Hemolytic Chrome Poisoning

A face then assumed a contortion. It may be accelerated by doors or
mouth a then

Taylor, McRae

Poisoning

W.R. Edin. M.R.C.S.

The M.D. degree.
Chronic Poisoning by Lead.

E. D. Kirby, M.B. Edin. M.R.C.S.

Thesis for the M.D. degree.
Chronic Poisoning
by Lead.

The subject of the action of Lead on the human economy appears to me to offer matter worthy of a thesis, for this reason. That though much has been written and by many authors, I have not been able to find any monograph of recent years dealing with the whole subject. It will therefore be my endeavour, in all humility, being conscious of how little original matter there will be, to compile such an essay.

First let us briefly consider the History. From the very earliest times the use of lead in the arts appears to have been known to civilized man. It was probably first employed by the Egyptians, those pioneers of art and civilization, but it is among the Romans that we first find the fullest mention of its various uses. For weapons and household utensils, for
paint, for powder for the face, and in glazing pottery it was very commonly and extensively used. Nor were the more enlightened of those who practised medicine in those very early times ignorant of the well-defined symptoms of lead colic and paralysis. Hippocrates indeed did not clearly differentiate the effects of lead from those of other metals, but he has these remarks on the symptoms of the "Vir Metallicus": "A man of this business," says he, "has his right hypochondrium tense, a large spleen, and a costive belly: he breathes with difficulty, is of a pale wan complexion, and is apt to have swellings in his left knee." But that injurious effects were caused by drinking water that had been in contact with lead was also early known, and we find Vitruvius the Roman architect providing the use of leaden pipes (fistulae) for conducting it, as cæruse or carbonate of lead was formed, which was injurious to health. Galen also mentions that lead makes water muddy. In the middle ages little further was discovered,
but Galen and Hippocrates were
slavishly followed, until Ramazzini
in the beginning of the eighteenth century
made a new epoch by his great book
De Morbis Artificiorum; after the publication
of which the effects of lead in the arts were
fully observed with increasing knowledge;
and its dangers, when utensils of domestic
use were composed of it, also thoroughly
recognized. The credit of first working
out this subject belongs to Dr. Lambe of
Warwick at the commencement of this century.
Another who should not be forgotten in a
list of authors who wrote on this subject is
Slochhausen, physician to the lead miners
of Goraz, who wrote the first treatise dealing
solely with lead diseases, which he published
in 1656.

Amongst the writers of the present century,
the greatest credit for scientific studies on
the subject must be given to the French physici-
ans Jardieu, Chevalier, and Tanquerel
Displanches; (the work of the last named
indeed is classical, and to it every subsequent
work is largely indebted); and amongst our
own countrymen to Sir Robert Christison and Harrison of Broughton.

By far the most numerous cases of lead poisoning occur among men and women engaged in various trades. The following list contains the principal trades whose followers suffer from it most:

The workers in lead mines and in metallic lead; those also who extract silver from Galena.

The makers of white and red lead.

Colour grinders, painters, and varnish makers.

Plumbers, and Glaziers.

Glazers of Cards and Pottery.

Enamel workers. Those that make enamel plate for advertisements, labels for streets, etc., various silicates of lead being used in the preparation of the enamel. By far the largest number of cases that have come under my personal observation have been of people engaged in this trade.

Printers, compositors, and type founders.

Glass makers; fluid glass contains about 10 per cent of red lead, the "paste" for imitation jewellery a still larger percentage. Cases in
Glass makers however occur principally in France.

Weavers, silk and lace makers, dyers and paperers all occasionally use lead colours.

File cutters. In cutting a file, the latter rests on a leader block and is cut by a chisel impelled by a large hammer.

Floor cloth and waterproof cloth manufacturers.

Lead enters the system in four different ways:—

1) By the stomach. Unquestionably in most cases this is the principal way, the powder containing the poison being mixed with the saliva and carried down into the stomach, or else being introduced in the food or drink.

2) By the lungs. Much lead is thus introduced in the workers where it is used in the form of powder or vapour.

3) By the mucous membranes elsewhere. Cases are on record of poisoning by collyria and vaginal injections.

4) By the skin. As to whether sufficient poison can be introduced by way of the skin there has been much discussion, some
authorities altogether denying its possibility, (notably Desplanches). Unquestionably cases of poisoning due to this cause alone are much rarer than those due to introduction through the stomach and lungs, but still there are cases reported from the use of cosmetics by Orfils and others, and since we know that mercury is capable of being thus absorbed, it seems only reasonable that lead also should be. That such is the case is certain, the opinion of the workmen themselves, and on reasonable grounds. One very intelligent man whom I questioned on the subject told me that the right hand being affected was by paralysis than the left was due to the greater use he believed of that hand in his work as printer, thus showing that he believed the paralysis to be caused by the local action through the skin. He further stated that he himself had not suffered as his skin was always dry, but that his son, whose skin was very soft and perspirable, had. Skin softness or dampness of the skin is a predisposing cause according to Dr. Fleming; and when we consider that the sweat contains con-
Sizable quantities of chlorides of sodium and for acids, including acetic, it would seem that lead could be easily introduced as chloride and acetate by this means. The drinking of water contaminated by lead is by no means an uncommon cause of poisoning, though naturally it often escapes detection. This cause is now however less common than it used to be, owing to the greater sanitary knowledge and the prohibition of lead for the making of cisterns and water pipes.

The comparative dangers of different water we find vary greatly. Briefly, "hard waters" are safe, and "soft waters" dangerous. The hard waters are from springs and contain the earthy sulphates and carbonates, and coming into contact with the lead, sulphate and carbonate of lead are formed, which are very insoluble salts. These form a coating on the surface of the cistern or pipe, so that after a little time the lead is rendered comparatively innocuous. On the other hand the soft waters derived from rains and rivers contain comparatively little mineral matter.
but a considerable quantity of organic, which of course contains nitrogen. Thus the soluble and dangerous salt of lead are formed, viz. the nitrates, nitrites, and chlorides.

