FILE NAME: Hercules Chemical (HERC)

DATE: 1956

DOC#: HERC004

DOCUMENT DESCRIPTION: Book Excerpt from Manual of Industrial Medicine

MANUAL

OF

INDUSTRIAL MEDICINE

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PHILADELPHIA

UNIVERSITY OF PENNSYLVANIA PRESS

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First Edition, January 1950
Second Edition, January 1954
Third Edition, March 1956

PRINTED IN THE UNITED STATES OF AMERICA
AMERICAN BOOK–STRATFORD PRESS, INC., NEW YORK

PREFACE TO THE THIRD EDITION

In the historical sense occupational medicine may be viewed as an ancient form of medical practice which has recently acquired a name. Our oldest medical literature (the Edwin Smith Surgical Papyrus) presents case reports of patients suffering from trauma, possibly due to accidents while building the step-pyramid of Sakkarah near Memphis, about 3000 B.C.

There can be no healthy atmosphere for business or industry without a healthy atmosphere for its essential components—men and women. It is becoming more evident that employee health is of primary concern to industrial management. Surveys of the health needs of men and women on the nation's industrial rolls show that the greater opportunity for constructive medicine lies in the field of prevention of disease and injury rather than in curative medicine. The objective of prevention is approached through improving the working environment (industrial hygiene) on the one hand, and through meeting the health needs of individual worker (clinical medicine) on the other.

Medicine is more than an art and a science; it is a potent and distinguished social instrument. Gorgas in 1904, by controlling disease (e.g., malaria and yellow fever), allowed men to build a canal across Panama. He turned a jungle into productive, habitable areas, making it possible for men and women to rise from marginal subsistence to a productivity commensurate with a higher standard of living. Man must be able to work if he is to enjoy the fruits of his labor.

c) Ceramic industries—pottery-making

d) Glass-manufacturing

e) Abrasives

f) Stone-finishing

g) Construction work (tubes, tunnels, aqueducts, etc.)

d. *Asbestosis*

The occupational fibrosis which results from the inhalation of asbestos fibers is due chiefly to the mechanical plugging of the alveoli or in the formation of fibrotic sleeves along the terminal bronchioles. The condition has been noted in workers mining and crushing crude asbestos. In 1940 Gardner stated that 27 per cent of workers so exposed had lung x-ray changes. In those with more than 15 years exposure the percentage rose to 60.[104] The characteristic x-ray finding is the so-called "ground glass" appearance which differs from the nodular pattern of silicosis.

Lynch and Cannon [111] described the characteristic lesion in 40 necropsied cases as an "asbestosis body" consisting of a central asbestos fiber with a shiny yellow-brown coating, found in terminal bronchioles and peribronchial lymph nodes. Some of these bodies may appear in the sputum. A feature of the disease in advanced form was pleural thickening with some adhesive obliteration of the pleural spaces. In 8 cases there was nodular fibrosis of the lungs, in 6 some form of active pulmonary tuberculosis, and in 3 carcinoma of the lung.

Wright [103] found in patients with asbestosis evidence of a marked inadequacy of oxygen transfer from the lung air to the lung blood (subnormal O_2 content of arterial blood) along with increased breathing or ventilation rates. In well-developed asbestosis he believes that lung tissue changes are more widespread, hence the oxygen transport defect in alveolar walls (increased

thickness). Many workers in asbestos, receiving intense exposure, fail to develop evidence of either physiologic or roentgenographic abnormality.

Behrens [112] stated that post-mortem reports from the literature indicate that in 309 cases of asbestosis there were 44 lung carcinomas (14.2 per cent), whereas in 2,204 cases of silicosis only 32 carcinomas were found (1.4 per cent). Pulmonary tuberculosis is less often associated with asbestosis than it is with silicosis.

e. *Fume Exposure in the Manufacture of Alumina Abrasives* [113]

An interesting pulmonary disorder has been described in workers who inhaled fumes from molten bauxite (aluminum oxide with clay, iron oxide, titanium dioxide and other impurities). The calcined bauxite is raised to a temperature of about 2,000° C. in furnaces. Chemical analyses of the fumes show alumina and silica as the chief constituents.

Symptoms: Cough, aggravated by exertion; moderate sputum, dyspnea; and pain, usually pleuritic, occasionally of a substernal discomfort type.

Findings: Physical examination in well-established disease shows restricted movement of the thorax, retraction of rib interspaces after spontaneous pneumothorax, rales and rhonchi inconstantly, and pleural friction rubs. There is reduced vital capacity. Roentgenograms show granular shadowing in lung apexes spreading later over the lung field. The mediastinum and heart shadow broadens and the diaphragm becomes elevated and shows adhesions. All except one patient in a group of forty-six had bilateral pneumothorax (spontaneous) sometime during the course of their disease. In some men the condition appeared after 3 years of exposure; others had 20 to 30 years of exposure. Cardiac failure,

bine with sulfhydryl (SH) groups of proteins in the pyruvate-oxidase enzyme system and cause neuritis somewhat in the manner of arsenic.[155] That other enzyme systems may also be affected by some metals is suggested by the failure of BAL (2, 3-dimercaptopropanol) to affect the dramatic protection against other metals which it gives to arsenic.

