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AN EVALUATION OF CLAIMS FOR OCCUPATIONAL FACTORS IN CANCER OF THE LUNGS

BY

William E. SMITH

(Post-Graduate Medical School, New York University, U.S.A.)

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The first intimation that an agent from the external environment might cause cancer in the lungs came from the experience of miners in the Schneeberg region of Saxony. The first diagnosis of lung cancer was made there in 1879 by HÄRTING and HESSE. Among several hundred miners dying over the 37 year period prior to 1913, ARNSTEIN found that carcinoma of the lungs accounted for about 40 % of all deaths. He identified the majority of the lung tumors as squamous cell carcinomata.

These findings prompted a search for lung cancer among the neighboring Joachimsthal miners in Bohemia, who handled rather similar ores. In 1932, a survey was made of the Joachimsthal miners and 323 of them were examined fluoroscopically. Not a single case of lung cancer was found. Nevertheless, among 89 Joachimsthal miners dying between 1928 and 1938, lung cancer was found at autopsy of 43.

Although cancer of the lungs has been recognized as an occupational disease among the miners in these two areas, the specific cause is not entirely clear. These mines contain radioactive ores, and it has been held that radon is the principle cause of the cancers. An excellent review of the subject has been published by LORENZ (1), who emphasized the possible contributory role of other factors, such as radioactive or arsenical dusts, pneumoconiosis and genetic influence deriving from inbreeding. Aside from the experience in the Schneeberg and Joachimsthal areas, lung cancer has not been associated with mining operations elsewhere.

The next association of respiratory tract cancer with occupation derived from the experience of a plant in Great Britain engaged in the manufacture of copper sulfate and the refining of nickel. No radioactive materials were present in the ores handled. Up to the present time, 52 cases of cancer of the nose or nasal sinuses and 93 cases of lung cancer have been reported from this plant (2). Since lung cancer is a relatively common disease, notably in Great Britain, detailed data on the population at risk in this plant would be needed to ascertain what proportion of the lung cases might be deemed excessive. Cancers of the nose and nasal sinuses are, however, relatively uncommon in the general population and the occurrence of 52 cases of them among employees of one plant signalized the existence of an occupational cancer hazard.

This matter was reviewed in 1938 by A. J. AMOR (3), who stated that over a period of 25 years copper had been extracted in this plant by sulfuric acid which contained arsenic. The arsenic precipitated as a metallic arsenide which escaped as dust in the process of calcining. AMOR suggested that arsenic, probably in combination with copper, was responsible for the tumors. Nickel was extracted by conversion to the volatile compound, nickel carbonyl. It has been suggested by some authors, as reviewed by HUEPER (4), that nickel, perhaps inhaled as this gas, caused the cancers. AMOR stated that there was a history of exposure to nickel carbonyl in only one of the cancer cases up to the time of his publication (3). He further argued that there had been no cases of nasal cancer in Canadian nickel refineries where sulfuric acid extraction was not used. He stated that the incidence of cancer of the lung and other sites in workers on the Canadian operations was lower than in the general population. Detailed data on the number of man-years involved in the Canadian experience have not been published, and the same is true of a Norwegian nickel refinery from which 3 cases of squamous cell carcinoma of the lungs have recently been reported (5).

In 1921, the plant in Great Britain shifted to a grade of sulfuric acid free of arsenic and in 1924 rebuilt the calciners in a manner

to decrease escape of dust (5, also personal communications). *No case of nasal cancer and only two cases of lung cancer have occurred in workers who were first employed there after 1924.* The latent period of the cancers that were recorded is given as 18 to 25 years (4). ~~Were it would appear that the occupational tumor hazard in this plant has been substantially reduced.~~ Whether this reduction reflects a prolongation in the latent period or represents an actual decrease in the eventual tumor rate should be ascertainable within the next decade.

