Chapter 20

Proportionate Mortality among New York Embalmers

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Since the turn of the century, formaldehyde has been the main preservative in commercial embalming fluids (1). In an industrial hygiene survey of a mortuary science college conducted by the National Institute for Occupational Safety and Health, the airborne formaldehyde concentrations exceeded 3.0 ppm in two samples when the ventilation system was closed and dropped to 0.20–0.91 ppm when the system was operating (2). A survey of six funeral homes revealed airborne formaldehyde levels ranging from 0.09–5.26 ppm, with average concentrations of 0.25–1.39 ppm. Paraformaldehyde particles with formaldehyde vapors were small enough to be deposited in the lungs (3).

In humans, formaldehyde irritates the eyes, skin, and respiratory system, but the chronic effects of exposure are unknown (4). Serious concerns were raised by preliminary results of an animal inhalation study by the Chemical Industry Institute of Toxicology, in which rats exposed to 15 ppm formaldehyde vapors developed a marked excess of nasal cancers (see Kerns et al., Chap. 11, this volume).

This preliminary study investigates whether embalmers, compared with the general population, have a greater proportion of cancer deaths that might be associated with exposure to formaldehyde.

METHODS

The licensure divisions of state health departments in several states were surveyed to determine whether records existed from which a cohort of licensed embalmers could be established. All states contacted lacked the records necessary for a retrospective cohort study. New York State, however, had maintained sufficient information on deceased embalmers so that it was possible to examine the proportion of deaths due to specific causes.

The study group consists of deceased embalmers licensed to practice embalming in New York State between 1902 and 1979. Names of decedents from 1925-1979 were obtained from records of the Bureau of Funeral Directing and Embalming in the New York State Department of Health. The Bureau offers two types of licenses: *a*) license for embalming and *b*) license for funeral directing (i.e., the general management of a funeral home). A qualified individual may apply for one license or two but cannot combine the tasks of embalming and funeral directing without having both licenses. Since exposure to formaldehyde was the variable of interest, deaths among persons who held only a funeral director's license were not included. Study subjects were identified through two data sources at the Bureau. The first was registration files of embalmers who were known to be deceased during recent years and whose files were kept at the Bureau. Each decedent's name, date of birth, first and last years of licensure, last known address, and date of death were abstracted from these files. The second source of data was a ledger in which names of all registered embalmers were entered at time of initial application. When the office was notified of a death, this fact was recorded in the ledger. For each decedent listed, the name, first year of licensure, residence, and date of death were abstracted. Forty-two percent of the study group was ascertained from registration files and 58 percent from the ledger.

Death certificates were requested for 1376 embalmers from the appropriate state vital statistics offices. At the present time, death certificates have been found for 92 percent of the decedents; 131 of these have not yet been received. Underlying cause of death was coded by a nosologist using the rules in effect at time of death and the rubrics of the 8th Revision of the International Classification of Diseases, Adapted (ICDA) (5). The deaths observed among the embalmers were compared to expected numbers computed by applying the age-, race-, sex-, and calendar year-specific proportions of deaths for each cause among the U.S. general population to the total number of deaths in the study group by 5-year age and time periods (6). Differences between observed and expected numbers of deaths for each cause were summarized in the form of the proportionate mortality ratio (PMR), which is the ratio of the number of deaths observed to that expected multiplied by 100. The statistical significance of each ratio was tested by a chi^2 test with one degree of freedom (7). PMRs and chi^2 values were not presented in tables for the total study group when both the

observed and expected numbers of deaths were less than five. Proportionate cancer mortality ratios (PCMRs) were also computed utilizing the total number of cancer deaths as the denominator for calculating the expected number of deaths for each individual cancer site (6).

It was not possible to measure length of employment or length of licensure in the analysis since year of last license was not available for decedents who were listed only in the ledger. As an alternative, length of time from first license to death was considered in the analysis.

RESULTS

Table 1 shows the race and sex distribution of the 1106 deceased embalmers. There were 1010 (91.3 percent) white males and 67 (6.1 percent) nonwhite males in the study group. The 24 males (2.2 percent) whose race was unknown and the 5 females were excluded from the analysis. (Their mortality patterns were examined separately and were not unusual.)

Table 2 shows the age distribution of the male embalmers at time of death by year of death. Fifty percent of the embalmers died before age 65. This relatively young age distribution is probably related to the fact that the Bureau is usually notified of the death of a registrant when a license renewal form is returned to the office by a surviving relative. Ninety-five percent of the embalmers for whom year of last license was known died within one year of license termination. Embalmer was listed as the usual occupation on 90 percent of the death certificates. The median birth year for those in the study group was 1901 and the median year of initial license was 1931.

