The nearest average figure (to one place of decimals) for the B.S.I. Haldane standard is 19.8 ml. of oxygen or 14.8 g. of haemoglobin. How it has come about that this standard, which has been checked and re-checked over a period of more than 40 years, could have changed from an original equivalence of 18.5 ml. O₂ to the present 19.8 ml. is a perplexing problem. There can be little doubt of the reliability of the 19.8 figure, since this value has been arrived at independently by Macfarlane and O'Brien, who report the results of their measurements in the accompanying paper (p. 248). It is worth pointing out, however, that the Haldane gas apparatus has repeatedly been observed to give variable and low results for O₂ capacities of blood (van Slyke and Stadie, 1921; Abeloos, Barcroft, Cordero, Harrison, and Sendroy, 1928; Litarczek, 1928; Bierring, Nielsen, and Nielsen, 1936). Although Haldane O₂ results often agree with van Slyke results, disagreement is more common and the error may be as large as 9%. It should be particularly emphasized that a gas analysis of a single specimen of blood is not sufficient to set up a standard. For this purpose determinations should always be made on several specimens, and the colorimetric or photometric standard established by reference to the average of the results.

It has long been a matter of speculation as to why the "normal" of English bloods should be lower than that accepted in Germany and in America. Several reasons have been advanced (cf. Price-Jones, Dill, and Wright, 1931), but it has always seemed unlikely that any real difference in fact existed. Jenkins and Don (1933), as the result of a large series of van Slyke estimations, came to this conclusion; and we have observed during the war years that there is no appreciable difference between the haemoglobin concentrations of British, Canadian, and American soldiers whose bloods have been tested at this school. The present finding that the accepted standard of British reference for haemoglobin values is much nearer to Continental and American standards should serve to bring British haematological figures into closer alignment with results obtained elsewhere. Past recorded results should be reviewed in the light of this standardization figure.

Summary

The Haldane colorimetric standard recently defined by the British Standards Institution is equal to a haemoglobin concentration of 14.8 g. per 100 ml. or 19.8 ml. of oxygen. Haemoglobin results by the Haldane and alkaline haematin methods were in good agreement when the correction for the Haldane standard was applied.

This investigation has been carried out at the request of the Subcommittee on Analytical Methods set up by the Medical Research Council and as the result of an inquiry from the medical officers of the Ministry of Supply. Part of the expenses incurred has been defrayed by a grant from the M.R.C., for which we make grateful acknowledgment.

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According to the *Aftontidningen* of Sept. 8, 1943, there were in Germany 71,500 new cases of tuberculosis in the first half of 1943, as compared with 67,000 in the whole of 1939. It is considered that the number may be even larger in view of the difficulties prevailing for people who wish to report sick, and in view of the shortage of doctors, which has meant that not all those persons who are ill get medically examined. As a sidelight on these figures it is interesting to note that in Germany the health authorities last year announced that milk can no longer be delivered to households free from bacteria, and the population are therefore requested to boil milk for five minutes before using.

CADMIUM POISONING

BY

PHILIP ROSS, M.D.

Because of the modern widespread use of cadmium and its salts in industry it is becoming increasingly important to recognize the possible toxic effects of these substances, and as the literature on this subject is rather meagre the following observations may prove of assistance in industrial medicine.

Industrial Uses of Cadmium.—These are legion: the process of plating; the preparation of certain fusible alloys; the manufacture of specialized solders, dry batteries, paints, pigments, and metal bearings; and in the car and armaments industries.

Industrial Risks.—These occur during the smelting of ores, the preparation and flame-cutting of cadmium alloys, cadmium welding, electro-plating, and metal spraying. It is not universally realized that finely divided cadmium of a particulate size of 10 microns or less is inflammable, producing in the presence of abundant oxygen dangerous fumes of cadmium oxide. It is possible, too, that this cadmium dust is explosive.

Pathology of Cadmium Poisoning

As with lead and mercury, the main danger lies with the inhalation of the fumes of the pure metal or its salts. It is therefore essential, first, to guard against the production of free fumes in the workroom, and, secondly, where such an occurrence is unavoidable, to provide an efficient exhaust mechanism and ensure the wearing of a suitable respirator. The late Sir Thomas Legge (1923) described a fatal case of cadmium poisoning caused by the inhalation of fumes while melting ingots of metal. Post-mortem examination revealed widespread inflammation of the lungs, gastro-intestinal tract, kidneys, and spleen. Other observers have found, in addition, a slight polymorph leucocytosis; and the Canadian observers Bulmer, Rothwell, and Frankish (1938), while describing similar appearances, stress the fact that the lungs bear the brunt in all cases of cadmium fume inhalation.

