Exhibit 268

Mortality Among Three Refinery/Petrochemical Plant Cohorts. I. 1970 to 1982 Active/Terminated Workers

R. Jeffrey Lewis, PhD, MBA
John F. Gamble, PhD
Gail Jorgensen

This study updates mortality rates for 19,075 active and terminated workers at three refinery/petrochemical plants. Mortality rates of the workers were compared with both national and state rates. The results indicated deficits of deaths for all causes, all malignant neoplasms, and respiratory and prostate cancer. The noteworthy finding was a statistically significant increase in leukemia among Louisiana male subjects (standardized mortality ratio [SMR], 181; 95% confidence interval [CI], 122 to 259), which showed suggestive trends of increasing SMRs with increasing tenure. This excess was largely due to increased chronic lymphocytic leukemia (SMR, 351; 95% CI, 168 to 645). The rate of kidney cancer remained elevated among Louisiana male subjects, but this finding was no longer significant, and there were no patterns in SMRs by tenure and latency. Mesothelioma was increased at the Louisiana (SMR, 198; 95% CI, 72 to 430) and Texas (SMR, 246; 95% CI, 99 to 507) locations. The leukemia findings have prompted a study of leukemia incidence at the Louisiana location.

Hanis et al[1,2] and Shallenberger et al[3] studied mortality patterns among petroleum and chemical workers employed at three Exxon locations in Texas, Louisiana, and New Jersey. The most recent study of this cohort[3] comprised 25,321 active, retired, and terminated employees observed from 1970 to 1982. Although mortality from all causes and all cancers was less than expected, an elevated rate of death due to kidney cancer among blue-collar workers was observed at one location based on state comparison rates (standardized mortality ratio [SMR], 246; 95% confidence interval [CI], 146 to 390).

The present study updates the Shallenberger et al[3] investigation by providing an additional 10 years of mortality follow-up (through 1992) for active/terminated workers. Pre-1970 retirees included in the previous update are analyzed separately and are reported elsewhere.[4] Analysis of only active and terminated workers allows for an assessment of more contemporary petrochemical exposures. Further, it enhances comparability with other petrochemical cohorts by eliminating incomplete cohort enumeration and by reducing potential bias from including only longer surviving retirees (see Gamble et al[4] for more detail).

The specific study objectives were to determine if the excess kidney cancer deaths observed in the previous update[3] persisted over time and to detect any new disease excesses present. Because kidney cancer and petroleum exposures in this cohort

From ExxonMobil Biomedical Sciences, Inc, Annandale, NJ.
Address correspondence to: R. Jeffrey Lewis, PhD, Staff Epidemiologist, ExxonMobil Biomedical Sciences, Inc, 1545 Route 22 East, PO Box 971, Annandale, NJ 08801-0971; e-mail RJLEWIS@ERENJ.COM.

were studied previously in a nested case-control investigation,[5] the focus of this update for kidney cancer was on mortality patterns in the most recent 10-year period. In addition, leukemia, other lymphopoietic cancers, malignant melanoma, and mesothelioma were of a priori interest in light of previous findings in petroleum workers.[6,7–13]

Methods

The study cohort included all active and terminated employees (n = 19,075) from a previously defined cohort of 25,321 refinery and petrochemical workers.[3] All employees had at least 1 month of service at the Baton Rouge, Louisiana; Baytown, Texas; and/or Bayway/Bayonne, New Jersey refinery and chemical plant sites during the period January 1, 1970 to December 31, 1982.

Vital status of each employee was determined as of December 31, 1992 by using a number of sources, beginning with vital status information from the previous update.[3] Company records were supplemented with linkage searches from the National Death Index (NDI) and the Social Security Administration (SSA). Death certificates for deceased workers were obtained from company annuitant benefits offices or were traced through the NDI or SSA. The underlying cause of death was coded by a single, trained nosologist according to the International Classification of Diseases (ICD) revision in effect at the time of death. All death certificates with ICD codes that could possibly include mesotheliomas were reviewed to identify mesothelioma deaths.

Employees contributed person-years from January 1, 1970 (plus 1 month if first employed after January 1, 1970) until the end of the study period (December 31, 1992) or their date of death, whichever came first. Employees who terminated employment during the study period without attaining retirement status were considered to be at risk until the end of the study period unless they were designated as lost-to-follow-up by our searches of company records, SSA, and NDI. Employees who terminated before 1979 (a time period not covered by NDI) and who were not confirmed as alive or deceased by SSA and company records were designated as unknown vital status. Employees who terminated after 1979 were classified as either alive or deceased based on the NDI search. Workers defined as unknown vital status were considered to be lost-to-follow-up and contributed person-years only until their date of termination from company service.

