Mortality Patterns Among Workers in Three Texas Oil Refineries

Terry L. Thomas, M.S.; Richard J. Waxweiler, Ph.D.; Rafael Moure-Eraso, M.S.; Sharon Itaya, M.D.; and Joseph F. Fraumeni, Jr., M.D.

The cause-specific mortality experience of 2,509 active and retired members of the Oil, Chemical, and Atomic Workers International Union (OCAW) who worked at three oil refineries in the Beaumont/Port Arthur area of Texas was examined to determine whether there might be unusual patterns of fatal disease related to workplace exposures. Deaths that occurred between 1943 and 1979 were identified from membership records of the OCAW headquarters in Denver and from the records of union locals in Texas which represent workers at the three refineries. Death certificates were obtained from state vital records offices for the decedents. Cause-specific Proportionate Mortality Ratios (PMRs) were calculated using the mortality experience of the U.S. general population as a standard. Excess mortality from stomach cancer occurred among active union members who worked at Refinery A and among active and retired members who worked at Refineries B anc C. PMRs for leukemia, multiple myeloma, and other lymphomas were elevated, especially among retired workers. Relative frequencies of brain tumor deaths were significantly elevated among active members at all three refineries and slightly elevated among retirees at Refineries A and C. Findings suggest that oil refinery workers may have elevated risks of these cancers and indicate that more definitive studies are necessary.

In a study of mortality patterns among active members of the Oil, Chemical, and Atomic Workers International Union (OCAW) in Texas, relative frequencies of leukemia, of multiple myeloma, and of cancers of the stomach, kidney, and brain were found to be increased among workers in petroleum refineries and petrochemical plants, particularly among those who had been union members for at least 10 years.[1] Proportionate Mortality Ratios for cancers of the liver, pancreas, lung, and skin were also elevated but were not associated with longer union membership. When data from those refineries with at least 100 deaths were analyzed separately, increased relative frequencies of cancers of the brain (Refineries A and C), lung (Refineries B and C), and stomach (Refineries A and B) were found.

Refineries A, B, and C are located within 20 miles of each other in the Beaumont/Port Arthur area of Texas, a region with a heavy concentration of chemical plants. All were opened shortly after oil was discovered there during the early 1900s. Although technology has changed with time, production processes at the three plants are very similar and consist primarily of standard refinery operations that involve separating crude oil into various components including fuels, petroleum solvents, lubricating oils, petroleum wax, greases and other products. Each of the plants has a small petrochemical operation.

Because of the limited nature of the original set of data[1] (i.e., only deaths among active union members), efforts were made to assemble a more complete set of deaths. With the additions of retiree deaths, this study examines the cause-specific mortality experience of an expanded group of union members employed at Refineries A, B, and C.

Materials and Methods

For the original study, data on the 3,105 active members of OCAW locals in Texas who died between 1947 and 1977 were obtained from the Membership Department at OCAW headquarters in Denver, Colorado. Among these decendents were 1,161 who had worked at Refineries A, B, or C. The present study focuses only on deceased active and retired OCAW members who had been employed by Refineries A, B, and C. Records of the union locals representing workers at these refineries were reviewed to determine whether data were available to identify deaths among retired union members and additional deaths among active members who had worked at the three refineries. The union local representing Refineries A and B had maintained records of deceased active and retired members since about 1943; however, most of the retiree deaths were reported after 1960. Records of retiree deaths within the local representing Refinery C were available only from 1972. Data from the original study were thus expanded to include 1,194 retiree deaths and 154 additional active member deaths that occurred as early as 1943 and as late as 1978. This number includes all deaths which occurred during 1979 among members of the local representing Refinery C.

From the Environmental Epidemiology Branch, National Cancer Institute, Bethesda, MD 20205 (Ms. Thomas, Occupational Studies Section; and Dr. Fraumeni); the Division of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health, Cincinnati (Dr. Waxweiler); and the Health and Safety Office, Oil, Chemical and Atomic Workers International Union, Denver (Mr. Moure-Eraso and Dr. Itaya).

