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INDEX TO VOLUME 1

The asterisk (*) preceding the page number indicates an original article in the Archives. Subject entries are made for all articles. Author entries are made for original articles. Book Reviews and Obituaries are indexed under these headings in alphabetical order under the letters B and O, respectively.

EFFECT OF PROTECTIVE OINTMENT IN PROPHYLAXIS OF ULCERATIONS DUE TO SULFURIC ACID IN WORKERS IN COPPER AMMONIUM PROCESSED RAYON. E. ZANETTI, Med. d. lavoro **40**:139 (May) 1949.

Observations were carried out on 15 workers in the spinning department of a large factory in which copper ammonium processed rayon is produced. It was noted that the continuous contact of the workers' hands with the rayon thread soaked in a 3 per cent sulfuric acid solution caused lesions of the skin in about 35 per cent of the workers. The lesions consisted of maceration of the skin of the hands, ulcerations of the hands and fingers, chronic purulent perionyxis and changes of the nails. The protective effect of the "invisible glove" of barrier ointment is excellent. In the cases observed by the author lesions and ulcerations rapidly healed, perionyxis disappeared and the nails greatly improved. The skin of the hands and fingers regained smoothness and softness.

EMPYEMA OF NASAL SINUSES AS AN OCCUPATIONAL DISEASE DUE TO DUST INHALATION. W. SCHMIDT, Pract. oto-rhino-laryng. **11**:282, 1949.

Schmidt says that in the course of animal experiments carried out over a period of years attention has been given to the effect of industrial dusts on the mucous membranes of the nose and of the nasal sinuses. Rabbits exposed to industrial dusts frequently presented empyema of the nasal sinuses. This empyema does not differ in its effects on the mucous lining from the empyema of the nasal sinuses of human subjects. Consequently when dealing with workmen who are exposed to dust the physician should give special attention to the nasal sinuses in addition to the main cavities of the nose.

DIAGNOSIS OF ASTHMA, EMPHYSEMA AND SILICOSIS BY INHALATION OF AEROSOLS CONTAINING VASODILATORS OR VASOCONSTRICTORS. J. C. GERRITS, Nederl. tijdschr. v. geneesk. **93**:1507 (May 7) 1949.

Gerrits shows that respiratory disturbances which follow the inhalation of an aerosol of a bronchoconstrictor substance ("acetylcholine 1 per cent") can reveal the existence of a latent bronchospasm. Likewise the inhalation of a bronchodilator ("aleudrine 1 per cent" ["aleudrine" is isopropylarterenol]) will show to what extent emphysema is reversible. Thus the inhalation of aerosols can be of help in arriving at a diagnosis. In healthy subjects these aerosols cause no changes.

The author says that in 9 of 13 patients with silicosis bronchospasm was detected by means of these aerosol tests. He suggests that this might explain the discrepancy between the slight roentgenologic changes and the severe functional disturbances and shortness of breath in certain cases of silicosis.

PULMONARY ASBESTOSIS; ANATOMICOPATHOLOGIC STUDY OF A CASE. A. FRANCHINI and G. CANEPA, Med. d. lavoro **40**:161 (June-July) 1949.

A man 40 years old had worked in a factory for twenty-two consecutive years, applying insulating material to articles of asbestos. He never complained about respiratory disorders, and he died as a result of a streetcar accident. The anatomicopathologic diagnosis of the cause of death was that of cerebral paralysis resulting from concussion of the brain and fracture of the cranial base. During the necropsy the lungs were found to be the seat of extensive asbestosis, manifested as extensive sclerosis mainly of the base and middle zones of the lungs. Photographs of the lungs are shown. Histologic features were fibrosis of the basal and middle zones of the lungs. There were also lymphoid cell infiltrations, thickening of elastic tissue, reticulum uniformly thick in the sclerotic zones, very numerous asbestosis bodies uniformly occupying the lungs, hyaline degeneration and asbestosis bodies in the

neighborhood of the lymphoreticular texture of the cortica lymph nodes.

On the basis of this study the case is interpreted, dealt two other cases unique in Italian literature. The authors disproportion between the gross features described and th the worker never having complained. The results pr prophylactic and therapeutic treatment and economic assist generally, particularly of those who apply insulating mater

Industrial Toxicology

THE VALUE OF BERYLLIUM DETERMINATIONS IN THE DI F. R. DUTRA, J. CHOLAK and D. M. HUBBARD, Am. J. Chem. Abstr. **43**:3119*a*, 1949.

