correspondence of the parts correlated. The existence of this excessive and perverted peristalsis is proved by the facts that pressure mitigates the pain, and that it is stopped by full doses of opium, which inhibits the peristaltic movements of the intestine. Suddenly, following these acute attacks of colic, we may find the patient paralysed. The paralysis may attack any part of the system, but it is most marked in the forearm, producing the dropped hand of lead poisoning, caused by the paralysis of the extensor muscles of the forearm, the supinator longus, singular to say, remaining intact. The muscles retain voltaic and galvanic, but lose faradic, irritability. Why the flexor muscles and the supinators are not attacked by paralysis is the paradox of lead poisoning. Very often paralysis of the Duchenne-Erb type develops, the deltoid and its corresponding group of muscles being attacked. The muscles of the legs often suffer, the lead selecting the extensors by preference. As to whether this paralysis is central or peripheral, I would observe that we know of two degenerations of nerve tissue—the Wallerian, where the centres are involved, and the other, where the axes cylinders are attacked. Erb and Remak state that the degeneration is Wallerian. In my opinion the degeneration is peripheral, and my reason for making this statement is, a few years ago I selected 50 of my worst cases of lead paralysis, and sent them to Dr. Auriol Armitage, of Wolverhampton, for electrical treatment. Dr. Armitage read the results in a paper to the British Medical Association. Remembering what helpless cripples these patients were, the effects of the treatment were marvellous: 75 per cent. of the paralytics were cured, while 47 out of the 50 were much benefited. The duration of treatment varied from three weeks to three months. I do not for a moment think that these beneficial results could have been obtained if the centres had been involved, as in tabes and infantile paralyzes, for example.

The blue line deepens in colour, and in some cases the *plaques tatouées* of Gubler may be seen marked on the buccal mucous membrane. Abortion is prevalent amongst the married women, who work as ware-cleaners, dippers, colour dusters, or litho-transfer makers, ground layers, majolica painters. Lead is frequently used in the Potteries as an abortifacient, the ordinary diachylon being scraped off and used in the form of pills. A patient I attended took twenty-four of these pills at once, with for her very happy results.

M. Paul, who has investigated this subject, says that women who work in lead frequently abort. In 123 pregnancies of lead workers, 73 children were born dead. Of these, 64 were abortions, 4 premature births, and 5 full time. Of the 50 born alive, 20 died in the first year, 8 in the second, 7 in the third, and only 14 reached the age of 10 years. Sir T. Oliver also says that lead workers miscarry in much larger proportions than other women. This has also been my experience. Unfortunately I did not segregate the married from the single women on my list, but I find I have a series of 97 abortions, one woman having had as many as 12.

I have mentioned the destructive action of lead on the blood and its consequent interference with the ovarian, the uterine, and nervous functions of a woman; we can therefore easily understand its abortive powers.

Tremors are often complained of as a later symptom of lead poisoning. The kidneys, after undergoing parenchymatous degeneration, are further attacked; Bowman's capsule becomes thickened and laminated, the capillaries in the glomeruli being distended with blood cells. The cells lying between the coils of capillaries undergo extensive proliferation, and are finally destroyed with an extensive production of connective tissue. A true interstitial nephritis is thus produced and causes atrophy of the kidneys.

At a *post-mortem* examination made with Dr. R. Alcock on a case of chronic lead poisoning it was difficult to find the kidneys; we eventually found two small atrophied organs, one weighing $2\frac{1}{2}$ oz. and the other $2\frac{3}{4}$ oz. In such cases the urine is suppressed and the gravest symptoms of lead poisoning ensue, ending in acute mania, blindness, epileptiform convulsions, and death.

Disturbance of vision is a common symptom of lead poisoning. The ordinary symptoms of anaemia and amenorrhoea being present, headache of a severe type is complained of, and suddenly either a partial loss of vision

(amblyopia) or a complete loss (amaurosis) ensues. I find, amongst the 235 women in my list, 75 had their eyes affected: 18 were totally blind, 24 partially blind, and 33 had disturbed vision. All these cases might be diagnosed as suffering from optic neuritis. I agree with Leber and Deutschmann that lead in the blood acts as an irritant and causes an increase of fluid in the subarachnoid spaces, this fluid increase being conveyed to the vaginal sheaths surrounding the optic nerve. All writers on lead poisoning—Oliver, Swanzy, Leber, Deutschmann, and others—describe an engorgement of the retina, the veins being swollen and enlarged and the arteries contracted, finally ending in atrophy of the disc.

Epileptiform convulsions generally mark a grave stage of lead poisoning; they were well marked in the man the inquest on whom I quoted at the beginning of this paper. Lancinating pains in the head are complained of, and the urine is suppressed. These convulsions may be either uraemic, or cerebral due to an increase of fluid in the brain ventricles. The convulsions are of a mixed character; the patient is very violent, and if not restrained may jump from his bed. After lasting a few hours, or in others a few days, death ensues.

