1949

PLAINTIFF'S EXHIBIT 1878

OCCUPATIONAL CANCER HAZARDS IN AMERICAN INDUSTRIES

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MODERN industry has brought along a considerable number and variety of carcinogenic agents and, no doubt, will bring ever new ones as it develops new methods of production and new products and applies established methods and agents to new purposes. If we look at the long and ever-growing list of known and suspected occupational carcinogenic agents, if we contemplate their widespread existence as industrial wastes contaminating air,[1] water, and soil of the waste-disposal areas of industries, if we consider their presence in many products of daily consumption, we have the general spectrum of the cancer hazards which originate from our modern industrial development. Control measures must be based on the realization of this wide potential scope of carcinogenic contacts. They must concern not only workers engaged in the production or the use of carcinogenic agents but also the population living in the environment of plants with carcinogenic hazards, as well as the general public.[2] It is well to remember that experience with occupational cancer has demonstrated that, given a carcinogenic agent and proper conditions of exposure, the occurrence of cancer among the exposed individuals is merely a question of time. The incidence rate and the length of the latent period depend mainly on the relative potency of the carcinogenic agent present and the intensity of the exposure. The lack of adequate epidemiologic studies and the usually long latent period of exogenous cancer often obscure the appreciation of causal relations between occupational factors and cancer.

A few illustrations as to the distribution of exogenous carcinogenic hazards of industrial origin may be appropriate. For instance, men engaged in the mining and smelting of copper, zinc, and silver ores are exposed to arsenicals. The makers and users of arsenical pesticides that are employed in the form of sprays or dusts suffer a similar exposure, as do patients who receive arsenical medication. Beyond these rather narrow circles of producers and consumers of arsenicals stands that appreciable part of the general population that comes in direct or indirect contact with arsenicals released into the atmosphere with smelter flue dusts or as a result of

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Address presented at a meeting of the Cancer Prevention Committee in New York on June 15, 1949.

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1. Hartwell, J. L.: Survey of Compounds Which Have Been Tested for Carcinogenic Activity, U. S. Public Health Service, 1941. (371 pp.)

2. Hueper, W. C.: Environmental and Occupational Cancer, U. S. Public Health Reports 1948, Supplement 209. (68 pp.).

large-scale dusting of orchards and cotton fields or from the use of sprays in truck gardens. Arsenicals may enter the human body in drinking water that passed as rain water through arsenic-containing slag heaps of smelters. The consumption of fruits, fruit juices, and wines contaminated with arsenical insecticides affords another source.

In the field of organic chemistry we meet with bladder cancers among producers and handlers of certain aromatic amines, and find that some of these amines are used in the manufacture of pharmaceuticals and that their derivatives are employed as flotation agents in the mining industry and as antioxidants in the manufacture of rubber. Finally, dust and fumes from aromatic-amine operations that have been improperly conducted as to exhaust ventilation may endanger not only workers in adjacent operations but also the population living in the fume zone of the plant. A similar environmental contact with vaporized aromatic amines may result from the burning of emptied containers on open lots within populated areas.

Carcinogenic soot or tar fumes cause cancer of the lungs and skin not only in stokers of coke ovens but also in makers of products for which heated tar and asphalt are used, for example tar paper and asphalt shingles. The possibility must be considered that carcinogenic hydrocarbons of industrial origin may cover as a film the extremely small particles of flue dust and exhausts of petroleum-cracking units. The question has been raised whether a similar hazard exists in concrete factories in which soot-producing diesel engines are used. Carcinogenic soot may also be released into the atmosphere during the manufacture and industrial use of carbon black obtained from oil residues or natural gas or from the burning of waste oils near refineries, causing an occupational and environmental hazard. Carcinogenic oil and tar dusts from oiled or tarred roads present a potential hazard, involving the general population. Similar considerations apply to other carcinogens, such as metallic and radioactive ores.

The recognition of carcinogenic agents and exposures is a prerequisite to a rational and intelligent occupational cancer control. Epidemiologic surveys of plant populations are very important in this respect. Exogenous occupational carcinogens not only excessively increase the cancer incidence rate of one particular organ but may elevate the total cancer incidence rate and primary cancer multiplicity. Likewise, not only workers exposed to aromatic amines show a high liability to bladder cancer, but also workers in gas plants. Thus, specific cancer sites are not necessarily indicative of any particular type of carcinogenic agent. Several agents may exert synergistic action when acting simultaneously or successively, or may independently produce cancer at a certain site.

