

OUTLINES OF
INDUSTRIAL MEDICINE,
LEGISLATION AND HYGIENE

BY
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TO
MY WIFE

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P R E F A C E

THIS small volume does not presume to be a treatise on the subjects with which it deals. It is intended solely as an introduction to their study for students and others who are required or wish to know something about industrial medicine, legislation, and hygiene. No attempt has been made to deal exhaustively with legislation, and so only the essential portions of the various Acts have been included. Hygiene in factories differs very little from the hygiene of ordinary premises, and can be studied better in one of the many works on Public Health. To have gone fully into this subject would have meant encroaching on the latter.

As time goes on the number of doctors (full or part-time) who are assigned to factories is bound to increase. Those who intend to take up this branch of medical practice after graduating must possess the necessary knowledge in order to fit them for their duties. This introductory volume will, it is hoped, serve them as a stepping-stone to more extended study and research. Apart from this, it is essential that the ordinary medical practitioner should be so trained that he is able to make an early diagnosis of those diseases met with in industry, a knowledge of which is at present sadly lacking. The author hopes that this introductory work will be of some assistance to him in this direction.

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OUTLINES OF INDUSTRIAL MEDICINE, LEGISLATION, AND HYGIENE

Part I.—INDUSTRIAL DISEASES

CHAPTER I POISONS

LEAD

LEAD poisoning is one of the most important of all the industrial diseases. Its occurrence must be notified by medical practitioners to the Chief Inspector of Factories, Home Office, whenever they meet with a case occurring in a factory worker in the course of their practice.

Lead poisoning is met with amongst workers in a great variety of occupations. The following are some of the chief of these :—

1. *Lead Mining*.—The ore which is mined is galena. This is a sulphide and is practically harmless. The oxide and carbonate of lead, however, are not. Lead miners in this country are apt to suffer from pulmonary fibrosis on which tuberculous lesions may become grafted.

2. *Lead Smelting*.—This is a dangerous occupation and one in which the risk of lead poisoning is great. This is due to the inhalation or ingestion of lead fumes and dust.

3. *Lead Manufacture*.—White lead is especially dangerous in this connexion. This is known as lead carbonate and is a potent source of poisoning. Lead oxide or red lead produces poisonous fumes in the course of its manufacture.

4. *Dyeing*.—This is sometimes carried out by the use of chromate of lead.

5. *Electric Accumulators*.—Here red lead is employed.

6. *Printing and Type-founding*.—Compositors are poisoned by handling type which contains lead. The metal used in the manufacture of type is an alloy of lead with antimony.

7. *Plumbing*.—Poisoning arises from the handling of lead pipes and sheet metal used in this industry.

8. *House Painting*.—In this occupation the risk of poisoning arises in preparing the paints as well as in their application. Poisoning may also be caused during the process of burning off old paint. Thus fumes, or dust given off from dried paint on overalls, may produce poisoning in the worker. At the present time the use of white lead in paints has become greatly reduced, and so the risks of poisoning are lessened.

9. *File Cutting*.—File cutters use what is termed a 'bed' of metallic lead on which the file to be cut is fixed. In the process a considerable amount of lead dust may be liberated and so inhaled. Accordingly there is a considerable amount of lead poisoning amongst such workers, who are also very liable to suffer from pulmonary tuberculosis.

10. *Pottery Work*.—In glazing pottery the ware is dipped into a creamy mixture which contains lead. In this process some of the glaze is apt to be splashed on the dipper. When dry this splashed material is given off in the form of dust, which is inhaled. In view of these risks a leadless glaze should be more extensively used. This is officially defined as a glaze which does not contain more than 1 per cent of its dry weight of a lead compound calculated as lead monoxide.

11. *Rubber Manufacture*.—Mixers and compounders may be affected. In the process of mixing lead is one of the substances handled and gives rise to considerable

quantities of dust. In compounding, the mass of rubber is kneaded between heavy heated rollers. During this process some of the dusty powder falls off and the risk arises not only from inhalation of this dust but also from fumes which are given off. Lead is used as an ingredient in the mixings as it has a toughening effect on the raw rubber.

12. *Ship-breaking*.—Here lead poisoning occurs during the process of demolition of the metal parts. In this process an oxyhydrogen blowpipe is used to cut up the lead plates. In burning off paint lead fumes may also cause poisoning.

Lead poisoning in industry is most commonly caused by the inhalation of dust. Moreover it is the constant inhalation or absorption of minute quantities of lead that gives rise to chronic poisoning. Sir Thomas Oliver* gave it as his opinion that those who went to work without taking food were more readily affected. Alcoholism, moreover, had a deleterious effect on lead workers as it tended to make them careless as well as less cleanly in their habits. He advocated that those who looked anæmic, whose glandular system was at fault, whose digestion was not normal, and, perhaps, those suffering from constipation or who had kidney disease, should not be accepted for work in any industry in which lead was used.

