

## **A Comparison of Analyses of Occupational Bladder Cancer: Death Certificate vs. Population-Based Case-Control Interview Data**

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The authors examined the utility of death certificate data for occupational health surveillance by comparing the ability of the data to identify high-risk occupations for bladder cancer with that of a population-based case-control study. Death certificate data for white males from 23 states for 1979-1987 were analyzed using proportionate mortality ratios. The case-control study used cancer registry cases for 1977-1978. Results were compared for 21 a priori suspect occupations. A broad definition of agreement resulted in agreement for 62% of the occupations; the death certificate study identified eight of 15 occupations identified by the case-control study and neither study identified five of the categories. While death certificate data have many limitations, our results indicate that death certificate data can provide clues to some potential occupational health problems. With the advantages of inexpensive data, large sample size, and industrial coverage, more refined analyses of the data should prove useful for occupational mortality surveillance and hypothesis generation. © 1994 Wiley-Liss, Inc.\*

**Key words:** bladder neoplasms, cancer registry, death certificates, occupation, proportionate mortality ratio, surveillance

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### **INTRODUCTION**

Occupational health surveillance activities are often based on information from death certificates. The data are relatively inexpensive and easily accessible. Occupational data from death certificates have been used to generate new hypotheses about associations of occupation with cause of death, to provide supporting evidence for hypothesized associations, and as a source of background information for more specific studies [OPCS, 1986; Milham, 1976, 1983].

Since the information on death certificates is collected for vital statistics purposes rather than for research, the adequacy of the data for effective occupational health surveillance has been questioned. Several studies have examined the accuracy

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of the occupation and industry information. They have compared the information on the "usual" occupation and industry of the decedent collected on death certificates with interview or employment information [Gute and Fulton, 1985; McLaughlin and Mehl, 1991; Olsen et al., 1990; Schade and Swanson, 1988; Schumacher, 1986; Steenland and Beaumont, 1984; Swanson et al., 1984; Turner et al., 1987]. The percent of agreement ranged from 50% to 80%. Other studies have investigated the accuracy of the cause of death information [Kircher et al., 1985; Gittlesohn and Senning, 1979; Percy et al., 1981]. They have found that the agreement rate varies for the broad cause of death categories, with the highest rate (80–95%) for neoplasms.

The purpose of our study was to evaluate U.S. death certificate data for occupational health surveillance by comparing the results of a proportionate mortality ratio (PMR) analysis of death certificate data with those of a case-control analysis of population-based cancer registry data. For our comparison, we used the two analyses affording the broadest, most representative coverage of the United States. The death certificate analysis included data from 23 states and the case-control analysis was based on data from the 10 geographic areas of the United States. We limited the comparison to white males because the number of bladder cancers in the other race-sex groups was not large enough to provide stable estimates of risk. We examined the ability of each analysis to identify occupations previously reported to be associated with bladder cancer, and the extent of agreement between the two studies.

## **MATERIALS AND METHODS**

### **Death Certificate Analysis**

The standard United States death certificate has contained information on the occupation of the decedent since 1900. Over the last decade, the National Institute for Occupational Safety and Health (NIOSH), the National Center for Health Statistics (NCHS), the National Cancer Institute, and the Bureau of the Census have collaborated to improve the quality of the occupational data collected on death certificates, to develop routine, standardized coding of this information by state health departments, and to partially reimburse selected states for the production of these data. For each year since 1984, 13 to 22 states have submitted occupational information in coded, computerized form to NCHS. Other states have provided the occupational mortality data to NIOSH for various years from 1979 through 1987.

The data for the evaluation were abstracted from 2,971,483 death certificate records from 23 states for one or more years from 1979 through 1987 (see Table I for a listing of number of deaths by state and year). Our analyses were restricted to 1,333,560 white male decedents aged 15 or more years who were residents of one of the 23 states, whose deaths occurred in one of the states, and who had codable occupation information recorded on the death certificate. This included 8,644 decedents with the underlying cause of death of bladder cancer.

The standard United States death certificate contains information on the "usual occupation" and "kind of business or industry" for each decedent. The information on industry and occupation was coded by state coders according to the 1980 Bureau of the Census classification system [U.S. Bureau of the Census, 1982]. The underlying cause of death was coded according to the Ninth Revision, International Classification of Diseases [WHO, 1977].

