FILE NAME: DuPont (DUP)

DATE: 1935 Dec

DOC#: DUP174

DOCUMENT DESCRIPTION: Journal Article - Chemical & Metallurgical Engineering

Gehrmann

Industrial Medicine and Toxicology

Speaking before the Columbus, O., meeting of the American Institute of Chemical Engineers, this well known medical director presented the following important conclusions:

(1) Industrial medicine should provide (a) proper selection of employees (Complete pre-employment examinations). (b) Protection of employees by periodic examinations. (c) Treatment of occupational diseases when they occur.

(2) Industrial toxicology reveals the toxicity of chemical compounds by studying the toxicity, mechanism of action, organs affected and symptons to be expected.

(3) No industrial medical program can be properly devised without first obtaining a complete picture of the toxicology.

(4) There is no material, regardless of its toxicity, which cannot be handled with safety, provided the toxicity is understood and proper methods of handling instituted.

MODERN civilization demands that we improve the old methods by which workmen were made ill and died by the score, and that we devise adequate methods of preventing occupational poisonings and diseases. Therefore, it is necessary that chemical engineers and physicians should become more closely associated in order to develop sufficient knowledge concerning these health hazards, and with this knowledge to institute protective measures which will make all plant operations safe.

Industrial medicine is not a new specialty; neither is the recognition of occupational diseases of recent origin. Bernardini Ramazini, during the 17th century, wrote a treatise on the diseases of tradesmen, in which he recognized many diseases of occupational origin. He defined industrial medicine when he said, "We must own that some arts entail no small mischiefs upon the respective artisans, and that the same means by which they support life and maintain their families are oftentimes the cause of grievous distempers which hurry them out of the world." Compare the simple industrial operations of Ramazini's time with the complex operations and toxic substances of today and it is obvious that we are facing a complicated problem that must be worked out by the clinician and the toxicologist, as well as the engineer.

What is industrial medicine and how may it be successfully applied? It is not simply the treatment of occupational diseases and intoxications, but includes that which is more important—medical methods for the prevention of these diseases.

Occupational diseases occur as a result of exposure to toxic substances and lack of proper medical supervision. Some of these diseases are the results of years of exposure and cannot be cured; for example, silicosis, a disease in which clinical symptoms do not appear until there has been extensive lung damage. Unfortunately, this damage is progressive and incurable. There are industrial diseases that are sudden in onset and terminate in death in a few hours; in this class we have chlorine poisoning, which causes an acute respiratory disease. There are acute occupational diseases which appear almost immediately after exposure, run an acute course for a period of 12 to 48 hours, and clear up in a few days. Aniline and nitrobenzol are examples of substances which cause this type of illness by their action upon the red blood cells, forming methemoglobin, which is followed by the destruction of many millions of the cells. These and other examples of industrial intoxications have developed with the progress of industry and have been recognized as the result of bitter human experiences, inestimable suffering and often death.

Industry must realize that the previous methods of trial and error are no longer acceptable, neither are they economical. Further, we must develop accurate knowledge of health hazards before operations are started. Operative procedures must be designed to prevent toxic exposure, and industrial health must have adequate medical protection.

The toxicologist, by proper methods of animal study, can develop the toxicity of a compound and the mechanism of its action. From these facts he can point out both the precautions necessary for safe operation in the plant and the clinical symptoms which indicate the beginning of poisoning. With this information the industrial physician can establish adequate methods of medical supervision, organized on three basic principles; viz, proper selection of all employees, special medical protective examinations, and treatment of occupational diseases.

