Risks of Pathologists Exposed to Formaldehyde

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Final Report

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Background, Objectives

The scientific goal of this project is to determine if a population of pathologists with formaldehyde exposure demonstrates an excess risk of cancer, particularly cancers of the nasopharyngeal and pharyngeal areas, sites found to have excesses in animal populations exposed to formaldehyde.

A population of 6411 physicians who would have had occupational exposure to formaldehyde because of their membership in pathology societies has been established through the use of American Medical Association (AMA) records. Of these 6411 pathologists an estimated 2768 individuals belong to the American Association of Pathologists and Bacteriologists (AAPB) and the American Society for Experimental Pathology (ASEP), two societies which have been under follow-up for several years as part of another study of professionals (refer to Chart I). Members of both societies have been followed from entry into the society (as early as 1900 for AAPB and 1913 for ASEP), with mortality data ascertained through 1978. An additional 3643 pathologists were included since they were members of other pathology societies. Tables 1-3 list the pathology societies included in the study. These societies were listed in the AMA Directory from 1912 through 1950. Death certificates have been ascertained on 3535 deceased members of this cohort, refer to table 7. A professional society of psychiatrists, with membership in the American Psychiatric Association from 1872-1974, has been followed over the same time period and will be used as the control group.

Methods

The American Medical Association Directory (AMA) was the major source used to establish the study's population database of a total of 6411 Pathologists. During the years 1912 through 1950 inclusive the AMA directory published Pathology, Bacteriology and Anatomy professional society membership rosters (refer to tables 1-3). Members of these societies were identified from these lists for all societies except the American Association of Pathologists (AAPB) and the American Society for Experimental Pathology (ASEP). The databases of these latter two societies were established from lists of members provided by the societies themselves, and the population was followed during previous studies. The data were combined with the Pathologist file (refer to chart I) and the vital status of the members were updated through 1978 using the same AMA follow-up methods described below. Individual record cards which included the member's name, society code and society entry year were prepared for each member of the societies. Often a member belonged to more than one society and as a result, overlapping membership of pathological societies occurred (refer to table 1). The earliest year of entrance into the pathological society is used as the individual's entry date into the study. For AAPB and ASEP, "entry date" is the actual date when the pathologist was elected into the society. For the other societies, "entry date" is the first year when the pathologist's name appeared on the AMA listing of that society.

The American Medical Association Directory (AMA) was the major source used to obtain information for the follow-up of the study population. The names of the society members were searched in each AMA Directory to identify the last year in which the physician was known to be alive. Physicians who disappeared from the directory were assumed dead. The published obituaries in the Journal of the American Medical Association (JAMA) were searched to determine the date and place of death for these individuals. The AMA Directories of 1912 through 1979 were searched. If the study subject's name appeared in the 1979 AMA directory which indicated November 1978 as the last entry date for publication, then he was considered alive and as a result, was not searched in JAMA. It was assumed that death occurred around the last year the study subject no longer appeared in the AMA Directory. As a result, a "range of death years" was developed based on the last year the name appeared in the AMA and the subsequent published year of the AMA. For example, a study subject first appeared as a society member in the 1940 AMA directory. He was followed in the subsequent published directories until his name was dropped, presumably due to death, from the directory. The last year that the subject's name appeared in the directory was 1969. Since the next directory was published in 1973, the "range of years" used for follow-up was 1968 through 1974. Due to the time elapsing from the date of death and the reporting of the death in JAMA a "range of death years", representing the year before the last year the name was listed in the AMA and the year after the next published AMA year, was developed.

The following problems were encountered when searching for the study subjects in the AMA directory:

1. father and son having the same name
2. maiden name changes due to marriage
3. misspelled last names
4. individuals having the same name
5. the society member was not a physician, and, as a result, the individual was not listed in the AMA Directory.