Table 3 shows the numbers of deaths observed and expected and the PMRs for five major causes of death among white males. The excess of deaths from all malignant neoplasms (PMR = 108) was not statistically significant. An elevated ratio of deaths due to diseases of the circulatory system was largely attributable to a significant excess of arteriosclerotic heart disease (PMR = 111). There was a deficit of diseases of the respiratory system, with deaths from pneumonia being significantly lower than expected. Among diseases of the digestive system, there was an elevated mortality due to cirrhosis of the liver. The PMR was significantly low for accidental deaths but slightly elevated for suicides.

The number of deaths observed among nonwhites was small (Table 4). As

Table 1 Distribution of Deceased Embalmers by Sex and Race

	White	Nonwhite	Unknown race	Total
Male	1010	67	24	1101
Female	4	1	0	5
Total	1014	68	24	1106

Table 2 Distribution of Deaths Among Male Embalmers by Age at Death and Year of Death, All Races Combined

Age at death	1925–54	1955–59	1960–64	1965–69	1970–74	1975–79	All calendar years	%
20–39	7	4	6	5	3	3	28	2.6
40–44	7	12	5	7	6	8	45	4.2
45–49	12	9	9	6	10	9	55	5.1
50–54	13	25	8	17	20	13	96	8.9
55–59	19	20	14	42	30	25	150	13.9
60–64	20	25	21	24	38	31	159	14.8
65–69	18	26	20	42	30	43	179	16.6
70–74	13	9	23	37	36	36	154	14.3
75–79	7	9	10	25	34	24	109	10.1
80+	5	12	6	10	36	33	102	9.5
All age groups	121	151	122	215	243	225	1077	
%	11.2	14.0	11.3	20.0	22.6	20.9		

Table 3 Numbers of Deaths and Proportionate Mortality Ratios (PMR) for White Male Embalmers by Major Cause of Death

Cause of death (ICDA Code, 8th Revision)	Number of deaths		PMR	Chi^2 value
	Observed	Expected		
Malignant neoplasms (140–209)	210	193.7	108	1.71
Circulatory system (390–458)	587	558.6	105	3.34
Arteriosclerotic heart disease (410–414)	428	384.8	111	7.97†
Cerebrovascular diseases (430–438)	87	80.1	109	0.66
Respiratory system (460–519)	47	60.0	78	2.99
Pneumonia (480–486)	13	22.4	58	4.08*
Emphysema (492)	11	15.9	69	1.59
Digestive system (520–577)	53	47.0	113	0.84
Gastric and duodenal ulcers (531, 532)	8	7.9	102	0.00
Cirrhosis of liver (571)	29	22.5	129	1.94
External causes (800–999)	50	74.4	67	9.67†
Accidents (800–949)	27	50.4	54	12.36†
Suicide (950–959)	21	18.5	114	0.36
All other causes	63	76.3	83	
All causes of death	1010	1010.0	100	

*$p < 0.05$.
†$p < 0.005$.

Table 4 Numbers of Deaths and Proportionate Mortality Ratios (PMR) for Nonwhite Male Embalmers by Major Cause of Death

Cause of death (ICDA Code, 8th Revision)	Number of deaths		PMR	Chi^2 value
	Observed	Expected		
Malignant neoplasms (140-209)	18	12.2	148	3.49
Circulatory system (390-458)	38	35.8	106	0.29
Arteriosclerotic heart disease (410-414)	27	17.9	151	6.46*
Cerebrovascular diseases (430-438)	3	8.5	35	4.08*
Respiratory system (460-519)	0	4.0		4.29*
Pneumonia (480-486)	0	2.2		
Emphysema (492)	0	0.5		
Digestive system (520-577)	4	2.3		
Gastric and duodenal ulcers (531, 532)	1	0.4		
Cirrhosis of liver (571)	1	0.9		
External causes (800-999)	1	4.2		
Accidents (800-949)	1	2.8		
Suicide (950-959)	0	0.2		
All other causes	6	8.5	71	
All causes of death	67	67.0	100	

*$p < 0.05$.

in white males, there was a nonsignificant excess of malignant neoplasms (PMR = 148) and a significant excess of arteriosclerotic heart disease (PMR = 151). Deaths due to respiratory diseases and external causes were lower than expected.