Mortality rates for workers were compared with US population rates (1970 to 1989) and with general population rates (1970 to 1992) for the states in which their respective plants were located by calculating the standardized mortality ratio (SMR). The expected number of deaths for workers was calculated by multiplying 5-year age, race, sex, and calendar-year specific death rates by the person-years at risk in the corresponding categories.

All analyses were performed by using the Occupational Cohort Mortality Analysis Program,[14] with SMRs being calculated for the overall cohort and by plant location. Analyses by latency and tenure were performed by location for causes of death found to be statistically significantly elevated or borderline statistically significant (ie, the lower 95% CI value was 95 or greater). To reduce imprecision in reported SMRs, the SMR and 95% CI were calculated only when either the observed or expected deaths were ≥5.

Results

Characteristics of the Study Population

Table 1 describes the demographic characteristics of the cohort. The 19,075 workers include primarily white men (79%), with 20% being deceased. The total number of workers at the Baton Rouge and Baytown facilities was similar, whereas a smaller number worked at Bayway.

The data on length of employment indicate a long average tenure of 21.1 years and an average time since hire of 30 years. The majority of deceased subjects were approximately retirement age or older at time of death.

SMR Analysis

Table 2 presents SMRs for all active and terminated male employees (national comparison rates). Statistically significant deficits of deaths from all causes, all malignant neoplasms, respiratory and prostate cancer, and other malignant neoplasms were observed. Most non-cancer–related causes showed deficits as well, with the exception of an elevated SMR for deaths due to hypertension with heart disease (SMR, 123; 95% CI, 88 to 166). Elevated SMRs were also observed for kidney cancer (SMR, 144; 95% CI, 100 to 200); all lymphatic and hemopoietic cancers combined (SMR, 122; 95% CI, 101 to 146); leukemia (SMR, 150; 95% CI, 113 to 195); benign, other, and unspecified neoplasms (SMR, 182; 95% CI, 114 to 276); and neoplasms of uncertain behavior and unspecified nature of the eye, brain, and nervous system (SMR, 240; 95% CI, 128 to 410). Mortality analyses for white men, non-white men, and women did not indicate substantially different SMRs compared with those in Table 2; however, these findings were based on small numbers.

Table 3 presents SMRs for all active and terminated male employees by location (state comparison rates). Deficits of deaths from all causes and all malignant neoplasms were observed at all locations, and, with the exception of Bayway, these were statistically significant. There was a general trend toward slightly higher, but not statistically significant, SMRs for digestive-related cancers at Bayway, with large intestine cancer being borderline statistically significantly elevated (SMR, 141;

TABLE 1
Description of Active/Terminated Worker Cohort, 1970–1992

	Total Cohort*		Baton Rouge		Baytown		Bayway	
	n	%	*n*	%	*n*	%	*n*	%
Total in cohort	19,075		7,689		7,130		4,643	
Male	17,025	89.2	6,986	90.9	6,357	89.2	4,030	86.8
White	15,041	78.8	5,937	77.2	5,735	80.4	3,700	79.7
Nonwhite	1,984	10.4	1,049	13.6	622	8.7	330	7.1
Female	2,050	10.7	703	9.1	773	10.8	613	13.2
White	1,760	9.2	567	7.4	687	9.6	542	11.7
Nonwhite	290	1.5	136	1.8	86	1.2	71	1.5
Total deceased	3,403	17.8	1,497	19.5	1,182	16.6	731	15.7
Male	3,339	19.6	1,479	21.2	1,149	18.1	718	17.8
White	2,995	19.9	1,238	20.8	1,067	18.6	697	18.8
Nonwhite	344	17.3	241	23.0	82	13.2	21	6.4
Female	64	3.1	18	2.6	33	4.3	13	2.1
White	62	3.5	16	2.8	33	4.8	13	2.4
Nonwhite	2	0.7	2	1.5	0	0	0	0
Average years (SD)†								
Length of employment	21.1	12.7	21.5	12.5	20.6	12.7	19.3	13.6
Age at employment	25.9	5.5	25.7	5.1	26.5	5.8	26.2	6.5
Age at death	66.3	11.5	66.6	11.8	66.5	11.1	65.2	11.6
Year of hire	1962		1961		1962		1964	

* Includes employees who worked at more than one of the three sites.
† SD, standard deviation.

95% CI, 98 to 196). Deaths due to central nervous system tumors were non-significantly elevated at Baton Rouge and Baytown.