Symptomatology

It would appear, then, that cadmium in a finely divided state is a powerful irritant poison, and though the lungs have been indicted as bearing the main burden of this onslaught, I would point out that the digestive tract shares with the pulmonary system the first line of defence. It must be emphasized that though the immediate effects are slight the delayed action is often severe and can even prove fatal—such catastrophes being described by Johnstone (1941) and others. We thus have a parallel to phosgene and other lung irritants of gas warfare. The following symptoms have been culled from current literature and from my own series of cases.

1. **Immediate Effects.**—These include smarting of the eyes, dryness and irritation of the throat, tightness of the chest, dyspnoea, cough, and feeling of prostration. A few have complained of giddiness and headache.

2. **Delayed Effects.**—These appear usually three or four hours after exposure. The earlier respiratory distress increases in severity; gastric disturbances make themselves manifest with nausea, retching, vomiting, and occasionally diarrhoea; metal fume fever is in frequent evidence, characterized by an attack of "ague" with rigors and pyrexia; prostration becomes marked; in the event of prolonged exposure pneumonia may supervene; and in fatal cases there may be signs of kidney and liver involvement.

Physical Signs.—In the moderate type of intoxication these are few. The patient is pale, dyspnoeic, prostrated, and inclined to retch; the pulse rate and temperature are at first normal. The pharynx is injected, no adventitious sounds are heard in the chest, but there is usually some epigastric tenderness. With the advent of "ague," rigors and pyrexia supervene. The serious case shows evidence of a diffuse bronchopneumonia best revealed by x-ray examination.

Treatment; Prognosis and Sequelae

Except where contact with the fumes has been slight and brief, cessation from work and complete rest in bed for at least

48 hours should be insisted upon. In mild cases the symptoms by that time will have subsided, excepting possibly some nausea, anorexia, and weakness. In severe cases more prolonged recumbency is necessary, treatment being symptomatic and carried out according to general principles: oxygen for marked dyspnoea, sulphonamides for pneumonia, and appropriate sedatives for the dry cough and gastric disturbances.

Mild cases recover in a few days; but when pneumonia ensues recovery is necessarily prolonged and disability may last for two months or more. In the few recorded fatalities death has occurred within ten days. Though it is stated that no permanent effects have hitherto been encountered I have noted the following residual symptoms at the expiration of two months: nausea, anorexia, weakness of the legs, slight dyspnoea on exertion, and epigastric tenderness.

An Analysis of 23 Cases

An outbreak of cadmium poisoning occurred recently in a factory to which I am attached. The mishap arose one Sunday morning at 10.30, when a workman, while cleaning out a cadmium-recovery chamber, dropped some red-hot ash from a lighted cigarette on the floor and ignited the cadmium dust deposited there. (The man was smoking, contrary to regulations.) As the metal was in a finely divided state (subsequent examination showed that the size of the particles was between 2 and 10 microns) it began to glow and soon became a red-hot mass emitting yellowish-brown smoke of cadmium oxide. Within a few minutes the wood and canvas filter-frames were blazing furiously. The fumes filled the shop very rapidly and affected in all 23 persons, the chief fireman bearing the brunt of the exposure for 30 minutes, while the rest were in contact with the smoke for not more than 20 minutes.

The *immediate effects* noted by the men were dryness of the throat, constriction of the chest, cough, and weakness of the legs. Two complained of irritation of the eyes, and a few others had headache and giddiness. They all, nevertheless, returned to their respective duties and attempted to resume work. Three, however, were unable to carry on and were allowed to rest.

Delayed effects began to manifest themselves about three hours later, when 10 men complained of nausea and epigastric pain severe enough to warrant attendance at the first-aid post, where they received palliative treatment from the trained nurse in charge. At this stage the dangerous nature of the fumes had not been appreciated, and it was assumed that the smoke had emanated solely from the burning filter-frames. Hence the men received stomach sedatives and were allowed to rest, but no alarm was raised.

