

**AN ANALYSIS OF CANCER MORTALITY IN
EMPLOYEES AND ANNUITANTS OF AN OIL
COMPANY AND AN OIL PIPE LINE COMPANY**

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Epidemiological studies of a group of fifteen thousand petroleum workers for a period of twenty-one years reveal a lesser incidence of cancer deaths than the general population in the same area.

The relationship of occupation to the incidence of certain types of cancer has been recognized by the medical profession for many years. Among the first such reports was in 1775, when Percival Pott described scrotal carcinoma in men constantly exposed to soot. In 1915 Yomagiwi and Ichikawa reported that continuous painting of rabbits ears with tar led to the appearance of carcinoma.

The similarity of the physical properties of crude oil and creosote oil, (a coal tar product) has led many investigators to carefully study petroleum crude oil for the presence of carcinogenic compounds. The results of these investigators have been inconclusive, or without evidence of carcinogenicity.

New techniques in refining processes in the early 1940's produced new compounds which have been shown to have carcinogenic properties when applied experimentally to laboratory animals. This makes it desirable to study the incidence of tumor mortality in petroleum workers as compared to the general population.

Epidemiological studies of employee groups offer one of the best methods of evaluating the relationship of a given occupation to the development of cancer.¹ There are limitations in the accuracy of

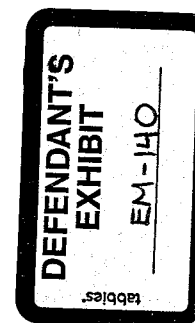
AN ANALYSIS OF CANCER MORTALITY IN EMPLOYEES, ANNUITANTS OF AN OIL COMPANY

studies based on information taken from death certificates generally.² The United States Public Health Service has studied this problem in selected metropolitan ³⁻⁵ and rural areas.⁶ This information is amplified by the experience accumulated by life insurance companies. Research by industrial medical groups may augment these epidemiological analyses by studies on specific segments of the working population.

We present, at this time, an analysis of the tumor mortality experience in a representative unit of the petroleum industry for a 21-year period ending in 1955.

At present, Humble Oil & Refining Company and its subsidiary, Humble Pipe Line Company, have a combined employee population of over 19,000 workers who have been engaged in the exploration, production, refining, transportation, and marketing of petroleum crude and its products in the Southwest portion of the United States. The death certificates for annuitants as well as employees of this group were routinely subjected to medical review and verification. While no claim of 100% diagnostic accuracy is made over this 21-year period, it is felt that the procedures used to insure accuracy are either comparable to or better than those included in similar analyses elsewhere.

We believe the first question of significance in an analysis of this type is whether the group of employees and annuitants studied shows an overall tumor mortality experience significantly different from that of the general population in the states from which the group was drawn. Because the employees under study in this analysis have gradually increased in number during the period of observation, for the purpose at hand, the average yearly number of employees and annuitants is used. In the 21-year period extending from January 1, 1935 through December 31, 1955, there were 179 cancer deaths reported in a population which averaged 15,257 annually. This is equivalent to an overall cancer death rate of 55.9 per hundred thousand per year. (Table 1) Since this represents an integrated rate for the 21-year period, it is best compared with public population figures reported around the midpoint of the period, i.e., 1945. This is a valid comparison as can be seen by examining the increase in United States cancer mortality rates during the period under review. This increase is approximately a linear one.



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COMPARISON OF CERTAIN TUMOR MORTALITY RATES*

Rate	Frequency
Death rate for cancer, all forms, for U. S. - 1945	131.7, per 100,000 per year
Arkansas	78.7
Louisiana	97.2
Oklahoma	102.1
Texas	88.0
Humble Companies, employees and annuitants	55.9

TABLE I

*Figures for U. S. and 4 states reduced by 2% to correct for tumor mortality 0-20 year age group.

The comparison is further supported by taking into account the fact that the employee population is over 18-20 years of age. The traditional method of applying a correction would be to use age specific death rates. However, with only 179 cases distributed into five or six age decades, the groups would become so small as to reduce the statistical significance of comparisons. For this reason we have corrected for that percentage of the total tumor mortality which is experienced by the age group 0-20 years.

The best information for this correction is provided by Public Health Service Monograph #29, which shows the percentage distribution of cancer by age groups for the year 1947. From these figures, we calculate that approximately 2% of the tumor mortality in the general population was experienced by the age group 0-20 years.