The diagnosis of acute or chronic beryllosis may, in son the beryllium content of the urine. Beryllium was isolated f working in beryllium plants who had no symptoms of b had previously had the acute pulmonary condition. D beryllosis, the urinary content of the element varies from negative results do not exclude beryllosis, and in an o may never be excreted in the urine. Appreciable amounts lungs of all patients dead from beryllosis, except those o occupational chronic condition. In some cases berylliu other tissues.

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INTRAVENOUS PROCAINE HYDROCHLORIDE IN ASPHYXIA DU REPORT OF THREE TREATED CASES AND TWO UNTREA TROENCEPHALGRAPHIC CORRELATION. C. W. OLSEN, A RAY and E. W. AMYES, Bull. Los Angeles Neurol. S

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SOLUBILITY AND RELATIVE TOXICITY OF LEAD CHROMATE I S. F. MEEK, Indust. Med. **18**:407 (Oct.) 1949.

In this study Harrold and Meek extended their previ for forty months 26 men exposed to lead chromate in qua of those regarded as safe for continuous exposure.

In their "Summary and Conclusion" the authors state: ' lead chromate cannot cause lead poisoning under certain co we have presented makes the appearance of lead intoxic highly improbable in the industrial exposures which are ! This conclusion is based almost entirely on the solubility compound. In those instances where the amounts of lead c dissolved in body fluids, are equal to, or less than, the amoun and eliminated without harm to the organism, the potentia important factor. The factor of solubility, in this inst particle size and, perhaps, of other possible influencing fac pounds soluble to a great degree in body fluids are depend in regard to the rate of solution and other factors such as t fine particles in protecting envelopes.

R. J. SHERW

neighborhood of the lymphoreticular texture of the cortical zone of the pulmonary lymph nodes.

On the basis of this study the case is interpreted, dealt with and compared with two other cases unique in Italian literature. The authors direct attention to the disproportion between the gross features described and the awareness of trouble, the worker never having complained. The results prove the importance of prophylactic and therapeutic treatment and economic assistance of asbestos workers generally, particularly of those who apply insulating material.

Industrial Toxicology

THE VALUE OF BERYLLIUM DETERMINATIONS IN THE DIAGNOSIS OF BERYLLIOSIS F. R. DUTRA, J. CHOLAK and D. M. HUBBARD, Am. J. Clin. Path. **19**:229, 1949; Chem. Abstr. **43**:3119*a*, 1949.

The diagnosis of acute or chronic beryllosis may, in some cases, be supported by the beryllium content of the urine. Beryllium was isolated from the urine of persons working in beryllium plants who had no symptoms of beryllosis, although some had previously had the acute pulmonary condition. During acute or chronic beryllosis, the urinary content of the element varies from day to day; hence a few negative results do not exclude beryllosis, and in an occasional case beryllium may never be excreted in the urine. Appreciable amounts were recovered from the lungs of all patients dead from beryllosis, except those of persons with the non-occupational chronic condition. In some cases beryllium was recovered from other tissues.

CHEMICAL ABSTRACTS.

INTRAVENOUS PROCAINE HYDROCHLORIDE IN ASPHYXIA DUE TO CARBON MONOXIDE: REPORT OF THREE TREATED CASES AND TWO UNTREATED CASES WITH ELECTROENCEPHALGRAPHIC CORRELATION. C. W. OLSEN, A. A. MARINACCI, J. W. RAY and E. W. AMYES, Bull. Los Angeles Neurol. Soc. **14**:1 (March) 1949.

This article was abstracted in the *Journal of the American Medical Association* (**141**:101 [Sept. 3] 1949).

SOLUBILITY AND RELATIVE TOXICITY OF LEAD CHROMATE II. G. C. HARROLD and S. F. MEEK, Indust. Med. **18**:407 (Oct.) 1949.

In this study Harrold and Meek extended their previous work by observing for forty months 26 men exposed to lead chromate in quantities greatly in excess of those regarded as safe for continuous exposure.