Table 1 – Distribution of Male OCAW Decedents by Membership Status at Death, by Refinery, and by Race

Membership Status	Refinery A				Refinery B				Refinery C				Total			
	White		Nonwhite		White		Nonwhite		White		Nonwhite		White		Nonwhite	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Active	484	48.0	79	90.8	346	47.5	119	77.3	210	53.0	77	56.6	1,040	48.8	275	72.9
Retired	524	52.0	8	9.2	382	52.5	35	22.7	186	47.0	59	43.4	1,092	51.2	102	27.1
Total	1,008	100.0	87	100.0	728	100.0	154	100.0	396	100.0	136	100.0	2,132	100.0	377	100.0

Information on date and place of death was abstracted from union records. Cause of death, age, sex, and race were determined from death certificates obtained from state vital records offices. Underlying cause of death was coded to the Eighth Revision of the International Classification of Diseases[2] by a trained nosologist according to the rules in effect at the time of death.

Observed numbers of deaths were compared to expected numbers that were calculated using cause-specific proportions of all deaths among U.S. males as a standard, with appropriate adjustments for age, calendar time, and race.[3] The ratio of observed to expected deaths is the Proportionate Mortality Ratio (PMR). For each cancer site with a significantly elevated PMR in the total group, expected deaths were re-calculated using as standards the site-age-time-race-specific relative frequencies of all cancer deaths among males in the total U.S. and among males in the two-county region in which the plants are located. Using this approach, the ratios of observed to expected deaths are the Proportionate Cancer Mortality Ratio (PCMR) and the County Proportionate Cancer Mortality Ratio (CPCMR), respectively. Statistical significance was determined by a summary chi-square test with one degree o of freedom.[4] Ratios and chi-squares were not computed when both observed and expected numbers of deaths were less than five.

Interpretation of the results is subject to several limitations in methodology. If the OCAW study group has a lower mortality rate for all causes than U.S. males, PMRs represent inflated estimates of cause-specific risks. Since the PCMR and CPCMR are based on the proportion of total cancer deaths, they might be better estimates of cause-specific risks if the age-specific rates for total cancer in the study group resemble those of the corresponding comparison population. Since the ratios are based on the relative frequency of specific causes of death, excesses for some causes will force the relative frequencies of others to be lower than expected. Finally, because of multiple comparisons, one would expect a few ratios to be statistically significant based on chance alone.

Results

About 92% of the death certificates requested from state vital records offices were located. Because of very small numbers, females were omitted from the analyses.

Table 1 shows the distribution of decedents by race and by membership status at death for each plant. About half of the whites were retirees. Less than 30% of the nonwhites were retired; however, 43% of the nonwhite decedents who worked at Plant C were retired.

Table 2 shows the distribution of study subjects by age at death. Seventy percent of the white male study subjects and about 60% of the nonwhites were age 55 or older at death.

PMRs for selected causes of death among white and nonwhite males are shown in Table 3 for the three refineries combined. PMRs for all cancers combined were significantly elevated among whites (PMR = 1.19) and nonwhites (PMR = 1.23). The PMR for circulatory disease was slightly increased for each racial group but was significantly elevated only among whites. There were relative deficits in mortality from respiratory disease and from "all other causes" in both racial groups. A significant excess of deaths due to accidents, suicide, and homicide occurred among nonwhites but no excess was seen among whites.

PMRs for cancers of the stomach, pancreas, and skin were elevated among whites and nonwhites (Table 3) and reached statistical significance when data for both races were combined. A significant excess of prostate cancer deaths occurred among whites but not among nonwhites. The observed number of kidney cancer deaths was greater than expected among whites; however, there was a deficit of deaths from bladder cancer. Among whites, the observed number of deaths from malignant brain tumors was more than twice that expected. There was also an increased frequency of benign and unspecified tumors of the brain among whites. Although many of these tumors actually may be malignant, the term "brain tumor" is often used clinically to describe brain cancer on death certificates; therefore, data for malignant, benign, and unspecified brain tumors are shown grouped in subsequent analyses. All of the deaths in the benign and unspecified category were of an unspecified nature (i.e., the underlying cause of death was recorded on the death certificate as "brain tumor"). The PMR for all hematopoietic and lymphatic

