Mortality Patterns among Female Nurses: A 27-State Study, 1984 through 1990

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ABSTRACT

Objectives. This study examined the mortality experience of 50 000 nurses using the National Occupational Mortality Surveillance database of death certificates.

Methods. Proportionate mortality ratios adjusted by race (White, Black, or other) and 5-year age groups were calculated for selected causes of death among female nurses vs all workers and white-collar workers.

Results. Excess deaths among nurses less than 65 years of age were seen in both comparison groups for viral hepatitis, cancer of the nasal cavities, accidental falls, suicide, and drug-related deaths. Among nurses 65 years old or older, deaths due to chronic myeloid leukemia were in excess. Proportionate mortality ratios for breast and colon cancers, diabetes, and heart disease varied by occupational comparison group.

Conclusions. These findings confirm results of previous studies and identify new associations. Redoubled efforts are called for in overcoming obstacles to reducing workplace hazards. (*Am J Public Health.* 1997;87:1539–1543)

Introduction

Nurses (i.e., registered nurses and licensed practical nurses), numbering more than 2 million workers, make up almost one fourth of the US health care workforce.[1] Most of these workers (95%) are women. Nurses face a number of potential hazards in the workplace, including (1) biological hazards such as viral hepatitis, tuberculosis, and the human immunodeficiency virus (HIV); (2) chemical hazards such as cytotoxic drugs and anesthetic agents; (3) physical hazards relating to radiation, needle-stick injuries, and patient handling; and, finally, (4) psychosocial hazards in the form of stress and shift work.[2] These exposures have been linked with outcomes such as cancers, injuries, and infectious diseases. The aim of this study was to examine these patterns of association from 1984 through 1990 using a national database of death certificates.

Materials and Methods

Analyses were conducted with data from the National Occupational Mortality Surveillance database of death certificates. Through a collaborative effort with the National Institute for Occupational Safety and Health (NIOSH), the National Center for Health Statistics (NCHS), and the National Cancer Institute, 25 states have submitted occupation-coded death certificate data to NCHS. Three additional states have provided data directly to NIOSH. The decedent's "usual occupation" was coded according to three-digit US census[3] codes, and the underlying cause of death was coded according to the ninth revision of the *International Classification of Diseases.*[4] Quality control for industry and occupation coding was maintained by NCHS.

Included in the analyses were women 15 years of age and older who had resided and died in one of the 27 states participating between 1984 and 1990. Of 2 121 677 eligible decedents, 77 500 whose death certificate listed occupation as student, never employed, or unknown or whose age was listed as less than 15 years or greater than 120 years were excluded. The study population consisted of 50 000 decedents coded as registered nurses and licensed practical nurses.

Proportionate mortality ratios (PMRs), adjusted by race (White, Black, or other) and age (5-year age groups), were calculated for selected causes of death for female nurses less than 65 years of age (working-age nurses) and 65 years of age and older (older nurses). A computer program developed at NIOSH[5] was used in these calculations. Proportionate mortality ratios compared the proportion of deaths among nurses for a specific cause of death with the proportion of deaths for that cause among women in all occupations (including housewives) and among women in white-collar occupations (managerial, professional, technical, sales, and administrative [census codes 003 through 389]). A white-collar comparison was made to identify potential differences due to socioeconomic status.

We calculated 95% confidence intervals using the Mantel–Haenszel chi-square[6]; when the observed number of deaths was fewer than 1000, we used the variance from a Poisson distribution.[7] We considered elevated proportionate mortality ratios of 125 or higher based on 10 or more deaths to be noteworthy, whether or not the lower bound of the confidence interval included 100. We also took into consideration the patterns of variation in proportionate mortality ratios of white-

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TABLE 1—Proportionate Mortality Ratios (PMRs) and 95% Confidence Intervals (CIs) for Selected Infectious Diseases by Age and Occupational Comparison Group: National Occupational Mortality Surveillance Database, 1984 through 1990

	Nurses vs All Workers						Nurses vs White-Collar Workers					
	Working-Age Group			Older Group			Working-Age Group			Older Group		
Cause of Death	Deaths	PMR	95% CI	Deaths	PMR	95% CI	Deaths	PMR	95% CI	Deaths	PMR	95% CI
All infectious and parasitic disease	223	107	94, 122	552	101	93, 110	223	112	98, 128	552	102	94, 111
Tuberculosis	8	146	63, 288	14	94	52, 158	8	288	98, 449	14	102	56, 171
HIV	41	114	82, 155	5	246	80, 575	41	99	71, 135	5	165	54, 385
Viral hepatitis	29	175	117, 252	19	97	58, 152	29	171	115, 246	19	106	64, 166

Note. White-collar occupations include managerial, professional, technical, sales, and administrative workers.