A society member who could not be located in any of the AMA Directories was presumed to be a non-physician. In these cases, the individual had no AMA number which was used as an additional identifying variable. It is a general rule that all physicians, upon medical school graduation, automatically are listed in the AMA Directory. As a result, the AMA method of following physicians was not useful when following the non-physicians (Ph.D.s) in the study population. As a result, the American Men and Women of Science (AMWS), a second follow-up source, was utilized. Usually a notation was made in the AMWS directory if the study subject was known to be deceased. In addition, the AMWS listed the individuals name, birth date, address and educational degrees. A "range of death years" was developed employing the same methods used when searching the AMA Directory. In some cases, the physicians who were difficult to search in the AMA Directory were also searched in the AMWS. Using the additional information found in the AMWS, the "range of death years", based on the AMA Directory information, was narrowed. This dual method of follow-up was also useful when requesting death certificate information.

The names of society members who were presumed to be deceased were subsequently searched in the Journal of the American Medical Association (JAMA) obituaries using the "range of death years" which had been developed. The following information was obtained from the obituaries:

1. verification of the subject's name
2. place of death
3. residence
4. age at death
5. death month and year
6. cause of death - if known

The study subjects not found in JAMA were put aside and subsequently researched in the AMWS along with the non-physician Ph.D. group.

For purposes of analysis members in each society were matched and individuals with duplicate membership were coded for each society to which they belonged. Then a non-duplicated listing of pathologists was formed which included 6111 males and 300 females.

Classification of Vital Status

Table 4 shows that 2559 subjects out of a total population of 6411 were found to be alive. This represents approximately 40 percent of the total population. The subject was classified as "alive" only if his name appeared in the 1979 edition or later editions of the AMA. This method was difficult to use when following the alive status of the non-physician group. As a result, a total of 65 study subjects (1 percent of the total

population) were "presumed alive". The small percent of this population which are living reflects the age of these societies.

The vital status of 140 deaths could not be determined by the usual follow-up methods. As a result, these study subjects were classified as presumed dead. This category represented 2 percent of the total population. The placement decisions into the "presumed alive" and the "presumed dead" categories were dependent upon the follow-up status of the study subject. For instance, if the study subject was followed through many years of the AMA Directory before his name disappeared, he/she was placed in the "presumed dead" category. The standard study follow-up methods to determine a date of death would be applied. Therefore, suggestive information was found to conclude that these subjects were dead. The last directory year of any known information was used as the withdrawal year if no date of death was found. In contrast, if we were unable to confirm the study subject's vital status through the usual AMA and AMWS follow-up methods and, if no identifiable death information was found, they were placed in the "presumed alive" category. As previously mentioned, the usual follow-up methods could not be applied to the non-physician group. As a result, they were "presumed alive" and the latest year of any known information was used as the withdrawal year. Some judgement was required in determining the follow-up status. The age distribution of the pathologists and psychiatrists by entry years are shown in tables 5 and 6 respectively. Despite the fact that the age distribution of the two groups is not very similar, the comparison society of psychiatrists is large enough so that their membership can be used for comparison for any year.

For both the psychiatrists and pathologists about 16 to 21 percent of the population enter the societies at ages above 45 years.

Death Certificate Ascertainment

The JAMA obituary information for each study subject was provided to the Vital Records Office in the Department of Epidemiology at Johns Hopkins to use for death certificate ascertainment. Table 7 shows out of a total of 3787 deaths that 3535 death certificates were collected. This represents a 93.3% death certificate ascertainment by the Vital Records Department. In addition, 3.0% of the deaths reported and coded reflect the information found in the JAMA obituary notices. These deaths represent a group of deaths for which the Vital Records Department was unable to locate a death certificate. As a result, for this group, the cause of death and the date of death reported in the obituary notice were used in the analysis. Vital status information for the remaining 3.7% of the deaths was not reported in the JAMA obituaries and were classified as "no records". Follow-up data suggest that these members are deceased but no further information on cause or date of death could be found. As a result, these subjects were coded as dead and given an unknown cause of death code. The subject's withdrawal date reflects the last year any information was found in the AMA.

The study subject's cause of death was obtained from the death certificate or the JAMA obituary notices. The underlying cause of death was coded in both the 7th and the 8th Revision of the International Classification of Diseases (ICD). The American Association of Pathologists

(AAPB) and the American Society for Experimental Pathology (ASEP) databases were previously coded in the 7th revision. As a result, an ICD computerized conversion program developed at Johns Hopkins was used to convert the 7th revision codes to 8th revision. Some of the more difficult death codes, specifically the cancers, were re-coded by the senior nosologist.

