

skin without the aid of grafting, such as has never fallen to my lot to see in cases treated by methods other than therapeutic immunization.

To sum up the results of my experience of vaccine therapy, I have not in a single instance had any reason to regret the application of the method in question; on the contrary, I am fully convinced that in all cases of localized bacterial infection therapeutic immunization, which, as I have pointed out, includes the determination of the flow of opsonized lymph through the infected tissue, gives better results than any other method.

Lastly, I would point out the simple giving of vaccines does not complete the treatment of every case of localized bacterial infection. The patient's opsonic content may be quite high, and yet, as I have already hinted, unless the richly opsonized lymph can, and does, reach the germ-laden tissues, it is practically useless.

THE CLASSIFICATION OF THE SYMPTOMS OF LEAD POISONING.*

By W. DOWLING PRENDERGAST, M.D., M.O.,
M.A.O., D.P.H.

ARMAND GAUTIER has enumerated seventy occupations in which the workman is subject by his occupation to lead poisoning. We have also to consider the fruits of their industry in the materials for our common and everyday use, all impregnated with a salt of lead. From our earliest age we come in contact with the poison. I have in my hand an ordinary child's toy tea set, which in a child of 4 years under my care produced lead poisoning; the child sucked the paint off it. I had another case of a child of 12 months, who was in the habit of sucking the leather covering of its perambulator; the leather on analysis was found to be impregnated with a salt of lead.

Sir Thomas Oliver, in his Goulstonian Lectures, cites the case of an old gentleman whose symptoms were of a puzzling nature; he consulted a leading London physician, who elicited that he was an inveterate snuff taker; the snuff was found to contain lead; when it was discontinued, the patient soon recovered. He quotes another case in which the symptoms were obscure; he noticed that the patient for her age had very black glossy hair, and found that she was accustomed to dye it with a wash which contained a large amount of lead.

A more remarkable series of cases occurred affecting the French navy in 1878, whilst serving abroad. In the first instance the symptoms were attributed to malaria; so grave was the outbreak that the French Government appointed a commission, which found that the outbreak was due to the large amount of lead used in the paint for the internal decoration of the warships. Since that time only zinc oxide paint is used. The use of tinned foods is prohibited as far as possible, and the distillation of drinking water is no longer conducted by lead pipes. The health of the men has since then improved considerably.

In another case I will cite I saw the patient the day before he died; he was convulsed, and showed to me unmistakable signs of lead poisoning. I will quote his wife's evidence at the inquest:

Dr. A.'s locum tenens called on January 3rd, and told her that her husband was suffering from typhoid. He was treated for typhoid from that day to his death. The witness added that Dr. A. came the following Sunday, and confirmed the diagnosis of typhoid. Afterwards, the sanitary inspector came, and steps were taken to remove him to the Bradwell Sanatorium, but there was no bed there for him. Deceased gradually grew worse, and the following Tuesday he became insensible, and jumped out of bed. He was convulsed from the Tuesday night until his death on Wednesday.

The man's organs were analysed for me by Professor Bedson of Durham, with the following result:

Bottle 1. Containing kidneys and spleen:		
Total weight of contents ...	13 oz.	
Total lead present ...	0.259 grain	
Bottle 2. Containing brain:		
Total weight of contents ...	3 lb.	
Total lead present ...	0.176 grain	

* Read before the North Staffordshire Division of the British Medical Association.

Bottle 3. Containing liver:		
Total weight of contents ...	4 lb. 3½ oz.	
Weight of liver ...	5 lb. 9½ oz.	
Total lead present ...	0.540 grain	

In this case a grave injustice might have been done to the widow, as she received £120 compensation. I quote these cases to show how obscure and difficult it is sometimes to diagnose lead poisoning.

My experience of lead poisoning has been gathered mainly among the potters of this district. Under the Compensation Act any potter suffering from the effects of lead is entitled to compensation, so that from a medico-legal point of view the need of classification is obvious.

In the potting industry the lead used is chiefly the carbonate of lead, and also the silicate—the glaze being composed of the silicate in what is known as the hard material, which is ground at the mill; the soft carbonate is added to this. In the different processes of dipping, ware-cleaning, glazing, in the mixing sheds, litho-transfer making, in the colours used in colour dusting, also in majolica painting, lead is evolved in a fine dust. I have on my clinical notes 405 cases of lead poisoning.

170 males, of the average age 37.4 years.
235 females, of the average age 27.6 years.