Clinical Features.—Chronic lead poisoning is characteristic. The two earliest evidences met with are: (1) an ashen-grey colour of the skin, with anæmia of the lips; (2) a blue line on the gums. In my experience the first-mentioned is usually the first sign of poisoning to be shown by the worker. It is undoubtedly due to some deleterious effect of lead on the circulating blood. The blue line on the gums is sometimes termed the 'Burtonian line' after Burton, who described it about a

**Lead Poisoning*, 1914. London: H. K. Lewis.

century ago. It is due to deposition of fine pigment granules and is unmistakable evidence of lead absorption. It is always most marked in those who never brush their teeth. Some lead workers I have examined presented a most foul condition of gums and teeth. When any of such workers develop evidences of poisoning the blue line was always found to be very strongly marked. The anæmia is characterized by more or less basophilia. The erythrocytes show stippling, and this is regarded by some authorities as the most reliable early evidence of lead poisoning. This granular appearance tends to vary from time to time so that frequent blood examinations may be necessary to confirm its existence. Along with this basophilia a mild degree of secondary anæmia is always present. It is caused by progressive destruction of the red blood-corpuscles. In the absence of other evidences basophilia should be looked upon as a danger signal.

Some authorities regard the finding of lead in the urine as a useful means of diagnosis. This, however, only proves lead absorption, and not necessarily the occurrence of lead poisoning. Nevertheless the finding of lead in a worker's urine should be looked upon as a warning sign. Other possible early evidences need only be listed, as they are not always present. These are: (1) Fine tremors in the hands, tongue, face, and eyelids; (2) Diminished extension power in the wrists; (3) A marked rise in blood-pressure; (4) Headache; (5) Loss of appetite; (6) Constipation; (7) Metallic taste in the mouth; (8) Nausea.

When chronic lead poisoning has unmistakably developed we meet with various sets of symptoms which may be grouped as follows:—

1. *Abdominal*.—This is characterized by severe, colicky pains in the abdomen. These may be due to the direct action of lead on the intestinal muscles or to its indirect action on the nerve-supply. This is probably the most

common type of lead poisoning. It is of the nature of severe spasm, which may even involve the bladder muscles so as to produce pain and difficulty in micturition. During the attack of lead colic there is cold, clammy sweating and the patient is doubled up in agony. The colic is always associated with obstinate constipation. The pain is usually so severe as to induce vomiting. The temperature may be slightly raised during the attack.

2. *Nervous*.—This type shows itself in a variety of paralyses, the commonest of which is wrist-drop. The fingers are first of all affected and paralysed. Then the wrist becomes involved. There is more or less wasting of the muscles concerned, and swelling of fingers and hands may be present. A second variety is known as brachial or upper arm paralysis. A third form involves the muscles of the thenar and hypothenar eminences of the hands as well as the interossei. In this way the appearance presented closely resembles that seen in patients who are suffering from progressive muscular atrophy. Very rarely the lower extremities, or even the larynx, may be paralysed. In my experience of Court work I have found that attempts are sometimes made by the opposing party to prove that the wrist-drop or other form of paralysis is due to alcoholic neuritis. If the claimant is alcoholic it may be difficult to disprove this contention. Well-directed medical evidence, however, can usually defeat the opponent's attempt to upset the worker's claim for compensation.

3. *Mental*.—Here we have a complex of symptoms which are comprised under the term 'encephalopathy'. This type sometimes develops quite suddenly and is very frequently manifested by convulsions. Less commonly there is delirium, and still less common is the occurrence of coma. Apart from all this most cases of industrial lead poisoning show some change in their mental condition. Restlessness, loss of memory, lack of concentration power,

and irritability of temper are the commonest evidences of this. The patient may even show signs of mental depression, verging on actual melancholia.

4. *Arthritic*.—This variety is characterized by pains in the muscles and joints, more especially those of the lower extremities, although in some instances the arms, chiefly the elbows, may be involved. The affected joints become swollen and are very sensitive on pressure and movement.

5. *Ocular*.—In some cases of chronic lead poisoning the eyes may be affected. Thus we may have paralysis of muscles, retinitis, keratitis and even optic atrophy with blindness, although fortunately the last-mentioned is extremely rare. Its exact mode of production is as yet undecided, although some believe that encephalopathy may have some bearing. The latter may be secondary to uræmia—at least this suggestion has been put forward.

Late evidence of chronic lead poisoning includes arteriosclerosis with raised blood-pressure. Nephritis may also be induced in chronic cases.