To assure that the ICD death coding was reliable and valid, quality control measures of the death coding were established. As a result, a 10% sample of the non-cancers and all of the cancers coded were checked by the senior nosologist. Some discrepancies were found between the two coders. In most cases these discrepancies reflected the difficulty in interpreting the causes of death. One major reason for this problem could be because some of the death certificates were old and therefore difficult to read. A second reason could be because the ICD revision guidelines may be applicable to the coding of more recent death certificates. For example, when many of these deaths occurred, the medical terminology used for diagnosis of certain diseases was different. In addition, many diseases, even some cancers as lymphomas, had no separate cause of death. For that reason, physicians would not have tried to classify some diseases separately. In the early time periods, diabetes took precedence over all other causes of death in coding underlying cause. For that reason diabetes may have been linked as the "underlying cause" by the physician. Because of these potential coding problems, all the cancers were re-coded by the Senior Nosologist. Her expertise and judgement regarding ICD death coding is used as the standard when analyzing the mortality data.

The distribution of deaths by death year as shown in table 8 will emphasize the problem of early deaths. Forth-three percent of the pathologists' deaths and 22 percent of psychiatrists' deaths occurred before 1950. Major changes in ICD classification of deaths occurred in the periods before 1950.

Analysis

The analysis compared the populations of both pathologists and psychiatrists to white males in the United States. This comparison used the program developed by R. Monson. The particular program included deaths occurring from 1925 to the current period. For that reason the total population was also truncated to include only those in the cohort who were known to be alive in 1925. For several diseases such as cancers, the specific causes of death are only included in the death system since 1940 or 1950. For that reason all deaths from that disease are omitted from that category prior to that date.

The program calculates the person-years for each age and calendar time period and multiplies the U.S. death rates by those person-years to develop expected rates. These expected numbers are compared to the observed number for fifty-five cause of death groups.

Expected rates were also generated using death rates among psychiatrists as the standard. These rates were available back to the same early time period during which pathologist deaths occurred and all death coding was done in the same way in both populations. Therefore, no deaths

among pathologists were omitted because of a lack of a comparison population.

Results

The all cause standardized mortality ratios (SMRs) for both pathologists and psychiatrists are low compared to that of USWM. Both SMRs are similar, 0.79 and 0.81, for pathologists and psychiatrists respectively. As seen in table 9, the ratios for other specific causes of death such as all cancers, diseases of the circulatory system and disease of the nervous system are low or close to 1.00 indicating that the mortality rates for most diseases are lower for these specialists than for the general population. Both populations have high ratios for the category "symptoms and ill-defined conditions" which may reflect the high proportion of physicians who died at advanced ages. As reported in other studies, the psychiatrists had a high SMR for suicides.

Table 10 presents the SMRs for solid cancers at several sites. Most SMRs are not high and, in fact, many are significantly low in both pathologists and psychiatrists. In fact, the SMR for cancers of the buccal cavity and pharynx was only 0.52 and for respiratory system cancers was 0.56 in pathologists. These sites are worthy of note because they are the sites which might have demonstrated risks in relation to formaldehyde exposure. The SMRs for these sites show similar values for psychiatrists. However, one site does have a significantly high SMR and that is pancreatic cancer in pathologists, a site which was also associated with excess mortality in chemists.

The SMRs for lymphatic and hematopoietic cancers are shown in table 11. Almost all of these sites are high for pathologists except for Hodgkin's disease which is primarily a disease of the young. For almost all of these sites, psychiatrists have low ratios. None of the differences in pathologists are significant but the variation in results between these specialists and psychiatrists is of interest. The question arises whether chemicals or other factors common to the work of pathologists may be causing these variations.

Although for both the pathologists and psychiatrists the SMRs for diseases of the nervous system are low, the overall rate is dominated by vascular lesions of the central nervous system. It is possible that the infrequent neurologic conditions, especially those that might be infectious in origin, could differ between the two groups. In order to see whether any lesions were worth investigating further, the 38 deaths in pathologists and the 35 deaths in psychiatrists. Table 12 shows the distribution of the specific causes of these lesions. The category of paralysis agitans occurs frequently among the pathologists. A comparison of the mortality from this disease in the two specialty groups will be presented below.