A statistically significant excess of deaths due to kidney cancer was observed among workers at Baton Rouge (SMR, 178; 95% CI, 107 to 278). Kidney cancer also was non-significantly elevated at Bayway, and bladder and other urinary organ cancers were increased at Baton Rouge and Bayway (see Table 3).

A statistically significantly elevated SMR for all lymphatic and hemopoietic cancers combined (SMR, 137; 95% CI, 104 to 178), due largely to excess leukemia deaths (SMR, 181; 95% CI, 122 to 259), was observed at Baton Rouge. Leukemia deaths at the other two locations were non-significantly elevated, as were lymphosarcoma and reticulosarcoma deaths at Baton Rouge. The leukemia deaths at Baton Rouge comprised 8 acute myelogenous, 2 acute lymphocytic, 4 chronic myelogenous, 10 chronic lymphocytic, 1 lymphoid (unspecified), 1 acute (unspecified), and 4 unspecified leukemias. Calculation of SMRs by cell type indicated that the leukemia excess was due primarily to a three-fold, statistically significant excess of chronic lymphocytic leukemia (CLL) (SMR, 351; 95% CI, 168 to 645, Louisiana rates). Acute myelogenous leukemia was non-significantly elevated nearly two-fold (SMR, 152; 95% CI, 66 to 300, Louisiana rates). The CLL patients all began working between 1937 and 1947 and worked in maintenance and/or operator jobs sometime during their career.

Death rates in the "other" neoplasms category were significantly elevated at Baton Rouge (SMR, 269; 95% CI, 108 to 155). Neoplasms of uncertain behavior and unspecified nature of the eye, brain, and nervous system were significantly increased at Baytown (SMR, 414; 95% CI, 152 to 901). However, both of these findings were somewhat imprecise because of the small numbers of deaths.

Finally, at Baton Rouge there was a statistically significant increase in deaths due to hypertension with heart disease (SMR, 155; 95% CI, 106 to 219) and a non-significant excess of deaths due to hypertension without heart disease (SMR, 143; 95% CI, 58 to 295).

Mesothelioma

In the absence of national death rates for mesothelioma, and because mortality is similar to incidence in this rapidly fatal disease, we calculated expected deaths by using incidence rates for invasive mesothelioma for the years 1973 to 1991 from the Surveillance, Epidemiology and End Result program.[15] There were 14 observed mesothelioma deaths versus 7.4 expected, resulting in a statistically significantly elevated SMR of 189 (95% CI, 103 to 318). Analyses by location indicated non-significant excess mesothelioma death rates at Baton Rouge (SMR, 200; 95% CI, 73 to 436) and Baytown (SMR, 250; 95% CI, 100 to 515) but not Bayway (1 observed, 1.6 expected). All decedents had been hired between 1935 and 1950, all had worked at least 25 years, and all were first employed at least 30 to 54 years before their death. Most were mechanical maintenance workers, primarily in refineries, and several did pipe fitting or insulation

TABLE 2
Observed and Expected* Deaths, SMRs,† and 95% CI† for Selected Causes of Death Among Male Employees (All Races Combined), Active/Terminated Cohort, 1970–1992