In 1854 Garrod brought forward his theory that lead poisoning is productive of gout; this has since then been given an accredited place in our textbooks. I am not a believer in Garrod's theory. Out of my 405 cases I find only 4 afflicted with gout. One of these had a family history of gout; the other three were excessive beer drinkers. In the Potteries the male lead workers consume large quantities of beer, no doubt on account of its action on the kidneys and bowels; among these men we should find gout, but we do not. I have never seen a case of gout in a female lead worker. I hesitated to bring forward these ideas in contradiction to such an authority as Garrod without further proof, and wrote to Sir Thomas Oliver asking his opinion, and received the following reply:

We do not see gout associated with lead here, except on the rarest occasions; when I have there has generally been a family tendency to gout, but cases of plumbism are probably too acute to favour the development, and it is just possible, too, that the beverage drunk by the lead workers does not encourage gout; and yet in the London hospitals the association of the two is said to be common. Under any circumstances gout is not common here as indicated by attacks of pains in the big toe, etc. We get plenty of degenerated arteries, but from other causes than gout. My experience confirms your own: I cannot recall a case of gout in a female lead worker.

PLUMBISM TREATED BY THE INTERNAL ADMINISTRATION OF CALCIUM PERMANGANATE.

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LAST year I drew attention in the *BRITISH MEDICAL JOURNAL* to the value of calcium permanganate in the treatment of gastritis and enteritis—that is, in inflammatory conditions of certain parts of the alimentary tract.

In the *JOURNAL* of March 12th, 1910, I pointed out the origin of the lead line on the gums as being due to the deposit of lead in the form of the sulphide on a pre-existing red line, which was caused by irritating particles in the atmosphere in which the men worked. This red line is undoubtedly an inflammatory effect, as shown by the enlarged and engorged papillae on the edge of the gum, and it is an inflammatory line that occurs at the anterior or upper end of the alimentary tract.

As I found calcium permanganate to be of value in inflammation of other parts of the alimentary tract, I thought it worth while to test whether it would be of value also with this inflammatory line on the gums, and at the same time with the lead line.

CASE I.

The first patient to whom I administered the drug was a man, W. E., aged 38, whom I saw for the first time on July 20th, 1909. At that time he complained of pains in the arms and legs, and of inability to lift the "rabble" at his work. He had a marked lead line, and the test for potassium sulphocyanide gave a very slight reaction. Paralysis was not present, but there was some tenderness over the lower third of both sciatic nerves.

This tenderness, I may say, I have found present in several patients suffering from plumbism, though I would not like to go so far as to say that this form of sciatica is pathognomonic of plumbic poisoning.

The next time I saw him was on February 14th, 1910, when in addition to the above signs I found both wrists somewhat weak and suggestive of plumbism. With the permission of his medical attendant I prescribed calcium permanganate, $\frac{1}{2}$ grain, three times a day; after fourteen days I found that the lead line had disappeared, as well as the sciatic tenderness, while the wrists were decidedly stronger.

CASE II.

C. F., aged 54, a mason, constantly employed at lead works, especially for repairing the culverts along which the fumes travel, fractured his clavicle, but this by December 13th, 1909, when I saw him for the first time, had healed well. He had a lead line and was very anaemic, but there was no other sign or symptom of plumbism present. I ordered calcium permanganate, $\frac{1}{2}$ grain, mixed with paraffin, and put up in the form of capsules by Messrs. Allen and Hanbury. This method of administration does away with the disagreeable taste of the drug, and it also allows its action to be gradual.

At the end of three weeks the lead line had disappeared and this appearance had distinctly improved, the anaemia having nearly disappeared.

CASE III.

J. P., aged 35, who had been fifteen years at the lead works, was very pale and both wrists were rather suggestive of plumbic weakness. There was a lead line on the gums and also a dark deposit on the mucous membrane of the lower lip.

After three weeks' treatment with the drug (in capsules) the lead line disappeared, and there was a considerable diminution of the dark deposit on the mucous membrane. The pallor, which at first was marked, became gradually less, and eventually he developed quite a healthy appearance, while the wrist weakness also disappeared. He observed that the drug had the effect of causing his bowels to act three times a day, instead of twice. All the deposit disappeared by the end of five weeks.

CASE IV.

F. S., aged 31, whom I saw on June 9th, 1909, had to give up work on account of "wrenched back." There was tenderness over the lower third of the sciatic nerves; he also had a lead line, as well as a line of black tartar. After taking calcium permanganate for fourteen days, the lead line disappeared, leaving the black tartar line, which only required the use of a toothbrush.

CASE V.

J. W., aged 40, was pale, and the wrists suggested plumbism. The saliva gave a very slight reaction in the test for potassium sulphocyanide.