The problem with using U.S. data as comparison is that the mortality rates of physician specialists are generally low and all SMRs using the general population standard might be anticipated to be low. There are probably differences in socioeconomic factors as well as differences in access to medical care which could account for this variation. This was especially true in the early calendar periods reported in this study. Therefore, the use of the psychiatrist's mortality rate for comparison

would represent a more similar group socioeconomically and diagnostically than the general population.

Table 13 presents the standardized mortality ratios for all causes, paralysis agitans and arteriosclerotic heart disease using the psychiatrists population as the standard. The pathologists have similar SMRs below 1.00 for both all cause and arteriosclerotic heart disease deaths suggesting their mortality for these diseases is lower than that of psychiatrists. However the risk of paralysis agitans appears to be 2.27 times higher in pathologists than psychiatrists.

Table 14 presents the ratios for several cancer sites which appeared high in a review of deaths of pathologists compared to the general population. When these specialists are compared to psychiatrists, the SMRs for brain, hypopharynx, kidney, pancreatic and thyroid cancers still exceed 1.00 but only pancreatic cancer appears to have significantly higher excess mortality in pathologists compared to psychiatrists. Although buccal cavity and pharynx cancers were low in both groups of physicians, hypopharynx cancer deaths are 4.70 times more common in pathologists than psychiatrists. Although this difference is not significant, it is of interest because the site may be similar to the area in animals where cancers occurred following formaldehyde exposure.

Table 15 compares the mortality for lymphatic and hematopoietic cancers in the pathologists to psychiatrists used as a standard. The SMRs suggest that all these cancers have higher mortality rates in pathologists than psychiatrists except for Hodgkin's disease. In fact, the risk of

leukemia is significantly higher in pathologists (SMR=1.68) than in psychiatrists.

Discussion

This study was undertaken to determine whether the exposure to formaldehyde which has occurred among pathologists has increased other mortality from specific diseases. Animals exposed to the chemical showed an increased risk of cancers of the nasal cavities. It was postulated that cancers in humans might occur at sites in the head and neck or respiratory system. The only cancers which fit this hypothesis were the three hypopharynx cancers in pathologists, Even though these cancers represented a risk about 4.7 times higher than that of psychiatrists, it is difficult to determine the importance of this finding in relation to formaldehyde exposure. The numbers are few; the excess occurs only with cancers at once specific area of the upper respiratory tract which may be difficult to distinguish from other areas diagnostically; and these cancers are not similar to those in animals. No other sites showed similar excesses. Although this is a site at which one might reasonably expect an excess of cancers in humans, it is hard to imagine that it would be so specific. Thus, we would need to have other populations with similar excesses from formaldehyde to suggest there is a real association.

Pathologists and other members of these societies are exposed to chemicals and infectious agents from both clinical and research activities. These exposures could also increase the risks of these specialists. Because formaldehyde is such an irritating substance it is difficult to

believe that a large dose of the agent could be absorbed and reach the pancreas or the brain. In fact, it is difficult to see how the external formaldehyde could add much to the internal dose produced by normal physiologic function. There is an apparent excess of mortality from pancreatic cancer and brain cancers as well as leukemia. Several other studies of professionals have shown excesses at these sites. Chemists have reportedly had excess risks of cancers of one or more of the following sites: pancreas, brain, and lymphatic and hematopoietic tissue (1, 2, 3, 4, 5, 6). Dentists, veterinarians and medical professionals have also been reported to have an excess of brain tumors especially gliomas (5, 6, 7). Other studies of pathologists and anatomists have reported excesses of lymphomas, leukemias and brain tumors with the excess of the latter tumors being primarily astrocytoma or glioblastoma. The study of anatomists also used the psychiatrists as a comparison population and found the brain tumor risk to be six fold (8, 9, 10).