Cause of Death (9th Revision ICD Code)	Observed	Expected	SMR	95% CI
All causes of death	3,339	4,350.2	77	74–79‡
All malignant neoplasms (140–208)	947	1,089.6	87	82–93‡
Cancer of buccal cavity & pharynx (140–149)	20	28.0	72	44–110
Cancer of digestive organs & peritoneum (150–159)	254	269.7	94	83–106
Esophagus (150)	27	29.2	93	61–135
Stomach (151)	32	38.3	84	57–118
Large intestine (153)	102	97.9	104	85–126
Rectum (154)	16	21.1	76	43–123
Biliary passages & liver (155–156)	23	23.0	100	64–150
Pancreas (157)	44	53.8	82	59–110
Cancer of respiratory system (160–165)	320	415.8	77	69–86‡
Larynx (161)	9	14.5	62	28–118
Bronchus, trachea, lung (162)	309	397.2	78	69–87‡
Cancer of breast (174–175)	0	1.3	–	–
Cancer of prostate (185)	72	91.8	78	61–99‡
Cancer of kidney (189.0)	35	24.3	144	100–200‡
Bladder & other urinary organs (188; 189.3–189.4; 189.8–189.9)	26	27.5	94	62–138
Melanoma (172)	12	14.4	83	43–145
Central nervous system (191–192)	29	26.6	109	73–157
Lymphatic & hemopoietic tissue (200–208)	116	95.2	122	101–146‡
Lymphosarcoma & reticulosarcoma (200)	13	11.4	114	61–196
Leukemia (204–208)	56	37.3	150	113–195‡
Other lymphopoietic tissue (202–203)	45	41.0	110	80–147
Other malignant neoplasms (171, 173, 195–199)	57	84.8	67	51–87‡
Benign, other & unspecified neoplasms (210–239)	22	12.1	182	114–276‡
Benign neoplasm of the eye, brain & nervous system (224–225)	0	1.4	–	–
Neoplasm of uncertain behavior and unspecified nature of the eye, brain & nervous system (237.5–237.9; 239.6–239.7)	13	5.4	240	128–410‡
Other neoplasms (210–223; 226–236; 237.0–237.4; 238.0–239.5; 239.8–239.9)	9	5.3	171	78–325
Tuberculosis (10–18)	4	6.9	58	16–148
Diabetes mellitus (250)	47	66.9	70	52–93‡
Cerebrovascular disease (430–438)	146	226.5	64	54–76‡
All heart disease (390–398, 402, 404, 410–429)	1,351	1,654.9	82	77–86‡
Rheumatic heart disease (390–398)	6	17.2	35	13–76‡
Ischemic heart disease (410–414)	1,067	1,298.1	82	77–87‡
Other endocardium disease and heart failure (424, 428)	49	54.8	89	66–118
Hypertension with heart disease (402, 404)	42	34.2	123	88–166
All other heart disease (415–417, 420–423, 425–427, 429)	187	250.5	75	64–86‡
Hypertension without heart disease (401, 403, 405)	9	12.0	75	34–142
Non-malignant respiratory disease (460–519)	188	326.6	58	50–66‡
Influenza & pneumonia (480–487)	53	96.0	55	41–72‡
Bronchitis, emphysema, asthma (490–493)	36	66.2	54	38–75‡
Bronchitis (490–491)	4	10.1	40	11–102
Emphysema (492)	29	50.4	58	38–83‡
Other non-malignant respiratory disease (460–466, 470–478, 494–496, 500–519)	99	164.5	60	49–73‡
Ulcer of stomach & duodenum, and peptic ulcer (531–533)	5	15.1	33	11–77‡
Chronic liver disease and cirrhosis (571)	56	99.0	56	43–73‡
Nephritis & nephrosis (580–589)	25	31.2	80	52–118
All external causes of death (E800–E999)	223	363.5	61	54–70‡
Accidents (E800–E949)	143	213.3	67	56–79‡
Motor vehicle accidents (E810–E825)	79	100.5	79	62–98‡
Suicides (E950–E959)	58	85.6	68	51–88‡
Homicides & other external causes (E960–E978, E980–E999)	22	64.6	34	21–52‡
Other causes (1–9, 20–139, 240–246, 251–389, 440–459, 520–530, 534–570, 572–579, 590–799)	316	446.0	71	63–79‡

* Expected deaths based on US male mortality rates (all races combined).
† SMRs, standardized mortality ratios; CI, confidence interval.
‡ 95% CI does not include 100.

TABLE 3
Observed and Expected* Deaths, SMRs, and 95% CI for Selected Causes of Death Among Male Employees (All Races Combined), Active/Terminated Cohort, by Plant Location, 1970–1992†