**TABLE I. Years of Data and Deaths According to State of Residence: NIOSH Occupational Mortality Data, 23 States: 1979-1987**

State	Years of data	Deaths
Alaska	1987	1,800
California <sup>a</sup>	1979-1981	176,816
Colorado	1985-1987	58,962
Georgia	1984-1987	183,694
Indiana	1986-1987	95,216
Kansas	1984-1987	83,900
Kentucky	1984-1987	131,286
Maine	1982-1987	63,477
Missouri	1984-1986	143,820
Nebraska	1984-1985	28,274
Nevada	1984-1987	26,929
New Hampshire	1984-1987	30,151
New Mexico	1986-1987	18,896
New York <sup>b</sup>	1980-1987	350,477
North Carolina	1984-1987	204,069
Ohio	1985-1987	286,574
Pennsylvania	1983-1987	590,280
Rhode Island	1979-1981	79,191
South Carolina	1984-1987	105,270
Tennessee	1985-1987	127,787
Utah	1984-1987	16,905
Vermont	1986-1987	9,605
Wisconsin	1984-1987	158,104
Total no. of deaths		2,971,483

<sup>a</sup>Ages 15-64, only.

<sup>b</sup>Ages 18-74, only.

Age-standardized proportionate mortality ratios (PMRs) were calculated using a computer program developed at NIOSH [Dubrow and Spaeth, 1987]. The PMRs were computed by comparing the proportion of deaths from a specific cause within a specific occupation group with the proportion of deaths from that cause in all occupations [Kupper et al., 1978]. To test for statistical significance of the PMR, the program calculates the Mantel-Haenszel adjusted chi-square [Mantel and Haenszel, 1959] (or variation from the Poisson distribution for fewer than 5 expected deaths [Bailar and Ederer, 1974]), and reports p-values of 0.05 or 0.01.

**Population-Based Case-Control Analysis**

The comparison study was a population-based case-control study using data from the National Bladder Cancer Study, the largest study of occupation and bladder cancer conducted to date [Silverman et al., 1989]. The case series of the comparison study consisted of 2,100 cases of bladder cancer among white men aged 21 to 84 years identified from cancer registries in 10 U.S. geographic areas, i.e., the states of New Jersey, Connecticut, Iowa, New Mexico, and Utah, and the cities of Atlanta, Detroit, New Orleans, San Francisco, and Seattle. The cases were first diagnosed during a one-year period that began in 1977 or 1978. The control series of 3,874

white men was drawn from the general population of the study areas, frequency matched to the cases for age and geographic area. Interviews were used to collect information on every job a subject had held for at least 6 months since the age of 12 years. Information on possible confounding factors, such as smoking, was also collected. Industry and occupation were coded according to the 1970 U.S. Bureau of the Census classification system [U.S. Bureau of the Census, 1971] and 163 occupational categories were formed according to potential for similar exposures. Risk associated with "ever employed" in each occupation was estimated relative to the risk for subjects "never employed" in the occupation. Relative risks adjusted for smoking were estimated by the maximum likelihood method [Gart, 1970].

The case-control study presented both positive and negative results for 28 a priori suspect occupational groups. These were occupations reported in the literature to have an association with bladder cancer. Seventeen of the groups were summary categories made up of two or more subcategories. For each summary category, results were also presented for subcategories for which workers had a statistically significantly elevated relative risk or a relative risk of at least 1.3, regardless of significance. The other eleven occupational groups for which results were reported were suspect occupational categories that did not fit under any of the summary categories.

### Method of Comparison

Using the 1970 Bureau of the Census occupation code groups for the 28 a priori suspect occupation categories in the case-control study, we selected the most comparable 1980 Census code or combination of codes for each occupation category and for all subcategories under the 17 summary categories. PMRs were computed for each of these occupational categories. We compared the results from the death certificate analysis with the results reported from the case-control analysis for each category and subcategory. Our comparisons are based solely on the previously published results for the case-control study. No additional analyses of the case-control data were made for this study. Seven of the 28 groups contained fewer than 15 cases in either the case-control analysis or the death certificate analysis. Due to the small sample size, these occupational groups were excluded from our reported results.