TABLE 2—Proportionate Mortality Ratios (PMRs) and 95% Confidence Intervals (CIs) for Selected Cancers, by Age and Occupational Comparison Group: National Occupational Mortality Surveillance Database, 1984 through 1990

	Nurses vs All Workers						Nurses vs White-Collar Workers					
	Working-Age Group			Older Group			Working-Age Group			Older Group		
Cause of Death	Deaths	PMR	95% CI	Deaths	PMR	95% CI	Deaths	PMR	95% CI	Deaths	PMR	95% CI
All MN	4899	101	99, 103	7748	105	103, 106	4899	87	85, 88	7748	92	90, 94
MN: colon	406	113	102, 125	1011	104	98, 110	406	92	83, 101	1011	91	85, 96
MN: liver/bile ducts	36	80	56, 111	107	105	86, 127	36	73	51, 101	107	103	85, 125
MN: breast	1393	111	106, 116	1247	108	102, 114	1393	86	82, 90	1247	86	81, 91
MN: kidney	88	121	97, 149	125	92	77, 110	88	104	83, 128	125	91	75, 108
MN: pancreas	204	117	102, 135	517	113	103, 123	204	92	79, 105	517	102	94, 111
MN: nasal cavities	9	212	97, 402	7	109	44, 225	9	183	84, 347	7	99	40, 204
MN: brain and nervous system	186	126	108, 145	145	108	88, 118	186	102	88, 118	145	90	76, 106
Acute lymphoid leukemia	10	89	43, 164	13	120	64, 205	10	70	34, 129	13	112	60, 192
Chronic lymphoid leukemia	17	150	88, 241	60	99	75, 127	17	127	74, 204	60	90	69, 116
Acute myeloid leukemia	52	99	74, 130	87	121	97, 150	52	85	63, 111	87	109	88, 135
Chronic myeloid leukemia	24	96	61, 142	44	157	114, 211	24	79	51, 118	44	132	96, 177

Note. White-collar occupations include managerial, professional, technical, sales, and administrative workers. MN = malignant neoplasms.

collar workers and all workers in assessing results.

The outcomes of interest included deaths from infectious diseases, cancers, and injuries. We chose those outcomes for which an increased risk among nurses had previously been reported and for which potential exposure–disease associations had been described.[8,9]

Results

Of 2 044 177 records for female decedents, 89% were coded as White, 10.4% were coded as Black, and 0.5% were coded as other. White-collar occupations were reported for 13.4% of Black women and 26.3% of White women. Nurses made up 2.4% of all workers.

Table 1 shows substantially elevated proportionate mortality ratios for viral hepatitis among working-age nurses in both occupational comparison groups (PMRs = 175 and 171). Although the number of tuberculosis deaths was small (n = 8) and the confidence intervals wide, proportionate mortality ratios were elevated for working-age nurses, especially in comparison with white-collar workers (PMR = 288). No excess deaths were seen for HIV among working-age nurses. Proportionate mortality ratios were elevated for older nurses, although the number of deaths in this group was small and the confidence intervals were wide.

Table 2 presents proportionate mortality ratios for selected cancer deaths. Ratios for breast and colon cancer were slightly higher than expected for nurses in comparison with all workers and lower than expected in comparison with white-collar workers. The number of deaths due to chronic lymphoid leukemia was higher than expected for working-age nurses in both occupational comparisons (PMRs = 150 and 127). Chronic myeloid leukemia deaths were in excess for older nurses in both comparison groups (PMRs = 157 and 132). More deaths than expected were seen for malignant neoplasms of the nasal cavities among working-age nurses in comparison with all workers as well as with white-collar workers (PMRs = 212 and 183), although the confidence intervals were wide. Working-age nurses had a

TABLE 3—Proportionate Mortality Ratios (PMRs) and 95% Confidence Intervals (CIs) for Selected Causes of Death by Age and Occupational Comparison Group: National Occupational Mortality Surveillance Database, 1984 through 1990

	Nurses vs All Workers						Nurses vs White-Collar Workers					
	Working-Age Group			Older Group			Working-Age Group			Older Group		
Cause of Death	Deaths	PMR	95% CI	Deaths	PMR	95% CI	Deaths	PMR	95% CI	Deaths	PMR	95% CI
Diabetes mellitus	356	105	95, 117	840	86	80, 92	356	137	123, 152	840	110	103, 118
Heart disease	2396	92	87, 96	14 846	97	96, 98	2396	111	107, 114	14 846	104	102, 105
Ischemic heart disease	1467	91	89, 96	9 823	96	95, 98	1467	111	106, 116	9 823	104	102, 106
Chronic liver disease/cirrhosis	296	92	82, 104	252	100	88, 113	296	115	103, 129	252	101	89, 114
Accidental poisonings	63	140	108, 179	15	96	53, 158	63	177	136, 226	15	116	65, 191
Accidental falls	49	145	107, 191	249	100	88, 113	49	150	111, 198	249	92	81, 104
Suicide/self-inflicted injury	398	126	114, 139	68	123	95, 156	398	116	105, 128	68	109	85, 138
Homicide	167	97	83, 113	15	61	34, 101	167	95	81, 111	15	52	29, 86
Alcohol-related deaths[a]	164	80	68, 94	32	110	84, 142	164	109	93, 127	32	94	72, 121
Drug-related deaths[b]	257	171	151, 194	59	107	73, 151	257	175	154, 198	59	105	72, 148