Cause of Death (9th Revision ICD Code)	Baton Rouge				Bayway				Baytown			
	Obs	Exp	SMR	95% CI	Obs	Exp	SMR	95% CI	Obs	Exp	SMR	95% CI
All causes of death	1,479	2,014.0	73	70–77	718	877.2	82	76–88‡	1,149	1,637.7	70	66–74‡
All malignant neoplasms (140–208)	424	508.1	83	76–92‡	223	236.0	94	82–108	304	405.7	75	67–84‡
Cancer of buccal cavity & pharynx (140–149)	6	13.7	44	16–96‡	8	6.4	125	54–246	6	10.1	60	22–130
Cancer of digestive organs & peritoneum (150–159)	100	110.8	90	73–110	75	65.2	115	90–144	79	91.0	87	69–108
Esophagus (150)	11	11.8	93	46–167	8	6.4	126	54–248	8	9.2	87	38–171
Stomach (151)	12	16.0	75	39–131	8	9.7	82	36–163	12	12.6	95	49–167
Large intestine (153)	37	37.0	100	70–138	35	24.9	141	98–196	30	30.8	97	66–139
Rectum (154)	5	7.4	67	22–157	4	5.7	70	19–180	7	5.5	128	51–263
Biliary passages & liver (155–156)	4	11.4	35	10–90‡	9	5.1	177	81–336	10	10.6	94	45–173
Pancreas (157)	28	25.2	111	74–161	7	11.9	59	24–122	9	20.3	44	20–84‡
Cancer of respiratory system (160–165)	151	212.2	71	60–83‡	69	84.5	82	64–103	102	164.1	62	50–76‡
Larynx (161)	6	7.2	83	31–181	1	3.3	–	–	2	5.1	39	5–141
Bronchus, trachea, lung (162)	145	203.5	71	60–84‡	68	80.1	85	66–108	98	157.5	62	50–76‡
Cancer of breast (174–175)	0	0.4	–	–	0	0.4	–	–	0	0.4	–	–
Cancer of prostate (185)	30	41.1	73	49–104	11	17.8	62	31–111	31	32.9	94	64–134
Cancer of kidney (189.0)	19	10.7	178	107–278‡	7	5.4	129	52–265	9	9.4	96	44–182
Bladder & other urinary organs (188; 189.3–189.4; 189.8–189.9)	12	10.5	114	59–199	8	6.6	122	53–241	6	8.3	72	27–158
Melanoma (172)	3	5.2	57	12–168	4	3.7	–	–	5	6.0	83	27–195
Central nervous system (191–192)	14	10.3	136	74–228	4	5.8	69	19–176	11	10.0	110	55–197
Lymphatic & hemopoietic tissue (200–208)	56	40.8	137	104–178‡	22	21.0	105	66–158	39	35.6	110	78–150
Lymphosarcoma & reticulosarcoma (200)	6	4.3	138	51–301	2	2.6	–	–	5	3.7	136	44–316
Leukemia (204–208)	30	16.6	181	122–259‡	10	7.9	126	61–233	17	14.2	120	70–192
Other lymphopoietic tissue (202–203)	20	17.6	114	70–176	9	9.1	99	45–188	16	15.8	102	58–165
Other malignant neoplasms (171, 173, 195–199)	30	48.3	62	42–89‡	13	16.9	77	41–132	15	34.3	44	24–72‡
Benign, other & unspecified neoplasms (210–239)	12	6.3	189	98–330	2	2.9	–	–	8	3.8	210	91–414
Benign neoplasm of the eye, brain & nervous system (224–225)	0	0.6	–	–	0	0.3	–	–	0	0.5	–	–
Neoplasm of uncertain behavior and unspecified nature of the eye, brain & nervous system (237.5–237.9; 239.6–239.7)	5	3.2	156	51–365	2	1.3	–	–	6	1.4	414	152–901‡
Other neoplasms (210–223; 226–236; 237.0–237.4; 238.0–239.5; 239.8–239.9)	7	2.6	269	108–555‡	0	1.2	–	–	2	1.9	–	–
Tuberculosis (10–18)	1	4.8	–	–	1	1.3	–	–	2	2.9	–	–
Diabetes mellitus (250)	23	37.0	62	39–93‡	10	17.5	57	28–105	14	26.8	52	29–88‡
Cerebrovascular disease (430–438)	77	112.9	68	54–85‡	23	38.2	60	38–90‡	46	84.1	55	40–73‡
All heart disease (390–398, 402, 404, 410–429)	605	760.3	80	73–86‡	300	344.8	87	77–97‡	448	589.9	76	69–83‡
Rheumatic heart disease (390–398)	1	4.6	–	–	3	4.8	–	–	2	42	–	–
Ischemic heart disease (410–414)	464	588.6	79	72–86‡	254	284.0	90	79–101	350	417.6	84	75–93‡
Other endocardium disease and heart failure insufficiency (424, 428)	27	30.9	88	58–127	7	9.3	76	30–156	15	26.8	56	31–92‡
Hypertension with heart disease (402, 404)	32	20.6	155	106–219‡	7	7.3	96	38–197	3	13.2	23	5–66‡
All other heart disease (415–417, 420–423, 425–427, 429)	81	115.6	70	56–87‡	29	39.5	73	49–105	78	128.1	61	48–76‡
Hypertension without heart disease (401, 403, 405)	7	4.9	143	58–295	0	1.9	–	–	2	4.2	–	–
Non-malignant respiratory disease (460–519)	78	136.7	57	45–71‡	30	53.4	56	38–80‡	80	122.3	65	52–81‡
Influenza & pneumonia (480–487)	21	38.5	54	34–83‡	10	17.5	57	27–105	22	34.6	64	40–96‡
Bronchitis, emphysema, asthma (490–493)	19	29.2	65	39–102	7	10.0	70	28–144	10	26.5	38	18–69‡
Bronchitis (490–491)	1	4.0	–	–	2	1.6	–	–	1	3.7	–	–
Emphysema (492)	16	22.7	70	40–114	4	7.8	52	14–132	9	20.9	43	20–82‡
Other non-malignant respiratory disease (460–466, 470–478, 494–496, 500–519)	38	68.9	55	39–76‡	13	25.9	50	27–86‡	48	61.2	78	58–104
Ulcer of stomach & duodenum, and peptic ulcer (531–533)	2	5.8	34	4–124	1	2.9	–	–	2	5.1	40	5–143
Chronic liver disease and cirrhosis (571)	18	32.3	56	33–88‡	21	23.9	88	54–134	17	32.9	52	30–83‡
Nephritis & nephrosis (580–589)	11	18.0	61	30–109	2	7.1	28	3–102	12	10.8	111	57–194
All external causes of death (E800–E999)	99	187.7	53	43–64‡	32	53.0	60	41–85‡	93	154.6	60	49–74‡
Accidents (E800–E949)	67	113.9	59	46–75‡	21	32.9	64	40–98‡	56	88.7	63	48–82‡
Motor vehicle accidents (E810–E825)	39	51.6	76	54–103	11	15.4	71	36–128	30	45.2	66	45–95‡
Suicides (E950–E959)	24	39.9	60	38–89‡	8	11.7	68	30–135	26	33.9	77	50–112
Homicides & other external causes (E960–E978, E980–E999)	8	33.9	24	10–47‡	3	8.4	36	7–104	11	31.9	34	17–62‡
Other causes (1–9, 20–139, 240–246, 251–389, 440–459, 520–530, 534–570, 572–579, 590–799)	122	199.1	61	51–73‡	73	94.2	78	61–98‡	121	194.6	62	52–74‡