Table 2 – Distribution of Male OCAW Decedents by Age at Death and by Race

Age at Death	White		Nonwhite		Total	
	No.	%	No.	%	No.	%
<45	233	10.9	60	15.9	293	11.7
45-54	394	18.5	96	25.5	490	19.5
55-64	621	29.1	133	35.3	754	30.1
65-74	570	26.7	58	15.4	628	25.0
75+	314	14.7	30	8.0	344	13.7
TOTAL	2,132	100.0	377	100.0	2,509	100.0

Table 3 – Mortality Experience of Male OCAW Members Employed by Refineries A, B, and C, by Race, 1943-1979

Underlying Cause of Death (8th Revision, ICDA)	White			Nonwhite			Total		
	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†
All causes of death	2,132	2,132.0	1.00	377	377.0	1.00	2,509	2,509.0	1.00
All cancer (140-209)	474	400.8	1.19§	79	64.0	1.23§	553	464.8	1.19§
Stomach (151)	36	25.5	1.41§	12	6.1	1.96§	48	31.6	1.52§
Large intestine (153)	38	36.6	1.04	6	4.0	1.48	44	40.6	1.08
Rectum (154)	8	14.5	0.55	0	1.6	–	8	16.1	0.50
Liver (155, 156)	7	9.0	0.78	1	1.9	–	8	10.9	0.73
Pancreas (157)	32	22.5	1.42§	5	3.5	1.41	37	26.0	1.42§
Larynx (161)	4	6.3	0.64	0	1.2	–	4	7.4	0.54
Lung (162, 163)	131	119.5	1.10	26	18.1	1.44	157	137.6	1.14
Skin (172, 173)	11	6.8	1.61	2	0.3	–	13	7.2	1.81§
Prostate (185)	39	26.8	1.46§	7	6.6	1.06	46	33.4	1.38§
Bladder (188)	1	12.9	0.08§	1	1.5	–	2	14.4	0.14
Kidney (189)	15	10.0	1.51	0	1.0	–	15	11.0	1.37
Brain (191, 192, 225, 238)‡	33	15.6	2.11§	3	–	–	36	–	–
Malignant (191, 192)	27	11.8	2.28§	1	0.8	–	28	12.7	2.21§
Benign and unspecified (225, 238)	6	3.8	1.58	2	–	–	8	–	–
Hematopoietic and lymphatic (200-209)	68	39.5	1.72§	3	4.5	–	71	44.0	1.61§
Hodgkin's disease (201)	8	5.4	1.48	0	0.5	–	8	5.9	1.34
Non-Hodgkin's lymphoma (200, 202, 208)	19	12.9	1.47	1	2.3	–	20	15.2	1.32
Multiple myeloma (203)	9	4.4	2.04	0	0.2	–	9	4.6	1.96
Leukemia (204-207)	31	16.4	1.89§	2	1.6	–	33	18.0	1.83§
Other malignant neoplasms	57	59.0	0.97	15	12.8	1.17	72	71.8	1.00
Circulatory disease (390-458)	1,177	1,124.1	1.05§	176	171.4	1.03	1,353	1,295.4	1.04§
Respiratory disease (460-519)	65	123.0	0.53§	17	21.7	0.78	82	144.7	0.57§
Accidents, suicide, homicide (800-998)	198	203.2	0.97	66	46.3	1.42§	264	249.5	1.06
All other causes	218	281.0	0.78§	39	73.5	0.53§	257	354.6	0.72§

*Based on proportionate mortality for U.S. males
†Observed deaths/expected deaths
‡Observed and expected for ICDA 225 and 238 are not included in the total for cancer
§Statistically significant at the 0.05 level
–Not calculated

malignancies was significantly elevated among whites. Within this category there was a significant excess of leukemia deaths (PMR = 1.89), as well as nonsignificant increased frequencies of Hodgkin's disease, non-Hodgkin's lymphoma, and multiple myeloma. Among nonwhites, the observed number of lung cancer deaths was greater than expected.