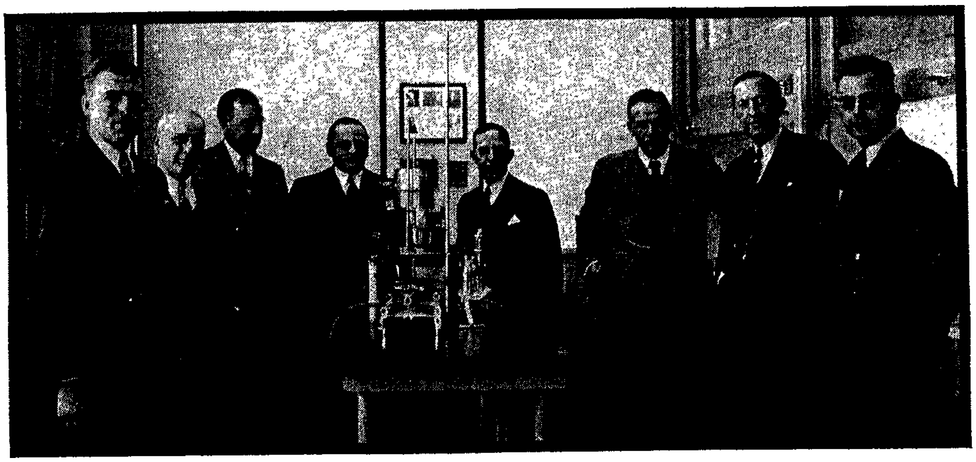
Pre-employment physical examination is the only means of making the proper selection of employees. The success of this examination is dependent upon several factors. The examiner must have at least a reasonable knowledge of the working conditions of the plant and the physical and mental requirements of the individual

Based on a paper entitled "Industrial Medicine and Industrial Toxicology" presented by the Author on Nov. 13, 1935 before the Columbus, O meeting of the American Institute of Chemical Engineers.

By G. H. GEHRMANN, M.D., F.A.C.P.
Medical Director, E. I. duPont de Nemours & Co., Wilmington, Delaware.

Make for

Safer Plant Operation



Du Pont company executives in the Toxicological room of the Haskell Laboratory of Industrial Toxicology.

From left to right: William Deichmann-Grueber, assistant to Dr. W. F. von Oettingen; Ernest B. Benger, assistant chemical director; Dr. A. P. Tanberg, director of the Experimental Station; C. C. Ahlum and E. F. Hitch, of the company's Jackson Laboratory at Deepwater Point, N. J.; Dr. W. F. von Oettingen, director of the Haskell Laboratory; Lammot du Pont, president; and Dr. G. H. Gehrmann, medical director.

jobs. Job requirements have a wide range of variation. For example, the physical effort necessary safely and efficiently to perform duties may range from physical perfection of 100 per cent down to a very low percentage. The worker who is engaged in lifting heavy materials all day must possess more physical ability than one who maintains temperature and pressure regulations in a chemical operation. Furthermore, the worker who possesses the physical strength to perform laborious work all day may not have the mental requirements that would make him an efficient chemical plant operator.

There are many compounds used in industry which are toxic and under certain conditions may cause sudden death; examples of these are HCN and H_2S. The latter in high concentrations kills almost instantly and, further, these high concentrations cause rapid paralysis of the olefactory nerve with a complete loss of the sense of smell. Therefore, it is possible to walk unaware into a high concentration of H_2S, become unconscious, and die before rescue is possible. Concentrations above 500 parts per million are dangerous.

Other compounds are toxic to a lesser degree, act more slowly and produce chronic disease—some in a short time and others after years of exposure. Lead is an example of the former. Lead gives rise to acute symptoms, depending upon the amount of the daily exposure, in a few days or a few weeks. Then, as examples of those compounds which require years to act are certain nitro- and amino-compounds which cause simple tumors and cancers of the urinary bladder after an average exposure of eleven years.

Some compounds have a selective action upon certain organs. Carbon tetrachloride interferes with the function of the heart muscle. This action is more severe when the heart muscle is affected by heart diseases. Therefore, an individual with a normal heart muscle may successfully withstand the effects of this substance, but one with a diseased heart muscle may die with acute cardiac failure.

Mercury compounds are eliminated through the kidneys and cause severe irritation with acute or chronic nephritis. Phosgene, nitrous fumes and other irritant gases cause marked inflammation of the lungs and may aggravate a more active pulmonary tuberculosis. Any chronic lung disease may be aggravated to such a degree as to cause acute illness, permanent disability, or death. Organic disturbances of the central nervous system may be aggravated by such compounds as carbon bisulphide and those of lead. Lead intoxication produces an encephalitis, which is almost impossible to differentiate from the mental disease produced by late syphilis.