* Expected deaths based on state (La., N.J., and Texas) male mortality rates (all races combined).
† SMRs, standardized mortality rates; CI, confidence interval; Obs, observed; Exp, expected.
‡ 95% CI does not include 100.

TABLE 4
Observed and Expected* Deaths, SMRs,† and 95% CI† for Selected Causes of Death Among Male Employees (All Races Combined), Baton Rouge, La., by Latency, Tenure, and Time Period, Active/Terminated Cohort, 1970–1992

Cause of Death (9th Revision ICD Code)	Latency, Tenure, and Time Period				
	<20 Yrs Latency	≥20 Yrs Latency, <30 Yrs Tenure	≥20 Yrs Latency, ≥30 Yrs Tenure	1970–1982 (previous study period)	1983–1992 (update period)
Cancer of kidney (189.0)					
Observed/expected	1/0.8	6/2.8	12/7.1	9/4.4	10/6.2
SMR (95% CI)	–	217 (80–472)	169 (87–296)	202 (93–384)	161 (77–296)
Leukemia (204–208)					
Observed/expected	2/1.6	7/4.1	21/10.9	15/6.9	15/9.7
SMR (95% CI)	–	173 (69–356)	193 (120–298)‡	219 (122–361)‡	154 (86–255)
Other neoplasms (210–223; 226–236; 237.0–237.4; 238.0–239.5; 239.8–239.9)					
Observed/expected	0/0.2	1/0.6	6/1.8	2/1.0	5/1.6
SMR (95% CI)	–	–	333 (122–727)‡	–	307 (100–715)
Hypertension with heart disease (402, 404)					
Observed/expected	1/1.5	8/4.4	23/14.7	10/6.8	22/13.8
SMR (95% CI)	–	184 (79–362)	156 (99–235)	148 (71–272)	159 (100–240)

* Expected deaths based on La. male mortality rates (all races combined).
† SMRs, standardized mortality ratios; CI, confidence interval.
‡ 95% CI does not include 100.

work. At least one decedent had been previously employed in a shipyard.

SMRs by Latency, Tenure, and Time Period

Evaluation of trends by latency and tenure were limited because of the lack of employees with short tenures. As a result, the number of categories that could be derived to determine if trends were present was limited.

Table 4 presents SMRs according to the limited ranges for latency and tenure as well as for time period for kidney cancer, leukemia, "other" neoplasms, and hypertension with heart disease for Baton Rouge. With regard to kidney cancer, there was no clear trend of increasing SMRs with increasing tenure among those with ≥20-year latency. All but one of the kidney cancer deaths involved at least 20 years of latency, although the number of expected deaths in the <20-year latency category was quite small. The SMR for kidney cancer in the update period was somewhat reduced but remained above 1.0.