Table 4 shows PCMRs and CPCMRs for those cancer sites shown in Table 3 to have significantly elevated PMRs. Among whites, PCMRs were elevated for every site shown except the stomach and were statistically significant for brain cancer and leukemia.

CPCMRs were elevated only for stomach, prostate, and

Table 4 – Proportionate Cancer Mortality for Selected Cancer Sites among Male OCAW Members Employed by Refineries A, B, and C, 1943-1979

	White					Nonwhite				
	Observed Deaths	Expected Deaths*	PCMR†	Expected Deaths‡	CPCMR†	Observed Deaths	Expected Deaths*	PCMR†	Expected Deaths‡	CPCMR†
Stomach (151)	36	34.1	1.06	26.9	1.34	12	8.9	1.34	13.0	0.92
Pancreas (157)	32	27.6	1.16	32.8	1.00	5	4.6	1.09	3.6	1.40
Skin (172, 173)	11	8.8	1.24	11.7	0.94	2	0.5	–	–	–
Prostate (185)	39	32.6	1.20	32.5	1.20	7	8.9	0.79	–	–
Brain (191, 192)	27	14.7	1.84§	18.4	1.47	1	1.0	–	–	–
Leukemia (204-207)	31	20.9	1.48§	29.1	1.06	2	2.0	–	–	–

*Based on proportionate cancer mortality for U.S. males
†Observed deaths/expected deaths
‡Based on proportionate cancer mortality for males in a two-county area
§Statistically significant at the 0.05 level
–Not calculated

Table 5 – Mortality Experience of White Male OCAW Members Employed by Refineries A, B, and C by Membership Status at Death, 1943-1979

Underlying Cause of Death (8th Revision, ICDA)	Active			Retired		
	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†
All causes of death	1040	1040.0	1.00	1092	1092.0	1.00
All cancer (140-209)	237	186.5	1.27§	237	214.2	1.11
Stomach (151)	21	12.6	1.66§	15	12.8	1.17
Pancreas (157)	18	10.0	1.79§	14	12.4	1.13
Lung (162, 163)	67	55.8	1.20	64	63.7	1.00
Skin (172, 173)	8	4.1	1.94	3	2.7	–
Prostate (185)	8	4.9	1.62	31	21.8	1.42§
Kidney (189)	9	5.2	1.74	6	4.8	1.25
Brain (191, 192, 225, 238)‡	25	10.9	2.29§	8	4.8	1.65
Hematopoietic and lymphatic (200-209)	26	20.9	1.24	42	18.6	2.26§
Hodgkin's disease (201)	3	4.0	–	5	1.4	3.65§
Non-Hodgkin's lymphoma (200, 202, 208)	9	6.6	1.37	10	6.4	1.57
Multiple myeloma (203)	2	2.0	–	7	2.4	2.95§
Leukemia (204-207)	12	8.2	1.46	19	8.2	2.32§
All other cancer	60	64.6	0.93	55	73.7	0.75§
Circulatory disease (390-458)	518	482.6	1.07§	659	641.9	1.03
All other causes	285	370.9	0.77§	196	236.8	0.83§

*Based on proportionate mortality for U.S. males
†Observed deaths/expected deaths
‡Observed and expected for ICDA 225 and 238 are not included in the total for cancer
§Statistically significant at the 0.05 level
–Not calculated

brain cancer. The CPCMR for pancreatic cancer was elevated among nonwhites.

There were several differences in mortality patterns among white active and retired union members (Table 5). Although PMRs for all cancer and for circulatory disease were elevated in both membership groups, they were statistically significant only among active members. Relative excesses of stomach, pancreatic, skin, kidney and prostate cancers were seen among active members and to a lesser extent among retirees. The observed numbers of brain tumor deaths were greater than expected among active members (PMR = 2.29) and retirees (PMR = 1.65), but the PMR was significant only among active members. There were significant excesses of deaths from Hodgkin's disease, multiple myeloma and leukemia among retirees but not among active members.