In their "Summary and Conclusion" the authors state: "We do not conclude that lead chromate cannot cause lead poisoning under certain conditions, but the evidence we have presented makes the appearance of lead intoxication from this source highly improbable in the industrial exposures which are likely to be encountered. This conclusion is based almost entirely on the solubility characteristics of this compound. In those instances where the amounts of lead compounds which can be dissolved in body fluids, are equal to, or less than, the amounts which are transported and eliminated without harm to the organism, the potential saturation limit is the important factor. The factor of solubility, in this instance, is independent of particle size and, perhaps, of other possible influencing factors, whereas lead compounds soluble to a great degree in body fluids are dependent on particle size, both in regard to the rate of solution and other factors such as the transport of extremely fine particles in protecting envelopes.

R. J. SHERWOOD, Brookline, Mass.

Ind Hyg & Occup Med 1950?

CHEMICAL CARCINOGENS

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BETHESDA, MD.

BOTH the industrial and the general population are being exposed to a growing list of chemicals, some of the biologic properties of which are still undetermined. There is a need for biologic assay of these substances. This is one way for an industry to determine whether it deals with actual or potential cancerigenic agents. In addition to the chemical cancerigens already identified, experimental animal research has shown that several hundred other chemical compounds have cancerigenic properties. As substances are being continually introduced, the job is never done. This is one of the reasons why the National Cancer Institute set up a cancerigenic study section with a laboratory. We of the National Cancer Institute hope to speed research by joining our efforts with those of industry, which has long been pursuing investigations in its own laboratories, as well as with those of the universities.

For some time, industry has been aware of the challenge of environmental cancer, and it has been endeavoring to meet that challenge with practical solutions where scientific knowledge has permitted. The remarkable progress made over the past 50 years has largely been achieved by industry itself. The interest shown in the past, and even more recently, by representatives of industry who have conferred with the National Cancer Institute and the Division of Industrial Hygiene of the Public Health Service, has been stimulating. We welcome a closer relationship with all of those interested, so that through cooperative effort there will be full protection of industrial employees and of the general public as well as of the interests of industry.

This is a job that industry can do more effectively and more efficiently than any outside agency. Industrial physicians and management have the practical experience and specialized knowledge that come from living with the problem. The rest of the investigators are on the periphery of the problem. While we are anxious to be of assistance in every feasible

Delivered at the combined meeting of the American Industrial Hygiene Association and the American Association of Industrial Physicians and Surgeons, Chicago, April 25, 1950.

ARCINOGENS

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way, the future control of occupational environmental cancer hazards is, as it has been in the past, mainly a task of industry itself. I want to assure industry that there is no thought in any one's mind to impose codes at a time when leadership in this field clearly belongs within industry itself.

In all the research that has been done in the field of cancer we have come to know or suspect the inciting cause of less than 1 per cent of all types of cancer. The results of research are largely concerned with chemical agents, some inorganic and some organic in nature. Given the required intensity, type and duration of exposure, agents of either of these groups may produce cancers in various organs.

During the past 20 years a vast amount of research has been made of chemical substances. These research efforts have been rewarding, for we know now that some 200 chemicals are capable of producing cancer in appropriate experimental animals.[1] Since the chemical carcinogens relate to controllable factors, investigators should not fail to do exhaustive research in the chemical field. The need today is for broader exploration.

Tables 1 and 2 summarize the known and some of the suspected chemical cancerigens, along with their target organs and their points of exposure, and the types of cancer produced. Table 1 shows the inorganic group of chemical agents; table 2 presents the organic group. Those which have more recently come under suspicion are followed by a question mark.

Although not yet implicated in human cancer, other environmental substances have produced animal cancers. Among them are estrogens,[2] urethane,[3] certain chlorinated hydrocarbons,[4] beryllium[5] and selenium.[6]

Experimental animal research is useful in that it flags the potentially dangerous chemical agents. However, our investigations are slowed up at this point. Even though chemical agents which are hazardous in the

1. Hartwell, J. L.: Survey of Compounds Which Have Been Tested for Carcinogenic Activity, Federal Security Agency, United States Public Health Service, 1941.

2. Abramson, W., and Warshawsky, H.: Cancer of the Breast in Male, Secondary to Estrogenic Administration, J. Urol. **59**:75, 1948. Fitzsimons, M. P.: Gynaecomastia in Stilboestrol Workers, Brit. J. Indust. Med. **1**:235, 1944.