Radioactive metals with long half-lives add to their chemical toxicity chronic radiation damage, after deposition in the body.

Sodium formaldehyde sulfoxylate reduces mercuric chloride to metallic mercury. Certainly by gastric lavage and possibly by intravenous administration, sodium formaldehyde sulfoxylate is useful in acute forms of mercury poisoning.[156]

Calcium salts have been thought to promote the deposition of circulating lead in bone.[156] Cadmium also tends to become part of the bone structure, and its presence there in small amounts may cause no symptoms.

9. Industrial Hygiene Codes

A code in the broad sense is "a system of principles, rules or regulations relating to one subject, or a formal statement of them." [157] A code may have a legal or regulatory background. A code may be considered to be a description of good operating practice, preferably with experimental and practical data to support it. Various states have such codes for the purpose of distinguishing between good and bad industrial practices. This effort, from the point of view of the physician in industry, is an approach to preventive medicine. Reference is made to codes at this point because they quite often deal with exposure to toxic materials used in industry and involve the concept of *Threshold Limit Values* (formerly Maximum Allowable Concentrations).

Tables of allowable concentrations have been devised to facilitate control of hazardous operations where air contamination by toxic chemicals is involved. This device has usefulness, but limited usefulness. Its chief advantage is found in the fact that if an industrial operation can be conducted well within the concentration recommended for a specific substance, rather good protection can be had for the majority of workers. Its disadvantages are:

a. The standards in some instances are unnecessarily low in order to avoid unsuspected chronic and cumulative effects. Many such "threshold limits" have insufficient basis in fact.

b. No standard, regardless of how low it is, suffices for the exceptional individual susceptibility. An occasional person is allergic, for example, to formaldehyde. For him the low concentration is no protection—he still gets his dermatitis!

c. There is the unfortunate concomitant implication of the threshold limit figure that a man sustaining a higher concentration is or will be ill, ipso facto, from his exposure.

The questions facing the physician when a complainant arrives are, "is this man ill, to what degree, and why?" Whether or not injury or illness actually results from a potentially hazardous occupation obviously depends on:

1) The nature of the exposure

2) The intensity of the exposure

3) The length of the exposure

4) The susceptibility of the person exposed

Biological reactions to air contamination are not a linear function of time and concentration. The physi-

cian deals with many variables in the patient and his environment, both at work and away from work.

In the use of the following table of hygienic standards (Threshold Limit Values for 1955) it must be remembered that

1) The table is intended for use by those versed in industrial hygiene.

2) Demands of safety or human comfort in some instances have introduced lower concentrations than experimental evidence can justify.

3) Constant eight-hour exposures are assumed.

4) No tabulated standard applies to inhalation of mixed chemicals.

5) The values shown are subject to change as additional evidence is obtained.

THRESHOLD LIMIT VALUES FOR 1955 [158]

Adopted at the Meeting of the American Conference of Governmental Industrial Hygienists, Buffalo, April, 1955

GASES AND VAPORS

Substance	*PPM*
Acetaldehyde	200
Acetic acid	10
Acetic anhydride	5
Acetone	1,000
Acrolein	0.5
Acrylonitrile	20
Ammonia	100
Amyl acetate	200
Amyl alcohol (isoamyl alcohol)	100
Aniline	5
Arsine	0.05
Benzene (benzol)	35
Bromine	1
Butadiene (1,3-butadiene)	1,000
Butanone (methyl ethyl ketone)	250
Butyl acetate (n-butyl acetate)	200
Butyl alcohol (n-butanol)	100
Butyl cellosolve (2-butoxyethanol)	200

GASES AND VAPORS (continued)

Substance	*PPM*
Carbon dioxide	5,000
Carbon disulfide	20
Carbon monoxide	100
Carbon tetrachloride	25
Cellosolve (2-ethoxyethanol)	200
Cellosolve acetate (hydroxyethyl acetate)	100
Chlorine	1
Chlorobenzene (monochlorobenzene)	75
Chloroform (trichloromethane)	100
1-Chloro-1-nitropropane	20
Chloroprene (2-chlorobutadiene)	25
Cresol (all isomers)	5
Cyclohexane	400
Cyclohexanol	100
Cyclohexanone	100
Cyclohexene	400
Cyclopropane	400
o-Dichlorobenzene	50
Dichlorodifluoromethane	1,000
1,1-Dichloroethane	100
1,2-Dichloroethylene	200
Dichloroethyl ether	15
Dichloromonofluoromethane	1,000
1,1-Dichloro-1-nitroethane	10
Dichlorotetrafluoroethane	1,000
Diethylamine	25
Dimethylaniline (N-dimethylaniline)	5
Dimethylsulfate	1
Dioxane (diethylene dioxide)	100
Ethyl acetate	400
Ethyl alcohol (ethanol)	1,000
Ethylamine	25
Ethyl benzene	200
Ethyl bromide	200
Ethyl chloride	1,000
Ethyl ether	400
Ethyl formate	100
Ethyl silicate	100
Ethylene chlorohydrin	5
Ethylene dibromide (1,2-dibromoethane)	25
Ethylene dichloride (1,2-dichloroethane)	100
Ethylene oxide	100
Fluorine	0.1
Fluorotrichloromethane	1,000
Formaldehyde	5