PMRs for selected causes of death among white male OCAW members who worked at Refinery A are shown in Table 6. Because of small numbers (N = 87), ratios for nonwhite males who worked at this plant were not calculated. There were twofold relative excesses of stomach and brain cancer deaths among active members. Mortality due to multiple myeloma and to cancers of the pancreas and prostate was slightly greater than expected, regardless of membership status. Among retirees there was a significant excess of deaths from non-Hodgkin's lymphoma as well as increased frequencies of Hodgkin's disease and leukemia.

Table 7 shows the mortality experience of OCAW members who worked at Refinery B. An increased relative frequency of stomach cancer deaths occurred among whites and nonwhites. Observed numbers of deaths for cancers of the stomach, pancreas, and skin were greater than expected among whites regardless of membership status. Increased relative frequencies of cancers of the brain and kidney among whites were more prominent among active union members. Mortality from brain cancer was more than twice that expected among white active members. There was an excess of leukemia deaths among white active members (PMR = 2.59) and retirees (PMR = 2.46). Among white retirees, four deaths from multiple myeloma were observed and less than one was expected. There was a significant twofold excess of lung cancer deaths among nonwhite males.

Among whites who worked at Refinery C, there was a significant excess of brain tumors (Table 8), with seven observed and only three expected. Brain and lung cancer deaths clustered among active union members. The increased relative frequency of stomach cancer was not associated with membership status. A significantly increased relative frequency of leukemia deaths was confined to retirees (PMR = 4.18). Among nonwhites, PMRs were not increased for any particular cancer sites.

Discussion

Although limitations of the PMR method are well known, its primary purpose is to generate hypotheses that can be tested by more definitive analytic studies. Our study also has limitations related to the "healthy worker effect," seen especially among actively employed workers.[5] Nevertheless, the unusual mortality patterns, including relative excesses of brain, stomach, and hematopoietic and lymphatic malignancies, are consistent with the findings re-

Table 6 – Mortality Experience of White Male OCAW Members Employed by Refinery A by Membership Status at Death, 1943-1978

Underlying Cause of Death (8th Revision, ICDA)	Active			Retired			Total		
	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†
All causes of death	484	484.0	1.00	524	524.0	1.00	1008	1008.0	1.00
All cancer (140-209)	101	84.7	1.19§	110	101.9	1.08	211	186.6	1.13§
Stomach (151)	11	5.7	1.92§	4	6.2	0.64	15	12.0	1.25
Pancreas (157)	7	4.5	1.55	7	5.9	1.18	14	10.5	1.34
Lung (162, 163)	27	24.9	1.08	30	30.2	0.99	57	55.1	1.03
Skin (172, 173)	2	1.9	–	0	1.3	–	2	3.2	–
Prostate (185)	5	2.2	2.22	15	10.1	1.49	20	12.3	1.62§
Kidney (189)	4	2.3	–	3	2.3	–	7	4.6	1.51
Brain (191, 192, 225, 238)‡	12	5.1	2.36§	4	2.4	–	16	7.5	2.13§
Hodgkin's disease (201)	0	2.0	–	4	0.7	–	4	2.7	–
Non-Hodgkin's lymphoma (200, 202, 208)	5	3.0	1.69	7	3.0	2.33§	12	6.0	2.00§
Multiple myeloma (203)	2	0.9	–	3	1.1	–	5	2.1	2.43
Leukemia (204-207)	3	3.9	–	6	3.9	1.53	9	7.8	1.15
All other cancer	25	29.5	0.85	27	35.3	0.77	52	64.8	0.80
Circulatory disease (390-458)	240	219.1	1.10§	325	306.4	1.06	565	525.5	1.08§
All other causes	143	180.2	0.79§	89	115.6	0.77§	232	295.8	0.78§

*Based on proportionate mortality for U.S. males
†Observed deaths/expected deaths
‡Observed and expected for ICDA 225 and 238 are not included in the total for cancer
§Statistically significant at the 0.05 level
–Not calculated

ported in other studies of petroleum and petrochemical workers. Despite biases that might exist for data sets which are limited to deaths among active employees,[5,6] the inclusion of retiree deaths did not change the patterns noted in our previous study limited to active union members.[1]

