Daubert

An Epidemiologic Mortality Study of Employees at the Chemolite Plant

Leonard M. Schuman, M.D.
Jack S. Mandel, M.P.H.

373-8030

Epidemiology Associates

February, 1980

An Epidemiologic Mortality Study of Employees at the Chemolite Plant

Introduction

A retrospective cohort mortality study of employees at the Chemolite Plant in Cottage Grove, Minnesota was conducted. All employees who had worked at least six months at the Plant were included in the study. The basic objectives of the study were twofold:

1. To determine whether the mortality experience of employees at the Chemolite Plant was significantly different from that expected in a population group of this demographic composition.
2. To determine whether the mortality experience of employees in the Chemical Division of the Chemolite Plant was significantly different from that expected.

Methods

All employee records for all divisions of the Chemolite Plant are stored in a central location (Personnel Office). The personnel recordkeeping system has been designed so that complete records have been maintained on all employees who ever worked at the Chemolite Plant. These records are also maintained for employees who transfer within the 3M Corporation. Thus, in constructing the study cohort it was assumed that a complete roster could be assembled of all employees who ever worked at the Chemolite Plant since its opening in 1947.

A careful review of the personnel records indicated that a total of 4218 had been employed at Chemolite for some period of time since 1947. Of these, 3688 were employed for at least 6 months. This group comprised

the basic cohort for study.

Information was abstracted from personnel records. In many instances a number of records existed for a given employee and these records were stored in different areas in the personnel office. Nevertheless, all sources of information were ascertained and the appropriate data abstracted.

For each individual the following information was coded onto Fortran coding sheets:

Employee number

Name

Address

Telephone number

Social security number

Sex

Birthdate

Marital status

Date of first employment at Chemolite

Date of last employment at Chemolite

Period of employment in the Chemical Division

Status (current, retired, deceased, disabled, laidoff, transferred, terminated, reason not stated and returned to school)

Date of death (if noted on record)

Area transferred to (if noted on record)

For each of the 3688 employees, two computer cards were punched with the information mentioned above.

A computer tape listing the name, social security number and birthdate of

all but the current employees was developed and sent to the Social Security Administration (SSA) to ascertain those individuals who had died during the period of study (1947 - 1978).

A total of 180 deaths were ascertained from SSA records. For each death the state of last residence, the state of last employment, or the state from which the benefit was filed along with the date of death was listed. This information was used to obtain a copy of the death certificate for each decedent. Unfortunately, since the most vital piece of information - state in which the death occurred - was not provided by the SSA, acquisition for all death certificates was a formidable task.

For those deaths for which a death certificate was not available from the state of last residence, the state of last employment, or the state from which the benefit was filed, a search was made in Minnesota using the Minnesota Health Department's commulative microfiche death index 1962 - 1978 and the death records prior to 1962. Information (name, social security number, birthdate, date of death) on all deaths for which the death certificate was not acquired by any of the above mentioned methods was sent to the Wisconsin Health Department to determine if a death certificate was on file in their records.

Utilizing these procedures, 168 of the 180 (93.3%) death certificates were acquired. Information on the remaining twelve with a request for a copy of the death certificate was sent to every state health department except Minnesota, Wisconsin and New York. Minnesota and Wisconsin were excluded since their records had already been reviewed. New York was excluded since they require the borough in which the death occurred to

ascertain the death certificate. However, if any of the twelve death certificates remain outstanding after a search by all other state health departments, then an attempt will be made to access New York vital records.

The death certificates were coded by a professional nosologist according to the International Classification of Diseases (I.C.D.), Eighth Revision. All information in the cause of death section of the death certificate was coded. This included the underlying cause of death, immediate cause of death, conditions related to the immediate cause of death (referred to on the death certificate as "as a consequence of" or "due to"), and other significant conditions. These codes along with the individual's name and social security number (to facilitate linking these data to the main file) were transferred onto Fortran coding sheets and keypunched.