These are some of the possibilities which must be considered by an examiner in order that he may protect an applicant, who has an already established disease, from working with compounds that will aggravate or activate his condition.

In 1911, the first compensation laws were passed in this country. Prior to this time there were, to the best of my knowledge, no physical examinations in industrial plants. The passage of these laws made industry responsible for accidents and physical disabilities, and the physical examination was introduced as a protection against claims for conditions that existed before employment. At that time applicants were refused employment for even minor physical defects. Later, the compensation laws were amended to include occupational diseases as well as injuries. This necessitated a more complete employment examination and developed the periodic examination as a method of detecting the beginning symptoms of occupational diseases. Experience indicated that respiratory diseases were being frequently missed, the errors in diagnosis being reflected in the incidence of activated lung processes occurring after exposure to irritant gases. Kidney damage was, in a like manner, being overlooked, and cardiac and circulatory pathology either missed entirely or the findings not given the proper interpretations.

Purpose of Physical Examination

There then came the realization that physical examinations for industry should be of such a nature as to accomplish two purposes: First, to select applicants and place them in occupations that would not aggravate any existing disease; second, to eliminate the unnecessary exclusion of applicants who, although they presented certain physical defects, were nevertheless able, safely and efficiently to fill properly selected jobs. In order to accomplish these purposes we realized that we must have more accurate diagnosis at the time of employment.

A medical diagnosis is made by combining what the patient tells the doctor with the findings as observed by the doctor. Both factors are extremely significant and probably of equal importance. Patients present themselves to their personal physician to be cured of an illness and naturally tell of all their complaints. On the other hand, applicants for employment present themselves to the examiner with hopes of passing their examinations and, therefore, have an incentive to cover up any existing illness and conceal many pertinent facts concerning their medical history. This places the examiner at a disadvantage, and so in order to detect lung pathology, liver disfunction, nephritis, cardiac diseases, circulatory disturbances and central nervous involvement, he must have at his command all the modern diagnostic equipment for making: urine analyses, blood examinations (including blood chemistry), blood counts, serum examination for syphilis, X-ray films of the chest and, in special cases, electrocardiograms and basal metabolism tests.

Unfortunately, there are too many industries today giving little or no consideration to such an examination and many others making no examination at all. They consider this work unnecessary as long as their insurance carriers give them adequate coverage. Many are unaware of the hazards that exist in their factories, others show no interest until they are forced to become interested, either because of compensation experiences, civil suits, or insurance rates that have increased to such an extent as to be reflected in higher production costs. Too many are satisfied with a superficial examination which costs comparatively little money, does not supply adequate information or protection, gives a false feeling of security and, in truth, is wasted time, money and effort. All too frequently the physicians making these examinations have little or no knowledge of factory conditions, job requirements, and health hazards that exist.

Selection is the first step toward the successful application of industrial medicine and the second is adequate protection. Adequate protection is provided by two means—properly designed operative, protective measures and equipment, and periodic medical examinations. Protective equipment is an engineering problem that should never be planned until the toxicologist has pointed out all the health hazards that may exist, and before he can do this he must make a careful toxicological study, which should be completed while prospective operations are in the experimental stages. By the time they have reached the semi-works, it is usually too late because the equipment for production has been selected.

In the past, many chemical engineers have assumed that because they have been able, or more frequently fortunate enough, to work through the experimental stages of a project without any visible damage to themselves, the compound at hand was non-toxic. This assumption is frequently erroneous since it is possible to have degenerative processes started in certain organs without visible or clinical evidence. For example, degenerative process in the liver may be very extensive before there is any clinical evidence. Therefore, it is a decided advantage, both from the health and economic viewpoints, to know how to start new operations with safety. There are today many operations which should be improved. Some can be made safe with reasonable changes; others will require a complete change of operating equipment.