I was apprised of the incident at 10.30 p.m. by the control officer, who became concerned at the continued disability among those who were still on duty, and the preliminary report to me included the information that a chemical extinguisher containing carbon tetrachloride had been used for a brief period at the onset of the fire. This led me to suspect delayed phosgene poisoning, and I arranged for the admission into hospital of those who had been seriously affected—eight in all. Subsequent exhaustive investigations, in which Dr. Middleton, the medical inspector of factories, co-operated, proved that the carbon tetrachloride played no part in the intoxication.

A Typical Case.—As the chief fireman was the most serious casualty I shall cite his symptomatology and progress as a "typical" case of poisoning. His early discomfort was slight—a feeling of dryness in the throat—but three hours later he complained of headache, nausea, vomiting, diarrhoea, and prostration, and he received attention at the first-aid post. Eleven hours after exposure he felt well enough to go home, and he refused assistance for this twelve-mile journey. He stated subsequently that his only clear recollection of this trip was the start, when he felt he was "walking on air"; but he was oblivious of the rest of the journey, nor did he remember being met by his wife at the destination. His sickness and diarrhoea continued for the rest of the evening, and I was informed that he had attacks of shivering also. He was admitted to hospital at midnight, July 11. His symptoms then were headache, dyspnoea, slight cough, dry throat, smarting of the eyes, vomiting, and diarrhoea. Examination revealed no cyanosis; breathing was rapid and laboured (rate 40 p.m.), the pulse 92, temperature 101°, and blood pressure 115/70. Both lungs showed generalized fine crepitations. A radiograph on July 13 disclosed shadows at both bases suggestive of patchy consolidation, and a repeat photograph four days later revealed slight clearing at the left base. The sputum showed no pneumococci or other pathogenic organisms, and investigations of the blood and urine were negative. He made steady progress with treatment, which included the administration of sulphamezathine. He was discharged for convalescence on July 26, and resumed work on Sept. 6, being restricted to light duties. He still complains of occasional headache, heaviness of the eyelids, and slight weakness of the legs.

The following table is a summary of the main symptoms displayed by the victims:

Symptoms	No. Affected
Irritation of eyes	2
Headache and vertigo	4
Throat irritation	6
Precordial constriction	21
Dyspnoea	21
Cough	9
Gastric pain, nausea, vomiting	16
Ague or fume fever	14
Pneumonia	1
Prostration	16

A survey of the incapacity caused by the accident shows that of the 23 men involved 7 lost no time, 4 were absent for one day, 3 for six days, and 1 for nine days. Of the more seriously affected, one was away for four weeks, another for seven weeks, and the fireman, who had pneumonia, was disabled for two months. One employee made a start but was unable to continue because of indefinite abdominal pains and anorexia; he is now away undergoing further investigations. These have shown that his abdominal symptoms had no organic basis and that there was no sign of cadmium poisoning.

Conclusions and Summary

Twenty-three cases of cadmium poisoning have been described.

The inflammability of finely divided cadmium has been emphasized and the dangers of cadmium fumes have been noted.

Nausea, epigastric pain, precordial constriction, dyspnoea, and prostration are fairly constant symptoms; and ague occurred in 14 cases.

The delayed action of cadmium intoxication is well illustrated.

No fatality occurred in this series.

Where the possibility of such fumes arises the worker must be protected adequately, by either an efficient exhaust system or a suitable respirator.

In the event of a fire in a department where cadmium is used the firemen must wear suitable respirators.

The rule "No smoking" should be strictly enforced where cadmium powder is present.

I wish to thank the factory management for permission to publish this report, also to express my appreciation of the co-operation of Dr. Middleton and Dr. Van der Walt.

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DRY BLOOD TEST FOR TYPHUS FEVER PRELIMINARY REPORT

BY

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In 1942 Steuer utilized a slide agglutination method for the rapid diagnosis of typhus fever. He claimed that 200 slides could be examined in 90 minutes, and that each individual slide could be read in from 5 to 10 minutes. We found his technique unnecessarily cumbersome, and it was therefore modified by us to make it more workable for general use. The essential difference between the two techniques was that, while Steuer used *exactly* measured quantities of blood and antigen suspension, we used *approximate* quantities. The technique we employ is:

Method

Place on a clean glass slide two drops of blood, obtained by pricking the finger or the ear lobe without squeezing, separated from each other by a grease-pencil line. Dry in air and mark the drops 1 and 2. Place a drop of concentrated suspension of OX 2 and OX 19 on blood drops 1 and 2 respectively. Leave for a minute, and then complete the mixing of the blood and the suspension by gently rocking the slide. (Mixing with a platinum loop or other