As in other cases of poisoning we find that recently-made cisterns or pipes, that have the metal bright, are the more dangerous. We find also as we should expect that water which has been for some time in contact with lead is more dangerous than that which has only recently been drawn through. Water that has been standing all night in a lead pump will exhibit traces of contamination, when water that has been drawn after the pump has been recently used will be perfectly innocent.

The following experiments were made by Gautier and Urlichs in 1844 on water taken from the River Seine, received into a new leaden vessel, and afterwards filtered.

(1) Water kept for 12 days in vessel
   (a) lead in the water per litre — 0.109
   (b) " remaining on the filtering medium — — — — — — 0.179
   Total lead per litre — 0.288
(1) Water kept 15 hours as before
(a) lead in the water free like a trace
(b) lead remaining on thefiltering medium 0.048
Total lead in water 0.048

When we say that the lead waters are safe, it should
be understood that they are only comparatively,
so, for no lead salts are absolutely insoluble; and
the long continued use of water, however lead, that
has been in contact with lead, is known to have
given rise to poisoning. Though only traces of
the metal are contained in the water, such a little
of the poison is at a time taken into the system,
that even these "traces" may cause the characteristic
effects.

Besides by inbibition of impure drinking water,
and working in lead, there are many other
modes in which this subtle poison may enter
the system. There may be found chronicled
in every volume and almost every number
of our medical journals. It will suffice to
enumerate some only. Firstly then, lead has
been used to adulterate wine and other drinks,
though happily in modern times the dangers
of this practice are too well known. A synonym
for lead colic is Colica Pictorum, the colic of the
Pictures or inhabitants of Poitou, caused by their habit of sweetening and preserving wine by putting bichlor into it during fermentation. The acetate of lead was also used in this way; "a coward is worse than a cup of sack with bone in it," says Falstaff, showing that the practice was not unknown in this country also in old times. Better known, however, was the Devonshire Colic from cider polluted in the same way. Several cases have recently been recorded of poisoning by home-made wines, but in these cases the lead was not introduced deliberately. By fermentation, in cheaply glazed earthenware glasses, the lead contained in the glaze was taken up by the wine, and to the old colic of Poitou has cropped up again. Artificial waters, moreover, are not without their danger, as several cases are on record of poisoning from the use of syrups which contain lead in their laps.

Poisoning has frequently been recorded in cases of articles wrapped up in lead-foil, notably snuff and cheese. Still more curious are other cases, as the epidemic in Paris caused by a baker using old painted wood to heat
his oven; or as that of the grocer's family, mentioned by Harrison, who were poisoned while their customers trespsted, by eating sugar from a barrel which had previously contained white lead, they confining themselves to sugar from the edges of the cask, while their customers were served with that from the middle of the barrel. Children are frequently poisoned by sucking toys in which lead paint has been used, and by the painted teats of feeding bottles, and a remarkable case of infantile poisoning is recorded in Germany as having occurred through the action of the sun's rays on the waterproof covering of a pramambulator! Poisoning by lead given medicinally is very rare, and large quantities of the drug have frequently been ingested without any evil effects having been noticed. I may mention that a case of suspicion of colic once occurred in a patient of mine who was phthisical and subject to chronic diarrhoea. She had previously taken for about six weeks 2 four grain pills of lead and opium (B.P.) per day, so that she had taken about 250 grains of the acetate of lead spread over 6 weeks, before
any symptom occurred. Of course this cannot hardly be taken as a test case as the anaesthetic effect of the opium would at any rate mask, and perhaps even postpone the appearance of the colic.

One other undoubted cause of Plumbism should be mentioned, viz. inhabiting a newly painted room, which has several times been noticed to cause an attack of poisoning, or of gout, a closely related disease.

While we are considering the Etiology of lead poisoning, it is right we should note certain conditions which seem to act as predisposing causes.

(1) Idiosyncrasy.
(2) A previous attack.
(3) Gout, or a gouty diathesis.
(4) Season of the year. Jaquezuel Deplanchon has noticed that cases are much more numerous during the summer.
(5) Sex. Jaquezuel has put on record his opinion that the female sex is much more prone to the complaint. Certainly when we consider how soon and how invariably that delicate index of female
health, the menstrual function, is affected, we are inclined to agree with him. Most other authors consider that the male sex is more liable, probably because men are more commonly employed in leadworks than women, and also because the latter are naturally of more cleanly habits, and more systematic in observing preventive measures, and less addicted to alcohol.

(6) Want of cleanliness.

(7) Mal-nutrition.

(8) Alcohol (in excess.)

The quantity of lead taken into the system before symptoms of poisoning are exhibited varies very much in different individuals, the length of time during which the poison is taken being a much more important factor, inasmuch as but an infinitesimally small amount is taken into the blood at one time. As little as .0015 per cent of lead in drinking water has been known to produce plumbeism after the lapse of a few months, and .05 g. per gallon is considered highly dangerous; while on the other hand considerable doses, as in the case previously mentioned, have been taken for
months without producing any symptoms. The amount of lead found in the system after death also varies much. According to Humble, most is found in the bones, about 0.025 per cent, next in quantity from about 0.01 to 0.02 per cent. The kidneys show the poison, while but very little is found in the muscles and intestines, showing that it is very improbable that it is from local action that the characteristic symptoms of lead poisoning ensue.

There is a great difference in different cases in the order and manner of appearance of the worst characteristic symptoms of poisoning. We should expect this as a natural sequence from what has already been stated as to predisposing causes. Some patients are physically stronger than others, some more cleanly, or less addicted to alcohol, or less exposed to the poison.

