Ethylene dibromide.
					Disinfectant, fumigant and synthetic resin formulators.	Cresol.

[8]Complete ICD rubric reads "Pneumoconiosis Due to Other Silica or Silicates"
[9]Complete ICD rubric reads "Pneumoconiosis Due to Other Inorganic Dust"
[10]Complete ICD rubric reads "Pneumopathy Due to Inhalation of Other dust"

APPENDIX H

ICD-9	CONDITION	A[1]	B[2]	C[3]	INDUSTRY/OCCUPATION[4]	AGENT
584, 585	Acute or Chronic Renal Failure (0)	P	P,T	P,T	Battery makers, plumbers, solderers. Aluminum industry, jewelers, bronzers. Battery makers, jewelers, dentists. Fluorocarbon formulators, fumigators, plastics industry.	Inorganic lead. Stibine and arsine. Inorganic mercury. Carbon tetrachloride.
606	Infertility, Male (0)	P	P	—	Formulators. DBCP formulators and applicators.	Kepone. Dibromochloro-propane.
692	Contact and Allergic Dermatitis (0)	P,T	P,T	—	Exposure.	*Irritants* eg. cutting oils, solvents, phenol, acids, alkalis, detergents. *Allergens* eg. nickel, chromates, formaldehyde, dyes, rubber products.

EXTERNAL CAUSES OF INJURY AND POISONING (OCCUPATIONAL)

External causes of injury and poisoning (occupational) include accidents and are classified in the ICD-9 as follows.

E800-E807 May be termed "occupational" only if the fourth digit .0 ("Railway employee") is utilized to identify the injured person.

E830-E838 May be termed "occupational" only if one of the fourth digits .2, .6, or .8 is utilized to identify the injured person.

E840-E845 May be termed "occupational" only if one of the fourth digits .0, .1, .2, .4, or .8 is utilized to identify the injured person.

E846

E860-E869, E880-E887, E891, E894, E914, E915-E928 May be termed "occupational" only if one of the fifth digit sub-classifications .1, .2, or .3 is utilized to designate place of occurrence (excludes E860.0, E865, E884, and E922).

E900.1, E901.1, E902, E910.3, E913.3.

APPENDIX I

PRESENTATIONS AND PUBLISHED REPORTS — REGARDING RHODE ISLAND SCANS PROJECT

Presentations at National Professional Meetings

1. "Using Death Certificate Data to Contribute to a Statewide Occupational Health Surveillance System: The Rhode Island Experience" Presented at the Public Health Conference on Records and Statistics held August 22, 1983 — Washington, D.C.
2. "The Association of Occupation and Industry with Mortality in Rhode Island" Presented at the Annual Meeting of the American Public Health Association held November 15, 1982 — Montreal, Canada.
3. "Sentinel Health Events: Occupational Disease in Rhode Island" Presented at the Annual Meeting of the American Public Health Association held November 15, 1982 — Montreal, Canada.
4. "The Rhode Island Occupational Health Surveillance System" Presented at the Annual Meeting of the Association of Vital Records and Health Statistics held July 27, 1982 — Kansas City, Missouri.
5. "Agreement of Industry and Occupation Data on Rhode Island Death Certificates With Two Alternative Sources of Information" Presented at the Annual Meeting of the Society for Epidemiologic Research held June 17, 1982 — Cincinnati, Ohio.
6. "The Development of Occupational Disease Surveillance Tool, Based on Available Health Data Sources in Rhode Island" Presented at the Annual Meeting of the American Public Health Association held November 3, 1981 — Los Angeles, California.

Publications

1. Gute, D.M. and Fulton, J.P. Agreement of Occupation and Industry Data on Rhode Island Death Certificates with Two Alternative Sources of Information. Submitted to the *Public Health Reports.*
2. Gute, D.M. Technical Report No. 23 "The Association of Occupation and Industry with Mortality in Rhode Island (1968-1972)." Providence: Rhode Island Department of Health (1981).

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