It may be worth while mentioning here that leukemia may result from low-level, prolonged, and diffuse exposure to x-rays, radioactive agents, or benzol. Nasal sinus cancers have been observed in men exposed to a volatile nickel compound (nickel carbonyl) in the course of nickel refining. Lung cancers have been observed in chromate workers. The use of metals in abrasives and as catalysts in the organic chemical and the petroleum industries as well as the production of metal dusts and mists or vapors in welding, spraying, and polishing operations and in the production of alloys from metal powders may greatly extend the potential scope of occupational metal cancers and may introduce occupational cancer hazards where these are not readily suspected.

One of the most important attributes of many exogenous carcinogens is their ambivalent properties; i. e., depending on the intensity of action or the dose, they may produce manifestations either in the degenerative, necrotizing, aplasiogenic range or in the hyperplastic, canceroid, leukemoid, cancerous range. In studying a worker population for the presence of a carcinogenic agent, a wide range of abnormal symptoms may be noted representing a diagnostically significant syndrome which I have termed the environmental-carcinogen pattern. Thus, an individual who develops an occupational carcinoma may exhibit not only various types of proliferative, precancerous reactions but, preceding or accompanying these hyperplastic reactions, manifestations which are of the degenerative, atrophic, necrotizing type. Likewise, various members of a worker population exposed to the same carcinogenic agent at different dose levels may display abnormal reactions representing the entire scale of the environmental-carcinogen pattern. Thus, in a benzol operation some workers may suffer from aplastic anemia, others from moderate anemia and leucopenia, a third group may display hyperleucocytosis and polycythemia, while still others may have leukemoid and leukemic reactions. A similar hematic syndrome may be seen in persons exposed to x-rays. Whenever a plant physician observes even parts of such environmental-cancer patterns, he should become alerted to the possibility of a carcinogenic hazard in the operation in which the affected workers are employed.

Other important clues in this respect may be obtained from the demonstration of excessive incidence of cancer in special groups of workers and also from shifts of the sex ratio of cancer incidence. For instance, the male-female ratio of lung cancer incidence is approximately 5:1. Merewether recently reported 31 cancers of the lung associated with asbestosis in a series of 235 cases of asbestosis. There was not only an excessive lung cancer incidence in this group (13.2%), but the male-to-female sex ratio of the cancer cases stood at 2:1.

The histologic type of cancer is as a rule of no significance as a clue concerning an occupational or a nonoccupational origin. However, in the case of lung cancers it appears as if an increasing preponderance of squamous cell and anaplastic cancers over adenocarcinomas favors an occupational or exogenous origin or perhaps more exactly reflects the action of a respiratory carcinogen. Thus, shifts in the ratio of squamous cell cancers to adenocarcinomas of the lung may have an etiologic significance and may indicate not only that an occupational carcinogen is present in a particular operation but that the injurious agent occurs in the form of a gas, vapor, mist, dust, or fume. It is not likely, on the other hand, that the inhalation of dust or mists might elicit cancers in the nasal sinuses, because the narrow passages leading to these cavities would prevent matter of relatively large particle size penetrating into these cavities. However, gases, vapors, fumes, and colloidal dust of carcinogenic property might enter the nasal sinuses.

It is obvious not only that the various types of information mentioned are essential for the discovery of an occupational cancer hazard and for the identification of the causative agent but that they are of utmost importance for the subsequent development of effective preventive and precautionary measures. The acquisition of these data thus forms a part of any sound control program and in fact represents the foundation of it.

While it is not possible to discuss here the full scale of control measures that might or should be applied in the numerous and different carcinogenic operations, it may be advantageous to present general directives and a few specially important considerations.

* Since we do not know the minimal effective dose of any of the many occupational carcinogens, it seems obvious that they should be completely eliminated wherever that is practical. This can be done by using or producing suitable non-carcinogenic substitutes. It is usually feasible without creating serious production difficulties to replace benzol by other organic solvents having similar effectiveness. In the case of the highly hazardous beta-naphthylamine it is possible to eliminate the hazard by starting with a sulfonated beta-naphthol which is later aminated and which in a sulfonated form is not carcinogenic. A closed system of production in which all hazardous phases are carried out is another effective method of eliminating cancer hazards in industry. Wherever bulky material is handled, the adoption of a closed system of production may be difficult. Then other means must be found to eliminate or considerably reduce the carcinogenic hazard. The goal may sometimes be obtained by changing from a dry method having a dust hazard to a wet method. Good housekeeping in plants and personal hygiene of the workers are other ways to reduce hazards. Good exhaust ventilation is essential wherever dust, fume, vapor, mist, or gas hazards exist. However, care should be taken that the carcinogenic material is removed from the exhaust air before the wastes are released into the atmosphere and that none of such wastes are blown into adjacent working places and living quarters. Many of the more recently constructed industrial plants are built in such a way that the machinery stands either free or in an open-air shelter, so that any injurious gases, fumes, or vapors may be readily dispersed into the surrounding atmosphere and thereby become harmless through dilution.