The characteristic symptoms of chronic lead poisoning are four, occurring as to frequency in the following order, viz. colic, anasarca, paralysis, and encephalopathy. As in their order of frequency, so is their date of appearance in most cases, the last two being found in more
advanced cases than the other two. Sangmeel gives the following statistics as to their relative frequency:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colic</td>
<td>1217</td>
</tr>
<tr>
<td>Articulargia</td>
<td>755</td>
</tr>
<tr>
<td>Paralytic</td>
<td>107</td>
</tr>
<tr>
<td>Echophalopathy</td>
<td>72</td>
</tr>
</tbody>
</table>

As a rule then, colic appears first, but if the disease is allowed to progress these symptoms can interchange in the most manner, one of them only, as a rule, being severe at one time, though mixed cases are not rare. It may here be mentioned also that, though the patient has for some time been absolutely free from contact with the poison, there may come a recurrence of the attack just in the same way as in gout. A patient having once had an attack, however thorough, may be his care and precautions, can never feel certain that another bout is not awaiting him. A patient of mine who has been a painter in a coach-building firm suffers every now and then from obstinate dyspepsia, sluggish state of the bowels, yellowish tint of the face and conjunctiva, with depression of spirits and overcern; and the fact of these symptoms
General

cause of the

Maladies.

The patient, who is suffering from poisoning

by potash or sodium, exhibits signs of generally

irritation and weakness. The skin, however, is

characteristic of the disease, being reddened and

puffy, and the urine

characteristic of the disease.

This disease is commonly called "potash poisoning".

In the usual case, the patient is a

woman, so called from Saturn, the planet of the

spheres, the effect of which is usually, and the

symptoms produced which are not specially

characteristic of the disease.

Many years ago,

when studying the

characteristics of the

disease, we believe that the

extract of

potassium would be

effective in curing the

disease.

But this was not

the case, and the

patience continued.

In every case, the

patient is a

woman, and the

symptoms are

characteristic of the

disease.
marked at the edges of the gums. This is due to the deposit around the teeth of black sulphide of lead. It is as a rule more easily seen on the upper jaw and in people who do not properly attend to the cleanliness of the mouth but allow particles of food to remain in the interstices of the teeth and undergo decomposition, when sulphuretted hydrogen is formed. This line must not be confused with the livid colour of the gums so generally seen in patients who allow tartar to collect and deposits to form without taking any pains to remove them, nor with the red line that is so frequently seen and is supposed to indicate phthisis. The true line is much more distinct and sharply limited than these, and is of a definitely bluish tint, except when the cases are of so old a standing that it becomes what may be termed black. Of itself this symptom does not actually indicate poisoning as it is present in all workers in lead; nor indeed is it necessary that lead should have caused it: the other black sulphides may do so equally, though more rarely. I have seen it caused I believe by a long course of bismuth, taken internally, for dyspepsia, and certainly
among those who work in silver and copper a similar line is present. The line is of course only found in persons with teeth; infants and old people without natural teeth do not exhibit it.

Dr. Hilton Fagge has found by microscopical observation that the discoloration is distributed in loops corresponding with the vascular papillae of the mucous membrane. The pigment is deposited in granules, some in the interior of the smallest blood vessels, others immediately outside them. Hence he concludes that the sulphuretted hydrogen must diffuse itself into the gums and there unite with the lead as it is actually circulating in the blood. He regards the pigment therefore as a precipitate, which must mechanically obstruct the nutrition of the teeth and help to cause their premature decay.

The teeth themselves are usually carious and discolored by tartar, the gums are receding, and the patient very subject to facial neuralgias from the dental disease. A loss of sensibility of the tongue is recorded, also perversion of taste from the habit of keeping painted bits of wood in the mouth.
A sweet mawkish taste is frequently complained of, and, probably, from the condition of the mouth, the breath is fetid.

The appetite is impaired, and the patient generally suffers from dyspepsia, which is often extremely obstinate. Constipation is nearly always present and the feces may be dark coloured from the presence of the sulphide. (The colic will be afterwards treated of.) The abdomen is usually retracted, and there is often nausea or even vomiting.

Anaemia is usually present. The blood examined with Gower's haemacytometer shows a marked diminution of the red corpuscles, from 5 to 4 millions in each cubic millimetre. The uric acid in the blood is increased. According to Dr. Wilson most lead is found after death in the spleen, but this observation however is not confirmed by Heubel.

The only noticeable fact in connection with this is the slowing of the pulse rate, even to 40 per minute, especially in the attacks of colic. There is a tendency to a low form of pericarditis.

Patients are liable to phthisis, pneumonia and pleurisy.
Acute of an obstinate character has been noted to occur in connection with plumbism; we should also expect to find the various skin affections to which the gouty are liable.

In the male nothing peculiar is found, but it is certain that the spermatozoa are somehow affected, as the following statistics taken from Jardieu very clearly show. Of 141 pregnant women whose husbands worked in lead, 82 aborted, 4 had premature births, and 5 of the remaining children were still born. Of the 50 living children 20 died before they were a year old, and 15 more before they completed their third year.

In the female, on inquiry we find results still more astonishing. Of 43 pregnancies there were 37 premature births and abortions, 3 stillborn and 2 very delicate living children. According to Mr. Paul, of 123 pregnancies 73 children were born dead (64 of these being abortions), and 4 premature births. Of the 50 born alive, 20 died in their first year, 8 in the second, and 7 in the third, while only 14 or about 11 per cent reached the age of ten. It will be only right to compare with these
figures others showing the ratio of abortions to normal pregnancies throughout all classes collectively. Whitehead in his treatise on "Abortion and Sterility" gives tables from the Manchester Lying-in Hospital. He found that 2000 pregnant women had had 8681 pregnancies, of which about 1 in 7 had terminated in abortion. Of course some of them might have been victims of lead poisoning. But these statistics agree generally with those of other observers: Hysag for instance reckons there is one abortion to every 8 or 10 full-term labours. Dr. Priestly (in the British Medical Journal of March 28th, 1887) found a rather higher proportion of abortions, but his figures are taken from the wealthier classes, and all his patients were over 40 years of age. Out of 2325 pregnancies there were 542 abortions, or about 1 in 4½.