Therefore, there are three cancer sites which are frequently reported in excess in laboratory and health professionals, pancreas, brain and lymphatic or hematopoietic cancers. The specific sites in excess may differ from study to study. The fact that formaldehyde is not necessarily a major exposure for all of these occupations suggests that this is not the cause of the excesses of these cancer sites in pathologists. Infectious agents or chemicals other than formaldehyde are more likely to be the etiologic factors. In fact, experimental evidence would suggest that the combination of viruses and chemicals might explain brain tumors especially gliomas in some of these populations.[11]

CHART I

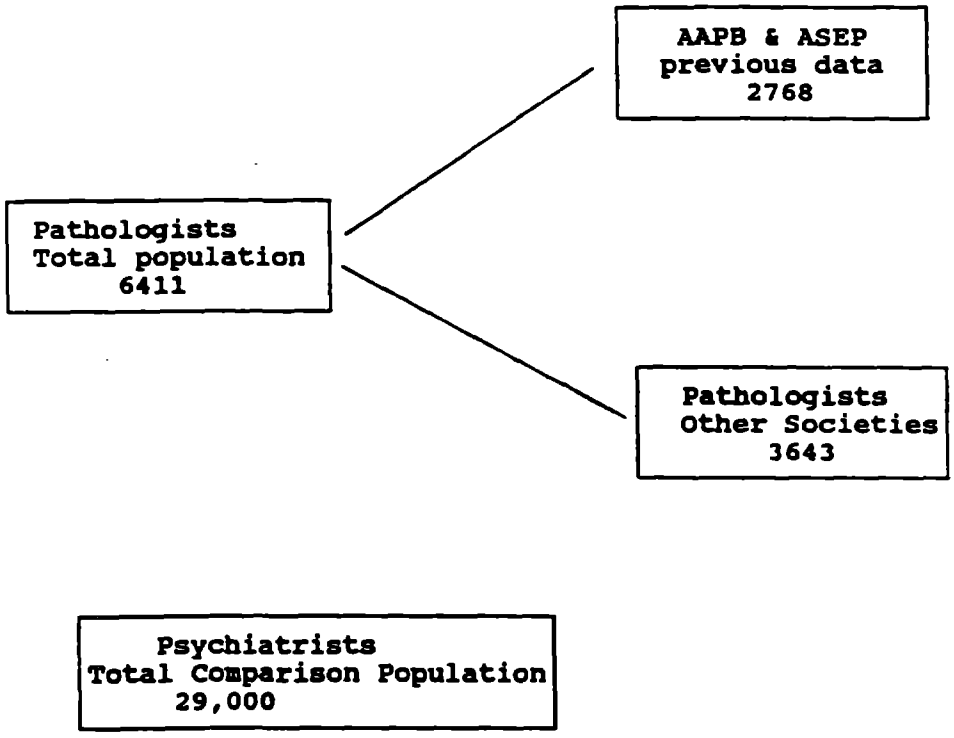
AAPB & ASEP
previous data
2768
Pathologists
Total population
6411
Pathologists
Other Societies
3643
Psychiatrists
Total Comparison Population
29,000

Table 1

Societies of Pathologists
Males Only

Society	First Year in AMA	Last Year in AMA	Number*
American Association of Anatomists	1912	1950	424
American Association of Pathologists & Bacteriologists**	1912	1950	1861
American Board of Pathology	1938	1950	869
American Society for Experimental Pathology**	1916	1950	1494
American Society of Clinical Pathologists	1923	1950	928
Atlanta - The Pathological Society	1912	1912	12
College of American Pathologists	1950	1950	464
Chicago - The Pathological Society	1912	1925	232
Des Moines Pathological Society	1912	1921	46
El Paso Clinical and Pathological Club	1925	1925	15
Lincoln - Pathological Club of Lincoln	1912	1912	17
Los Angeles - Clinical and Pathological Society	1914	1925	99
Minnesota Pathological Society	1914	1925	185
New York - Academy of Pathological Science	1912	1925	279
New York Pathological Society	1912	1925	229
Omaha Pathological Society	1912	1916	79
Philadelphia Pathological Society	1912	1925	490
Society of American Bacteriologists	1923	1950	516

Note: *Numbers represent overlapping membership in multiple societies.
**Societies include entry years before 1912 and after 1950.