3. Nettleship, A., and Henshaw, P. S.: Pulmonary Tumor Induction with Ethyl Carbamate, J. Nat. Cancer Inst. **4**:309, 1943. Henshaw, P. S.: Minimal Number of Anesthestic Treatments with Urethane Required to Induce Pulmonary Tumors, ibid., **4**:523, 1944.

4. Edwards, J. E.: Hepatomas in Mice Induced with Carbon Tetrachloride, J. Nat. Cancer Inst. **2**:197, 1941.

5. Gardner, L. U.: Osteo-Sarcoma from Intravenous Beryllium Compounds in Rabbit, Federation Proc. **5**:221, 1946.

6. Nelson, S. A.; Fitzhugh, O. G., and Calvery, H. O.: Liver Tumors Following Cirrhosis Caused by Selenium in Rats, Cancer Research **3**:230, 1943.

laboratory have been identified, it is not easy to establish whether these chemicals have an identical effect in man, since the development of the

TABLE 1.—*Inorganic Chemicals*

Cancerigenic Agents	Type of Contact	Organs Affected and Types of Cancer
Arsenicals	Cutaneous	Skin (basal cell and squamous cell carcinoma)
	Alimentary	.....
	Respiratory	Lungs (carcinoma?)
Chromates	Respiratory	Lungs (carcinoma)
Chrome pigments?	.....	.....
Nickel carbonyl?	Respiratory	Nasal Sinuses (carcinoma) and lungs (carcinoma)
Asbestos?	Respiratory	Lungs (carcinoma)
Radioactive chemicals	Cutaneous	Skin (carcinoma and sarcoma)
	Alimentary	Bones (sarcoma)
	Respiratory	Lungs (carcinoma)
	Systemic	Blood-forming organs, lymph nodes (leukemia and lymphosarcoma?)

TABLE 2.—*Organic Chemicals*

Cancerigenic Agents	Type of Contact	Organs Affected and Types of Cancer
Aromatic amines		
Beta naphthylamine	Cutaneous	Bladder, ureter, renal pelvis (carcinoma)
Benzidine	Respiratory	.....
	Alimentary	.....
Benzene?	Cutaneous	Blood-forming organs, lymph nodes (leukemia, lymphosarcoma [?], myeloma [?])
	Respiratory	.....
Coal tar, pitch, asphalt, soot, bitumen, creosote-oil, anthracene oil (3, 4-benzpyrene)	Cutaneous	Skin (carcinoma)
	Respiratory (Fumes)	Lung (carcinoma)
Shale oil		
Lubricating oils	Cutaneous	Skin (carcinoma)
Crude paraffin oils	Respiratory	Lung (carcinoma?)
Petroleums and petroleum products (High Boiling)		
Lubricating oils	Cutaneous	Skin (carcinoma?)
Fuel oils	Respiratory	Lung (carcinoma?)
Crude paraffin oils	.....	.....

disease in man has been known in many instances to take many years. About the best that we can do is to temper our experimental laboratory research according to the clinical pattern of the known cancerigens in setting up a hypothesis with which to study the chemicals which have been flagged as potentially dangerous.

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Organs Affected and Types of Cancer
Skin (basal cell and squamous cell carcinoma)
.....
Lungs (carcinoma?)
Lungs (carcinoma)
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Nasal Sinuses (carcinoma) and lungs (carcinoma)
Lungs (carcinoma)
Skin (carcinoma and sarcoma)
Bones (sarcoma)
Lungs (carcinoma)
Blood-forming organs, lymph nodes (leukemia and lymphosarcoma?)

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Organs Affected and Types of Cancer
Bladder, ureter, renal pelvis (carcinoma)
.....
.....
Blood-forming organs, lymph nodes (leukemia, lymphosarcoma [?], myeloma [?])
.....
Skin (carcinoma)
Lung (carcinoma)
Skin (carcinoma)
Lung (carcinoma?)
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For instance, the manufacture of isopropanol by-products seems to be implicated in the occurrence of cancers of the nasal sinuses and lungs among workers employed in those operations. The osteogenic sarcomas produced experimentally in rabbits by injections of certain beryllium compounds raise the question whether similar lesions of the bones may ultimately develop in human beings affected by pulmonary berylliosis.[7] The hepatomas appearing in mice given chlorinated hydrocarbons, such as carbon tetrachloride,[4] or chloroform,[7] or fed selenium[6] or various aromatic azo compounds[8] also raises our index of suspicion in relation to the human problem.