We defined a positive association in either study as a significantly elevated relative risk or PMR, or a non-significantly elevated relative risk of at least 1.3, or PMR of at least 130. For the summary occupation categories, we considered the association positive *if either the overall category or one of the subcategories met the above criteria.*

## RESULTS

Results of the comparison are shown for the 21 a priori suspect occupation categories that had 15 or more cases in both the case-control and death certificate analyses: 16 summary categories and five individual categories. Of these 21, the case-control analysis identified 15 occupations having a positive association. The death certificate analysis identified nine of the a priori suspect occupation categories as having a positive association (Fig. 1).

Tables II, III, and IV compare the death certificate PMRs with the case-control relative risks for the 21 a priori suspect occupation categories. Eight occupational

## Case-Control Analysis

		Positive	None	
Death Certificate Analysis	Positive	8	1	9
	None	7	5	12
		15	6	21

Fig. 1. Comparison between the bladder cancer associations found for 21 a priori suspect occupations in the National Bladder Cancer Study case-control analysis and in the analysis of death certificate data from 23 states (1979–1987). A positive association in the case-control analysis is indicated by a relative risk of at least 1.3 or significantly elevated. A positive association in the death certificate analysis is indicated by a proportionate mortality ratio of at least 130 or significantly elevated.

categories had positive associations in both studies (Table II), five were negative in both studies (Table III), and for eight categories, the studies did not agree (Table IV).

For the summary categories, results are also presented for all subcategories in which the relative risk or PMR was statistically significantly elevated or for which the relative risk was at least 1.3 or the PMR at least 130. For subcategories meeting these criteria in the death certificate analysis but not published in the case-control study because they did not meet the criteria, only the results from the death certificate study were available. Each summary category with its subcategories is considered as a unit in determining the positive associations.

Table II lists the eight occupational categories with positive associations in both studies:

1. The summary category of painter had a positive association in both studies. Several subcategories were also positive.
2. For the summary category of mechanic, the subcategory of auto mechanic in the trucking service industry had a positive association in the case-control study. In the death certificate analysis, the subcategory of household appliance and accessory mechanics was positively associated with bladder cancer.
3. For the summary category of metal machinery worker, the subcategories of machinists and drill press operatives were positively associated in the case-control study, while the subcategory of lathe and milling machine operatives was positive in the death certificate study.
4. For the summary category of metal working and fabrication, the case-control study had five subcategories with positive associations. Two subcategories, metal heaters and riveters/fasteners, were positive in the death certificate study.

**TABLE II. A Priori Suspect Occupational Categories Associated With Bladder Cancer for Which Both the Case-Control Analysis and the Death Certificate Analysis Identified a Positive Association\***

Occupation	Case-control analysis			Death certificate analysis	
	Cases	RR <sup>a</sup>	95% CI <sup>a</sup>	Deaths	PMR <sup>a</sup>
1. Summary painter	116	1.5	1.2-2.0	147	126 <sup>c</sup>
Painter, construction and maintenance	76	1.5	1.1-2.2	101	122 <sup>d</sup>
Painter, manufactured articles	25	1.3	0.8-2.3	38	189 <sup>e</sup>
Artistic painter	13	1.8	0.8-4.3	8	77
Sign painters and letterers		NA <sup>b</sup>		10	203
2. Summary mechanic	353	1.2	1.0-1.4	363	107
Auto mechanic in trucking service industry	11	10.2	2.1-68.6	9	127
Mechanics, household appliance and accessories		NA <sup>b</sup>		8	153
3. Summary metal machinery worker	477	1.1	1.0-1.3	499	100
Machinist	102	1.3	1.0-1.7	200	95
Drill press operative	51	1.4	0.9-2.1	1	32
Lathe and milling machine operative		NA <sup>b</sup>		13	138
4. Summary metal working and fabrication	255	1.2	1.0-1.4	141	104
Forgeman, hammerman, roller, finisher	11	1.4	0.6-3.4	33	101
Blacksmith <sup>c</sup>	7	2.4	0.7-8.2		
Heaters, metal	5	1.9	0.4-8.7	9	133
Filer, polisher, sander, and buffer	53	1.5	1.0-2.2	19	95
Structural metal worker	12	1.4	0.6-3.3	15	94
Riveter and fastener		NA <sup>b</sup>		6	148
5. Summary hairdresser and barber	28	1.3	0.8-2.3	41	100
Hairdresser	7	2.8	0.7-11.6	6	142
6. Summary petroleum processing worker	71	1.3	1.0-1.8	35	135
Petroleum processing, crude extraction	16	2.4	1.1-5.5	22	140
Petroleum processing, refining	39	1.3	0.8-2.0	13	142
7. Summary cook, baker, food counter	144	1.2	0.9-1.5	67	105
Food counter and fountain work	48	1.4	0.9-2.1	2	509
Baker		NA <sup>b</sup>		33	142 <sup>d</sup>
8. Rubber processing worker	28	1.3	0.8-2.2	18	194 <sup>e</sup>

\*Relative risk for a summary category or one or more subcategories or for an individual category at least 1.3 or significantly elevated and PMR for a summary category or one or more subcategories or for an individual category at least 130 or significantly elevated.