Analyses utilizing the Proportionate Cancer Mortality Ratio method did not substantially change the patterns seen for most cancer sites. CPCMRs for most cancer sites were very different from PCMRs. However, it is not clear whether a comparison utilizing proportions from the two-county area is appropriate, since about 25% of the total workforce in these two counties is employed in the petroleum and chemical industries.[7-9] Mortality rates for brain cancer and leukemia in the two-county area are higher than

Table 7 – Mortality Experience of Male OCAW Members Employed by Refinery B by Membership Status at Death and by Race, 1943-1978

Underlying Cause of Death (8th Revision, ICDA)	White									Nonwhite		
	Active			Retired			Total					
	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†
All causes of death	346	346.0	1.00	382	382.0	1.00	728	728.0	1.00	154	154.0	1.00
All cancer (140-209)	79	62.0	1.27§	86	73.5	1.17	165	135.5	1.22§	43	26.1	1.65§
Stomach (151)	7	4.5	1.57	8	4.8	1.67	15	9.3	1.62	7	2.7	2.54§
Pancreas (157)	6	3.3	1.80	6	4.3	1.40	12	7.6	1.57	2	1.5	–
Lung (162, 163)	18	18.2	0.99	23	21.1	1.09	41	39.3	1.04	15	7.2	2.07§
Skin (172, 173)	4	1.4	–	3	0.9	–	7	2.3	3.02§	0	0.1	–
Prostate (185)	1	1.6	–	8	7.6	1.06	9	9.2	0.98	3	2.4	–
Kidney (189)	4	1.7	–	2	1.6	–	6	3.4	1.78	0	0.4	–
Brain (191, 192, 225, 238) ‡	8	3.7	2.19§	2	1.6	–	10	5.3	1.90	1	–	–
Hodgkin's disease (201)	3	1.3	–	1	0.5	–	4	1.8	–	0	0.2	–
Non-Hodgkin's lymphoma (200, 202, 208)	2	2.1	–	2	2.1	–	4	4.3	–	0	–	–
Multiple myeloma (203)	0	0.7	–	4	0.8	–	4	1.5	–	0	–	–
Leukemia (204-207)	7	2.7	2.59§	7	2.8	2.46§	14	5.6	2.52§	1	0.6	–
All other cancer	22	21.7	1.02	20	25.7	0.78	42	47.3	0.89	14	9.5	1.47
Circulatory disease (390-458)	172	162.1	1.06	228	226.9	1.00	400	389.0	1.03	73	71.6	1.02
All other causes	95	121.9	0.78§	68	81.6	0.82	163	203.5	0.80§	38	56.3	0.67§

*Based on proportionate mortality for U.S. males.
†Observed deaths/expected deaths.
‡Observed and expected for ICDA 225 and 238 are not included in the total for cancer.
§Statistically significant at the 0.05 level
–Not calculated

Table 8 – Mortality Experience of Male OCAW Members Employed by Refinery C by Membership Status at Death, 1943-1979

Underlying Cause of Death (8th Revision, ICDA)	Active			Retired			Total		
	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†	Observed Deaths	Expected Deaths*	PMR†
All causes of death	210	210.0	1.00	186	186.0	1.00	396	396.0	1.00
All cancer (140-209)	57	39.8	1.43§	41	38.8	1.06	98	78.6	1.25§
Stomach (151)	3	2.4	–	3	1.8	–	6	4.2	1.42
Pancreas (157)	5	2.2	2.29	1	2.2	–	6	4.4	1.37
Lung (162, 163)	22	12.6	1.74§	11	12.4	0.88	33	25.1	1.32
Skin (172, 173)	2	0.8	–	0	0.4	–	2	1.3	–
Prostate (185)	2	1.1	–	8	4.2	1.91	10	5.3	1.89§
Kidney (189)	1	1.1	–	1	0.8	–	2	2.0	–
Brain (191, 192, 225, 238)‡	5	2.2	2.31	2	0.8	–	7	3.0	2.35§
Hodgkin's disease (201)	0	0.7	–	0	0.2	–	0	0.9	–
Non-Hodgkin's lymphoma (200, 202, 208)	2	1.5	–	1	1.2	–	3	2.7	–
Multiple myeloma (203)	0	0.4	–	0	0.4	–	0	0.7	–
Leukemia (204-207)	2	1.6	–	6	1.4	4.18§	8	3.1	2.60§
All other cancer	13	13.5	0.96	9	13.0	0.69	22	26.5	0.83
Circulatory disease (390-458)	160	101.5	1.04	106	108.1	0.98	212	209.5	1.01
All other causes	47	68.7	0.68§	39	39.1	1.00	86	107.9	0.80§

