

Morbidity and Mortality Study of Shale Oil Workers in the United States

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The study of the carcinogenic potential of domestic U. S. shale oil has increased significantly in importance because of the present energy problem and resulting research into alternative sources of fuel. With the increased scope of planned oil shale activity on the Colorado Plateau, it is important that an attempt be made to determine the health effects, if any, of occupational exposure to shale oil.

This paper briefly reviews some past work of Soviet and British investigators concerning potential health hazards of shale oil. It reviews the results and conclusions of the 1952-1955 dermatological study of oil shale workers by the U. S. Public Health Service, and it discusses in detail the plans of a NIOSH morbidity and mortality study currently under way.

Introduction

With widespread oil shale activity planned for the Colorado Plateau, the study of the carcinogenic potential of domestic U. S. shale oil has become considerably more important. At present, only about 800 persons have been occupationally exposed to shale oil in pilot scale prototype oil shale retorting and laboratory work. Design of facilities capable of handling up to 160,000 tons per day of oil shale which will yield about 100,000 barrels of shale oil per day are being developed. Part of these may involve the underground heating of shale. These plants are expected to be operating near capacity by 1985 or 1990. Four such operations are now either in production or being contemplated. Undoubtedly, if the planned facilities prove feasible, an increase in the number of retorting facilities may be expected. It is important, therefore, that an attempt be made at the present time to determine the health effects, if any, of occupational exposure to shale oil.

Review of Literature

A review of the literature indicates that potential dermatologic and respiratory health problems exist for oil shale workers. Background studies from the

Soviet Union and Scotland have demonstrated an association of shale oil with human skin cancer. Furthermore, emphysema, bronchitis, pneumonia, catarrh of the upper respiratory tract, and other respiratory illnesses have occurred more frequently among shale oil workers than in appropriate control groups. There are virtually no data on the carcinogenicity of oil shale dust.

In the Soviet Union, Loogna and Hering (1) reported that workers exposed to shale oil experienced occupational dermatoses such as dermatitis, eczema, folliculitis, and verruca. In addition, they reported that shale oils are sensitizers. Bogovski (2) indicated that no cases of occupational tumors have been found (as of 1961) in the Estonian shale industry, but that this may be because the industry is relatively young. He suggested that whether or not the products of retorting shale oil were carcinogenic was becoming a critical question.

In the area of respiratory diseases, Feoktistov (3) found that the leading diseases in temporarily disabled shale oil workers at the Estonian Kava-2 mine were influenza and catarrh of the upper respiratory organs, which taken together, accounted for 85% of all diseases in these workers. Luts (4) found that the greatest morbidity from grippe, acute catarrh of upper respiratory tract, angina, bronchitis and pneumonia occurred in the workers of the mechanized oil shale mines. The lowest morbidity occurred in the above-ground pits. Maripuu (5) showed an average chronic bronchitis rate of 16.3% in Estonian shale oil workers.

Scott (6, 7) found a high incidence of skin cancer

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in the paraffin workers of the Scottish shale oil industry. Carcinogenic action became apparent soon after the establishment of the Scottish shale oil industry which produced oil for lighting, lubricating oils and paraffin (kerosene). Hueper (8) found, in his study of environmental factors, that the majority of human tumors were skin cancers caused by products of thermal treatment of mineral fuels. Of 8400 cases surveyed, the shale oil industry accounted for 1907 cases. With the exception of coal tar and coal tar pitch, substantially less numbers of cancer cases were noted from other products associated with thermal treatment of mineral fuels.

The First U.S.P.H.S. Morbidity Study

In 1952, Donald Birmingham of the Division of Occupational Health of the U. S. Public Health Service initiated a medical study of workers at the Anvil Points Oil Shale Demonstration Plant of the Bureau of Mines near Rifle, Colorado (9). This study was concerned principally with dermatologic problems which might be caused by the oil shale operations. During the three-year period from 1952 to 1954, 266 different men were examined, many more than once. In 1952, 197 workers were examined in 1953, 170 men, and in 1954, 181.

The following types of skin lesions were considered to be of prime importance to shale oil workers because of their relation to shale oil exposure or sunlight: telangiectasia, flat warts, seborrheic keratoses, senile keratoses, and pigmentation. The percentage of workers having each of the various types of lesions were as follows: telangiectasia, 64%; flat warts, 42%; seborrheic keratoses, 8%; senile keratoses, 8%; and pigmentation, 1%.

Particular attention was paid to age, severity of exposure to shale oil, complexion of worker's skin, and length of residence in the Colorado Plateau, in addition to the various skin lesions. The reason for considering these factors was that a higher than normal incidence of skin cancer has been reported for residents in this area because of high elevation.

Contact with shale oil was found to have no effect insofar as causing skin lesions is concerned. The percentage of workers having lesions among those with no contact, light contact, and severe contact with shale oil was 75%, 83%, and 79%, respectively. Length of residence in the Colorado Plateau showed a gradual increase in skin lesions for the first ten years of residency, after which it leveled off at approximately 85%. There was a statistically significant difference in the proportions of persons of dark and light complexion having skin lesions. Of per-

sons with light complexion, 84% had either telangiectasia or flat warts, while 71% of persons with dark complexion were similarly affected.

Because of the small numbers of workers involved in the study, Birmingham concluded that it was impossible to assess unequivocally the distinct effects and interactions between age, length of residence in the Colorado Plateau, complexion of the worker's skin, and the severity of exposure to shale oil. He did conclude, on the basis of the dermatologic examinations, that contact with shale oil was not a significant factor in the production of the skin lesions.