Since carbamates are used in the manufacture of rubber, the cancer of the lung developing in mice treated with certain carbamates has human cancerigenic implications.[9]

In view of the recognized carcinogenic action of soot from domestic sources, on man and experimental animals,[10] it appears to be pertinent to study the various types of commercial soots on a long range basis. A short term study made in plants producing carbon black has shown no significant increase in cancer incidence over the period of study[11] but it is desirable that studies of commercial soots be continued for 15 to 30 years, since this is the probable latent period.

These illustrations show how research done on laboratory animals can serve to alert us to the chemicals which may possess potential cancerigenic properties in human subjects. Considering that a danger of the chemical cancerigens lies in the slow, almost unnoticeable harm that comes from contact with them, it might be wise from a preventive point of view to consider all chemical agents which have elicited cancers in animals as having the potential properties for producing cancer in the human organism.

The results of some experimental research may be sufficiently conclusive to permit a fairly general prediction of the clinical analogy. For example, data are available to indicate that certain distillation and

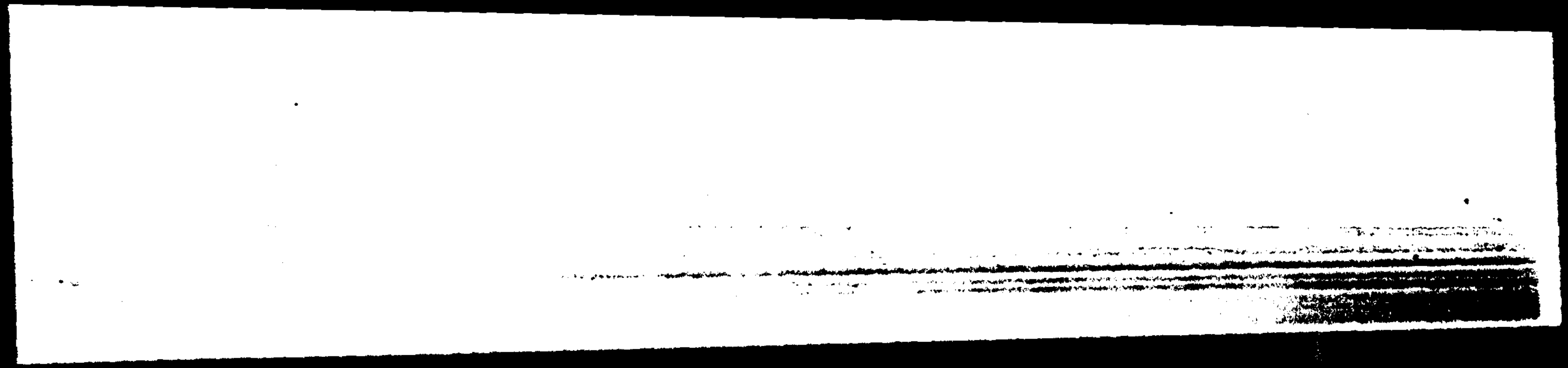
7. Eschenbrenner, A. B.: Induction of Hepatomas in Mice by Repeated Oral Administration of Chloroform, with Observations on Sex Differences, J. Nat. Cancer Inst. **5**:251, 1945.

8. Orr, J. W.: The Production of Liver Tumours by Azo Compounds, Brit. M. J. Bull. **4**:385, 1947.

9. Guyer, M. F., and Claus, P. E.: Tumor of the Lung in Rats Following Injections of Urethane (Ethyl Carbamate), Cancer Research **7**:342, 1947. Larsen, C. D., and Heston, W. E.: Induction of Pulmonary Tumors in Mice by Anesthetic Agents, Cancer Research **5**:592, 1945.

10. Earle, J.: Cancer Scroti, in The Chirurgical Works of Percival Pott, London, Wood & Innes, 1808.

11. Ingalls, T. H.: Cancer Incidence in the Carbon Black Industry, Arch. Indust. Hyg. & Occup. Med. **1**:622 (June) 1950.



fractionation products of coal, oil and shale which have been found to elicit cancers in mice have the same effect in man.[12]

It is remarkable that there is apparently no relation between toxicity and cancerigenicity of chemical agents. While some are highly toxic, others display a very low degree of toxicity. Some of the toxic ones are benzene, nickel carbonyl, arsenic and radioactive chemicals. Notable for their lack of toxicity are the cancerigenic aromatic amines. As a rule, the toxic dose of a chemical is definitely higher than its cancerigenic dose. Thus, precautionary standards suitable for coping with toxicity hazards in plants will prove to be inadequate for controlling cancerigenic hazards of the same chemicals.