Arsenic, known to be capable of causing cancer of the human skin (6), has been investigated in several situations for carcinogenicity upon other tissues. In studies of mortality data from a British factory handling inorganic compounds of arsenic, HILL, PERRY and associates (7), (8) found that 29 per cent of deaths were attributed to cancer whereas cancer accounted for death in only 13 per cent of instances among control populations living in the same area. The proportional excess was confined to workers exposed to arsenicals and was not found among employees of the same factory whose tasks did not involve such exposure. Cancer of the respiratory tract (7 cases) and skin (3 cases) contributed the majority of the excess. The authors call attention to the small numbers involved in their study. A survey (9) of mortality records of a plant in the United States handling large quantities of arsenic trioxide showed that out of 72 deaths from all causes over the past 25 years, 18 were due to cancer of which 7 were attributed to the respiratory system. In the age group under 55, there were approximately twice as many cancer deaths in the plant population than would be expected on the basis of mortality data for the state as a whole. The authors concluded, however, that this difference was not statistically significant by reason of the small size of the plant population relative to the state population.

Data that may bear on the question of carcinogenicity of arsenic are contained in a general review of environmental factors in lung cancer published by HUEPER (10). These data offer lung cancer mortality rates for males in various counties of a state in the U. S. A. where copper ores of high arsenic content are mined and smelted. In counties containing smelters, the rates were 46 and 145. In a county where mining was done, the rate was 48.6. A rate of 5.2 was found in a county where the major occupation was agriculture, and a rate of 10.9 in the United States as a whole. HUEPER calls attention to the large quantities of arsenical fumes formerly released into the air by smelters in this state and suggests that these may have influenced the rates found.

Ores of high arsenical content are mined in Sweden. It is possible that studies conducted in that country may reveal data as to whether arsenic presents a respiratory cancer hazard. I have explored this question with Professor SVEN FORSSMAN. Professor Forssman states that mining of copper ores rich in arsenic began in Sweden in 1928, and smelting a few years later. To date, there has been no evidence of an occupational cancer hazard. Since these Swedish operations have now continued for 24 years under good medical supervision, an integrated study of exposure records of workers, arsenical content of dusts and mortality experience over the next decade may provide a definitive answer as to hazardous levels of arsenic or indeed as to whether arsenic is carcinogenic for the human respiratory tract. The question has wide interest, for it will be recalled that arsenical dusts have been thought to play a role in the occupational respiratory tract cancers of the Schneeberg and Joachimsthal mines and in the nickel refinery discussed above. Furthermore, finished tobacco products have been found to contain considerable amounts of arsenic, a large percentage of which is volatilized into the smoke (11). It is probable that arsenic present in tobacco products derives largely from the use of arsenical insecticides upon tobacco crops.

During the past 20 to 30 years, there have been reports of cancer of the lungs in chromate workers in Germany, which have been claimed to have occupational etiology. A detailed study of mortality experience among employees of six major chromate producers in the United States was recently conducted by MACHLE and GREGORIUS (12). This study concluded that cancer of the lung was substantially more frequent among chromate workers than in a control population provided by the records of a life insurance company. The diagnostic facilities available to the control population may be open to question, but there seems little doubt that the lung cancer

rate among the chromate workers was unduly high. The authors felt that monochromates presented the hazard, but the exact nature of the carcinogenic material has been discussed further and with differing points of view by others (10). These studies were restricted to chromate producing plants. There is no data as to whether such a hazard exists for workers exposed to inhalation of chromates in other processes, such as spraying chromate primers (paints).

In view of the German and American experience, a survey was recently made of employees in three chromate plants in England (13). Chest X-rays were made on 724 men, representing nearly all those employed in these plants. 165 had worked in the industry for more than 20 years. Only one case of lung cancer was found. Another man died of lung cancer in the year following the survey. The author states that the examined men will be followed for mortality experience. It is tempting to recall the situation referred to above in which a fluoroscopic survey of Joachimsthal miners failed to detect any cases of lung cancer although many deaths from this disease occurred among these miners over the succeeding few years.

The 1947 report of the Chief Inspector of Factories in Great Britain (14) called attention to the occurrence of primary lung cancer in 31 instances among 235 cases of asbestosis. The lung cancer rate (13.2 %) in these asbestotic lungs contrasted with a rate of 1.32 % found in a large group of silicotic lungs reported through similar channels to the Inspector's Office. The mortality rate for lung cancer in the general population of England and Wales can be calculated as 1.36 % on the basis of death statistics published by the Registrar General. For these considerations, the question has arisen as to whether asbestosis predisposes to carcinoma of the lungs. I have elsewhere presented a detailed discussion of evidence available on this subject (15). Lung cancer has occasionally been described in autopsies upon asbestotics in Germany, the United States and Canada, but the cases have been too few to provide convincing evidence of the existence of an occupational tumor hazard for asbestos workers in these countries. It must be remembered that working conditions tend to vary in different countries and at different times within a single country. For example, ventilation regulations for control of dust in asbestos work rooms were adopted in Great Britain in 1931. The number and severity of cases of asbestosis has decreased markedly since that time. In 1950, the Factory Inspector's Office had a record of only a single case of lung cancer among individuals whose employment in the asbestos industry in Great Britain had taken place wholly in the period since ventilation regulations were instituted. Immediately prior to the present conference, I visited the Senior Medical Inspector, Dr. E. R. A. MEREWETHER, and learned that additional cases had subsequently occurred. These, as well as the earlier ones, will require careful analysis with reference to the population at risk.