Occupation.		No.	Percentage.
Males—			
Glazepacers ...	...	76	44.
Dippers ...	...	74	43.5
Colour ...	...	8	4.5
Not stated ...	...	12	7.0

Females—			
Ware-cleaners ...	...	89	37.8
Colour dusters ...	...	86	24.4
Dippers ...	...	34	9.8
Majolica painters ...	...	23	9.4
Not stated ...	...	33	14.4

Symptoms.		No.	Percentage.
Males (170)—			
Paralysis ...	...	97	57.0
Totally blind ...	...	4	2.3
Partially blind ...	...	6	3.5
Vision disturbed ...	...	17	10.0
Gastric trouble—colic and vomiting ...	...	122	71.6
Epilepsy ...	...	23	13.6
Encephalopathy ...	...	27	15.9
Blue line ...	...	105	61.7
Insanity ...	...	1	0.6
Rheumatoid arthritis ...	...	10	5.8
Gout ...	...	4	2.4

Females (235)—			
Paralysis ...	...	71	30.0
Totally blind ...	...	18	7.7
Partially blind ...	...	24	10.2
Vision disturbed ...	...	33	14.0
Gastric disturbance—colic and vomiting ...	...	161	68.8
Epilepsy ...	...	40	17.0
Encephalopathy ...	...	82	34.9
Blue line ...	...	143	60.8
Miscarriages ...	...	97	41.2
Insanity ...	...	6	2.5
Rheumatoid arthritis ...	...	3	1.3

Age.		No.	Percentage.
Males—			
Average age for 68 cases ...	...	37.4 years	
Age of the youngest ...	...	16	
Age of the oldest ...	...	67	

Females—			
Average age for 80 cases ...	...	27.6 years	
Age of the youngest ...	...	15	
Age of the oldest ...	...	53	

Died.		No.	Percentage.
Males ...			
...	...	16	9.4 per cent.
Females ...			
...	...	15	6.4

Two main systems of classification may be made. In the one regard is had to the action of lead on (1) the brain and nervous system; (2) the sensori-motor apparatus, including the voluntary muscles; and (3) on the involuntary muscles, including the vasomotor system. The other system, that which I propose to adopt in cases of lead poisoning, is classified under two main heads: (1) *Saturnina mitior*, and (2) *Saturnina gravior*.

I. *Saturnina mitior* would include the prodromata and the lesser symptoms, namely:

1. Disorders of digestion, such as dyspepsia and constipation.
2. Cachexia.
3. Slight blue line on gums.
4. Slight colic.
5. Anæmia, especially in women, with accompanying symptoms of a minor character.
6. Pains of an undefined character in trunk and limbs.
7. Loss of appetite, and vomiting.
8. Polyuria.
9. Slight albuminuria.

II. *Saturnina gravior* would comprise:

1. Cachexia and emaciation of a marked character.
2. Acute colic, prolonged.
3. Fœtid breath.
4. Paralysis of arms and limbs.
5. Blue line well marked.
6. Acute pains in the head.
7. Disturbance of vision.
8. Tremors.
9. Suppression of urine.
10. Epileptiform convulsions.

From a clinical point of view, lead poisoning presents two aspects: in one the poison enters daily into the system in small doses, and is eliminated by the main excretories—the liver, the kidneys, and the skin; in the other, the kidneys and the liver are enfeebled from the action of the poison, and lose their eliminating functions, and the poison exerts its baneful powers and produces the major symptoms.

Armand Gautier, in his work *Le cuivre et le plomb*, says that a person may take 100 to 300 mg. without showing any acute symptoms of lead poisoning, but the daily absorption of 8 to 20 mg. of lead will in time result in a serious deterioration of the health. At the Chateau de Claremont 13 out of 34 people were affected with lead poisoning through drinking for a short time water which only contained 1 grain of lead to the gallon.

Again, we have to consider the sex and the idiosyncrasy of the patient. Women are more subject to lead poisoning than men. Their nervous and uterine systems show quickly the effects of the poison; this is shown by the comparative table:

Comparative Percentage.

	Males.	Females.
	Per cent.	Per cent.
Paralysis	57.0	30.0
Totally blind	2.3	7.7
Partially blind	3.5	10.2
Eyes affected	10.0	14.0
Gastro disturbance	77.6	69.8
Epilepsy	17.5	17.0
Encephalopathy	15.0	31.9
Blue line	61.7	60.8
Miscarriages	—	41.2

Saturnina Mitior.