It is noteworthy for epidemiological and diagnostic reasons that some of the environmental cancerigens are ambivalent, inasmuch as they exhibit, when given in proper doses, anticancerous properties.[13] It seems that many of the functional and anatomic reactions elicited by the chemical cancerigens are not related to, or a part of, the cancerization process. These manifestations may serve as stigmas of exposure and thus represent warning symptoms.

Mention should also be made of the gradually changing picture in the types and sites of environmental cancers observed.[1] While the majority of occupational cancers caused by chemicals discovered before the turn of the century affected the skin, those revealed during the last four decades appear to affect other organs. These are aromatic amines, radioactive chemicals and chromates; possibly we should consider among these asbestos, nickel carbonyl and isopropyl oil. In general, these chemicals have been found to affect the bladder, bones, hemopoietic tissue and organs of the respiratory tract (lungs and nasal sinuses).

Moreover, it is now recognized that certain chemical cancerigens, formerly related exclusively to cancer of the skin, may elicit cancers in other organs also. So identified are tar, mineral oil, radioactive

12. (*a*) Henry, S. A.: Study of Fatal Cancer of the Scrotum from 1911 to 1935 in Relation to Occupation, with Special Reference to Chimney Sweeping and Cotton Mule Spinning, Am. J. Cancer **31**:28, 1937. (*b*) Twort, J. M., and Lyth, R.: Concentration of Carcinogenic Material in Mineral Oils by Distillation Processes, J. Hyg. **29**:161, 1939. (*c*) Oliver, T.: Tar and Asphalt Workers' Epithelioma and Chimney Sweeps' Cancer, Brit. M. J. **2**:493, 1948. (*d*) Hill, A. B., and Fanine, E. L.: Studies in the Incidence of Cancer in a Factory Handling Inorganic Compounds of Arsenic, Brit. J. Indust. Med. **5**:2, 1948. (*e*) Neubauer, C.: Arsenical Cancer: A Review, Brit. J. Cancer **1**:192, 1947.

13. Allemann, R.: Ueber das Blasenkarzinom und über jugendliche Blasengeschwulstträger, Schweiz. med. Wchnschr. **76**:1009, 1946. Henschen: Chemotherapeutik des Blasenkarzinoms mit Aminokörpern, Arch. f. klin. Chir. **189**:19, 1937. Haddow, A.; Harris, R. J. C., and Kon, G. A. R.: Inhibition of Growth by Amino-s-Diarylethylenes, Biochem. J. **39**:ii, 1945.

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chemicals and arsenic. These have been found to produce cancers of the lung, the nasal sinuses, bones and hemopoietic tissue.

During the last four decades there appears to have been a remarkable increase in the number of cases of lung cancer which have been attributed to the chemical carcinogens.[14] Statistical analyses of large series of cases of lung cancer have failed to reflect these occupational relations. Nevertheless, the observations cited should be given consideration through studies directed at determining the cause or causes of the apparent increase in the frequency of lung cancer in this period.

Even in this short discussion of the chemical cancerigens the vital role of epidemiology is conspicuous. Often it has been the effect of a chemical agent that has led to the identification of the agent as a cancerigen. Field research augments the laboratory, whether it precedes or follows laboratory research.

Experience has shown that epidemiological study is an effective means of research. Through this means we can obtain a wider knowledge of the nature and variety of the chemical agents. Epidemiological studies should take into account the known peculiarities of the recognized environmental and especially the occupational cancers. They should be sufficiently broad to include consuming industries as well as producers of known or suspected cancerigens, and the entire present as well as the former worker population that had appreciable contact with cancerigenic chemicals. Special attention should be paid to any unusual frequency of cancer of a specific site among employees in a restricted plant department or operation. Where chemical cancerigens may have polluted air, water or soil, the surveys might well include the general population living in the fume or waste disposal zone.

Much of this information can be obtained from medical and employment records and can be supplemented by data from public health departments and insurance carriers.