The distribution of malignant neoplasms by primary site among white males is shown in Table 5. The number of deaths from cancer of the buccal cavity and pharynx approximated the expected value and did not include any deaths from nasopharyngeal cancer. Mortality from cancers of the digestive tract was close to that expected, but there was an excess of colon cancer and a deficit of rectal cancer. Respiratory cancer mortality was not unusual. No deaths were attributed to nasal cancer, although the expected value was only 0.7. There was a significant excess mortality from skin cancer. Four of the eight cases were malignant melanoma (PMR = 231), three were squamous cell carcinoma, and one was unspecified. There was a slight excess of kidney cancer (8 deaths versus 4.7 expected), cancer of the brain and central nervous system (8 deaths versus 5.1 expected), and leukemia (10 deaths versus 7.6 expected). The cell types of leukemia were as follows: five myelogenous (four acute and one NOS), one acute monocytic, three lymphatic (two chronic and one NOS), and one acute leukemia NOS.

Proportionate cancer mortality ratios among white males were low for cancers of the stomach (PCMR = 72), rectum (PCMR = 23), and prostate (PCMR = 79). Elevated PCMRs were seen for cancers of the lung (PCMR = 107),

Table 5 Numbers of Deaths Due to Malignant Neoplasms and Proportionate Mortality Ratios (PMR) for White Male Emblamers

Cause of death (ICDA Code, 8th Revision)	Number of deaths		PMR	Chi² value
	Observed	Expected		
All malignant neoplasms (140–209)	210	193.7	108	1.71
Buccal cavity and pharynx (140–149)	8	6.4	126	0.43
Digestive organs and peritoneum (150–159)	59	58.4	101	0.01
Esophagus (150)	4	4.7		
Stomach (151)	11	12.2	90	0.12
Colon (153)	25	18.0	140	2.78
Rectum (154)	2	7.0	29	3.59
Liver and gallbladder (155, 156)	4	4.3		
Pancreas (157)	12	11.0	110	0.10
Respiratory system (160–163)	63	61.9	102	0.02
Larynx (161)	2	3.0		
Lung and pleura (162, 163)	61	58.2	105	0.14
Skin (172, 173)	8	3.2	253	7.40*
Prostate (185)	13	14.5	89	0.16
Bladder (188)	6	6.5	92	0.04
Kidney (189)	8	4.7	170	2.26
Brain and central nervous system (191, 192)	8	5.1	157	1.68
Lymphatic and hematopoietic system (200–209)	21	18.2	115	0.44
Lymphosarcoma and reticulosarcoma (200)	4	4.2		
Hodgkin's disease (201)	2	2.0		
Other lymphatic cancers (202, 203)	5	4.2	118	0.14
Leukemia (204–207)	10	7.6	132	0.80
Other cancers	16	14.8	108	

*$p < 0.01$.

skin (PCMR = 206), kidney (PCMR = 157), and brain (PCMR = 136). This pattern is consistent with the PMR analysis except the PCMR was lower than expected for cancers of the stomach and prostate.

The distribution of malignant neoplasms among nonwhite males is presented in Table 6, although the numbers of deaths are small.

Mortality for selected cancer sites among white males was examined by latency period, defined as length of time from first license to death (Table 7). Since almost all of the embalmers in this study were licensed at time of death, latency period is assumed to be synonymous with length of licensure. Although the numbers involved are small, mortality from skin cancer was significantly greater than expected (PMR = 354) among those licensed for 35+ years. On the other hand, the elevated PMR for kidney cancer was limited to embalmers licensed under 35 years. No unusual patterns were seen for cancers of the brain and lymphatic-hematopoietic system.

Mortality patterns by age at first license are shown in Table 8. Excess

Table 6 Numbers of Deaths Due to Malignant Neoplasms and Proportionate Mortality Ratios (PMR) for Nonwhite Male Emblamers

Cause of death (ICDA Code, 8th Revision)	Number of deaths		PMR	Chi^2 value
	Observed	Expected		
All malignant neoplasms (140–209)	18	12.2	148	3.49
Buccal cavity and pharynx (140–149)	0	0.4		
Digestive organs and peritoneum (150–159)	5	4.1	123	0.23
Respiratory system (160–163)	5	3.3	150	0.89
Larynx (161)	2	0.2		
Lung (162, 163)	3	3.1		
Skin (172, 173)	0	0.1		
Prostate (185)	3	1.9		
Bladder (188)	1	0.3		
Kidney (189)	1	0.2		
Brain and central nervous system (191, 192)	0	0.1		
Lymphatic and hematopoietic system (200–209)	2	0.8		
Other cancers	1	1.0		

mortality due to skin and brain cancers was seen among those who began to practice embalming at age 30 or later.