Table 2

Median Age of Entry Into Each Society By Sex

Society	Median Entry Ages			
	Males		Females	
	No.	Age	No.	Age
American Association of Anatomists	424	39.0	23	38.0
American Association of Pathologists & Bacteriologists	1861	35.0	82	39.0
American Board of Pathology	869	41.0	74	44.0
American Society for Experimental Pathology	1494	37.0	70	40.0
American Society of Clinical Pathologists	928	40.0	74	43.0
Atlanta - The Pathological Society	12	37.0	0	0
College of American Pathologists	464	47.0	42	51.0
Chicago - The Pathological Society	232	39.0	11	42.0
Des Moines Pathological Society	46	40.5	0	0
El Paso Clinical and Pathological Club	15	45.5	0	0
Lincoln - Pathological Club of Lincoln	17	37.0	0	0
Los Angeles - Clinical and Pathological Society	99	44.0	1	38.0
Minnesota Pathological Society	185	39.0	4	32.5
New York - Academy of Pathological Science	279	38.0	0	0
New York Pathological Society	229	41.0	9	46.5
Omaha Pathological Society	79	39.0	0	0
Philadelphia Pathological Society	490	38.0	15	33.0
Society of American Bacteriologists	516	41.0	28	47.0

Table 3

Total Number of Living and Dead by Society
Males Only

Society	Membership by Society		
	Living	Dead	Total
American Association of Anatomists	101	323	424
American Association of Pathologists & Bacteriologists	1021	840	1861
American Board of Pathology	488	381	869
American Society for Experimental Pathology	1198	296	1494
American Society of Clinical Pathologists	370	558	928
Atlanta - The Pathological Society	0	12	12
College of American Pathologists	237	227	464
Chicago - The Pathological Society	7	225	232
Des Moines Pathological Society	0	46	46
El Paso Clinical and Pathological Club	1	14	15
Lincoln - Pathological Club of Lincoln	0	17	17
Los Angeles - Clinical and Pathological Society	2	97	99
Minnesota Pathological Society	11	174	185
New York - Academy of Pathological Science	14	265	279
New York Pathological Society	9	220	229
Omaha Pathological Society	0	79	79
Philadelphia Pathological Society	28	462	490
Society of American Bacteriologists	154	362	516

Table 4

Vital Status of Pathologists By Sex

Vital Status*	Males		Females		Total	
	No.	%	No.	%	No.	%
Alive	2418	39.6	141	47.0	2559	39.9
Presumed Alive	49	0.8	16	5.3	65	1.0
Dead	3526	57.7	121	40.3	3647	56.9
Presumed Dead	118	1.9	22	7.3	140	2.2
Total	6111	100.0	300	100.0	6411	100.0

Note: Presumed alive - not confirmed alive. No identifiable death information based on the standard follow-up methods.

Presumed dead - information suggests that subjects are dead.

*Combined population - each person counted once.

Table 5

Pathologists

Age at Entry into Societies by Ten Year Calendar Time Periods
Total Living and Dead
Males Only

	Age Groups						
Entry Years	< 30	30-34	35-39	40-44	45-49	50+	Total
< 1910	83	70	42	31	8	17	251
1910-19	220	271	355	282	204	306	1638
1920-29	137	225	274	163	128	115	1042
1930-39	68	205	193	106	55	43	670
1940-49	30	123	155	57	34	27	426
1950-59+	46	173	411	263	104	122	1119
1960-69+	31	148	265	133	39	35	651
1970-79+	16	48	70	77	30	15	256
Total	631	1263	1765	1112	602	680	6053*

*Total does not include 17 subjects having no entry years and 41 subjects havin no birth year.

+The later entry years reflect only members of the two societies whose membership was established directly through the societies from 1900 and 1913 through 1974.