As can be seen, the gathering of epidemiological data requires investigation of many sources of information. In some areas a great deal of initiative may be necessary, because there are no apparent sources of information. Analyses of death certificates from various parts of a state or within different states may yield suggestive data as to the presence of a local environmental or occupational cancer hazard. Often these data are meager.

14. (*a*) Lisco H., and Finkel, M. P.: Observations on Lung Pathology Following the Inhalation of Radioactive Cerium, Federation Proc. **8**:360, 1949. (*b*) Lorenz, E.: Radioactivity and Lung Cancer, J. Nat. Cancer Inst. **5**:1, 1944. (*c*) Pirchan, H., and Sikl, H.: Cancer of the Lung in Miners of Joachimsthal, Am. J. Cancer **16**:681, 1932. (*d*) Teleky, L.: Occupational Cancer of the Lung, J. Indust. Hyg. & Toxicol. **19**:73, 1937. Hill and Fanine.[12d] Neubauer.[12e]

On the other hand, if the industrial conditions are exceptionally simple and have acted over a long period on a rather stable population, it is, in general, not too difficult to ascertain the suspected occupational or environmental cancerigenic chemical. This is especially true if employment data concerning cancer patients and information about the substances used, produced or handled in the local industrial establishments are available for long periods.

Striking examples are those offered by the lung cancers occurring among the cobalt miners in Schneeberg, Saxony, in Germany.[15] Another is the history of the pitchblende miners in Czechoslovakia.[14c] In these relatively isolated and mountainous regions the mining of cobalt and uranium ores in radioactive mineshafts and the production of cobalt or uranium pigments and radium represent the occupational environment of the population.

As the vast amount of literature shows, industries have contributed and can contribute much to the field of environmental cancer if they have the resources to undertake epidemiological studies. Where resources are not available, and industry recognizes the need, provision may be made for such surveys through appropriate state agencies. At the present time, environmental cancer surveys are being carried out by state agencies in New York, New Jersey, Ohio, Colorado, Pennsylvania and California to ascertain the relative merits of such epidemiological approaches in areas having highly diversified as well as relatively singular industrial activities.

In stable population groups, such as those of industry, medical records may provide invaluable source data. The chances of obtaining more definite information about cancer are usually much better if medical and employment records carry data which can be analyzed for the incidence rates and the topographic distribution of cancers among workers employed in different operations. From data so recorded it is possible to determine whether a cancerigenic hazard may be present somewhere in the various operations of the plant, what site in the body is mainly affected and what type of agent and of exposure is most likely responsible for the occurrence of the cancers, if they do occur.

It is beneficial to industry itself if analytical surveys of this type become a part of the routine medical and hygienic care in all those plants which produce, handle or use any of the chemical cancerigens mentioned previously. As has been established by some plants, in industrial organizations where such hazards are already recognized, periodic analyses are useful in showing the effectiveness of the precautionary measures taken.

15. Hueper, W. C.: Occupational Tumors and Allied Diseases, Springfield, Ill., Charles C Thomas, Publisher, 1942.

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d Allied Diseases, Springfield, Ill.

Wherever it is obvious, or industry suspects, that a cancerigenic chemical may pollute the air, water or soil beyond the confines of the plant area, the cooperation of the local health department should be enlisted. The health department can aid industry in ascertaining whether or not such pollution factors may have any appreciable effect on the people living in the fume or waste disposal zone of plants.

Observation of neighborhood cases of berylliosis offers an illustration of the potential effects of such minute contaminations of the environmental air.[16] It is well to keep in mind that hazards may extend into the cancer field through the atmospheric release of carcinogenic chemicals in the form of fumes, dust, gases and vapors.

It is important in surveys conducted in industries having recognized or suspected cancerigenic hazards that provision be made for ascertaining the fate of former workers known to have sustained effective exposure. The inclusion of these workers is essential for the accurate calculation of incidence rates of the exposed population. Of greater import, it will provide data for determining the minimal exposure time required to cause cancer. Also, it will be of value in guiding industrial management in future employment policies relating to the formulation of industrial codes and in specifying the length of time which may be considered safe for workers to be employed in hazardous operations.

The discovery and effective control of chemical cancerigens naturally require the cooperation of many persons. Broadly, it calls for the joint efforts of local, private and state health agencies, on one hand, and of industrial and labor organizations on the other. Wherever industrial factors extend into the environment of other states, as sometimes may be the case, cooperation between these many agencies and those of the neighborhood states will be required to effect control in the total area.