In addition to identifying the deaths, SSA reported that for 485 members of the study cohort no benefits were currently being paid. This meant that SSA could not emphatically state whether these individuals were dead or alive. However, published reports (see for example Wang, H. and MacMahon, B., J. Occup. Med., 21, 745, 1979) have stated that the ascertainment of mortality by SSA is virtually complete and that additional follow up on individuals for whom no information is available from SSA records is unnecessary. Nevertheless, in order to be absolutely certain that all deaths were ascertained, every effort was made through extensive tracing efforts to determine the current status of these 485 unaccounted for study members. The status of virtually all of these people was determined in this way.

Method of Analysis

The method of analysis is based on a comparison of the observed to expected death rates specific for cause, age, time, sex and race. The

method is described in detail in Monson, R., Analysis of relative survival and proportional mortality, Comp. Biomed. Res., 7, 325-332, 1974.

The output from this analysis provides the observed and expected number of deaths, the ratio of observed to expected (SMR), and the upper and lower 95% confidence limits.

The 95% confidence limits are defined as follows:

$$\text{Lower Limit} = LL = (O(1 - 1/9O - 1.96/3\sqrt{1/O})^3)\ /E$$

$$\text{Upper Limit} = UL = ((O+1)(1 - 1/9(O+1) + 1.96/3\sqrt{1/(O+1)})^3)\ /E$$

Where O = observed number of deaths

E = expected number of deaths

Results

Records on 4,218 employees were reviewed and abstracted (Table 1). Only those who worked at Chemolite for six or more months (3,688) were included in the mortality followup.

Of the 180 known deaths, 168 (93.3%) death certificates were obtained. There were 159 male deaths and 21 female deaths.

Table 2 presents the results for Chemolite Plant male employees. Overall, the number of deaths (149) was significantly less than expected (208.3). This "deficit" was primarily due to the lower than expected number of deaths from diseases of the circulatory system and all external causes of death. The observed-to-expected ratio for cancer deaths was 1.0, indicating no disparity between the number of deaths observed and the number expected. The only O/E ratios which exceeded 1.0 were for deaths due to asthma (2.8) and motor vehicle accidents (1.1). However, neither even approached statistical significance.

Table 1. Epidemiologic Mortality Study of Chemolite Plant
July, 1978 - December, 1979

Records Abstracted	4,218
Number Studied	3,688
Number of Deaths	180 (4.9%)
Death Certificates Analyzed	168

Table 2. Results of Cause-Specific Mortality Analysis
Males, Chemolite Plant (≥ 6 months)

Cause of Death	O	E	O/E	LL	UL
140 - Malignant Neoplasms	37	37.1	1.0	.7	1.3
000 - All Infective and Parasitic Diseases	1	2.5	.4	.0	2.3
Tuberculosis	1	1.3	.8	.0	4.5
240 - Allergic, Endocrine, Metab., Nutr. Diseases	3	3.4	.9	.2	2.6
Diabetes Mellitus	2	2.8	.7	.1	2.6
320 - All Diseases of Nervous Sys. & Sense Organs	2	2.4	.9	.1	3.1
390 - All Diseases of Circulatory System	64	83.0	.8	.6	< 1.0
Chronic Rheumatic Heart Disease	1	2.6	.4	.0	2.2
Arteriosclerotic H.D., Incl. CHD	50	61.4	.8	.6	1.1
All Vascular Lesions of CNS	4	8.5	.5	.1	1.2
460 - All Respiratory Diseases	6	8.9	.7	.3	1.5
All Pneumonia	2	3.5	.6	.1	2.1
Emphysema	1	2.0	.5	.0	2.8
Asthma	1	.4	2.8	.0	15.8
520 - All Diseases of Digestive System	7	12.4	.6	.2	1.2
All Gastric and Duodenal Ulcer	1	1.3	.8	.0	4.4
Cirrhosis of Liver	4	7.6	.5	.1	1.4
800 - All External Causes of Death	29	49.0	.6	.4	.8
All Accidents	24	33.4	.7	.4	> 1.0
Motor Vehicle Accidents	20	18.3	1.1	.6	1.6
Suicide	5	10.1	.5	.2	1.2
All Causes of Death	149	208.3	.7	.6	.8