In a series of 126 cases of asbestosis reported from Finland by WEGELIUS (16), there were no instances of carcinoma. Work with asbestos in Finland has, however, been conducted for a period of only 20 years. The British cases of asbestosis dying with carcinoma of the lung had a mean exposure of 16.5 years compared with 13.4 years exposure for asbestotics dying with no evidence of lung cancer, according to the Factory Inspector's Report for 1947. The most advanced cases of asbestosis in the Finnish series had an average exposure of only 11.5 years and there were only 9 individuals in this group. Furthermore, it must be noted that the British figures are based on autopsy records whereas the Finnish survey was based on radiographic examination of living persons who were actively at work.

I am unaware of observations for lung cancer in asbestos workers in countries other than the above where mining of asbestos or manufacturing of asbestos articles is carried out. Russia and Rhodesia are countries where such studies might be possible.

It is noteworthy that our consideration of environmental factors in lung cancer has thus far taken up only inorganic compounds. This is unusual in that the great majority of occupational tumors of other tissues have been traced to organic compounds. Several types of exposures involving organic compounds notably tar and tarry materials, have been considered to present occupational respiratory tract cancer hazards as reviewed by HUEPER (4) who cites a Japanese paper listing 21 cases of lung cancer found over a period of 6 years in workers exposed to inhalation

of distillation products of coal tar in generator gas plants of steel mills. A greater than expected frequency of lung cancer was attributed to gas works stokers and coke oven chargers in Great Britain by the KENNAWAYS (17). Their paper presents an extensive analysis by occupational groups of all death certificates filed in the General Register Office for cancer of the lung and larynx in males between 1921 and 1938. The population at risk in the various occupations, from which the « expected » number of deaths for each occupational group was calculated, was estimated from census returns. Judged on this basis, there was a less than expected frequency of lung cancer among cotton spinners and piecers. This finding, as the KENNAWAYS point out, is of unusual interest in that such persons are engaged in an industry that has for many years had a serious skin cancer problem from use of carcinogenic oils to lubricate the spindles. Skin exposure in these textile mills has been attributed in part to spray of oil from the spindles, but I am unaware of any measurements of the amounts of oil mist. The question has importance, for HUGUENIN has recently described a series of cases of lung cancer in metal workers in France and suggested a relationship to their exposure to mists of cutting oils (18).

Quite recently, a new and previously unsuspected respiratory cancer hazard has been discovered and is about to be described in the *A. M. A. Archives of Industrial Hygiene and Occupational Medicine* by WEIL, SMYTH and NALE. These authors have permitted me to present their experience to this conference. (Addendum : their paper has appeared in *A. M. A. Arch. Indust. Hyg. and Occup. Med. 1952, 5*, 535-547). Among 71 men employed 5 or more years in a unit for production of isopropyl alcohol, there have occurred 4 cases of nasal sinus cancer, one case of lung cancer, one case of laryngeal cancer and one papilloma of a vocal cord. It would seem clear that an occupational factor must have operated to yield such a series of respiratory tract tumors in this small group of men. Animal experiments have disclosed no carcinogenic action on the part of the alcohol itself, but an increase over the expected number of pulmonary adenomas was observed in a few groups of mice exposed to inhalations of « isopropyl oil ». This is a highly complex mixture of materials encountered as an intermediate in the course of production of the alcohol.

The present paper has been concerned with evaluation of data derived from human experience, but investigations conducted upon animals have contributed to our knowledge and much additional information can be expected from them. I have elsewhere published a review of experimental studies of lung cancer (19). To date, most experimentally induced lung tumors have been the pulmonary adenomas of mice, which bear little resemblance to the majority of human lung cancers. Direct introduction of potent carcinogens into the lungs have generally elicited sarcomas rather than carcinomas.