Table 6

Psychiatrists

Age at Entry into Society by Ten Year Calendar Periods
Total Living and Dead
Males Only

	Age Groups						
Entry Years	< 30	30-34	35-39	40-44	45-49	50+	Total
< 1910	89	96	63	43	19	36	346
1910-19	103	144	142	87	34	67	577
1920-29	109	161	138	95	96	116	715
1930-39	121	404	262	122	100	169	1178
1940-49	423	1070	765	454	212	295	3219
1950-59	1066	2117	999	516	377	630	5705
1960-69	931	2816	1387	787	448	573	6942
1970-79	669	1842	798	367	266	279	4221
Total	3511	8650	4554	2471	1552	2165	22903

Table 7

Source of Death By Sex

Source of Death	Males		Females		Total	
	No.	%	No.	%	No.	%
Death Certificate	3425	94.0	110	76.9	3535	93.3
Obituary Notes	101	2.8	11	7.7	112	3.0
No Record*	118	3.2	22	15.4	140	3.7
Total	3644	96.2	143	3.8	3787	100.0

*Presumed Dead - information suggest study subjects are deceased.

Table 8

Pathologists and Psychiatrists

Distribution of Deaths by Ten-Year Calendar Periods
Males Only

Death Years	Pathologists		Psychiatrists	
	No.	%	No.	%
< 1910	6	0.2	6	0.1
1910-19	133	3.6	48	1.0
1920-29	287	7.9	138	2.9
1930-39	519	14.2	353	7.4
1940-49	615	16.9	492	10.3
1950-59	781	21.4	866	18.1
1960-69	730	20.0	1377	28.8
1970-79	573	15.7	1508	31.5
Total	3644		4788	

Table 9

Standardized Mortality Ratios for Selected General Causes
Males only - USWM as Standard
Deaths 1925-1978

	Pathologists				Psychiatrists			
Total Population		5,810				22,794		
			95% CI				95% CI	
	No.	SMR	LL	UL	No.	SMR	LL	UL
Causes of Death	3358	0.79	0.76	0.82	4682	0.81	0.79	0.83
Cancers	508	0.78*	0.71	0.85	723	0.67*	0.63	0.72
Diseases of Nervous System	411	0.86	0.78	0.95	433	0.90	0.81	0.98
Vascular Lesions CNS	373	0.86	0.77	0.95	397	0.92	0.83	1.02
Diseases Circulatory System	1651	0.86	0.82	0.90	2287	0.88	0.84	0.92
Arteriosclerotic Heart Dis.	1168	0.99	0.94	1.05	1725	0.87	0.83	0.91
Ill defined Conditions	137	4.14	3.48	4.90	151	2.67	2.26	3.13
External Causes	155	0.60	0.51	0.70	478	0.93	0.85	1.02
Suicides	51	0.89	0.66	1.17	218	1.76	1.53	2.01

(* Significant differences from USWM rates - either low or high - at p = 0.05 or less.)

Table 10

Standardized Mortality Ratios for Solid Cancers
Males only: USWM as Standard
Deaths 1925-1978

	Pathologists				Psychiatrists			
			95% CI				95% CI	
	No.	SMR	LL	UL	No.	SMR	LL	UL
All Cancers	508	0.78*	0.71	0.85	723	0.67*	0.63	0.72
Buccal Cavity & Pharynx	13	0.52*	0.28	0.89	21	0.59*	0.36	0.90
Digestive Organs	197	0.76*	0.66	0.87	238	0.73*	0.64	0.82
Esophagus	9	0.54	0.24	1.02	11	0.43	0.21	0.77
Stomach	31	0.37*	0.25	0.53	38	0.52*	0.37	0.71
Large Intestine	64	0.94	0.72	1.20	89	0.90	0.72	1.10
Liver	22	0.92	0.58	1.40	31	1.23	0.84	1.75
Pancreas	47	1.39*	1.02	1.85	43	0.73*	0.53	0.99
Respiratory System	77	0.56*	0.44	0.70	147	0.44*	0.37	0.52
Prostate	61	0.80	0.61	1.02	82	1.06	0.84	1.31
Kidney	14	1.05	0.58	1.77	17	0.65	0.38	1.03
Bladder	30	1.06	0.72	1.51	26	0.75	0.49	1.10
Eye	2	4.20	0.47	15.18	1	1.05	0.01	5.84
Brain	13	1.34	0.71	2.29	25	0.83	0.53	1.22
Thyroid	3	3.04	0.61	8.88	4	1.90	0.51	4.86

(* Significant differences from USWM rates - either low or high at p = 0.05 or less.)