But it is not in married women only, that the reproductive organs suffer. The first symptom I have found in young girls is amenorrhoea with great pain when the menstrual flow comes on, and in some cases menorrhagia though this is not so common as the opposite condition. There is often certainly ovaritis.
Strangury is sometimes found especially during the attacks of colic. There is sometimes a colic-\footnote{Note: The text seems to be cut off here and may not be complete.}eral state of the bladder, and a sensation of pain is often referred to the urethra. Lead workers are also (as the gouty) very liable to suffer from chronic Bright's disease. Whether there is actual disease or not, during work amongst lead the amount of urine is increased, and is of low specific gravity, being deficient in urea. This form of kidney disease is however too endemic among lead workers as almost to be entitled to be considered a characteristic form or symptom of the poisoning. According to Oliver of 15 cases of lead poisoning 7 had temporary albuminuria, and 4 chronic Bright's disease. Dr. Dickinson also records 26 deaths from it out of 47 cases of lead poisoning, and Dr. Porter out of 30 cases noted albuminuria in 13, and 2 died of Bright's disease. As mentioned above the urea and uric acid are not excreted to the normal amount in lead workers. The blood therefore contains an excess of these substances. A like pathological state obtains in gout. No less than 30 per cent of Garrod's hospital patients who suffered from gout had been engaged in
lead trades. The same observer noted that the quality were very susceptible to the action of lead, even small medicinal doses sometimes producing colic.

On post mortem examination of cases of lead poisoning the kidneys are usually found smaller than the normal size, the cortex is adherent, the stroma increased, and there is tubular as well as intertubular nephritis. In connection with this it is astonishing to find that lead has been given therapeutically in Bright's disease with the idea of preventing the escape of albumen from the blood. George Lewald made some experiments with a view of testing this point. According to him lead constantly diminished the albumen, though only to a small extent, i.e. about 10 grains in the 24 hours. This seems to be homoeopathy with a vengeance! The quantity of water was simultaneously increased by 200 c.c. in the 24 hours. These two results seemed to hold no relation to the quantity of lead employed.

Besides the arthralgia, which will be afterward referred to, and which is doubtfully of nervous origin, and the eclampsia and palsy,
find that lead very strongly affects the nervous system. Neuralgias of various parts of the body are very common, particularly of branches of the fifth and of the intercostal nerves. Sometimes local anaesthæsia are noticed. There is sometimes a transient deafness, and there is a more or less constantly recurring head ache. The patient is apathetic and morose, very often suffering from sleeplessness and terrible dreams. If these symptoms do not abate or are not relieved encephalopathy ensues. Lead amaurosis will be subsequently described under encephalopathy.

It will be serviceable to present briefly a table of the various lead trades showing the relative frequency with which various diseases occur in them.

This has been taken from Buck's "Treatise on Hygiene and Public Health".

By way of comparison the tanners have been put into it, as they is known to be a fairly healthy trade, though indeed cases of lead poisoning are not unknown amongst them, as lead is used in the preparation of patent leather.
<table>
<thead>
<tr>
<th>Trade</th>
<th>Percentage of workers suffering from Phthisis</th>
<th>Percentage of workers suffering from poison of occupation</th>
<th>Average duration of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead miners</td>
<td>12.0</td>
<td>87.15</td>
<td>41</td>
</tr>
<tr>
<td>Lead smelters</td>
<td>18.0</td>
<td>62.0</td>
<td>41</td>
</tr>
<tr>
<td>Silver smelters</td>
<td>30.0</td>
<td>58.0</td>
<td>42.5</td>
</tr>
<tr>
<td>Sugar of lead workers</td>
<td>15.0</td>
<td>71.0</td>
<td>45.5</td>
</tr>
<tr>
<td>White lead workers</td>
<td>6.5</td>
<td>68.0</td>
<td></td>
</tr>
<tr>
<td>Tin foundries</td>
<td></td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td>Yankees</td>
<td>9.2</td>
<td></td>
<td>61.2</td>
</tr>
</tbody>
</table>

Of the special symptoms that are peculiarly found in saturnine poisoning, the first to appear is what is known as lead colic among a host of other names. This is a violent abdominal pain of a persistent character which appears after the lead has entered the system for some little time, and after giving notice of its approach by more or less acute fleeting pains and by constipation. Other prodromata are nausea and vomiting, hicouche, borborygium, loss of appetite and depression of spirits. As a rule we find the
patient in bed, his face expression quite anguish, his body doubled up, his abdomen pressed upon by his arms or sometimes by a pillow, and occasionally giving very to cries of pain. No food can be retained, and the ordinary domestic remedies, tonics, and saltbags, give no relief. During the attack the pain is never altogether absent, but it has remissions and exacerbations. The abdomen is generally hard and the muscular muscles contracted, especially the recti. Pressure usually gives relief, but pressure appears to be badly borne. Sometimes the abdomen is distended and tympanitic, and in these cases I have noticed that even the weight of the bed clothes may be troublesome. Nausea and vomiting are usual, prominent symptoms, and constipation is almost always present though diarrhea has been noticed. There is often straining and occasionally retention. Tachyphleps indeed states that on passing a catheter he could feel the sphincter vesica contracting spasmodically; there certainly is an energetic contraction of the rectum and anus. The locality of the pain varies, a good deal sometimes, about the umbilicus, sometimes above, sometimes below, and occasionally about the
kidney. As a rule it is a sharp lancinating pain which shoots through the abdomen, often down the ureters to the genital organs. The pulse is singularly slow and hard. Palæy records even as slow a pulse as 30 per minute. There is no pyrexia, but respiration is increased in frequency. The intellect is always clear except in very severe cases, when there may be manifestations of delirium. As a rule the pain is worse towards night. Its duration is usually not longer than a week, but relapses are very frequent. When recovery takes place the change is often very rapid, the colic suddenly ceases, and so does the vomiting, the retention of the abdomen, and the constipation.