Note. White-collar occupations include managerial, professional, technical, sales, and administrative workers.
[a]ICD codes include 291, 303, 3050, 3575, 4255, 5353, 5710–5713, 7903, 8600, and 8601.
[b]ICD codes include 292, 304, 3052–3059, 850–858, 9500–9505, 9620, and 9800–9805.

small excess of kidney cancer (PMR = 126) and brain and nervous system cancers (PMR = 117) only in comparison with all workers. No excess deaths due to liver cancer were seen.

Table 3 shows excess mortality due to diabetes for nurses only in comparison with white-collar workers (PMRs = 137 and 110). Fewer than expected deaths due to heart disease were seen in comparison with all workers. A small increase in chronic liver disease and cirrhosis occurred only among working-age nurses in comparison with white-collar workers. Working-age nurses had elevated proportionate mortality ratios for accidental poisonings from drugs and medications (PMRs = 140 and 177), accidental falls (PMRs = 145 and 150), and drug-related deaths (PMRs = 177 and 175) relative to both occupational groups. Somewhat higher ratios for suicide were seen in the comparison with all workers than in the white-collar comparison (PMRs = 126 and 116). Proportionate mortality ratios were not elevated for homicides or for alcohol-related deaths.

Discussion

Analyses were conducted to examine variation in mortality patterns of working-age and older nurses. We included housewives in the category of all workers. Housewives are unpaid workers who undertake a variety of tasks and face many physical and psychological burdens associated with the domestic role. In addition, participation in the workforce may be part time or irregular, with childbearing and child-rearing responsibilities being primary.

White-collar workers were used as a comparison group for nurses to allow a crude adjustment for differences in socioeconomic status. The elevated proportionate mortality ratios seen for both comparison groups strengthen the case for an association between occupational exposures and the outcome. On the other hand, excess deaths (or fewer than expected deaths) due to a particular cause seen only in comparison with the all-workers group may be due to lifestyle factors, education, screening practices, reproductive history, or differential access to medical care.

The results of this analysis showed excess mortality among working-age nurses for viral hepatitis, chronic lymphoid leukemia, and cancer of the nasal cavities, as well as for accidental falls, accidental poisonings, and drug-related deaths, regardless of which occupational comparison group was used. Among older nurses, deaths due to chronic myeloid leukemia were in excess in comparison with either occupational group. Excess mortality from brain cancer was seen only for working-age nurses in comparison with all workers. Proportionate mortality ratios for suicide were higher than expected in all categories, although they exceeded 125 only for working-age nurses in comparison with all workers. For breast and colon cancers as well as heart disease and diabetes, ratios varied with respect to the occupational comparison group.

Viral hepatitis, specifically hepatitis B, has long been recognized as an occupational hazard in health care workers as a result of their exposure through needle-stick injuries and contamination of wounds and abrasions.[10] HIV infection has also occurred among health care workers, primarily through needle-stick injuries.[11–13] Although we found no excess of HIV deaths among working-age nurses, any possible excess may not be represented in these data because of the latency of 10 to 15 years between HIV infection and mortality. Recent evidence shows a reversal in the decline of tuberculosis that has been associated with HIV infection, low-income populations, residents of correctional institutions, alcoholics, and drug users.[14,15] Occupational risk increases with increased exposure to these high-risk groups.

A number of studies have shown nurses to be at risk for leukemia.[9,16–18] Chemotherapeutic agents have been shown to be mutagenic and carcinogenic in animals and are associated with secondary tumors in humans, especially leukemias.[19–21] Exposures to anesthetic gases and ethylene oxide are thought to increase the risk of leukemias.[22] In addition, health care workers face potential exposure to

ionizing radiation through many diagnostic and therapeutic procedures.[23] The excess of brain and nervous system cancers in our study for working-age nurses only (in comparison with all workers) is suggestive of a diagnostic bias.[24] Nevertheless, several studies have suggested an occupational risk for brain tumors[25,26] in which exposures to formaldehyde or other chemicals, radiography, and amalgams have been implicated.[23]