TOXIC DUSTS, FUMES AND MISTS (continued)

Substance	*Mg. Per Cu. M.*
Tellurium	0.1
Tetryl (2,4,6-trinitrophenyl-methylnitramine)	1.5
Trichloronaphthalene	5
Trinitrotoluene	1.5
Uranium (soluble compounds)	0.05
Uranium (insoluble compounds)	0.25
Zinc oxide fumes	15

MINERAL DUSTS

Substance	*MPPCF*
Alundum (aluminum oxide)	50
Asbestos	5
Carborundum (silicon carbide)	50
Dust (nuisance, no free silica)	50
Mica (below 5 per cent free silica)	20
Portland cement	50
Talc	20
Silica	
high (above 50 per cent free SiO_2)	5
medium (5 to 50 per cent free SiO_2)	20
low (below 5 per cent free SiO_2)	50
Slate (below 5 per cent free SiO_2)	50
Soapstone (below 5 per cent free SiO_2)	20
Total dust (below 5 per cent free SiO_2)	50

NOTE:

The foregoing sections on Dusts, Fumes, Gases (VI, B, 6), Poisons (VI, B, 7), Detoxication Mechanisms (VI, B, 8), Industrial Hygiene Codes (VI, B, 9), and the Table of Threshold Limit Values are but a meager introduction to the subject matter concerned.

For example, Browning's review of the toxicity of industrial organic solvents alone lists 126 materials.[134] It is feasible to include in a Student Manual only a few examples of hazards from dust, fumes, gases and poisons.

A physician responsible in any degree for the health of workers must acquaint himself with the materials to which those workers are in any manner exposed. Chemical compounds often appear in industry under proprietary names, sometimes as mixtures. Fundamental data on toxicology is available, or can be derived by suitable experiments, from laboratory work with animals. Guide lines from this source orient the physician in the medical observations to be made, and the control required, in the environment of the working man.

For fuller information on specific materials one should consult

10. Infections and Dermatoses—Occupational diseases of the skin [159]

a. *Classification*

1) Stigmata or occupational marks [160] (usually from physical and mechanical causes) Examples:

a) Harp players with thickening of the finger tips due to friction from strings

b) Housemaids or cotton pickers—prepatellar callosities and bursitis

2) Injuries—cuts, excoriations, etc.

3) Ulcerations—traumatic, chemical or other

4) Inflammations

5) Proliferations of the skin

b. *Incidence*

Seventy per cent of all occupational diseases in European countries are stated to be dermatoses. An analysis of several states in the United States showed an incidence of 66 per cent of occupational disease claims (exclusive of accidents).

c. *Causes*

Predisposing causes may be

1) Race. The Negro is less susceptible than are races of lighter skin color.

2) Diet

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such works as (a) "A Guide to the Diagnosis of Occupational Disease" prepared by the Staffs of The Industrial Health Division, Department of National Health and Welfare (Canada) and The Division of Industrial Hygiene, Department of Health for Ontario, Edmond Cloutier, Ottawa, 1949; (b) the "M.C.A. Chemical Safety Data Sheets," Manufacturing Chemists' Association, Inc., 1625 Eye Street, N. W., Washington 6, D. C.; (c) *A.P.I. Toxicological Reviews,* American Petroleum Institute, 50 West 50th Street, New York 20, New York; (d) Texts listed in bibliography of this Manual; and (e) the indispensable *Quarterly Cumulative Index Medicus* for references to specific compounds.

cidence of disease, the effect of medical service procedures, the advance of degenerative physical changes, aging, and like fields where additional medical information is needed. The character and incidence of acute illness need close study by the physician for the proper administration of disability wage and salary plans, sickness insurance and related benefits which are now available to the industrial workers.

N. The maintenance of contacts with national and local scientific institutions whose research work deals with the health of industrial workers.

O. Coöperation with medical associations and official agencies on problems of industrial health.

P. Coöperation with the employee and employer in the proper administration of workmen's compensation benefits. Industrial disabilities frequently are of a nature which calls for advice and appearance before industrial boards by physicians who are acquainted with industrial processes indicted by the claimant's appearing before such boards.

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