**Prognosis**
The prognosis is very favourable, unless there is any palsy ensuing, the mortality being only 2 per cent.

**Post-mortem appearances**
Post-mortem examinations reveal nothing except an extensive contraction of the intestinal canal. As to the relative frequency of colic, Sanquerelle found it to be present in 12 out of 14 cases of the very large number (over 1400) which he examined. Dr. Oliver of Newcastle noted it in 11 out of 18, and Dr. Porter of Sheffield in
27 out of 30. For my own part I have noted it in 17 out of 20.

This according to Jauquerelle is the second in frequency of the forms in which chronic lead poisoning manifests itself. After prodromata similar to those of colic, or sometimes after colic, or even occasionally without any warning, there appear severe burning and boring pains in the regions of joints or in the neighbouring muscles. These pains have remissions and exacerbations. The exacerbations are accompanied with cramps but there is no local inflammation or elevation of temperature. The joints are usually flexed, the flexor muscles being especially attacked. According to Jauquerelle was a notable symptom in rather more than 50 per cent of his patients. Pain is often observed over the lower part of the spine also, whence indeed Astour gave the name of Radic-alsgia (pains the spine, lyses pain) to lead-poisoning generally. But it may certainly be doubted whether this pain might not be due to the state of the uterus or kidneys, both of which organs we know suffer much from the poisoning.

In my own experience arthralgia is not so
common as Jauquemelle found, and other observers have stated so also. I have seen it characteristically exhibited only in 4 cases out of 20. I have however sometimes seen the cramps without the arthralgia. Dr. Olivi states that he has not observed it, and Dr. Porter says the same. It is possible however that these discrepancies in statistics may be accounted for by the fact that different races were under observation in different degrees of latitude and under different conditions as to habits of life &c., exactly as we know that gout is very rare indeed in the north while about London and in the midlands it is comparatively common. I have certainly met with gout caused by lead poisoning in two well marked cases, though both patients had also indulged freely in malt liquors. Still these are almost the only cases of true gout I have seen among the poor. Dr. Olivi tells us that lead poisoning as a cause of gout is unknown in Newcastle, though he has met with these symptoms. Professor Spranger Steward also in his lectures does not mention the arthralgia by name, but states that there is "a tendency to
chronic rheumatic affections of the joints and muscles, implying apparently that the arthralgia is not such a definite and characteristic symptom in this experience as the records of Taucurelle asserted. It may be added in connection with this that though as a rule there is no swelling of the joints in arthralgia, yet Dr. Ferrier especially mentions tendinous swellings at the back of the wrist as occurring frequently in the subjects of pleurism. The arthralgic pains next to the arthralgia before mentioned occur most frequently in the knees, accompanied by cramps in the calf, the muscles standing up in knots; then in the flexors of the thigh upon the abdomen; next in frequency, are the joints of the upper extremity. They have even been known in the neck and thorax, when the symptoms are said to simulate angina pectoris. Several of my patients have told me that, when they have suffered from colic, at the termination of the attack the pain has shifted to the knee, and they recognize this as a symptom of recovery. Relief is usually, as in the colic, afforded by pressure.
Lead paralysis, speaking broadly, is the third in order of frequency and the third in order of appearance of the characteristic symptoms of saturnine poisoning. As to its order however it varies as the others do, and sometimes even it is the first symptom. The typical paralysis consists of the well known "dropped wrist." As a rule it occurs slowly and after the poison has been for some time at work, and is generally preceded by prodromata, as neuralgia, hypesthesia or anesthesia, or a feeling of "doll-
ness." Gauguerelle found that out of 107 cases 3 occurred in the first month, 5 in the second, 34 in the first two years, and many after that, 48 indeed not occurring till after ten years, and many of these at twenty years or even after longer intervals. He found also that only about 1 in 14 contracted it, though observers in this country have chronicled a much larger percentage, viz. Ramskell 11 out of 25, Porter 18 out of 30, and Olivier 8 out of 18. My own experience has been 7 out of 20.

The wrist drop is caused by a local paralysis of the extensor muscles of the wrist and hand, and confined to those supplied by the posterior
ulnaioreus nerve. The order of the implication of the muscles is pretty constant, the extensor communis digitorum with its related muscles the extensor indicis and medianus digiti being first affected, then the long extensor muscles of the thumb and the extensor carpi radialis brevis. The extensor carpi radialis longus is I think usually the last of the group to be affected. This and the supinator longus, which in the great majority of cases escapes, are not supplied by the posterior interosseous but by branches directly from the musculo-spiral nerve. I have seen the supinator paralyzed in two cases.

The wrist drops in usually at first not marked; there is only a sparing of the muscles, which gradually extends into paralysis till we have the characteristic features well marked and unmistakable. It is generally bilateral, though often rest to the same extent on both sides, and often in different muscles. When only unilateral or when the paralysis affects one side more than the other, that side seems to suffer most which is most used in the work, as in the case of the print-setters before mentioned. Dr. Porter states that among file-cutters it is usual to find the ex-
Sensory of the right wrist and the muscles of the base of the left thumb suffer most. In workers at this trade the right hand is used to wield a heavy hammer, and between the left thumb and finger the chisel is held in a constrained position. Simultaneously, or not with the paralysis of the wrist, paralysis of the group of muscles forming the thenar eminence is often to be noted but generally as a later symptom, and thus may be partly accounted for by atrophy from want of use. As their nervous supply is both through the ulnar and median, the cause cannot be the paralysis of any one nerve. This wasting much resembles that of progressive muscular atrophy, which disease is indeed an occasional sequence of saturnine poisoning. In all cases the muscles appear to be attacked in groups, which are more closely related in function than in nerve supply.