Preventive Measures.—The prevention of lead poisoning in industry is a matter of the greatest importance. This has long ago been recognized by the Home Office and regulations have been made regarding it. Section 47 of the Factories Act, 1937, provides that in every factory in which, in connexion with any process carried on therein, there is given off:—

1. Any dust or fumes or other impurity of such a character and to such an extent as to be likely to be injurious or offensive to the persons therein employed ;

2. Any substantial quantity of dust of any kind : the following requirements shall apply:—

1. All practical measures must be taken

- i. to protect the persons employed against inhalation of the dust or fumes or other impurity ; and
- ii. to prevent the dust or fumes or other impurity accumulating in any workroom ; and

2. Where the nature of the process makes it practicable, exhaust appliances must be provided and maintained as near as possible to the point of origin of the dust, etc., so as to prevent it entering the air of the workroom.

Section 58 of the same Act prohibits the employment of women and young persons (i.e., under 18 years of age) in certain lead processes. Section 109 extends this prohibition in a similar manner to places other than factories. Moreover, lead workers are required to be examined once a month by the approved Examining Surgeon and the results of his examinations are recorded in a special register.

Preventive measures include the following :—

1. Examination of workers before being allowed to undertake work in any lead process, and their rejection if found to be anæmic, to have bad teeth or pyorrhœa, high blood-pressure, or albuminuria.
2. The use of suitable clean and protective clothing.
3. Chewing of tobacco prohibited.
4. No food or drink to be taken in any lead process workroom.
5. Provision of a supply of hot water and clean towels, and of suitable cloakroom accommodation.

The wearing of respirators would be very helpful. Unfortunately this is by no means a practical, but rather a theoretical, preventive measure. Milk, too, has been advocated, and is recommended on the ground that it contains calcium and is said to fix the lead absorbed by hindering its liberation from the bones. It has been stated that a positive calcium balance tends to favour lead storages whereas a negative balance raises the rate of its excretion.

A schedule to Section 47 of the Factories Act, 1937, constitutes lead poisoning in industry a compensable disease whenever or wherever it occurs in connexion with

a lead process. Then, again, Section 60 of the Act is important in this connexion, because under it the Secretary of State has made certain Dangerous Trade Regulations, some of which apply to lead manufacture, pottery, electric accumulators, painting of vehicles, and so on.

MERCURY

Mercury poisoning is very rare as an industrial disease. Like lead poisoning it is notifiable. In most of the occupations concerned poisoning is only produced after a considerable period of exposure. It may be produced either by dust inhalation or fume absorption. It is met with in those who are engaged in the production of mercury and its salts, makers of thermometers, those who prepare furs for hats, makers of mercury lamps, and bronzers.

Clinical Features.—Industrial mercurial poisoning is usually chronic from the outset. The symptoms at first are digestive disturbances and neuromuscular affections. Prominent among the digestive symptoms is stomatitis which is predisposed to by dental caries. There are salivation, foetid breath, and sponginess of the gums, which bleed readily. In addition the worker complains of a metallic taste in the mouth, vomiting, and diarrhoea. As regards the neuromuscular affections, tremors and muscular incoordination are early evidences of mercurial poisoning. In one of my cases a diagnosis of incipient disseminated sclerosis had been made by the doctor attending the patient. Tremors are met with chiefly in the hands, arms, and face, especially the lips. At first these tremors are fine, but later they become more or less coarse in character. They are apt to develop slowly, but they are always of a progressive nature. Sometimes, however, they seem to make their appearance quite suddenly. Mercurial erethism is the term given to a mental syndrome which includes apathy and mental depression.

In the course of time the worker becomes emaciated and a mild degree of secondary anæmia is met with. Among other features resulting from chronic mercurial poisoning are nephritis and dermatitis, but these do not present any special characteristics.

Preventive Measures.—These include selection of workers, proper ventilation, and cleanliness of the person and factory. The risks from mercury dust and vapour may be reduced by securing a low temperature in the factory. Medical inspection of workers at regular intervals is also an essential preventive measure.

PHOSPHORUS

Two varieties of phosphorus are described, viz., the colourless and the red or amorphous. As an industrial proposition, chemically pure phosphorus is prepared from bones. In this process poisonous fumes are given off.

1. *White Phosphorus.*—White phosphorus is not much in use nowadays, although it is employed as a rat poison. In the *acute* type of poisoning there develops a garlic-like taste in the mouth, with a sense of constriction and pain in the throat, nausea, and black vomit. These symptoms are apt to be followed, after a short interval, by jaundice, which may be very intense. Later, muscular cramps are experienced and there may be delirium and hallucinations followed by great depression. In the *chronic* type of poisoning necrosis of the jaw occurs.

2. *Amorphous Phosphorus.*—The amorphous form is now chiefly used in match manufacture. The Factories Act now absolutely prohibits the use of white phosphorus for this purpose. Various research workers have from time to time stated that red phosphorus is toxic, but as this conclusion was arrived at by experiments on animals it by no means follows that it is a poison so far as industry is concerned.