Another significant feature in this overall comparison is the geographical distribution of cancer deaths. In this connection, the area of Humble Companies' operations is that portion of the United States identified by the National Office of Vital Statistics as West South Central, comprising the states of Arkansas, Louisiana, Oklahoma and Texas.

The fact that the cancer death rate in the employee and annuitant population studied is well within "normal limits" suggests that the magnitude of any potential carcinogenicity problem which may be present is not sufficient to affect the overall rates. Another very general type of comparison that may be useful is the proportion of the total deaths that are due to tumors, i.e., the commonly used figure of relative frequency. It is again apparent that by a second generally accepted yardstick, Humble Companies' overall tumor mortality experience does

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not significantly differ from that of control groups. These figures are presented in Table II. In addition, the "length of service" for the group as a whole averaged 19 years, a period which may encompass at least a proportion of the latent period of any occupational associated lesions.

RELATIVE FREQUENCY OF CANCER DEATHS

Area	Total Deaths*	Tumor Deaths†	Percent
U. S., 1945	1,258,744	173,915	13.8%
Arkansas, 1945	13,203	1,457	11.0%
Louisiana, 1945	19,868	2,333	11.7%
Oklahoma, 1945	16,991	2,171	12.8%
Texas, 1945	52,850	5,891	11.1%
Humble Companies	1,481	179	12.1%

TABLE II

*Reduced by 10.2% to correct for the mortality occurring in the age group 0-20 years.

†Reduced by 2% to correct for the tumor occurring in the age group 0-20 years.

If a positive correlation existed between occupation and tumor mortality, one might expect it to appear in organ systems most directly exposed to environmental agents. These would include the skin and the respiratory tract. With reference to skin cancer, the data on mortality rates and relative frequency are summarized in Table III.

The respiratory tract would appear to be a logical target tissue for hypothetical carcinogenic factors related to occupation. It will be useful, therefore, to compare the Humble Companies' respiratory tract tumor mortality with other experiences. This is done in Table IV.

MORTALITY EXPERIENCE DUE TO SKIN CANCER AMONG MALES

Group	Skin Cancer Deaths/100,000/Yr.
Humble Companies Employees and Annuitants (1935-55)	3.75
Arkansas (1945)	5.40
Louisiana (1945)	4.86
Oklahoma (1945)	8.95
Texas (1945)	7.40
Above States Combined	6.93
United States (1945)	5.96

TABLE III

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MORTALITY EXPERIENCE DUE TO RESPIRATORY TRACT CANCER AMONG
MALES

Group	Respiratory Tract Deaths/100,000/Yr.
Humble Companies Employees and Annuitants (1935-55)	13.1
Arkansas (1945)	14.9
Louisiana (1945)	25.2
Oklahoma (1945)	14.7
Texas (1945)	18.5
Above States Combined	17.6
United States (1945)	30.8

TABLE IV

Having looked at overall rates and relative frequencies of tumor deaths, and having followed this with an examination of these indices as they relate to neoplastic lesions of the skin and respiratory tract, let's examine the effect of occupational grouping on these indices. Table V shows the overall mortality rates and relative frequencies for cancer deaths arranged by Humble Companies' major departments. Inspection of Table V shows that, in general, departmental grouping was not associated with significant increases in tumor mortality rates nor with increases in the relative frequency figures. One group, exploration, deserves mention however. The cancer death rate for this group is not remarkable but it appears that, as judged by the relative frequency value, about twice as high a proportion of the deaths were due to cancer than in any of the other departmental groups. Note, however, that the

TUMOR MORTALITY EXPERIENCE BY MAJOR DEPARTMENTS OF
HUMBLE COMPANIES

Occupational Group	Average Population	Cancer Deaths	Total Deaths	Total Death Rate per 100,000 per yr.	Cancer Death Rate per 100,000 per yr.	Relative Frequency
Humble Pipe Line Company	2373	38	367	736	78.3	10.4%
Humble Oil & Refining Company:						
Production	4592	61	456	473	63.3	13.4%
Refinery	6239	60	531	405	45.8	11.3%
Sales	743	9	82	528	57.7	10.9%
Exploration	1060	11	45	204	49.9	24.4%
Total	15257	179	1481	462	55.9	12.1%

TABLE V

total death rate for this department is about half that of the other departments. A relatively small number of non-cancer deaths appears to have pushed the relative frequency higher than would be expected on the basis of the cancer death rate.