<sup>a</sup>Relative risk (RR), adjusted for smoking. CI, confidence interval; PMR; proportionate mortality ratio.

<sup>b</sup>Not reported in the comparison paper, i.e., not a positive association.

<sup>c</sup>Can't identify with 1980 Bureau of the Census codes.

<sup>d</sup> $p < 0.05$ ; <sup>e</sup> $p < 0.01$ .

5. For the summary category of hairdresser and barber, hairdressers had a positive association in both studies.
6. The summary category of petroleum processing worker had a positive association in both studies. Two subcategories were also positively associated: crude extraction and refining.
7. For the summary category of cook, baker, and food counter worker, food counter and fountain workers had a positive association in the case-control study. Bakers were positive in the death certificate study.

**TABLE III. A Priori Suspect Occupational Categories Associated with Bladder Cancer for Which Neither the Case-Control Analysis nor the Death Certificate Analysis Identified a Positive Association\***

Occupation	Case-control analysis			Death certificate analysis	
	Cases	RR <sup>a</sup>	95% CI <sup>a</sup>	Deaths	PMR <sup>a</sup>
1. Summary printer	37	0.8	0.5-1.2	63	110
2. Summary welder and solderer	88	1.0	0.7-1.3	78	98
3. Summary salesman and sales manager	422	1.0	0.9-1.2	914	104
4. Summary food service worker	133	0.9	0.7-1.1	112	104
5. Textile worker	38	0.6	0.4-0.9	83	75 <sup>b</sup>

\*Relative risk for a summary category and all subcategories or for an individual category less than 1.3; PMR for a summary category and all subcategories or for an individual category less than 130.

<sup>a</sup>Relative risk (RR), adjusted for smoking. CI, confidence interval; PMR, proportionate mortality ratio.

<sup>b</sup>p<0.01.

8. The individual category of rubber processing worker had a positive association in both studies.

Five occupational groups showed no positive association in either study (Table III). The groups are (1) summary printer, (2) summary welder and solderer, (3) summary salesman and sales managers, (4) summary food service worker, and (5) textile worker.

For the remaining eight occupational groups (Table IV), the analyses produced conflicting results. The summary categories of (1) motor vehicle driver, (2) railroad worker, (3) construction worker, (4) lumberman and woodworker, and (5) paper processing worker, and the individual categories of (6) stationary engineer, and (7) stationary fireman or furnace operator were positively associated in the case-control study but not in the death certificate study. The category of chemical processing worker was positively associated in the death certificate study but, although the relative risk was elevated, it did not meet our criteria for a positive association in the case-control study.

## DISCUSSION

Death certificate data have been used in several components of occupational health surveillance. The data have been used for monitoring trends over time for inherently occupational diseases, such as mesothelioma, coalworkers' pneumoconiosis, asbestosis, and silicosis [NCHS, 1989; NIOSH, 1991]. They have been used more extensively for hypothesis generation or for providing background material for preliminary studies of occupational disease. For example, the possibility of elevated leukemia rates in workers exposed to electric and magnetic fields was first suggested by an analysis of death certificate data from Washington State [Milham, 1982]. This was followed by supporting evidence from the British mortality data [McDowall, 1983] and other surveillance studies. Several epidemiologic studies are now on-going to investigate this hypothesis. A meta-analysis based on 12 studies using primarily death certificate data identified lung cancer in motor vehicle drivers as a high research priority [Dubrow and Wegman, 1983]. Two recent studies give support to this hy-

**TABLE IV. A Priori Suspect Occupational Categories Associated with Bladder Cancer for Which the Case-Control Analysis and the Death Certificate Analysis Had Conflicting Results**