If we take an ordinary case of lead poisoning, we shall be able to see the working out of the classification. An individual in good health continues to absorb daily a certain amount of lead, either by the skin, the respiratory or the digestive organs. His first complaints of a feeling of malaise, accompanied by digestive disturbances and constipation. A peculiar cachexia is then developed, owing to the destructive action of the lead on the red blood corpuscles. A sweet taste in the mouth is described, and we may then find a slight blue line appearing at the junction of the teeth with the gums. This is Burton's blue line. It is the most diagnostic sign of lead poisoning, and is formed by the sulphide of lead, the lead being acted on by the sulphuretted hydrogen of the buccal secretions. Personally I think the line produced mechanically, the trituration of the food in the mouth

forcing the lead salt into the interstices between the teeth and the gums. If there be no teeth there is no blue line; if there be a marked blue line the "plaques latentes" of Gubler, the tattooed marks on the buccal mucous membrane will be observed. I have always found them present with erosion from a decaying molar tooth. The line may not exist in some cases where lead is not absorbed by the mouth; still, if it is not indicative of lead poisoning, it is the finger-post which directs us to the fact that the individual has absorbed lead in some form or the other. There is no other drug or poison which shows this blue line; carbon may show a black line and copper a green one.

Slight colic is one of the first and most frequent symptoms complained of. It was originally called colica Pictonum, a name derived from a district in France, where wine was made and stored in earthenware receptacles, glazed with galena, or alquifoux—a soft glaze, the cadest of all glazes known to the potter. The wine dissolved the lead in the glaze, and people drinking the wine contracted colic or intestinal cramps. This symptom is complained of in *saturnina mitior*, but the great nerve centres are not involved.

One other symptom which marks lead poisoning in its early stages is anæmia. Lead has a very destructive action on the red blood corpuscles. Sir Thomas Oliver says: "I have never found the normal number of red corpuscles in a lead worker." Zinn says that the hæmoglobin is decreased 50 per cent. Oliver puts it at 45 per cent. to 50 per cent. of the normal. In a paper lately published by him, Kenneth Goadby quotes 10 cases of lead poisoning in which the red blood corpuscles varied in each case from 3,758,000 to 1,354,000, the normal being about 5,000,000. He described a granular condition of the red corpuscles, indicating a destructive tendency. There is no doubt that the uneliminated lead, circulating in the blood, has a most deleterious effect, and is deposited here and there in the tissues. In women lead workers we find in *saturnina mitior* very often menorrhagia, the symptoms of a minor character being dyspnoea and palpitation. Pains of an undefined character are also complained of, sometimes in the muscles, but more often in the joints. I have found these pains to be due to the amount of uric acid circulating in the blood, for it has been proved that lead favours the retention of uric acid, so much so that Sir William Roberts has described the condition as one of uratosis.

Polyuria and albuminuria are amongst the earliest symptoms we have to deal with. Lead seems to act as an excitant to the kidney cells, at first in *saturnina mitior*; the albuminuria is of a transient character. The increase in the quantity of urine is marked, the lead being eliminated in the urine, as can be proved by analysis. Bouchard found the urine of a patient in the early stages of lead poisoning to be highly toxic on injection. He again injected the urine when the patient was suffering from the epileptiform convulsions of *saturnina gravior*, and he found that it had lost this toxic property. Oliver describes a parenchymatous nephritis which as the poisoning advances finally changes into an interstitial nephritis. These are the stages of *saturnina mitior* as I would classify them.

Saturnina Gravior.

If the individual still continues to absorb lead in minute quantities the system becomes more enfeebled, and the liver and kidneys cease their eliminatory functions. The cachexia which is characteristic of lead poisoning then develops. The countenance assumes an ashen grey colour, different from that seen in the anæmia of the ordinary or pernicious type. Through faulty nutrition the emaciation is marked.

A further stage is marked by the onset of acute colic, the pain being severe and prolonged. This colic, in my opinion, is due to a perverted peristalsis. In health the peristaltic action of the intestines is of a rhythmic character, and goes on unnoticed. The intestines with their circular and longitudinal fibres have the plexus of Meissner between them to carry on and control this rhythmic action. Writers describe this continuous spasm of the intestines in lead poisoning as in parts nearly of the nature of an intussusception. The sympathetic and splanchnic centres become involved, with consequent excessive action of parts of the intestines, without due

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 axon cylinders are attacked. Erb and Romak 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. Auriel 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 paralysis, for example.

The blue line deepens in colour, and in some cases the plaques *latoues* 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 dustors, 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 2½ oz. and the other 2½ 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 arterics 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. Lancing 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 arterios, 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. B., 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.