Leukemia mortality showed a suggestive trend of increasing SMRs with increasing latency and tenure (see Table 4). The SMR for the ≥20-year latency/≥30-year tenure group was statistically significantly elevated (SMR, 193; 95% CI, 120 to 298). Leukemia SMRs went from 219 to 154 (not significant) in the current update period.

The category of "other" neoplasms showed increasing mortality only in the longest latency/tenure group, with a statistically significantly elevated SMR (SMR, 333; 95% CI, 122 to 727); there were too few deaths in the remaining categories to assess trends. The SMR for "other" neoplasms in the update period is borderline significantly elevated but is based on small numbers (SMR, 307; 95% CI, 100 to 715). Finally, SMRs for hypertension with heart disease were similar across latency/tenure categories, and there was no meaningful difference in SMRs by time period.

Table 5 presents SMRs by latency and tenure for disease categories that were statistically significantly, or borderline significantly, elevated at Baytown and Bayway. At Baytown, the number of neoplasms of uncertain behavior and unspecified nature of the eye, brain, and nervous system was too small for meaningful analyses. However, observed and expected deaths were similar across the tenure categories having 20+ years of latency. The results for Bayway indicated that all large intestine cancer cases had at least 20 years of latency, with the SMR in the ≥20-year latency/≥30-year tenure categories being statistically significant. However, the magnitude of the SMRs was similar in the two tenure groups.

Discussion

This study provides an additional 10 years of mortality follow-up for a cohort of active/terminated refinery and chemical plant workers employed during 1970 to 1982. The strengths of the study are the relatively large cohort size, the enhanced ability to assess more contemporary petrochemical exposures, and the long tenure and latency periods of employees. These long periods of the cohort are advantageous for detecting long-latency, occupationally related disease excesses if present. Like many cohort studies, this investigation was limited by a lack of

TABLE 5
Observed and Expected* Deaths, SMRs,† and 95% CI‡ for Selected Causes of Death Among Male Employees (All Races Combined), Baytown, Texas and Bayway, N.J. by Latency and Tenure, Active/Terminated Cohort, 1970–1992

Cause of Death (9th Revision ICD Code)	Latency and Tenure Category: <20 Yrs Latency	≥20 Yrs Latency, <30 Yrs Tenure	≥20 Yrs Latency, ≥30 Yrs Tenure
Baytown, Texas: Neoplasms of uncertain behavior & unspecified nature of the eye, brain & nervous system (237.5–237.9; 239.6–239.7)			
Observed/expected	0/0.2	3/0.4	3/0.8
SMR (95% CI)	–	–	–
Bayway, N.J.: Large intestine (153)			
Observed/expected	0/1.7	7/4.8	28/18.3
SMR (95% CI)	–	146 (58–300)	153 (102–221)‡

* Expected deaths for Baytown, Texas based on Texas male mortality rates (all races combined). Expected deaths for Bayway, N.J. based on New Jersey male mortality rates (all races combined).
† SMRs, standardized mortality rates; CI, confidence interval.
‡ 95% CI does not include 100.

information on exposure, job type, and smoking.

Analyses based on national and state comparison rates showed deficits of deaths from all causes, all malignant neoplasms, respiratory cancers, and prostate cancer, with many of these findings being statistically significant. With the exception of the deficit rate of prostate cancer, these findings are in agreement with previous studies of petroleum workers.[6] All non-neoplastic causes of death, with the exception of deaths due to hypertension with and without heart disease at Baton Rouge and nephritis and nephrosis at Baytown, showed deficit rates as well. Many of these deficits are likely to be related to the well-known Healthy Worker Effect.[16]

The increase in kidney cancer deaths among Baton Rouge employees was observed in an earlier study of this cohort[3] and among Baton Rouge retirees.[4] Analyses by time period suggest that since 1982 (the last update), kidney cancer mortality has decreased slightly and is no longer statistically significant. Most importantly, there were no clear trends of increasing SMRs with increasing tenure in the ≥20-year latency group.

Several studies of rats exposed to wholly vaporized, unleaded gasoline have shown dose-related increases in kidney cancer, although this effect has been limited to male rats and has not been observed among mice of either gender.[17–19] A US Environmental Protection Agency task force reviewed these data and concluded that male rat kidney tumors are not relevant to assessing human risk.[20] A review by Swenberg[21] supports this conclusion. With regard to human evidence, some cohort studies of petroleum workers have found increased deaths due to kidney cancer,[6] and a population-based case-control study reported an association between exposure to aviation gas and kidney cancer.[22] However, case-control studies of kidney cancer nested within this[5] and other petroleum cohorts[23,24] have found no relationship between petroleum-related exposures and kidney cancer.