I should like to comment briefly upon a procedure we developed which has proved useful for experimental production of carcinomas from lung tissue. Lungs are removed from mouse embryos, cut fine, and implanted into the thigh muscles of adult animals of the same inbred line (the C strain, obtainable from Jackson Laboratory, Bar Harbor, Maine, U. S. A.). When such tissue is implanted together with methylcholanthrene, benzpyrene or dibenzanthracene, the bronchial epithelium undergoes metaplasia and carcinomas of transitional cell or frankly squamous cell type develop. This method, the « tissue transplant technique » has been described in detail elsewhere (20), (21). Obviously, inhalation techniques are essential for adequate study of materials suspected to present inhalation hazards. These, however, require elaborate equipment. The tissue transplant technique is mentioned merely as an inexpensive and simple procedure that may serve as a useful screening measure for test of substances suspected to play a role in lung cancer.

In closing, it may be pertinent to emphasize a general concept that is evident from the foregoing attempts to evaluate claims for occupational factors in cancer, namely that such studies require the integrated efforts, not only of physicians, but also of industrial hygienists, statisticians and personnel familiar with the technology of the various industrial operations involved. Further, the interest and cooperation of management and labor is needed for effective study and control of such hazards as may exist. In an endeavor to bring together individuals from such diverse fields, the Cancer Prevention Committee was established in 1948 for the purpose of studying environmental, particularly industrial factors, in cancer. The Proceedings of this committee were published in 1952 as the March

issue of the *A. M. A. Archives of Industrial Hygiene and Occupational Medicine.*

It is conceivable that studies in this field may disclose occupational tumor hazards not presently recognized and thereby afford further means for effective prevention of cancer. On the other hand, the widespread occurrence of cancer, and especially of lung cancer, makes evident that many cases of this disease would occur no matter what the occupation of its victims. Many such cases have no doubt been wrongly attributed to occupation. For scientific progress as well as for proper compensation practice, the reporting of occasional cases with implication of occupational etiology must be replaced by sound statistical study of occupational group experience. Studies of inbred lines of mice have shown that genetically different strains living under normal conditions develope tumors of certain tissues with differing and predictable frequencies. Exposure of such animals to carcinogens increases the frequency and time of appearance of the tumors for which they possess inherent potentialities. Evidence for increase in tumor frequency over and above that found in properly selected control populations is needed when claims for new occupational factors in human cancer are considered.

DISCUSSION

DR. MORGAN : I should like to say something more about the nickel risk. The process for manufacturing nickel carbonyl was first evolved in 1900. The first cancer cases occurred in 1923. Earlier records showed a number of cases of lung fibrosis but these have diminished since cancer has been occurring. The nickel ore comes from Canada to Swansea. It contains very many other metals. It is first ground into a very fine powder and in the old process the dust was very profuse. The new type of calciner is nearly dust-free- as is also the present crushing and grinding process. Sulphuric acid is then added and until 1923 this contained arsenic — but it is now arsenic free. Other dust prevention measures were also instituted in 1924, i.e. the men wear gauze masks. Since then there have been no cases in men engaged since 1924 and only two or three new lung cases which would have been expected anyhow.

The shortest period of work in dust among the cases seen is 1-1 1/2 years. The lag period is 18 to 25 years. The particle size of the dust is 1 to 10 μ. The ratio of lung to nose cases is 100 : 50.

The nickel made at Swansea goes to other factories in London, Birmingham, and Glasgow, where precious metals are extracted, alloys made and so on. No unusual incidence has been seen in these factories. The conditions seem, therefore, to be associated with the refining process at Swansea. All the cases have been in calciners and grinders. The pathological type of lung cancers have been mixed.

DR. LEVIN : Do your findings support the hypothesis that arsenic is the cause ?

DR. MORGAN : They could do.

DR. DOLL : I have had the opportunity of seeing Dr. Morgan's figures and I think they show that there is a definite lung risk in addition to the nose risk. The incidence — as far as one can tell — is twenty times the expected incidence.

With regard to arsenic I would mention a study made by Professor Bradford Hill of a small factory outside London, which has been handling arsenic for many years. A greatly increased proportion of deaths from cancer was found among people who had been employed there and was due to skin and lung cancer.