Table 3. Results of Cause-Specific Mortality Analysis
Males. Chemolite Plant (≥ 6 months)
Cancer

Cause of Death	O	E	O/E	LL	UL
All Malignant Neoplasms	37	37.1	1.0	.7	1.3
Cancer of Digestive Organs & Peritoneum	9	9.0	1.0	.5	1.9
150 - Cancer of Esophagus	1	.8	1.3	.0	7.1
151 - Cancer of Stomach	1	1.6	.6	.0	3.5
153 - Cancer of Large Intestine	3	2.9	1.1	.2	3.1
154 - Cancer of Rectum	1	1.0	1.0	.0	5.6
157 - Cancer of Pancreas	2	1.9	1.1	.1	3.9
Cancer of Respiratory System	9	12.5	.7	.3	1.4
161 - Cancer of Larynx	1	.5	1.9	.0	10.7
162 - All Cancer of Lung (Prim. & Sec.)	8	11.8	.7	.3	1.3
172 - Cancer of Skin	1	1.1	.9	.0	5.0
185 - Cancer of Prostate	2	1.0	2.0	.2	7.3
186 - Cancer of Testis	1	.7	1.5	.0	8.3
189 - Cancer of Kidney	1	1.0	1.0	.0	5.6
191 - Cancer of Brain & Other CNS	2	1.9	1.1	.1	3.9
All Lymphopoietic Cancer	4	5.0	.8	.2	2.0
201 - Hodgkins Disease	2	1.1	1.9	.2	6.8
208 - Cancer of Lymphatic Tissue	2	.9	2.2	.3	8.0

158 Other Digestive 1

195 Ill Defined Sites 1

199 Malig. Neopl. Without Specif. of Site 6

In Table 3, the 37 cancer deaths are distributed by site. None of the results were significant.

Tables 4 and 5 present results for deaths among men who were employed for at least six months in the Chemical Division of the Chemolite Plant. Overall, the observed number of deaths (55) was less than expected (66.1). This was mainly the result of the lower than expected number of deaths from diseases of the circulatory system. The highest O/E ratio, 9.2, occurred for deaths due to asthma. However, this ratio, based on only a single death in the 21 year study period, was not statistically significant.

A total of 13 cancer deaths occurred among the Chemical Division male employees. This was approximately the number expected (11.2). Although the O/E ratio for a number of cancer sites exceeded one, none were statistically significant.

A distribution of the 19 observed deaths among female employees is presented in Table 6. No major departures from expected were noted in these results.

Discussion

The lower than expected mortality from all causes is often found in studies of occupational cohorts. This reflects "the healthy worker" effect. Generally, individuals who are disabled or chronically ill are excluded from certain work situations, particularly those requiring considerable physical activity. Thus, employee cohorts compared to the general population generally have more favorable mortality outcomes, particularly for younger employees. To compensate for this effect the data could be reviewed with an O/E ratio of less than 1, (perhaps .9 is appropriate) considered equivalent to no difference between observed and expected deaths. Reviewing the data with

Table 4. Results of Cause Specific Mortality Analysis
Males. Chemical Division (≥6 Months)

Cause of Death	O	E	O/E	LL	UL
140 - Malignant Neoplasms	13	11.2	1.2	.6	1.9
240 - Allergic, Endocrine, Metab., Nutr. Diseases	2	1.1	1.9	.2	6.8
Diabetes Mellitus	1	.9	1.1	.0	6.5
320 - All Diseases of Nervous Sys. & Sense Organs	1	.8	1.3	.0	7.0
390 - All Diseases of Circulatory System	16	24.3	.7	.4	1.1
Arteriosclerotic H.D. Incl. CHD	14	17.9	.8	.4	1.3
460 - All Respiratory Diseases	4	2.7	1.5	.4	3.9
All Pneumonia	2	1.1	1.9	.2	6.7
Asthma	1	.1	9.2	.1	51.1
520 - All Diseases of Digestive System	5	3.9	1.3	.4	3.0
All Gastric and Duodenal Ulcer	1	.4	2.6	.0	14.5
Cirrhosis of Liver	3	2.4	1.3	.3	3.7
800 - All External Causes of Death	14	18.1	.8	.4	1.3
All Accidents	12	12.5	1.0	.5	1.7
Motor Vehicle Accidents	9	7.0	1.3	.6	2.4
Suicide	2	3.6	.6	.1	2.0
All Causes of Death	55	66.1	.8	.6	1.1