Cancer mortality was examined separately for persons licensed only as embalmers and for those who held licenses for both embalming and funeral directing. We assumed that persons licensed only as embalmers accumulated a longer average exposure to formaldehyde than embalmers who were also

Table 7 Observed Numbers of Deaths with Proportionate Mortality Ratios for White Male Embalmers by Length of Time From First License to Death

Underlying cause of death category (8th Revision, ICDA)	Length of time from first license to death					
	< 35 yr (n = 551)			35+ yr (n = 459)		
	O	PMR	Chi^2	O	PMR	Chi^2
All malignant neoplasms (140–209)	109	107	0.54	101	110	1.26
Respiratory system (160–163)	34	106	0.11	28	94	0.11
Skin (172, 173)	4	196	1.90	4	354	7.32†
Kidney (189)	6	223	4.09*	2	98	0.00
Brain and central nervous system (191, 192)	6	169	1.72	2	129	0.13
Lymphatic and hematopoietic tissue (200–209)	11	106	0.04	10	127	0.60

O = Observed number of deaths.
*$p < 0.05$.
†$p < 0.01$.

Table 8 Observed Numbers of Deaths with Proportionate Mortality Ratios for White Male Embalmers by Age at First License

Underlying cause of death category (8th Revision, ICDA)	Age at first license: Before age 30 ($n = 578$) O	PMR	Chi^2	After age 30 ($n = 432$) O	PMR	Chi^2
All malignant neoplasms (140–209)	130	113	2.29	80	102	0.05
Respiratory system (160–163)	42	105	0.12	21	95	0.05
Skin (172, 173)	3	151	0.52	5	424	12.41*
Kidney (189)	4	136	0.37	4	224	2.77
Brain and central nervous system (191, 192)	3	84	0.09	5	328	7.98*
Lymphatic and hematopoietic tissue (200–209)	15	133	1.23	6	87	0.12

O = Observed number of deaths.
*$p < 0.01$.

Table 9 Observed Numbers of Deaths with Proportionate Mortality Ratios for White Male Embalmers by License Type

Underlying cause of death category (8th Revision, ICDA)	Type of license: Embalmer only ($n = 528$) O	PMR	Chi^2	Both embalmer and funeral director ($n = 482$) O	PMR	Chi^2
All malignant neoplasms (140–209)	103	108	0.70	107	109	1.02
Respiratory system (160–163)	26	94	0.09	37	107	0.21
Skin (172, 173)	5	337	8.34†	3	178	1.04
Kidney (189)	6	256	5.75*	2	84	0.07
Brain and central nervous system (191, 192)	6	245	5.17*	2	76	0.15
Lymphatic and hematopoietic tissue (200–209)	8	91	0.07	13	138	1.40

O = Observed number of deaths.
*$p < 0.025$.
†$p < 0.005$.

funeral directors. Table 9 shows that mortality from skin, kidney, and brain cancers was significantly elevated for those who were licensed only as embalmers. No unusual mortality was observed among those who held both licenses.

DISCUSSION

Using the proportionate mortality approach, embalmers in this study experienced a slightly elevated mortality from cancer, a significant excess of arteriosclerotic heart disease, and a significant deficit of pneumonia and accidental deaths. Skin cancer mortality was significantly elevated, with the excess primarily among those licensed for more than 35 years and those who began employment at age 30 or later. Also elevated was the proportionate mortality from kidney and brain cancers. There was no excess mortality from cancers of the respiratory tract, including the nasal passages. This is noteworthy in view of reports that formaldehyde induces nasal cancer in rats following inhalation. In our study, the excesses of cancers of the skin, kidney, and brain suggest that the further investigation of the carcinogenic effects of formaldehyde should not be limited to the respiratory system. It must be borne in mind, however, that embalming fluids contain a mixture of other chemicals (e.g., tissue moisturizers, antiseptic solutions, dyes, and deodorizers) that are partly intended to offset the adverse reactions of formaldehyde (1, 8).

This study was intended as a preliminary investigation of the chronic effects of exposure to formaldehyde and has several deficiencies. Length-of-employment information was unavailable for those in the study group, and ascertainment of deaths among retirees was incomplete. Of special concern are the weaknesses of the proportionate mortality method, especially the uncertainty that an excess proportion of deaths from a specific cause reflects a real elevation of mortality or a deficit in the proportion of deaths from other causes. Despite these limitations, our findings suggest a need for cohort studies of embalmers and other workers exposed to formaldehyde to quantify the risks of various cancers in relation to job exposures.

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