With regard to chromates, I would strongly support Dr. Smith's remarks regarding the perils of relying on mass X-ray of present industrial populations. Dr. Bidstrup in her British survey found only one case in a chromate factory. But she is now following up the employees and is finding some deaths and we begin to think that our experience may not be so different from Dr. Machle's.

Our study of gasworkers was based on 831 deaths among pensioners who had been employed in a gasworks. There were 25 deaths from lung cancer against an expected 13.8. I think we can attach some significance to this result as the experience of our population of 831 was comparable with that of the general population at similar ages for all other causes of death.

DR. LEVIN : Am I right in thinking that arsenic is not an experimental carcinogen ?

DR. STEWART : As far as I know it is not.

DR. FIRKET : I have seen several specimens of asbestos cancer of the lung in Professor Gough's laboratory in Cardiff. The lower lobe was always the one affected. Is this special localisation always found ?

DR. SMITH : No, but I can give you no figures on distribution.

DR. FIRKET : The suggestion has been made that beryllium is cancerproducing. Professor Chevremont has done some tissue culture experiments which are very interesting biologically (*). Dilute berylliums will inhibit alkaline phosphates. It acted like an antimitotic poison — as will many other poisons. But it is interesting that many of the cells in his tissue culture were not killed but recovered and became resting cells. Of course most carcinogenic poisons are anti-mitotic.

DR. CLEMMESEN : Has Dr. Smith got more detailed statistical information on the material he presented ? For instance the minimum and maximum latent periods — the age when tumours occurred etc.

DR. SMITH : There is additional material on the chromate work in U.S. Public Health Service report in 1948 by Machle and Gregorius. The asbestos cases have not yet been reported in detail except in a short posthumous paper by Gloyne in the Lancet 1951.

DR. CLEMMESEN : Would Dr. Morgan's material justify the precise definition of a latent period ?

DR. MORGAN : I have some difficulty in presenting details as the material comes from an industrial firm, but I hope to as soon as possible.

DR. MAISIN : Could Dr. Denoix give some information on the French workers who used Bordeaux mixture in preparing their vineyards ?

DR. DENOIX : I have no information on this at present, but cannot give a negative answer. I will look into the question in S. and S. E. France where many people work in a fog of copper sulphate.

(*) M. Chevremont & H. Firket : Action du beryllium sur la croissance et la mitose en culture de tissus. Compt. Rend. Assoc. Anatom., 38. 19 mars 1951.

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ZUSAMMENFASSUNG

Die Karzinome der Atemwege wurden mit mehr oder weniger plausibler Argumentation den verschiedensten beruflichen Einflüssen zugeschrieben. In Anbetracht der Verschiedenheiten der Industrien, wie auch der Materialien und der Verarbeitungs-methoden in den verschiedenen Ländern sollten die aufgeworfenen Probleme in gewissen bevorzugten Gegenden studiert werden und es wäre wünschenswert die Erfahrungen der verschiedenen Gegenden zu vergleichen.

Der Berufskrebs der Lungen bei Mineuren wird nur in den deutschen und böhmischen Urangruben gefunden. Die Aufmerksamkeit wird auf die Auffindung oder Verhütung ähnlicher Karzinome bei Mineuren oder anderen Arbeitern mit radioaktiven Stoffen an anderen Orten hingelenkt. Die Frage, ob auch berufsbedingte Einatmen von arsenhaltigen Stäuben ein Karzinome der Atemwege verursacht, muss untersucht, muss weiterhin angeklärt werden. Gewisse Vorkommnisse in U.S.A. und in Schweden scheinen bestimmte Aufschlüsse in dieser Richtung geben zu können. Man hat festgestellt, dass unter den Arbeitern von Nickelraffinerien in Grossbritannien Karzinome des Respirationstraktes als Berufskrankheit auftreten, nicht aber in Kanada. In Grossbritannien wurde ebenfalls die Asbestosis mit Lungenkarzinom in Zusammenhang gebracht, sonst aber nirgendswo. Lungenkarzinom trat als Berufskrankheit nur bei Grubenarbeitern in Deutschland und in U.S.A., nicht aber in Grossbritannien. Es ist sehr wünschenswert weitere Untersuchungen über diese Probleme anzustellen unter besonderer Berücksichtigung der Verschiedenheiten in den Arbeitsgängen und in der qualitativen und quantitativen Exposition in verschiedenen Gegenden. In mehreren Ländern wurden Teerdämpfe für die Lungenkarzinome verantwortlich gemacht. In Anbetracht der bekannten karzinogenen Eigenschaften gewisser Teerderivate sollte alles getan werden um solche Tumoren aufzufinden und zu verhüten überall dort, wo entsprechende Expositionen vorkommen. Neuerdings wurde in U.S.A. behauptet, dass bei der Herstellung von Isopropylalkohol Karzinome der Luftwege entstehen können.