The Present U.S.P.H.S. Mortality and Morbidity Study

The objective of the present study is to determine the health effects, if any, of occupational exposure to shale oil. In particular, the study objectives are designed to answer questions related to specific health risks of persons employed in a potentially large scale oil shale industry within the United States. These risks involve respiratory problems and skin dermatoses.

This study is divided into a morbidity phase and a mortality phase. The morbidity phase is designed to determine whether exposed workers exhibit increased prevalence of respiratory and dermatologic disease when compared with a control group from the same area. The mortality study will attempt to determine if shale oil workers are subjected to increased risk of early death compared to U. S. white males.

The universe from which the cohort was drawn is not precisely known but is estimated to be about 800. The sample was not randomly chosen. All males found on the following employee rosters, the only sources of names available, have been included: (a) 294 employees of the U. S. Bureau of Mines who worked at the Anvil Points oil shale retort from 1948 to 1956 are included in the study from an estimated 600 ever employed in the facility (It is believed that the cohort of 294 contains most of the men who were employed for a year or more); (b) 135 employees who worked at the Anvil Points retort facility from 1966 to 1969 for the joint venture of the Colorado School of Mines Research Institute and COLONY (a 6-company consortium) (This group contains all of the men who worked at the facility during the three year period); (c) 15 men who worked from 1956 to 1959 at the Union Oil Retort facility in Grand Valley. All of them are included in the cohort.

The first phase of this study is an in-house mor-

tality study which is currently under way. We are in the process of dividing the cohort into a living group, which will be used in the morbidity portion of the study, and a deceased group, which will be used as the basis for the mortality study. Vital status of the cohort members is determined by using the following methods. First, a 3×5 card listing a cohort member's name and last known address is sent to the postmaster in the town of last address for correction. The postmaster returns the 3×5 card to us indicating whether or not the address is correct, the person is unknown, or the person is deceased. Secondly, the Social Security number for each cohort member is sent to the Internal Revenue Service and the Social Security Administration for checking. The Internal Revenue Service gives us the last year that the person paid income tax, and the Social Security Administration indicates the last quarter which the person paid into Social Security and whether or not a death benefit claim has been paid. In addition, because the cohort is fairly small and is confined to an area of two or three counties, a field trip was made to the Rifle, Colorado area. Visits were made to the Anvil Points Oil Shale Demonstration Plant (currently in operation) to review the cohort listing with people who were familiar with the employees in the cohort, to the local Registrars of Vital Statistics for leads on deceased persons, and to the local postmasters for additional information on locations of people. In addition, local telephone directories were consulted for addresses of persons for whom we had no address. All of the information obtained in the field trip is currently being placed on magnetic computer tape for eventual analysis.

The next step in the mortality study will be the ordering of death certificates from the various states' Registrars of Vital Statistics. These certificates will be coded for primary cause of death by a nosologist using the Eighth Revision International Classification of Diseases, Adopted for Use in the United States. Standard mortality ratios will be calculated by using a modified life table procedure.

The morbidity portion of the shale oil workers study will be done partially in-house and partially on outside contract. Identification of the cohort and final analysis of the study results will be done in-house. The physical exams and sputum cytology will be done by outside contractors. We hope to examine 320 oil shale workers.

A control sample of about 320 males will be chosen. These subjects will be matched with the study group on the basis of birthdate, tobacco smoking habits, skin complexion, hair color, eye color, amount of time spent on the Colorado Plateau, and amount of time spent in outdoor recreation and work. A brief personal information survey ques-

tionnaire will be chosen. This will gather the information which is necessary for selecting matches and will solicit participation.

The morbidity study will consist of a personal and medical questionnaire covering both respiratory diseases and dermatological diseases and a dermatological examination performed on each cohort member by a qualified dermatologist. Sputum samples will be taken to analyze for all changes indicative of lung cancer, and urine samples will be analyzed. In cases where possible skin malignancies are found, a biopsy will be done. If any significant abnormalities are found, the person involved will be notified and advised to see his family physician. Examinations will generally be done in regional centers. In a few cases in which workers live out of the area, examinations will be done in their homes.

Because most of the data collected will be of an enumerative nature and most of the "prevalence" data will not be of a normal distribution, non-parametric techniques of data analysis most probably will be used. Methods using normal tests will be used whenever necessary and feasible. Analysis will be done on the entire study group and matched controls. Since matched controls are to be used, confounding variables such as age, body build, length of time in outdoor work, number of years spent on the Colorado Plateau, skin complexion, hair color, eye color, smoking habits, other industrial exposure, etc., should be factored out of the analysis. However, to verify this and to examine the data for other artifacts, the control and study groups will be stratified for further analysis according to some or all of the variables mentioned above. Also, the study group will be stratified by exposure and compared to controls. Analysis will determine whether differences in morbidity patterns are more pronounced among the longer exposed group. Similar comparisons will be made for other variables.

In addition, an analysis of the study group will be carried out comparing those having had lengthy exposure to shale oil to those with less exposure. Also, the groups will be stratified according to type of jobs held and duration within the plant, assuming the other variables can be factored out without rendering sample size inadequate.

"Prevalence data" will be related, as far as possible, to environmental data gathered in a concurrent effort. It is obvious from the lapse of time since exposure was incurred that only rough indications of exposure can be made.

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