Other sets of muscles are occasionally attacked as the biceps and deltoid, and in the lower extremity the extensors of the foot and the peronei. But paralysis of the leg muscles is rare. Those of the trunk however may not altogether escape, notably the intercostals and other voluntary muscles of respi-
alive, from paralysis of which Sauqueville records two deaths. Occasionally, though rarely, the paralysis has been so general as to amount to hemiplegia, though this form seems to be associated with a distinct disease of the central nervous system, and thus differs from the ordinary form of lead paralysis. The same remark applies to cases of general paralysis which will be discussed later on.

It is interesting in this connection to observe that in many paralyses of other parts of the body, than the wrist is rare—while this is not the case with the lower animals. Horses which work in lead mills often have paralysis of the vocal cords, which renders intubation necessary. The atrophy of the muscles in cases of lead paralysis is very great, and all the more noticeable from the abrupt demarcation of the affected from the unaffected muscles, so that there appears a deep furrow on the outside of the forearm. The reactions of the paralyzed muscles to electricity are those typical of peripheral nerve paralysis. Thus is speedy diminution, even to disappearance, of reaction to the faradic current; unchanged reaction to the galvanic like much later; and
an occasional appearance of greatly increased excitability to mechanical irritation, all of these showing the peripheral nature of the lesion. The onset as mentioned before is usually gradual, but a sudden seizure is, I am inclined to believe, just so rare as the books would lead us to think. I have seen two cases where, according to the patient, the symptoms came on within two hours; and patients have spoken to me of having seen the hands of their fellow workers while at work. The progress of the disease varies much; sometimes the attack is slight and disappears spontaneously; at other times it may obstinately resist treatment. From a serious attack convalescence is naturally slow, as the atrophied muscles have to be replaced by new tissue. Relapses are common.

Muscular tremors are not infrequently to be noted in the affected muscles. But more common, they occur in parts unaffected by paralysis, especially in the face. As in the case of tremors from other causes, as paralysis agitans, or chronic alcoholism, or in the chronic form of poisoning by the allied metal mercury, they are increased by coldness.

Under this term are comprised certain conditions in which the encephalitis is affected through the
influence of lead. They are the most serious in prognosis, as they are the last to appear in point of time of all the various manifestations of the poison. Sauquereille has classified the various forms into the delirious, the comatose, the convulsive, and the mixed. As a matter of fact however these varieties are always more or less mixed, though in some coma, in others delirium, and again in others convulsion, or eclampsia predominates. It is often difficult to diagnose the encephalopathy produced directly from lead from urinary symptoms caused by the nephritis which we know is almost endemic amongst those exposed to the influence of the metal. A diagnostic help is of course the presence of albumen in the urine, though we must bear in mind that its absence by no means negates the possibility of nephritis and it also seems that it may be even present without kidney mischief. Dr. Saunders of Birmingham states that he finds albumen to be present in 91 percent of cases of chronic Bright's disease.

Of encephalopathy Sauquereille states 72 cases, in one developing in 8 days, in ten in
1 month, and in 6 to 8 months. In animals, encephalopathy is frequent. Of its onset we usually find prostration, especially headache and amnesia. Following these come sensory disturbances and general or partial convulsions. The convulsions indeed are as a general rule the most prominent features of the attack, alternating with coma or delirium, and gradually increasing in duration and intensity till the convulsive attacks become very violent, when they follow each other in rapid succession and the patient succumbs. This is the most usual course, but sometimes recovery takes place, usually after several days. In very violent cases the attack may only last a few hours before the patient dies. Sometimes the delirium is the most prominent symptom, resembling very much and liable to be mistaken for delirium tremens, especially if the patient has an alcoholic history. Many eminent neurologists consider that lead poisoning gives rise to a variety of General Paralysis of the insane, and have classified it accordingly. The patient passes into a state of stupor, becomes paralyzed, dyshy in his habits, loses his memory, and is incoherent.
in his speech. The delirium is in some cases tranquil, in others furious, but the expression of the face is very changeable, and there is a peculiar alternation of wanderings and rational ideas. In this form convulsions are more protracted than in that in which epilepsy or eclampsia pre-dominates.

The prognosis is very unfavourable, and though Lacassagne had only 16 fatal cases out of 472, other authors have recorded a much higher rate of mortality, usually over 50 per cent.

The attacks are liable to recur on a very slight re-exposure to the influence of lead. In recovery, the patient usually retains a degree of mental weakness, sometimes indeed being permanently insane.

The results of post mortem examination have hitherto been entirely negative.

Dr. Oliver of Newcastle has recorded his opinion, see page 36, that encephalopathy is by no means to be a symptom as other authors have it, occurring he says not infrequently in young girls after a few months exposure.

Attention or Anesthesia.

This symptom may be mentioned here, as it is really one of the forms in which encephalopathy...
occurs, and is often a premonition to the epileptic
convulsions. We find it has two forms which it is
important to distinguish, as one is of much more
serious import than the other. The first form we
may call transient or functional. It comes and
disappears equally suddenly, and is probably due
to retinal anaesthesia. Ophthalmoscopic examin-
ation reveals nothing.

The second form is associated with organic change,
and it is hard to tell how much is due to the
albuminuria that usually accompanies it and
how much to the direct action of the lead. It is gen-
erally a late symptom. On ophthalmoscopic
examination we find the changes concentrated
about the disc. There is a condition of in-
flammation; the disc is swollen, its edge obscure,
and there is a marked shrinking of the retinal
arteries while the veins are increased in size.

