

PLAINTIFF'S EXHIBIT

MBL-72

REFINERY WORKERS

Update of a Mortality Study of Workers in Petroleum Refineries

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A large cohort of petroleum refinery workers with long duration of employment, long latency, and relatively young age at hire had its vital status updated through Dec 31, 1980. The standardized mortality ratio (SMR) for all causes was 78. Each hematopoietic cancer had an SMR below 100, including SMRs of 54 for esophagus and for all diseases of the gastrointestinal system and of 78 for chronic myeloid. The SMR for all causes was 87. SMRs for specific neoplasms included digestive system, 90; lung, 88; kidney, 68; brain, 89; leukemia, 101; multiple myeloma, 183; unspecified lymphoma, 118; polycythemia vera (four deaths), 458; myelofibrosis (three deaths), 801; and benign and unspecified brain neoplasms, 108. There were also deaths from mesothelioma; all nine employees had more than 20 years of employment, with an SMR of 841.

In January 1975, Tabernash-Cooper Associates, Incorporated (TCA), under the sponsorship of the American Petroleum Institute (API), began a retrospective cohort mortality study of workers in a sample of United States petroleum refineries. The original report was widely distributed by API. Because the cohort is not only large but is also one with long latency and duration of exposure with early age at hire, this study is likely to be a particularly valuable addition to the literature. Therefore, the cohort's vital status has been updated, and a detailed analysis was carried out.

Methods

The vital status of the cohort was updated through

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0278-1728/86/0007-4108\$02.00
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Dec 31, 1980. Data were analyzed by a modified life table program adapted from the one described by Monson¹ and a computer program from the National Institute for Occupational Safety and Health (NIOSH).² For study cohort members lost to follow-up, person-years were accumulated until time of loss. The standardized mortality ratio (SMR) for multiple myeloma (which was not available in either the Monson or NIOSH program) was calculated from data provided by Dr Gary Marsh. SMRs for mesothelioma were calculated from expected numbers generated by age-specific rates for white males for the years 1969 to 1971 from the Third National Cancer Survey (M. Myers, personal communication, 1984) and annual age-specific rates for males from the SEER Program for the years 1973 to 1978.³

In all the above analyses, black males were analyzed in comparison with the mortality experience of nonwhite males. All other study cohort members had their mortality experience compared with that of white males and the results were combined. Based on the distribution by plant of those cohort members with known race, we estimate that 99.3% of those whose mortality experience was compared with that of white males were white.

TCA collected 80,100 individual records for this study. Of these, 178 (0.2%) were eliminated from the analysis for the following reasons:

1. Seventy-nine workers from one refinery were eliminated because the records for men who had quit or were discharged were kept for only 1 year unless the employee had died on the job.
2. Forty-one had worked less than 1 year between 1969 and 1971.
3. One was female.

4. Fifty-seven were duplicate records, including us of employees who qualified in more than one participating refinery.

With the elimination of these records, the total cohort size for follow-up and analysis became 79,921.

Petroleum Refinery Workers/Kaplan

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TABLE—Continued

Cause	Observed Deaths	Expected Deaths	SMR	95% Confidence Interval
Diseases of genitourinary system	33	52.52	63	43-88
Chronic nephritis	13	17.93	73	39-124
Diseases of the skin and subcutaneous tissue	3	3.15	95	19-278
Diseases of the musculoskeletal system and connective tissue	3	7.54	40	8-116
Symptoms and ill-defined conditions	54	63.78	85	64-110
Accidents, poisonings, and violence	260	375.52	69	61-78
All accidents	164	237.98	68	59-80
Motor vehicle accidents	77	106.32	72	57-91
Subsides	57	81.95	70	53-90
All other causes	12	19.14	63	32-110
Unknown	80			

*No. of workers 19 991. No. of person-years 297 591.9

specific causes of death. The 96.6% follow-up rate compares favorably with follow-up rates usually achieved in retrospective cohort mortality studies and fewer than 5% of the death certificates were not obtained.

Part of the explanation for these low SMRs appears to be the well-known healthy worker effect. Anecdotally, people familiar with petroleum refineries have noted that heavy smokers are not likely to work there because of the smoking restrictions for safety purposes that are imposed at work. In combination with the usual healthy worker effect, the anecdotally noted low smoking prevalence among refinery workers may explain these findings.

The accuracy of the diagnoses and the appropriateness of the comparison data could have affected the results for mesothelioma. The probable net result is that the expected number of deaths from this cause is slightly overestimated, which means that the SMR is, if anything, underestimated.

There were nine observed deaths and 7.93 expected deaths from ICD Code 209.9 in the Eighth Revision (other primary malignant neoplasms of lymphoid tissue) for an SMR of 113 with a 95% confidence interval of 52 to 218. For the remainder of Code 209 (other than

209.9) in the Eighth Revision (and for Codes 202 and 206 in the Seventh Revision, which equate to Code 202 in the Eighth Revision) there were one observed death and 1.03 expected deaths, for an SMR of 97. For polycythemia vera there were four observed deaths and 3.98 expected deaths from this cause for an SMR of 155 and 95% confidence interval of 190 to 1,164.

The 88 observed deaths from neoplasms of lymphatic and hematopoietic tissue are three more than the expected deaths from each of the components (lymphomas and reticulum cell sarcoma, Hodgkin's disease, leukemia, and cancer of other lymphatic tissue). The difference is the three deaths from myelofibrosis. The expected number of deaths was 1.49, which gives an SMR for that cause of 901 with a 95% confidence interval of 41 to 688.

It would appear that the concern about neoplasms of the lymphatic and hematopoietic system arises primarily from polycythemia vera, and perhaps from myelofibrosis. There is some question as to whether these are really neoplasms, and the Seventh Revision places them both under diseases of the blood and blood-forming organs. However, the numbers are too small for polycythemia vera and myelofibrosis to warrant further investigation at present.

Acknowledgments

This work was supported in part by a contract from the American Petroleum Institute.

The contributions of Dr. William R. Gaffey and Dr. Neil K. Verrier to the original study design, the advice and technical assistance of numerous employees in the petroleum industry and the cooperation of the study of Dr. Irving P. Tabachnick are gratefully acknowledged.

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