SUMMARY

Cancers of the respiratory tract have, with varying degrees of plausibility, been attributed to a variety of occupational factors. Since the types of industrial operations as well as the materials and methods employed vary in distribution among various countries, the several problems involved present certain preferred areas for study and in some instances merit comparison of experience in different areas.

Occupational lung cancer among miners has thus far been restricted to the German and Bohemian uranium mines. Attention is required for the detection or prevention of similar cancer among miners or other workers with radioactive materials elsewhere.

The question of whether inhalation of arsenical dusts presents an occupational hasard of respiratory tract cancer requires further study. Certain situations in the United States and in Sweden are indicated as affording approaches to this problem.

Cancers of the respiratory tract have been found to occur on an occupational basis among nickel refinery workers in Great Britain, but no such hazard has been evident in Canada. Asbestosis has been associated with lung cancer in Great Britain, but no such association has been manifest elsewhere. Lung cancer has appeared as an occupational hazard for chromate workers in Germany and the United States but not in Great Britain. Further studies of these problems are desirable with special reference to differences in operations and to qualitative and quantitative differences in exposure in the various areas.

Coal tar fumes have been associated with lung cancer in several countries. In view of the known carcinogenicity of certain coal tar fractions, close attention should be given to detection and prevention of such tumors in any localities where such exposures may occur.

Production of isopropyl alcohol has recently been claimed to involve a respiratory tract cancer hazard in the United States.

RESUMEN

Los cánceres de las vías respiratorias han sido asociados, por razones mas o mesnos justificadas, a diferentes tipos de agentes profesionales. Dado que los tipos de operaciones industriales, y que las materias primas y los métodos empleados varian de un pais a otro será preferible estudiar los diferentes problemas en ciertas regiones y, en determinadas circunstancias, será útil comparar los resultados obtenidos en las diferentes regiones.

El cáncer profesional del pulmón se encuentra únicamente en las minas de uranio de Bohemia y de Alemania. Hay que llamar la atención sobre el descubrimiento y la prevención de este tipo de cáncer en los obreros que utilizan otras substancias radioactivas en otros lugares. Son indispensables juevos estudios para determinar si el pólvo de arsénico constituye un peligro profesional capaz de hacer aparecer cánceres de vías respiratorias.

Se han observado cánceres de vías respiratorias en los obreros de las refinerías de níquel en Inglaterra. Este fenómenos no ha sido observado nunca en el Canadá. En Inglaterra se ha asociado la asbestosis al cáncer de pulmón pero esta sociación na se ha comprobado en ninguna otra parte. El cáncer de pulmón se señala como un peligro profesional en los obreros de la industria del cromo en Alemania y en los Estados Unidos pero no en Inglaterra.

Son indispensables otros estudios para elucidar estos problemas. Sería preciso insistir, sobre todo, en el análisis de las diferencias cualitativas y cuantitativas en los procedimientos y las diferencias en el tiempo de exposición al agente tóxico en las distintas regiones. Los vapores de alquitran se han considerado como responsables de la apairicón del cáncer pulmonar en diversos paises.

Teniendo en cuenta esta acción cancerigena de determinadas fracciones del alquitran se deberia dedicar una gran atención al descubrimiento y la prevención de estos tumores en los lugares en que es posible tal exposición. Recientemente se ha pretendido en los Estados Unidos que la producción de alcohol isopropílico constituiria un peligro para las vias respiratorias en el terreno del cáncer.

RESUME

Les cancers des voies respiratoires ont, pour des raisons plus ou moins plausibles, été associées à différents types d'agents professionnels. Etant donné que les types d'opérations industrielles, que les matières premières et les méthodes employées varient d'un pays à l'autre, il serait préférable d'étudier les différents problèmes dans certaines régions et dans certaine circonstances, il serait utile de comparer les résultats obtenus dans différentes régions.