After three weeks' treatment the lead line was very much less, the wrists better, and the potassium sulphocyanide reaction much more satisfactory. The man's alcoholic habits considerably interfered with the treatment in this case.

Several other cases have responded to the treatment in such a satisfactory manner as to emphasize the value of calcium permanganate in the treatment of cases of plumbism.

The drug should in all cases be given in capsular or palatinoid form, as otherwise it has a tendency to nauseate the patient, and terminate the treatment somewhat abruptly.

On reflection the good result is not surprising, for the drug has been found, not only by myself but also by many other medical men, to be of great value in inflammatory states of the alimentary canal, and my original observation that the lead line is superimposed on a red line is, I venture to think, corroborated by the result of this treatment.

In addition I would draw attention to the fact that the alcoholic habits of the men employed at lead works, together with the usually foul state of the mouths and teeth, are more than likely to result in an inflammatory state of the stomach, on to which inflamed area the lead, as in the case of the gums, is more than likely to find its way and settle.

Calcium permanganate being of value in gastritis acts therefore in the nature of a preventive, and if my results are corroborated it is worth while considering whether it will not be advisable in the future to order the periodic administration of this drug to all the men at the works.

THE French Chamber of Deputies has passed a law giving communes, or portions or groups of communes within whose area there may be mineral springs, power to constitute themselves, after permission obtained from the Government, hydromineral or climatic stations. For the maintenance and development of these stations the communes may be empowered to levy special rates during a season or the whole year. On these rates they may be authorized to raise loans for the purposes indicated.

THE CAUSES OF ABSORPTION OF OXYGEN BY THE LUNGS.

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(PRELIMINARY COMMUNICATION)*

It has for long been a subject of controversy among physiologists whether the absorption of oxygen through the walls of the lung alveoli into the blood occurs simply by diffusion or by an active physiological process analogous to glandular secretion.¹ Pflüger, Fredericq, and, quite recently, Krogh,² have brought forward experimental evidence in favour of the diffusion theory, while Bohr, and Haldane and Lorrain Smith have supported the secretory theory, which was originally suggested by Ludwig.

If the partial pressure of oxygen is ever greater in the arterial blood leaving the lungs than in the air of the lung alveoli, it is clear that the simple diffusion theory must fall to the ground; and the experiments hitherto made have been designed to ascertain whether or not the oxygen pressure in the arterial blood is ever greater than in the alveolar air. Bohr, Fredericq, and Krogh have with this object employed improved forms of Pflüger's well-known "aerotonometer," the instrument finally devised by Krogh being very perfect of its kind. Haldane and Lorrain Smith's method depends upon the following facts: When blood is brought into prolonged and intimate contact with a mixture of carbon monoxide and air the haemoglobin of the blood corpuscles combines partly with the oxygen and partly with the carbon monoxide, the final proportions (which can be easily and accurately determined) depending, in accordance with the laws of mass action, on the relative partial pressures of the oxygen and carbon monoxide, and on a constant. Hence, if the final proportions, the constant, and the partial pressure of the carbon monoxide are known, the partial pressure of the oxygen can be accurately deduced. By supplying to an animal air containing a fixed proportion of carbon monoxide, until the final saturation of its haemoglobin with carbon monoxide is reached, the partial pressure of oxygen in its arterial blood can be calculated on the same principle. If the arterial oxygen pressure is greater than that of the alveolar air, the final saturation of the haemoglobin with carbon monoxide will be less than that of blood saturated with the same air outside the body and vice versa. It is, of course, assumed that carbon monoxide diffuses freely through the body, since, apart from its property of combining with the haemoglobin, it is, as was experimentally shown by Haldane, a physiologically indifferent gas, like nitrogen or hydrogen.

Haldane and Lorrain Smith determined the constants required in their calculations, not from experiments at body temperature on blood from the animals experimented on, but on dilute blood solutions or undiluted human blood. This omission, which in the then existing state of knowledge did not seem important, has, we find, seriously affected their estimates of the oxygen pressure in the arterial blood. The constant varies distinctly for the blood of different animals, and even for different individuals of the same species. We have therefore repeated the experiments, using mice, on which most of Haldane and Lorrain Smith's experiments were made, and determining the constant for the blood of each animal experimented on. We find that in general their estimates of oxygen tension were about a third too high. We have also supplied an omission in their experiments by investigating the arterial oxygen pressure in animals breathing a very low percentage of carbon monoxide (less than 0.02 per cent.), so that no physiological disturbance is produced by the gas.

Our results with mice are as follows:

1. When a very low percentage of carbon monoxide is breathed, so that no want of oxygen is produced in the body, the arterial oxygen pressure is slightly below the alveolar oxygen pressure. Apparently, therefore, the absorption of oxygen is by diffusion alone, as indicated by the experiments of Fredericq and Krogh and by most of Bohr's experiments.

* Communicated to the Royal Society, March, 1910.