While such a system may be suitable for some carcinogenic hazards, it seems to be unsuitable for others, especially for those which are due to agents that are not readily decomposed but accumulate on the ground and in the water and thus may gradually reach dangerous concentrations.

In instances in which the carcinogenic factor represents only a very small portion of the entire product, as in tar, pitch, petroleum derivatives, and similar products, an attempt should be made to develop either production methods through which the production of carcinogenic contaminants is avoided, or, when this is not possible, to remove or destroy the carcinogenic portion in the hazardous product. Until such measures have been developed other procedures are being utilized. In the case of carcinogenic oils or tars, these procedures consist in diluting the oil or tar with noncarcinogenic material so that the carcinogenic potency is lost or reduced to such a low degree that any potential cancer resulting from prolonged and repeated contact with such products has a latent period surpassing the average life span of man.

While such engineering and technical measures are of utmost importance in the control of occupational cancer, the intelligent and ready cooperation of the workers in observing additional precautionary measures when handling carcinogenic material should be obtained. Unless the handlers are informed of the hazards connected with their work, they cannot be expected to follow rules and regulations issued by management. Only when they know and realize the potential risks which carelessness may entail, can they be expected to cooperate intelligently. It seems only fair to industrial users and the general public that a reasonable amount of information about the existence and types of occupational carcinogens is made available to them, so that such hazards cannot be spread or sustained any longer by sheer ignorance of such matters. This does not imply that such information has to make headlines in newspapers, but in a quiet way, preferably through trade circles, pertinent data on recognized, suspected, and potential carcinogenic agents should be distributed, so that the necessary technical and commercial adjustment processes can be initiated and carried out in an orderly fashion without causing any serious disruptions in the industrial, economic, and social pattern.

Without any doubt, a great deal of educational work has to be done in medical circles so that the members of the medical profession become aware of the existence of occupational cancer hazards and learn to discover and evaluate properly precancerous conditions and thereby aid industrial management in controlling occupational canceration effectively from a medical standpoint. While medical efforts are not likely to reduce in any fundamental fashion existing cancerigenic conditions in industrial plants, they can contribute definitely in alleviating the prognosis of the unfortunate victims.

While much evidently remains to be done in controlling occupational cancer hazards, I do not believe that mankind will succeed in eliminating them completely. As little as this result was obtained in connection with contagious diseases, all of which to some degree are still with us, so will our best efforts fail of entirely eradicating occupational cancers. These will remain with us as manifestations of our self-created modern industrial environment from which we are unable to escape and which we can modify only within certain limits. Though cancer is one of the risks of living, we doubtless shall succeed in reducing these risks to a considerable degree, particularly where they are excessive, for occupational-industrial reasons.

(The two works referred to in Footnotes 1 and 2 are available at a cost of $1 and of 20 cents, respectively, from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.)

ABSTRACT OF DISCUSSION

The question was raised as to the feasibility of avoiding the betanaphthylamine hazard by sulfonation. Dr. Hueper stated that the use of sulfonated beta-naphthol as a starting material is a process developed in Switzerland.[3] It has not as yet been employed in the United States. Dr. Hueper also stated that he had noted the use of alpha-naphthylamine in the preparation of pharmaceuticals. He pointed out that commercial alpha-naphthylamine always contains some beta-naphthylamine, which apparently has been responsible for the occurrence of bladder cancer among alpha-naphthylamine producers.

Radioactive materials were considered with reference to the need of long-range planning for disposal of radioactive wastes.

The problem of latency was discussed. Dr. Hueper stated that the latent period of tumors induced by the following materials increases in the order shown: tar, pitch, shale oil, petroleum. It was the consensus that the employment of elderly rather than young persons should be recommended for tasks involving uncontrolled carcinogenic hazards. The view was that the life span of elderly workers would run out before cancer could be induced by the materials to which they were exposed.

3. Müller, A.: Ueber Blasen- und Nierenschädigungen in der Farbstoffindustrie, Helvet. chir. acta 18:1-41, 1951.