Table 5. Results of Cause-Specific Mortality Analysis
Males. Chemical Division (≥6 Months)
Cancer

Cause of Death	O	E	O/E	LL	UL
140 - Malignant Neoplasms	13	11.2	1.2	.6	1.9
Cancer of Digestive Organs & Peritoneum	3	2.6	1.1	.2	3.3
Cancer of Esophagus	1	.2	4.4	.1	24.5
Cancer of Large Intestine	1	.9	1.2	.0	6.6
Cancer of Pancreas	1	.6	1.8	.0	10.2
Cancer of Respiratory System	4	3.7	1.1	.3	2.8
Cancer of Larynx	1	.2	6.7	.1	37.3
Cancer of Lung (Prim. & Sec.)	3	3.5	.9	.2	2.5
Cancer of Skin	1	.4	2.7	.0	15.1
Cancer of Prostate	1	.3	3.9	.1	21.8
Cancer of Testis	1	.3	4.0	.1	22.1

199 - Malig. Neopl. Without Specification of Site - 3

Table 6. Specific Causes of Death
Females. Chemolite Plant (36 months)

		O	E
009	Diarrheal disease	1	.4
162	Malig. neopl. of lung	1	1
172	Malig. neopl. of skin	1	.2
174	Malig. neopl. of breast	2	2.5
183	Malig. neopl. of ovary	1	.8
191	Malig. neopl. of brain	1	.4
402	Hypertensive H.D.	1	7.5
410	Acute M.I.	1	
412	Chronic Ischemic H.D.	4	
427	Symptomatic H.D.	2	
472	Influenza with other resp. manifestations	1	1
493	Asthma	1	.1
812	Car accident with other car	1	1.5
819	Car acc. of unspecified nature	1	
	Total	19	

a null hypothesis of .9 would not substantially alter the conclusions.

Deaths for U.S. white males and females were used to derive expected values. A more appropriate comparison population might have been deaths for the counties in which the employees resided, namely Dakota, Ramsey and Washington in Minnesota and Pierce and St. Croix in Wisconsin. There are two major problems with using data from these counties to derive expected values. First, age - sex - race and cause specific death rates are not available by county for periods back to the late 1940's. Second, if such rates could be derived from the basic data, the relatively small population bases would result in highly unstable rates. One strategy for considering geographic differences in mortality is to examine available data for the counties of interest in relation to the United States rates. For cancer, age adjusted death rates are available by county for the period 1950–69. These data were examined for the above mentioned counties and compared to the rates for the United States. For those cancer sites where the rate was based on an average of at least one death per year the only notable difference between the rates for the 5 counties and the U.S., was for lung cancer where the age-adjusted rate was appreciably lower in 4 of the 5 counties than in the U.S. as a whole (the rate for Ramsey county approximated the U.S. rate). The O/E ratio for lung cancer was less than 1.0. This is an underestimate of the SMR if calculated using county rates. However, re-calculating the SMR using county data to derive expected values would probably result in an SMR of about 1.5, which would not be statistically signiticant.

Although the results of this analysis revealed no significant findings, a number of SMR's, particularly for the cancers, did exceed one. Thus, continued surveillance for mortality is warranted.

As of the writing of this report (February 26, 1980) information on the 12 deceased study members whose death certificates were not available at the time the data was analyzed is as follows:

2 died in service, one in Vietnam and one in Korea

4 died from cardiovascular disease

2 died from cancer

1 died from injuries sustained in an airplane crash

3 cause of death unknown (2 of these deaths occurred among employees who worked at Chemolite for less than 6 months)

From the above distribution of deaths, it is obvious that the addition of these deaths to the analyses presented in this report does not alter the conclusions.