*Based on proportionate mortality for U.S. males
†Observed deaths/expected deaths
‡Observed and expected for ICDA 225 and 238 are not included in the total for cancer
§Statistically significant at the 0.05 level
–Not calculated

those for the total United States.[10] If exposures in the petroleum and chemical industries account for the higher rates in the two counties, the CPCMR would underestimate those risks in our study group.

Although the increased frequency of stomach cancer among members who worked at Refinery A was limited to active union members, PMRs for stomach cancer were elevated among both active and retired members who worked at Refinery B, and to a lesser degree among those at Refinery C. These findings are consistent with a report of excess mortality from stomach cancer among petroleum refinery workers in Canada.[11]

Our earlier study indicated a slight excess of leukemia deaths among active union members who worked at Refinery B.[1] Results of the present study indicated more than a twofold increased frequency of leukemia deaths among retired as well as active union members at Refinery B and a fourfold excess among retirees at Refinery C. In addition, PMRs for multiple myeloma (Refineries A and B) and other lymphomas (Refinery A) were elevated. Although the responsible factors are not clear, it is noteworthy that leukemia is associated with benzene exposure[12,13] and that other petrochemical exposures may be related to lymphoproliferative malignancies.[14,15]

The most consistent pattern in all three refineries was the significant elevation of PMRs for brain cancer, particularly among active union members. A more detailed discussion of the brain tumor deaths in this study group is presented elsewhere.[16] The increased risk among active members may be due to a period in midlife of increased susceptibility to brain tumors, for which a peak in mortality is exhibited between ages 50 and 69 in the general population.[10] Our findings are of special interest in view of the excess risk of brain cancer reported among petroleum refinery workers in Canada[17] and among workers in a chemical plant located in the Gulf Coast area of Texas.[18] Brain tumors also appear to be excessive among workers exposed to vinyl chloride,[19,20] and some studies have suggested high risks in the pharmaceutical[21] and rubber[15,22] industries. In several of these studies, brain tumors occurred primarily among employees under the age of 65. It is not clear whether this pattern reflects the age distribution of the populations studied or a biologic phenomenon related to the origins of brain cancer.

In summary, our analysis of proportionate mortality data encompassing active and retired members of the OCAW employed in three Texas petroleum refineries suggests that refinery workers have elevated risks of brain, stomach and hematopoietic and lymphatic malignancies. More definitive studies are needed to estimate cancer risks in the petroleum industry and to identify exposures that are carcinogenic.

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Holding Up the Sky

Do the nurse and physician really become too busy to see the patient with advanced cancer, or are they withdrawing becuase they are reluctant to face what appears to be a personal failure or a deep frustration?

To the patient, withdrawal is abandonment. We must see to it that the patient and the patient's family are brought together in communication with the physician, nurse, and selected medical personnel, for at no other time in life is the need for human contact greater than when a diagnosis of cancer is made.

We must place humanistic priorities above all others. If we do, we can show that the sky never really falls in on most cancer patients, no matter how bleak their prospects may seem. And the sky doesn't fall because there are interested, dedicated, sincere people who raise their hands against the sky, to hold up the very heavens and give cancer patients the room they need to breathe and to accomplish, the space in which to live, and the hope and resources needed to help them cope with their illness and find further enrichment in their lives.

— From "Editorial: Raise Your Hands Against the Sky" by A. I. Holleb, M.D., in *Ca-A Cancer Journal for Clinicians*, July/August, 1981.