This goes on to atrophy and the blindness is com-
plete. The disease is nearly always symmetrical,
though as in the paralysis it may be more ad-
vanced on one side than the other. Sometimes,
the atrophy is primary.

The prognosis in any case is very grave as re-
gards sight, though sometimes, the inflammation
may cease and the patient recover a certain amount of vision. When however there is atrophy there is but little hope, but if the disc is only oedematous of course the fluid may be absorbed, and the nerve terminations be little the worse for their temporary compression.

The diagnosis of lead poisoning merits a few words. On first thought it would appear from the definiteness and variety of the symptoms to be extremely easy, but there are so many cases on record in which mistakes have been made that it is evidently not always so. We may exclude at once all those cases in which the poisoning has been brought about by the patient's occupation, and in which that occupation is known to be lead working. Mistakes are only likely to happen when the poison has been subtly introduced through the medium of food or water. Neuralgias and dyspepsias caused by lead often have their cause unrecognized, and are in consequence very intractable. Again the derangement of the reproductive system in females when due to this cause are often attributed to other causes. I have in my mind a case of a woman who before marriage had worked in
a glass factory, and who came as an out-patient to a London hospital suffering from severe headache, neuralgia and endometritis. There was a history of two miscarriages. It is the custom at this hospital to diagnose every case, not evidently attributable to other causes, as due to syphilis, especially if there be a history of a miscarriage; and that was the diagnosis here. The patient was put on the iodide of potassium and after a time was much benefited, and this test was triumphantly pointed out at the clinic as confirmatory of the diagnosis. As a private practitioner afterwards attended the woman's family, saw two children who were delicate but without any specific fault, and could find no evidence whatever of syphilis; while I elicited the fact that she once had suffered from a severe attack of colic pain during the time she had worked in the glass factory, and this would account for her uterine troubles. The diagnosis in such cases as this is of course important, as affecting the patient's moral character. Touching on this question, the amenorrhoea has often given rise to unfounded suspicions of pregnancy in single women.
The colic may be confused with colic from other sources, as hepatic, or renal, or ordinary colic, or rheumatism in the muscles, or even petitionitis. In 1874 Bergeron and Thode made autopsies on two persons who were supposed to have died of typhoid fever, and found that the cause of death was salomonic poisoning. Probably in these cases the colic had been attended by diarrhea.

The arthralgia has been frequently mistaken for subacute rheumatism.

The paralysis has to be distinguished from: (1) progressive muscular atrophy, (2) lesions of the peripheral nerves, and (3) the atrophy that is sometimes present in affection akin to writer's cramp and other professional hyperkineses. I have seen a girl, a slapper in a brass foundry, with a flexed hand that much resembled lead paralysis.

From the first it is distinguished by its more rapid onset and by the parents being in excess of the atrophy. From the second and third conditions by the history.

Finally, the encephalopathy has been confused with urticaria poisoning and with hysteria.
With regard to treatment prophylaxis is the most important consideration. It is the duty of everyone, but especially of the physician, to discourage the employment of lead for articles of domestic use, such as in the glazing of panes, and for pipes for carrying water that is liable to be used for drinking purposes. Among those employed at work where lead is of necessity used, much more I believe may be done than is at present, by inculcating perfect cleanliness of the person, allowing no meals to be taken in the workshop or with unwashed hands, and by inserting in frequent baths, which are better if sulphur is used in them, as the black sulphide which is formed calls the attention to the fact of the presence of the metal. The workshops should be well ventilated and fans used if necessary. Special clothes should be kept for working in, and if possible flannel respirators should be worn. But of all measures probable, the best is frequent changing of the nature of the work allotted to the workman, so that no one individual is for long exposed to the most dangerous work. At the first symptom of poisoning occurring the employee should be put on the sick list, and not
be permitted to resume work without a medical certificate. And finally it would be well if, where there were a large number of females employed, there were appointed a woman overseer who might inquire into the health of those whom she superintended. If, as at one factory that is known to me, all these measures were employed, I believe very little poisoning except an occasional colic would be found to happen. Among the employees themselves milk is highly esteemed as a prophylactic; a tradition as to its beneficial action having been handed down from time immemorial, but unfortunately, it seems to have but little influence for good. Sulphuric acid lemonade has also been used probably with considerable benefit, though of course it has many objections, as its astringent action on the intestines and its destructive effect on the teeth. The rationale of its use is that it may form the comparatively insoluble sulphate of lead.

The more strictly medical treatment should always include the iodide of potassium. This drug forms the iodide of lead, a very soluble salt, and also probably acts otherwise than chemically; at any
rate it is the most efficient elixirant. Warm baths should also be employed as they increase tissue metabolism. In addition, for the colic, the best treatment is purgation. Among the older writers, the most favoured drug was castor oil, but this I think can be but rarely needed, and is certainly not fashionable at the present time. Sulphate of magnesia is generally sufficient, and is commendable also on chemical grounds. If insufficient an enema should also be administered. The colic being probably caused by a spasm of the intestines, opium will be found valuable, and as under it the spasm relaxes, it does not seem to add to the constipation.

For the arthralgia, besides the iodide of potassium and the warm baths, galvanization locally of the sympathetic has been recommended. In lead paralysia, besides the general means before mentioned, local faradization and galvanization are to be used, the latter being the more beneficial. Seurinelle very strongly advocates the use of strychnine, which he seems to have given in very large doses, and which he considers of very great use. Its action of course
must be carefully watched.

For the encephalopathy Taquereille advocates an expectant treatment, and his good statistics are certainly a strong point in favour of non-intervention. But it seems to me that, knowing how closely it is allied to uremia, hydroaques and sudorificates should be at least tried. The convulsions may be controlled by chloroform, and the iodide of potassium should be pushed to the verge of toleration.