Occupation	Case-control analysis			Death certificate analysis	
	Cases	RR <sup>a</sup>	95% CI <sup>a</sup>	Deaths	PMR <sup>a</sup>
Positive association in case-control analysis only <sup>b</sup>					
1. Summary motor vehicle driver	556	1.2	1.1-1.4	377	97
Taxicab driver, chauffeur	77	1.5	1.1-2.0	23	76
2. Summary railroad worker	57	1.3	0.9-2.0	104	104
Railroad mechanic, repairman	17	1.3	0.7-2.6	13	97
Railroad conductor	7	1.4	0.4-4.9	30	113
Railroad switchman	13	2.0	0.8-4.9	17	98
3. Summary construction worker	292	1.0	0.9-1.2	316	109
Cement and concrete finisher	10	1.9	0.8-4.9	6	94
Inspector, grader, weigher, construction foreman	47	1.6	1.1-2.5	110	109
4. Summary lumberman and woodworker	213	1.3	1.0-1.5	266	95
Carpenter	148	1.4	1.1-1.8	224	94
Lumberman	37	1.5	0.9-2.4	24	95
5. Summary paper processing worker	30	1.1	0.7-1.9	56	102
Misc. paper and pulp products worker	10	1.3	0.5-2.3	6	86
6. Stationary engineer	40	1.4	0.9-2.3	64	121
7. Stationary fireman or furnace operator	57	1.3	0.9-1.9	21	76
Positive association in death certificate analysis only <sup>c</sup>					
8. Chemical processing worker	58	1.2	0.8-1.7	40	135

<sup>a</sup>Relative risk (RR), adjusted for smoking. CI, confidence interval; PMR, proportionate mortality ratio.

<sup>b</sup>RR for a summary category or subcategory or for an individual category at least 1.3 or significantly elevated; PMR for summary category and all subcategories or for an individual category less than 130.

<sup>c</sup>PMR for a summary category or subcategory or for an individual category at least 130 or significantly elevated; RR for summary category and all subcategories or for an individual category less than 1.3.

pothesis [Hayes et al., 1989; Steenland et al., 1990]. The British occupational mortality data have been used as background material supporting a number of studies, such as mortality studies of coal miners and gas workers and a study of nasal cancer in the boot and shoe industry [Alderson, 1972].

Our results indicate that a standard PMR analysis of death certificate data can be effective in occupational health surveillance. The death certificate analysis of bladder cancer identified 53 percent (eight of 15) of the a priori suspect occupational associations identified in the population-based case-control study using interview data. As further evidence of agreement, of the six a priori suspect occupations not associated with risk in the case-control study, only one, chemical processing worker, was positive in the death certificate study. The case-control study, as would be expected, identified more occupations selected a priori than the death certificate study. Overall, the two studies had an agreement rate of 62 percent (13 of the 21 occupational groups), both studies being positive for eight groups and both negative for five (Fig. 1).

Although we evaluated the sensitivity of death certificate data for identifying a

priori suspect occupational groups, we did not evaluate the specificity of the data, that is, the percentage of true negatives identified by the death certificate analysis. We also chose not to compare results for other occupations because we felt it would be difficult to determine which of the negative associations were "true" negatives. We did not compare positive results for occupations other than those selected a priori, since new findings will require future confirmation. Studies testing many occupational associations typically make a number of "false positive" identifications. All positive identifications must be further evaluated in terms of the strength of the association, consistency with other studies, and biological plausibility to determine those likely to be true.

We selected the case-control study for our comparison, rather than selecting a priori suspect occupations from the literature, because we sought to compare analyses with the broadest geographical coverage. The comparison study had high potential of accuracy of the information collected using interview and cancer registry data. The availability of the Bureau of the Census occupation codes enabled us to construct accurate comparison occupation categories. The comparison study has some limitations. It is specific to ten geographical areas and limited to those industries and occupations well represented in the areas covered. Although it is the largest bladder cancer study conducted to date, the sample size is smaller than that of the death certificate study. Because many comparisons are made in the analysis, the risk estimates for some associations may be elevated due to chance.