We are entering an era in which increased attention is being given to all health problems arising from environmental factors. Immediate attention is being given those which arise from pollution of the human environment. Counterparts to environmental cancer control may now be found in many other fields. Association with representatives of these other fields offers the opportunity to exchange information of mutual benefit.

The results of environmental, and especially occupational, cancer investigations, whether these deal with already known or with new hazards, should be widely disseminated. It is extremely important that this information be promptly communicated to the medical profession at large. Since the physician is usually the first to see cancerous and pre-

16. Hardy, H., in discussion on papers of Pendergrass and Robert, Hatch, Corcoran, Machle, Shaver and Wilson, in Symposium on Industrial Diseases, Radiology **50**:781, 1948.

cancerous patients, this information will alert him to existing cancer hazards and speed early diagnosis and treatment. With this information the physician is in a better position to aid materially the solution of the environmental cancer problem. It will enhance his opportunity to contribute to medical literature. The physician's case histories are still one of our best means of ascertaining occupational exposure to cancerigenic agents.

Because of the unusually long latent period of environmental cancers, it is essential that the physician's aid be elicited in observing those former workers who were effectively exposed to occupational carcinogens. Not only will many of these workers have changed their occupations, but many will have moved into other states.

Some industries have taken the initiative in setting up programs for medical supervision of former employees who were exposed to potent occupational carcinogens. This is a complex type of program to operate. In any program which is largely concerned with a transitory aspect, it is extremely difficult to obtain a 100 per cent net response. However, through practice and experience, improvement will be achieved. Gradually, as the idea of this type of service spreads, cooperation may be expected from many groups and individuals. It is a worthy program, and it merits both wide cooperation and wide application.

Our common experience in the control of other public health hazards has shown us that the effectiveness of control measures runs parallel to frank and open acknowledgment when the facts are known. This is well exemplified by the success of a program of the food industries in which employee and industrial participation brought far-reaching control of environmental hazards arising from tuberculosis and typhoid. A similar success story may be written in connection with environmental cancer hazards, as these are dealt with in a similar fashion. In many instances the success of a control program is dependent on the industrial organization's taking the employee into its confidence. Since all preventive measures are not based on mechanical devices, the intelligent cooperation of the exposed worker concerning the precautionary and preventive measures adopted by management may be required.

Cancers caused by environmental chemical cancerigens are amenable to existing public health methods as to detection and control. An appreciable portion of the sharp drop observed in the incidence of the infectious diseases as well as in their death rates has been the result of preventive measures—that is, the elimination of contact of the population with the causative agents. The epidemiological characteristics and the nature of the chemical cancerigens leave little doubt that we can achieve effective control if we apply public health methods similar to those which brought success in the field of infectious diseases.

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The research that is needed to solve the mysteries of environmental and occupational cancer presents a challenge of tremendous proportions. It involves a study of thousands of case histories of cancer patients. It involves the devising of new technics in the gathering of case histories to provide much more background detail than we get in most case histories today. It involves the laboratory testing of suspected cancerigenic agents. It involves a program of follow-up study of exposed workers. It involves a study of the safety procedures and preventive measures adopted or to be adopted in plants where carcinogenic agents are handled.

In view of the lack of knowledge of where the danger lies, or the extent of it, no one is in a position to say today just what remedial action is needed. But in view of what we do know, we have to consider precautionary action now to protect the workers involved and the general public. As industry becomes cognizant of cancerigenic agents, it will begin to introduce or perfect safety procedures in all its plants. In time there will follow provision for periodic and extensive medical supervision of all exposed workers.

As we increase our understanding of all the factors involved, changes in industrial operation may be necessary in some cases in order to protect employees and the public. It is important to emphasize, however, that more knowledge than we now have must be acquired before such action would be justified in many instances. Much of the discussion today has been concerned with potential dangers, but attention is being given to them because their magnitude has not yet been fully determined.

It is obvious that the study of chemical cancerigens will continue to be an active and provocative problem for some time to come. Our knowledge will increase with the participation of scientists, of management and labor, of public health agencies, physicians, and the many individuals and groups concerned or affected by the problem. Through cooperative effort, fruitful results are inevitable.