Le cancer professionnel du poumon se rencontre uniquement dans les mines d'uranium de Bohême et d'Allemagne. Il faut attirer l'attention sur le dépistage et la prévention d'un pareil cancer chez les ouvriers utilisant d'autres substances radio-actives dans d'autres endroits. De nouvelles études sont indispensables pour déterminer si les poussières d'arsenic constituent un danger professionnel capable de faire apparaitre des cancers des voies respiratoires. Aux Etats Unis et en Suède, certains cas l'imposent comme apportant des vues nouvelles sur ce problème.

On a observé des cancers des voies respiratoires chez les ouvriers des raffineries de nickel en Grande-Bretagne. Jamais ce phénomène n'a été mis en évidence au Canada. On a associé en Angleterre, l'asbestose au cancer du poumon, mais cette association ne se révèle nulle part ailleurs. Le cancer du poumon est signalé comme un danger professionnel chez les ouvriers de l'industrie du chrome en Allemagne et aux Etats Unis mais pas en Angleterre.

D'autres études sont indispensables pour élucider ces problèmes. Il faudrait s'attacher spécialement à l'analyse des différences qualitatives et quantitatives dans les procédés et les différences dans le temps d'exposition à l'agent toxique dans les différentes régions. Les fumées du goudron ont été rendues responsables de l'apparition du cancer du poumon dans divers pays.

Tenant compte de cette action cancérigène de certaines fractions du goudron, on devrait porter grande attention pour la détection et la prévention de ces tumeurs dans les endroits où une pareille exposition est possible. Récemment on a prétendu, aux Etats Unis, que la production de l'alcool isopropyle constituerait un danger du point de vue cancer pour les voies respiratoires.

RIASSUNTO

I cancri delle vie respiratorie, per ragioni più o meno plausibili, sono stati attribuiti alle più svariate cause professionali. Poichè le attività industriali, come pure i materiali lavorati ed i metodi impiegati variano in distribuzione a seconda dei paesi, i diversi problemi connessi mostrano logicamente aree preferenziali di studio ed, in alcuni casi, meritano uno studio comparativo delle diverse esperienze a seconda delle differenti regioni. Il cancro professionale del polmone è stato fino ad ora circoscritto alle miniere di uranio della Germania e della Boemia. E' perciò necessario mettere in rilievo questa coincidenza onde prevenire ed allontanare l'insorgenza di un cancro del genere negli operai che lavorano materiali radioattivi in altre regioni. Ulteriori studi sono oggi indispensabili onde accertare se la polvere di arsenico costituisca un serio

pericolo professionale, tale da favorire l'insorgenza del cancro del polmone. Negli U.S.A. ed in Svezia si sono verificati casi tali da suggerire nuove teorie su questo problema. Sono stati osservati cancri delle vie respiratorie fra gli operai delle raffinerie di nickel in Gran Bretagna. Tale evenienza non si è mai riscontrata nel Canadà. In Inghelterra l'asbestosi è stata messa in rapporto con l'insorgenza del cancro del polmone, ma tale associazione non è stata mai riscontrata altrove.

Il cancro del polmone d'altra parte viene segnalato come un rischio professionale negli operai dell'industria del cromo sia negli Stati Uniti che in Germania, ma non in Inghilterra. Ulteriori studi si impongono in proposito con particolare riguardo alla analisi delle differenze qualitative e quantitative sul tipo di industria e sul tempo di esposizione all'agente tossico nei diversi paesi. Le esalazioni del fumo del catrame sono ritenute responsabili dell'insorgenza del cancro del polmone in diversi paesi. Tenuto conto della azione cancerigena di determinate frazioni del catrame, è indispensabile adottare misure di controllo accuratissime onde mettere in evidenza e prevenire questi tumori nelle zone in cui l'esposizione alla loro azione è più facile a verificarsi.

Affermazione recente negli U.S.A. è quella che la produzione dell'alcool isopropilico possa costituire un notevole pericolo dal punto di vista della insorgenza del cancro delle vie respiratorie.

Il nous a été impossible, par suite de circonstances indépendantes de notre volonté, de faire figurer la totalité des traductions des Résumés.

Nous le regrettons et nous en excusons vivement.

La Rédaction.