There are a number of differences between the death certificate and the case-control analyses. First, the source of the data is different. The case-control study was based on morbidity data and the death certificate analysis on mortality data. Data from the Surveillance, Epidemiology, and End Results program show an 80% 5-year bladder cancer survival rate for white males for 1981-1986 [Gloeckler et al., 1990]. Survival may be related to access to health care and thus confounded with occupation since access to health care varies by occupation. If so, occupations in which workers have poor access to health care should have higher risks for bladder cancer in mortality data than in morbidity data, and lower risks for those occupations with good access. Second, the geographical area covered by the studies only partially overlapped. The predominant industries and industrial processes may vary among regions of the country, resulting in different occupational exposures for persons with the same job title. Third, the information on occupation was provided by the study subjects in the case-control study; in the death certificate study, it was provided by the next of kin. Fourth, the surrogate for exposure in the case-control study was "ever worked in an occupation"; in the death certificate analysis, it was "usual occupation." Fifth, the point estimates from the case-control study were controlled for smoking; there was no information on smoking in the death certificate analysis. Sixth, in the death certificate study the PMR method of analysis was used; relative risks were calculated in the case-control study. Although relative risks could be computed using the death certificate data, we used the PMR method of analysis since it is most often used to analyze death certificate data for surveillance purposes. Despite these dissimilarities between the two sets of data, however, the results of the comparison of these two standard analytical methods for occupational health surveillance are relatively consistent.

Since there are many differences between the two studies, we used a broad definition of agreement. Had we chosen a narrower definition of agreement, for

example requiring agreement of the summary category or the same subcategory, we would have found a lower rate of agreement. However, given the differences in the data sources (morbidity vs. mortality), occupational data ("ever employed" versus "usual occupation"), the coding schemes (1970 vs. 1980 Census codes), time period (1977-78 vs. 1979-1987), and geographic coverage, a broader definition seemed appropriate for surveillance purposes.

Death certificate data have a number of advantages as a resource for occupational health surveillance. They are routinely collected and coded and are relatively inexpensive to adapt for occupational mortality surveillance. The data are population-based, with complete coverage of each state included. There is little missing data. For example, in this data set, although the information on occupation is less complete than that for the other variables, sufficient information was available to code 94.8% of the records for white males to a valid occupation code. The data are collected and coded in a uniform manner by trained coders in individual state health departments. They are available for analysis in a relatively timely manner. The data can be used for all causes of death, both sexes, and all racial groups. It is feasible to collect data on many cases in a short period of time. The present U.S. database of occupational coded information represents a broad geographic and industrial coverage of the nation.

Death certificate data have a number of limitations, however, that have raised questions about their usefulness for occupational health surveillance. The information on occupation and industry is minimal. Death certificates collect information on the "usual" occupation and industry as reported by the next of kin or other surrogate for the decedent. This information is not always accurate [Gute and Fulton, 1985; McLaughlin and Mehl, 1991; Olsen et al., 1990; Schade and Swanson, 1988; Schumacher, 1986; Steenland and Beaumont, 1984; Swanson et al., 1984; Turner et al., 1987]. Death certificates contain no additional information on occupation, such as other jobs held by the decedent, workplace exposures, or length of job. The cause of death information may not be accurate [Kircher et al., 1985; Gittlesohn and Senning, 1979; Percy et al., 1981]. There is no information on potential confounders, such as smoking and alcohol consumption. However, some investigators have indirectly adjusted for smoking by using data on smoking patterns by occupation from national surveys [Beaumont et al., 1992]. This method needs to be evaluated.

We used the PMR method of analysis to be consistent with the standard analyses of state or national data sets of death certificate data. The PMR method has certain advantages for analyzing death certificate data. It does not require information about the population at risk and is a relatively inexpensive and easy method of analyzing large data sets. There are also limitations. Biases may arise from the PMR method of analysis. The PMR will overestimate risks if the overall mortality rate for an occupation or industry group is lower than that of the comparison group and will underestimate risks if the overall mortality rate is higher. The PMRs will also be biased if the rate for a common cause of death is much higher or lower than expected in the occupation or industry.

One approach that can overcome some of these limitations is to follow the initial PMR analysis with more refined analyses involving case-control designs, methods for indirect adjustment for smoking, and selection of comparison occupations having lifestyles similar to the occupations under study.

## CONCLUSIONS

Data from death certificates have many limitations and cannot be expected to identify occupationally-related disease with the sensitivity of population-based case-control interview data. Our results indicate that death certificates can provide clues to some potential occupational health problems, while others may be overlooked. But with continued collection and routine analysis of these and other surveillance data, consistent findings across studies can lead to a body of evidence that will provide the impetus for further study of important occupational health problems. Without such surveillance systems, we would have to rely on more costly and less timely sources of data to supply our surveillance clues.

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