ARSENIC

Arsenical poisoning is not common in industry. It may occur in those engaged in preparing green colours, in preserving skins and furs, animal stuffing, handling birds' feathers preserved by means of arsenical compounds, painters using green paint, and the making of sheep dip. Poisoning in industry is practically always of a chronic nature.

Clinical Features.—These include pigmentation of the skin, keratotic changes in the skin of the palms and soles, and sometimes loss of the nails and hair. Nervous phenomena are common. They include peripheral neuritis which is progressive and localized in the hands and feet. Motor disturbances are rarely encountered. Ulceration may occur in the tips of the fingers or even in the nasal septum, while cancerous lesions have been described. It must be kept in mind that as the industrial disease is due to inhalation and not to ingestion the symptoms met with in chronic cases of poisoning are not the same as those encountered in ordinary practice. The earliest symptoms met with are usually vomiting, diarrhoea, and salivation, with numbness and tingling sensations in the lower extremities. Mental confusion may be encountered in severe cases of poisoning.

Preventive Measures.—Such measures are directed to efficient ventilation of workrooms, the floor of which should be formed of cement. Downward exhaust ventilation is essential in those parts of the workroom where operations are carried on. Suitable clothing and arrangements for washing should be provided. The Chemical Regulations, 1922 (S.R. and O. No. 731) apply to operations involving the manufacture of arsenical compounds. These may be consulted for further details.

MANGANESE

The use of manganese in industry is relatively slight, consequently cases of poisoning are seldom met with.

Poisoning is due chiefly to dust inhalation, but also to fumes in some instances. In the operations of crushing, sieving, and packing the washed manganese ore dust is constantly being inhaled, while fumes are given off by the furnaces. Manganese is used in the manufacture of enamel and certain varieties of oil paint and varnishes and in the making of galvanic batteries. Poisoning is also met with in persons engaged in colouring glass ware, in calico workers, dyers, linoleum operatives, and pottery workers, as well as in manganese ore and steel workers.

Clinical Features.—Manganese poisoning closely resembles cases of Parkinson's disease. In fact, but for the occupational history the case may readily be mistaken for this. The face becomes mask-like and the speech is slow and monotonous. Tremors are seen in the hands. Retropropulsion gait may be developed. Movements become stiff and the patient becomes highly emotional. He may be irritable at times. The symptoms tend slowly and steadily to progress until eventually the sufferer becomes bedridden and paralysed.

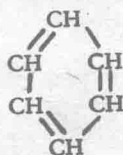
Preventive Measures.—These consist in the wearing of a suitable respirator and in adopting every possible precaution against the inhalation of dust. Proper exhaust ventilation has been found very successful in removing fumes, and should be provided at the furnaces.

BENZENE

Benzene forms the basis of the aromatic hydrocarbons. All of these are closely related to benzene, although some of the derivatives of benzene are either odourless or possess a disagreeable smell. The chief source of benzene and its homologues is coal-tar which is produced in the process of manufacturing coal-gas. When submitted to fractional distillation a number of volatile products are obtained. These are passed through water and are condensed. This mixture of condensed

liquids is termed coal-tar. It is separated and redistilled. The distillate is collected in a number of fractions. The first of these is the benzene fraction. This is purified and then distilled. Benzene, toluene, and several xylenes are then separated from this fraction by a further distillation. It is to be noted that commercial benzene is really a mixture of benzene and its homologues. The formula for benzene is C_6H_6 and for toluene $C_6H_5CH_3$. Benzene is represented graphically thus :—

Benzene has also been synthesised from acetylene. It is a colourless substance with a characteristic odour. It is highly inflammable and resists the action of all the usual oxidising and reducing agents. It must not be confused with petroleum benzine (note the spelling). The latter is one of the products of the fractional distillation of crude petroleum oil. It is also known as benzoline.



The uses of benzene in industry are very various. Thus it is employed in the manufacture of benzene derivatives, aniline, explosives, and pharmaceutical products. It is used in the manufacture of linoleum and celluloid, and in pottery works. In dyeing and cleaning works benzene is often in use. Its use in glue works is well known, as also in india-rubber factories. In the rubber industry benzene finds a place in the manufacture of tyres and in spreading balloon cloth. The wings of aeroplanes are doped with a solution containing benzene. Its use in place of benzine as a carburetting agent in the motor industry has also to be borne in mind.

Clinical Features.—The clinical features of benzene poisoning are most marked in the case of commercial benzene which is never a pure product. Poisoning is caused by inhalation of the vapour given off. It may be either acute or chronic.

1. ACUTE POISONING.—Headache and giddiness are the earliest warning symptoms. These may be rapidly