The excess leukemia rate at Baton Rouge was limited primarily to CLL. To date, no chemical exposures have been consistently linked with CLL, although a few studies have reported increased CLL deaths and/or risk associated with aliphatic and chlorinated hydrocarbons,[25] acid-containing chemicals and caustic substances,[25] benzene,[26,27] toluene and other solvents,[27] styrene,[26] and employment in the styrene-butadiene rubber manufacturing industry.[28] In the present study, analyses by latency and tenure for all leukemias combined indicated a trend of increasing SMRs in the ≥20-year-latency group. These trends, combined with our a priori interest in leukemia in light of other petroleum worker studies,[6,7] has prompted a follow-up investigation to examine leukemia incidence among Baton Rouge employees.

Statistically significant increases in "other" neoplasms and neoplasms of uncertain behavior and unspecified nature of the eye, brain, and nervous system were observed at Baton Rouge and Baytown, respectively. Further analyses were hindered by small numbers and no clear pattern. There seem to be no consistent reports of increased deaths for these disease categories in other petroleum worker cohorts. However, deaths due to neoplasms of uncertain behavior and unspecified nature of the eye, brain, and nervous system were significantly elevated among retirees.[4] Overall, the final interpretation of these findings is difficult because of the heterogeneous, unspecific nature of the disease categories and the relatively small number of deaths.

There was a borderline statistically significant 50% excess of deaths from large intestine cancers at Bayway that showed no trend by tenure in the ≥20-year-latency group. Studies of other petroleum workers, including the other two facilities in this study, generally have not found this cancer type to be elevated.[6] In addition, tumors of the large intestine were not of a priori interest in this study. Finally, it was not possible to evaluate the role of several well-established risk factors for large intestine cancer (eg, diet and family history of the disease).[29–31] Thus, there is little persuasive evidence to suggest that the increased deaths from large intestine cancers observed

at Bayway may be related to occupational factors.

The increased rate of mesothelioma deaths observed is consistent with reports of mesothelioma excess rates among other petroleum worker cohorts.[8,9,11–13] Most of these cases involved workers who were employed in earlier time periods in maintenance-type jobs with potential asbestos exposure. Some of the mesothelioma decedents in this study were included in an earlier analysis that provides a more detailed examination of mesothelioma deaths.[10]

The only non-neoplastic cause of death found to be statistically significantly elevated was death due to hypertension with heart disease at the Baton Rouge facility. The occupational etiologic significance of this finding is unclear for several reasons. First, death rates from hypertension-related causes at other locations were not elevated, but rather were less than expected. Second, if the findings represented a true elevation related to an occupational exposure, one would expect a corresponding increase in total deaths from related conditions such as ischemic heart disease and strokes, which were not increased. Third, hypertension-related causes of death were not of a priori interest in this study. Finally, there was no clear trend in the SMRs by latency and tenure. Thus, on the whole, the evidence does not suggest a relationship with occupation, but rather other possible factors such as lifestyle, diet, or the manner in which death certificates were completed.

Summary

Deficits of deaths from all causes, all malignant neoplasms, respiratory cancer, prostate cancer, and most non-malignant causes of death were observed at all locations. Kidney cancer, leukemia, mesothelioma, "other" neoplasms, and hypertension with heart disease were statistically significantly increased at Baton Rouge. Bayway had borderline statistically significant increased deaths due to large intestine cancer, whereas Baytown had non-significant increases in mesothelioma and neoplasms of uncertain behavior and unspecified nature of the eye, brain, and nervous system. The findings for leukemia have prompted a follow-up investigation of leukemia incidence among Baton Rouge men. With the exception of mesothelioma, there was little evidence to support an occupationally related interpretation for the other statistically significant findings observed.

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The Methuselah Factor

For now, reaching 100 is still considered news. Of the 273 million people in the United States, only 70,000 are centenarians. But in the next 50 years, as science extends the span of human life, 100th birthdays will lose their mystique. By 2050, the number of centenarians in the United States could jump to 834,000, according to the US Census Bureau, and that is a mid-range projection. If large numbers of baby boomers reach the later stages of life in good health, the centenarian population could explode to 4.2 million by 2050.

Welcome to the age of longevity. At the dawn of the 21st century, people 85 and older are the fastest growing segment of the US population. And it is a broad-based trend: 50 years from now, approximately 45% of centenarians will be people of color, compared with 22% today. Even today's babies are starting a long-term boom. James Vaupel, PhD, director of Germany's Max Planck Institute for Demographic Research, predicts that a third of all boys and half of all girls recently born in developed countries will live to 100.

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