Animal studies note that formaldehyde induces cancer of the nasal passages in rats,[27] but studies of anatomists and other health professionals exposed to formaldehyde have not been conclusive.[28] Rather than formaldehyde, this excess may be related to other chemical exposures more common in the health care setting. Breast cancer risk, which has been associated with higher socioeconomic status and delayed childbearing, is not unexpectedly higher among nurses in comparison with all other women.[29,30] An excess of breast cancer has been reported among nurses in Wisconsin[8] and in British Columbia.[9] Delayed parity may play a role in colon cancer as well.[31]

Stress and burnout are significant risks for health care workers.[32–34] These conditions may be related to the excess mortality due to suicide previously reported among nurses.[8,9] It is worth considering whether the elevated proportionate mortality ratios for accidental poisonings due to drugs and medications may have been misclassified because they occurred among workers familiar with drug dosages. Mortality due to accidental falls was higher than expected among working-age nurses in both occupational comparison groups. Unfortunately, this data set provided no information on whether these falls occurred in the workplace. Although there are risks associated with patient handling or spills on floors, most falls in the hospital setting are not likely to be fatal, which may indicate misclassification of these deaths.

Among the limitations of this study is the lack of information on possible confounders, such as smoking and alcohol use. In addition, cause of death may be misclassified less often for nurses than for other women because of possible advantages in access to health care. Possible misclassification of occupation between registered nurses and licensed practical nurses did not permit separate analyses. Another limitation is that proportionate mortality ratios may overestimate mortality risk if the overall death rate for nurses is low in relation to the comparison occupations or underestimate risk if the death rate is high.[35] We included a white-collar comparison group with similar socioeconomic status levels and, possibly, similar overall death rates to overcome this limitation. Finally, these results should be interpreted in light of the multiple comparisons made in the analysis.

Summary

Interventions such as universal precautions and immunizations, as well as training in the handling of drugs and waste products and in the handling of patients and equipment, have been recommended and have been implemented in some workplaces.[36,37] The needs of the worker must be addressed to identify issues concerning accessibility of equipment, constraints to use of new equipment, and barriers to compliance with universal precautions. One example is the need to better understand the barriers to hepatitis B virus immunization among many nurses (disproportionately Black and of older age) who remain unvaccinated.[38] Safety and health programs, along with periodic inspection and industrial hygiene monitoring, can play an important role in the evaluation of interventions. Mortality studies also have a role in detecting changes in preventable conditions or in uncovering new problems. However, the implementation and evaluation of preventive measures require an occupational safety and health infrastructure that is being sorely tested in light of federal and state budget cuts, downsizing of the occupational health workforce, and decentralization of regulatory authority and enforcement control. Redoubled efforts are called for in overcoming the many obstacles to reducing workplace hazards. □

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Controlling Tuberculosis in an Urban Emergency Department: A Rapid Decision Instrument for Patient Isolation

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ABSTRACT

Objectives. This study examined whether data routinely available in emergency departments could be used to improve isolation decisions for tuberculosis patients.

Methods. In a large emergency department in New York City, we compared the exposure histories of tuberculosis culture-positive and culture-negative patients and used these data to develop a rapid decision instrument to predict culture-positive tuberculosis. The screen used only data that are routinely available to emergency physicians.

Results. The method had high sensitivity (.96) and moderate specificity (.54).

Conclusions. The method is easily adaptable for a broad range of settings and illustrates the potential benefits of applying basic epidemiologic methods in a clinical setting. (*Am J Public Health.* 1997;87:1543–1547)

Introduction

This study examined whether routinely available data could be used to improve isolation decisions for tuberculosis patients in an urban emergency department. The resurgence of tuberculosis in the United States has been attributed to many factors, including homelessness, increasing immigration, and the epidemic of human immunodeficiency virus (HIV).[1–9] This resurgence has been most marked in our inner cities,[10–14] where patients at high risk for tuberculosis often use an emergency department as their initial or sole source of health care.[15–18]

Effective and rapid isolation of patients with active tuberculosis in inner-city emergency departments is essential because the presence of infectious patients in this crowded setting could contribute to outbreaks of tuberculosis.[19–27] The emergence of multidrug-resistant strains has made the situation even more hazardous.[28–35] Indeed, exposure in emergency departments has been implicated in institutional transmission of tuberculosis.[36–39] Urban emergency departments are likely to be subject to long waiting times, however, and to have limited respiratory isolation space.[40] The Centers for Disease Control and Prevention (CDC) suggest that emergency departments develop protocols for rapid identification and isolation of possible tuberculosis patients, and that such protocols "be based on the prevalence and characteristics of TB in the population served by the specific facility."[41] An emergency department triage procedure for rapid chest x-ray and respiratory isolation has been published in abstract form, but only four patients in that data set (.4% of those placed into isolation) had positive sputum acid-fast bacillus smears.[42]

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