Of this subject we know but little. Some lead we know passes off in the urine, but it is a question whether it is separated by the kidneys with the urine, or by the mucous membrane of the urinary tract. On theoretical grounds it is hard to understand how metals existing in the body as albuminates can be eliminated with a non-albuminous secretion. Certainly, after the administration of lead an increased amount of albumin is found in the urine, with signs of irritation of the lining membrane of the bladder even amounting to a carbuncular condition. So that it has been inferred that the metal is separated with the albumin secreted by the mucous membrane. During the administration of the iodide of potassium
if, as is usually the case, we give it in large doses (grs. xx t.d.s.), it is worthy of notice that a few days after its administration the symptoms of the patient become very often aggravated. This is explained by the lead previously deposited comparatively innocuously in parts of the body becoming liberated, and by acting on the nervous system, the system most susceptible to the effects of the poison. This should be hailed as a good sign, and the patient encouraged accordingly.

On this subject it is necessary to say a few words, although they will be words of doubt and confessions of ignorance. By autopsies and anatomical and microscopic researches many observers have sought to find the truth of the why, wherefore, and how of lead poisoning. Their results and conclusions however are so contrary and confusing that the unbiased judgment is obliged to admit that it knows little for certain. It is in an apocalyptic condition. It will be sufficient therefore to collate the observations of the principal writers on the subject.

According to Hulea lead acts directly on muscle, especially on the unstriped form. Hence the colic by action on the intestinal muscular fibres;
The heart pulse by the constriction of the muscular fibres in the arteries, the paralysis being explained in a like manner. This theory however, with regard to the paralysis must be considered untenable on account of the electrical reaction which is typical of peripheral neuritis, and if in the one case it is incorrect it probably also is in the other. Hruby is of opinion that the primary action is on the nervous system. Hence according to him the colic comes from irritation by compression of the intestinal nerves, and the constipation from cessation of the intestinal secretion by contraction of the blood vessels through the irritation of the vaso-motor ganglia of the abdominal sympathetic.

These two, Hruby and Hrubel, respectively represent the opposing forces in argument as to whether it is the muscular or nervous system that the lead especially affects. The followers of each are numerous, and each follower has a modification of his own.

Let us first take the pathology of the colic. On post mortem examination the bowels, especially the large intestine have generally been found contracted, or alternately contracted and dilated in
portions. Sometimes portions are found congested, or even the appearance of severe oblitera-

The school of Heube attribute the colic to a paralysis or spasm of a portion of the bowel and ineffectual contractile efforts of the portions above to overcome the obstruction, the poison acting directly on the muscular fibres. The followers of Heube on the other hand attribute it to an irritation of the sympa-

The hand pulse at the same time is explained by a similar irritation of the vaso-motor centres in the sympathetic and consequent contraction of the muscular coats of the arteries.

The cruralgia is due to tonic muscular con-

The paralysis. The muscles are in a state of atrophic degeneration, and there is hyperplasia of the connective tissue. The nerve trunks are also found more or less atrophied.

As before mentioned, Heube's theory will not probably be sufficient to account for the paralysis. But it should be noted that Hitzig, a follower of

This attempt to account for the paralysis of the
extensors by a peculiar disposition of the veins at the back of the wrist which favours the deposit of the lead there. The veins at the back of the forearm and wrist are often, in these cases dilated, but still this theory would not account for paralysis elsewhere.

The electrical reaction seems certainly to show that the cause of the paralysis is peripheral neuritis, but whether this be primary or secondary to central degeneration in the cord is not so certain. It has conclusively shown that this reaction is not infrequent in paralysis of central origin.

Although the paralysis in many cases appears to be unilateral, yet on the application of the electrical test to the apparently unaffected side, the muscles will almost invariably be found here to be also implicated. This asymmetry would seem to argue in favour of a central spinal origin. This view is also supported by its similarity to infantile paralysis (poliomyelitis anterior), and by the fact that the affected muscles are closely allied in function, but have not the same nerve supply. In many cases, also on post mortem examination lesions have been found.
in the anterior cornua, and recorded by Vulpian, Remond, and Bernhardi.

On the other hand lesions have been found in the nerves [and none in the cord] by Lareau, Frankland, and Westfield. Dr. Ferrier concludes that the most frequent appearance is a peripheral neuritis, especially in the nerves of the paralyzed muscles, but observable elsewhere if the electrical test be used. That those muscles which possess least vitality yield most readily to the action of the poison he also concludes; and this proves that the extensors and abductors are physiologically weaker than their opponent muscles. He believes that if the origin were central other groups of muscles would be involved than is usually the case, on account of the close connection between the nuclei (?) of the extensors and those of other muscles, a fact which he has demonstrated by experiment on monkeys. He therefore sums up by saying that while lead poisoning might cause poliomyelitis anterior, it usually causes a general peripheral neuritis.

The encephalopathy seems to be a functional disease, and is to be explained in the same way as the very similar pathological conditions which are
produced by the excessive use of alcohol, the poison in both cases producing certain nutritive changes in the system, which eventually cause functional disturbances. On post mortem examination no lesion is to be found and therefore we must conclude that this affection is functional.

On the following pages will be found tabular synopses of the cases that have come under my notice, — also a list of the principal authors whose works I have consulted.
# Table of Cases

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Occupation</th>
<th>Other symptoms</th>
<th>Family history</th>
<th>Reproductive system</th>
<th>Other symptoms</th>
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<td>Colic</td>
<td>1/2 year</td>
<td>Has lost &quot;feel&quot; to now break in intellect.</td>
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<td>¥</td>
<td>55</td>
<td>File cutter</td>
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<td>W.P.</td>
<td>¥</td>
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<td>S</td>
<td>Gout</td>
<td>3 years</td>
<td>Has slight rise in blood pressure.</td>
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<td>45</td>
<td>Labourer. The result of a cold from drinking tea made from a barrel which the house was divided with common sewer.</td>
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