The question may well be asked, "Why do we need periodic medical examinations if our factories are equipped with operative devices that eliminate exposure to health hazards?" My answer is: First, I have yet to see the mechanical equipment, no matter how perfect, that will continue to remain so, and very often the first knowledge of its faulty function is the appearance of toxic phenomena in the employees. Secondly, there frequently arise new sources of contamination, sometimes from within the operation and sometimes from without. Thirdly, the human flesh is heir to many ills, some developing slowly, others rapidly, many insidiously. There are many chronic ailments that are never suspected until far advanced. Many of these can be detected early and at least improved by removing the individual from any source of possible toxic irritation.

Frequency of Periodic Examination

The frequency of periodic examinations should be determined by the toxicity of the compound involved and the rapidity with which it may enter and attack the human body. Lead, for example, may produce symptoms in a few days or it may take years, depending upon the atmospheric concentrations. Benzol may cause chronic poisoning in a few days and I consider monthly examinations necessary in both lead and benzol operations. Nitro- and amino-compounds are all more or less toxic and workers in these compounds should have an examination at least every three months. Chemical plant workers who are not exposed to any known hazards should be examined once a year.

Periodic examination should be designed to bring out the physical signs and symptoms to be expected with the exposure to certain substances and need not necessarily include a general physical examination. Beta naphthylamine, alpha naphthylamine and benzidine, for example, cause tumors of the urinary bladder, and in so far as we know, do not affect other organs. Therefore, it is only essential to make a careful search for these tumors. Benzol, by its action upon the blood-forming elements causes a primary anemia which can be detected by certain blood examinations. Thus, the entire field of periodic examinations should be based upon the clinical signs to be expected. Here again the toxicological study of a compound makes it possible to design a type of examination that will reveal to the clinician the evidence of beginning organic changes within the body.

The appearance of clinical evidence of intoxication in a well-controlled operation may mean either a failure of proper function in the equipment or a careless workman who is not following the rules of hygienic control. Faulty equipment is usually reflected in a group of employees; disobedience to rules and regulations in single individuals. In either event, the evidence indicates that employees are being poisoned, and the source of contamination should be corrected. The correction of faulty operative conditions is necessarily an engineering problem. The matter of proper handling of an individual who is showing signs of toxic absorption is entirely medical and in each individual case the physician must decide whether it is safe for the employee to continue in his operation or whether he must be removed from source of further intoxication and given special treatment.

Industrial toxicology offers the means of avoiding frequent repetition of our past experiences of human suffering, acute illness, chronic illness and death. With the aid of the toxicologist and the pathologist, we can eliminate from our industries occupational diseases and toxic processes. We can start all new operations with adequate protective measures and a scientific understanding of the toxic symptoms to expect, based upon our knowledge of the mechanism of their production.

The toxicity of a compound may vary with the conditions under which it is used. Substances which give little or no trouble at ordinary temperatures become extremely toxic at higher temperatures; some substances decompose and give off poisonous products when heated. Carbon tetrachloride brought into contact with hot metal or an open flame is oxidized and phosgene is liberated, which has a destructive action on lung tissue. In order fully to understand the toxicity of a compound, we must know how the material is handled, the temperatures to which it will be subjected, physical changes in the operation, the various conditions under which it will be handled and the possible chemical changes which may occur.

There must be a very careful study of the effect of a compound upon the body organs. What does it do? How does it do it? What organs of the body are affected and what clinical symptoms are to be expected as the result of intoxication? There are certain substances which produce disease mechanically and in themselves are not poisonous. Silica dust is an excellent example of this type of material. Fine silica dust when inhaled eventually becomes imbedded in the lung tissues, setting up an irritation which is followed by the formation of fibrous tissues. The physical characteristics of the lung change. It loses its elasticity and its function is interfered with, depending upon the stage of the disease. This is the disease known as silicosis. Silicosis is chronic, progressive, incurable and often leads to total and permanent disability. When complicated with tuberculosis it is usually fatal.

The subject of toxicology requires the development of an extensive amount of knowledge, otherwise its application to industry is of no practical value.

Haskell Laboratory of Industrial Toxicology, a new medical research laboratory of the du Pont company, which has been erected on the grounds of the company's Experimental Station near Wilmington, Del.