Further light on the effect of departmental grouping on these mortality figures is shed by some other characteristics of the departmental groups which are shown in Table VI. Here, note that certain departmental segments have a less seasoned group of employees than others, with a spread around the 19-year average length of service ranging from 13 years in exploration to 23 years in Humble Pipe Line. In this connection, it is interesting and expected to note that the highest cancer death rate, 78.3, was in the Humble Pipe Line employees, the group with the longest service. This is also the group with the oldest average age, by approximately 7 years. While the exploration group had a relatively low total death rate, the mortality experienced appears to have occurred at a younger age although in smaller numbers.

ADDITIONAL CHARACTERISTICS OF OCCUPATIONAL GROUPS

Occupational Group	Average Length of Service	Average Age at Death
Pipe Line Company	23 yrs.	55 yrs.
Production	21 yrs.	56 yrs.
Refinery	20 yrs.	55 yrs.
Sales	18 yrs.	54 yrs.
Exploration	13 yrs.	43 yrs.
Total	19 yrs.	52 yrs.

TABLE VI

In looking at this 21-year experience, certain questions suggest themselves. First, do oil company employees differ significantly from comparable segments of the general population and overall tumor mortality experience? The data says "no"; in fact, the group under study appeared to show a favorable tumor mortality experience as compared with that of the public in areas from which they were drawn.

In view of potential skin contacts with certain petroleum derivatives known to be capable of producing tumors in experimental animals, how does the death rate from skin cancer compare with that of comparable segments of the general population? Here again our employee and annuitant population experience a rate at least as good or better than that of the population from which they were drawn.

In view of the potential inhalation of vapors and fumes that may be present around manufacturing operations, how does the death rate from respiratory tract cancer compare with that of the general population? The respiratory tract tumor mortality rate compares favorably with control groups. Although the relative frequency figure for this group of neoplastic diseases is somewhat higher than that of the general population, statistical analysis indicated that this difference was insignificant.

In addition to mortality rates, certain types of potential occupational exposures may result in the earlier development of neoplastic lesions in the group, although the overall final rates may be the same. Is there any evidence that neoplastic diseases occur earlier in this group than in comparable segments of the general population? Again, the answer is "no."

In view of the different types of potential exposures that are possible in refining, marketing, producing, and transporting petroleum products, are there significant differences in the experience of these broad departmental categories of the employee population? Humble Companies' data showed there were no significant correlations between broad occupational groups and higher tumor mortality experience. Because of their greater exposure, it is noteworthy that the refining group had the lowest cancer death rate and the next to the lowest relative frequency rate of any of the occupational groups observed.

In the petroleum industry, as in the chemical and other related industries, considerable attention has been devoted to possible relationships between occupational exposure and neoplastic diseases. The introduction in 1942 of catalytic cracking in the petroleum industry, stimulated continuing research and preventive effort. The data presented above suggests that this effort may have been a successful one.

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FORMS, INTERVALS BETWEEN EXAMINATIONS,
WHAT SHOULD BE INCLUDED

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When developing the forms and procedures for the medical examination of prospective and regular employee, a great deal of time and effort was spent in reviewing forms in use by our own and other companies. Consideration had to be given to the great distances, variation in concentration of Company population, and availability of well-trained, interested internists. Finally, our forms and a "Guide for Medical Examiners" were approved. The forms have been revised once, and a revision of the "Guide for Medical Examiners" is under consideration.

The completed forms are kept in our Health Centres. Where examinations are being arranged outside the Company Health Centres, the applicant or employee is given forms, with certain portions completed by management, as well as a self-addressed stamped envelope. The classification on preplacement examination is sent to management; the other forms come to the Medical Director or to the Regional Health Centre concerned.

All applicants for employment, except short-term temporary help, are examined completely. We examine applicants for summer or seasonal employment. They account for much of our turnover. We have seen serious conditions, requiring immediate medical care or restricted work, even in college students who have regular examinations at the beginning of the school year. During one summer season, we found two cases of active tuberculosis among sons of our own employees, one of whom had been brought a great distance but who had not been examined until after he made the trip.

Our Medical Examination Record (form Med. 17) has parts, I, II, III, IV, and V. In addition, a family and personal history sheet, and a summary sheet, are used in our Health Centres. Physicians' Examination Summary cards (I.B.M. card 89133) are used to record the results of the examinations and for statistical work.

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