Table 11

Standardized Mortality Ratios of Lymphatic and Hematopoietic Cancers
Males only: USWM as Standard
Deaths 1925-1978[+]

	Pathologists				Psychiatrists			
			95% CI				95% CI	
	No.	SMR	LL	UL	No.	SMR	LL	UL
All cancers	508	0.78*	0.71	0.85	723	0.67*	0.63	0.72
Lymphosarcoma and RS	11	1.31	0.66	2.35	26	1.22	0.80	1.79
Hodgkin's disease	2	0.36	0.04	1.31	14	1.09	0.60	1.83
Leukemia	31	1.35	0.92	1.92	35	0.83	0.58	1.16
Cancers of other lymphatic	13	1.54	0.82	2.63	18	0.79	0.47	1.26
All lymphopoietic	57	1.25	0.95	1.62	93	0.93	0.75	1.14

[+] Note: for some causes, deaths are only included from 1940 or 1950. For example, lymphosarcoma and other lymphatic cancers are included from 1950 resulting in a loss of 7 deaths in pathologists and 4 in psychiatrists.

* Significant differences from USWM rates - either low or high at p = 0.05 or less.

Table 12

Diseases of the Nervous System in Specialists
Excluding Vascular Lesions

ICD Code		Pathologists	Psychiatrists
340	Meningitis	5	2
341	Phlebitis of venous sinuses	1	0
342	Intracranial abscess	0	1
342	Encephalitis	2	2
344	Late effects of abscess	0	0
345	Multiple sclerosis	1	7
350	Paralysis agitans	14	7
351	Cerebral spastic infantile paralysis	0	1
352	Other cerebral paralysis	4	4
353	Epilepsy	1	0
354	Migraine	0	0
355	Other diseases of brain	3	3
356	Motor neuron disease*	2	6
357	Other disease spinal cord	1	0
364-395	Other categories	4	2
TOTAL		38	35

Table 13

Standardized Mortality Ratios for Selected Causes
Males only: Psychiatrist Rate as Standard
Deaths 1925 - 78

	Pathologists		
	No.	SMR	95% C.I.
All Causes	3358	0.84	
Paralysis Agitans	14	2.27	1.24, 3.81
Arteriosclerotic Heart Disease	1168	0.89	

C.I. based on exact Poisson

Table 14

Standardized Mortality Ratios for Selected Solid Cancers
Males only: Psychiatrist Rate as Standard
Deaths 1925 - 78

	Pathologists		
	No.	SMR	95% C.I.
All Cancers	508	0.92	
Brain	13	1.41	0.81, 2.61
Hypopharynx	3	4.70	0.97,13.70
Kidney	14	1.25	0.68, 2.10
Pancreatic	47	1.41	1.04, 1.88
Thyroid	3	1.68	

C.I. based on exact Poisson

Table 15

Standardized Mortality Ratios of Lymphatic and Hematopoietic Cancers
Males only: Psychiatrist Rate as Standard
Deaths 1925 - 78

	Pathologists		
	No.	SMR	95% C.I.
All Cancers	508	0.92	
Lymphosarcoma and RS	15	1.11	
Hodgkin's Disease	2	0.34	
Leukemia	31	1.68	1.14, 2.38
Cancers of Other Lymphatic	16	1.53	
All Lymphopoietic	64	1.22	0.94, 1.56

C.I. Based on exact Poisson

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15. Supplementary Notes

16. Abstract (Limit: 200 words) A study was conducted to determine if pathologists with exposure to formaldehyde (50000) demonstrate an excess risk of cancer, particularly cancers of the nasopharyngeal and pharyngeal areas. A population of 6411 physicians with occupational formaldehyde exposure participated in the study. The occurrence of these types of cancers was 4.7 times higher in these persons than in a comparable sized group of psychiatrists, but even so it is difficult to determine the importance of this increased risk as being directly tied to formaldehyde exposure. Pathologists and other members of the study group were exposed to other chemicals and infectious agents as well as formaldehyde. There was an apparent excess of mortality from pancreatic cancer and brain cancers as well as leukemia. According to the author, it is difficult to see how a large dose of the agent could be absorbed and reach these areas of the body as formaldehyde is such an irritating substance.

17. Document Analysis a. Descriptors

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