
Chronic Lead Poisoning

Lead introduced into the system from without is well known to be poisonous. That form of lead poisoning brought about by drinking contaminated water will be mainly considered, though before entering upon this subject I will enumerate the chief causes of chronic lead poisoning.

According to Tanguerel, youth, summer time, intemperance are predisposing causes. Among the direct causes are the taking for a more or less prolonged time of medicinal doses of Acetate of Lead; using over large surfaces, or for long periods of time, lead lotions or plasters; working in white lead factories; handling paint; handling lead brights on looms by weavers; working on gas- and water-pipes with lead cement; plumbing; printing; shaving; lead type founding; working on coloured paper; making...
and sewing lace; brush-making, where the bristles are coloured with lead; working in enamel; making cosmetics; glazed crockery; Beer & Cider drawn through lead pipes; taking Snuff that has been wrapped in leady tin foil, sleeping on hair mattresses dyed with lead; The foregoing causes are mentioned by Vaun-

yn. He concludes by saying that "very rarely drinking water from lead pipes may cause this disease." If other towns supplied with water through lead pipes have as many cases of lead poisoning from this cause as we have had in Keighley, this source of poisoning must be more common than is usually suspected. Indeed I can but fear a very large number of people must suffer every year from this disease without it being so much as suspected by the physi-

ician, and this opinion I found confirm my own experience which now dates back to 1873 when I entered the profession as a pupil to a practitioner in large general practice in Bradford. During the three years in Bradford I only one case of lead disease, a case of Painter's colic

{*Zimmerman's Encyclopedia of Medicine* Vol. xvii p. 561}
came under my notice. During the four years at Edinburgh I only remember seeing one case of head-furring, a case of paralysis in a boy in Professor Froger's ward.

From the time of leaving Edinburgh until I came to Keighley at the beginning of 1882, a period of eighteen months, which I spent in Bradford as assistant in a large general practice, I did not see a single case.

During the first few months of my residence in Keighley I do not remember meeting with a case. From about June 1882 up to the present time I have come across about a dozen cases suffering from the disease. The nature of the first case was not discovered until paralysis had set in, for I had previously treated his attacks of colic associated with slight jaundice and anorexia as due to gall-stone. About the time the paralysis set in, the patient's brother could have it he was suffering from lead poisoning from drinking the town's water, as he himself had been similarly affected some time before. His disease had been traced to lead in the water. To satisfy the brother I had the water examined for lead
t was satisfied that it contained quite enough to cause mischief. Some water taken from the chemist's tap was even worse and that from my own house was as bad. I am stopped off all town water for my patient, and no recurrence of the colic. Though the paralysis is still uncured. Once on the look out for the disease I soon discovered others suffering from lead poisoning, and thinking over the matter I wondered if I had failed to recognize the disease during my previous professional experience, or was it highly different from other places in having water that was peculiarly apt to act upon lead and hence the experience I was getting of its effects. How far the first supposition is a correct one I am not able to say, but from what I have been able to ascertain of highly is exceptional in having water that acts so injuriously on lead. However, to show a disease does chronic lead poisoning appear that I think too much cannot be exerted about it, with a view of possibly of remedying this most preventible of troubles. The forms in which the lead is conveyed into
The systems are chiefly the oxide (litharge) and the carbonate (white lead). Whether soluble or suspended in the water, the poisonous actions follow all the same. The oxide is soluble in the extent of about a grain, in the fluid of river or lake water. The carbonate is usually suspended, but may be rendered soluble by excess of carbonic acid gas in the water. As a result of the action of water on lead a coal is usually formed on the pipes. The behaviour of this coal and its constitution have formed the subject of much research. Waters act variously on lead pipes, according to their constitution and temperature. All authorities appear to agree that pure water free of air does not act on lead at all. Taylor says, that through the action of pure water mixed with air on lead a white powder is formed, a mixture of hydrated oxide and carbonate of lead. The purer the water the more free from salines, the more dangerous it is as a solvent of lead, the process going on until either the lead is eaten through, or a firm coat is formed on it. From an experiment of Sir Robert Christison,
by keeping such water still, you favour the production of a preservative coat on the pipes; a rapid flow of water through the pipes, especially if under high pressure, may still favour the displacement of this coat as soon as formed. The particles of suspended matter being thus taken into the system do cause no disease. Rain from free water acts readily on lead (Taylor). According to Christopher Rain water from the country acts more energetically upon lead than that of towns. Spencer of Liverpool holds the contrary view, arguing that the gases dissolved in town water render it more active.

Pure, soft spring or lake water containing five grains or less of saline, to the gallon are dangerous, acting more vigorously on bright than on dull lead. In the case of hard Katrine water, its passage over limestone or old red sandstone deprived it of its action on lead.

River or hard spring waters containing twenty grains and upward of saline, to the gallon are least active, especially if they contain Carbonate or Sulphate of Lime in excess and not much a "letter respecting the action of water on lead." Liverpool 1830.
of chloride or nitrates. As a matter of fact, all water used for household purposes acts on lead and although soft water are as a rule much damper, it is not always the case, some soft waters having little action and some hard waters acting vigorously, the action of the latter being attributed to an excess of those very salts that are considered protective in hard waters. Accordingly, it may be said however, that the alkaline nitrates, chloride, are dangerous in any quantity. Taylor observes further that it is curious that the vapours of an unsinusious water should corrode lead, but vapourised water will be similar to distilled water free from calxine and hence its action. In general, sulphates, carbonates, phosphate, in solution, diminish the corrosive action of the water on lead, but when these salts are in excess there may be action, and especially if there is free carbonic acid present, which renders carbonate of lead soluble. If the salts in solution act chemically upon one another, solution of lead oxide and other salts is favoured. Sulphate of lead, which is
scarcely soluble in pure water, is so in water containing salts in solution. Plaster of Paris
where, similarly. Solution of lead is also
favoured by the galvanic action resulting from
the contact of lead with some other metals; for
example, lead pipe is found much corroded
near joints, and where solder is present.

Dr. Nevin of Liverpool says „ „Tea lead (contain-
ing tin) is more soluble than lead. Pipe-
lead (containing zinc probably) is less soluble.
The tin, in one case favours, and the zinc in
the other, delaying solution in virtue of galvani-
action. Vitrate, + Chloride, favour the corro-
sive action of the water. Medlock maintains
that „ „by the decomposition of organic matter
and ammonia, nitrites and Nitric Acids
are formed, and these are the sole cause of the
water acting on lead. „ „Dana says that
 „ „organic acids form the decay of organic
matter, of which, Carbonic acid is chiefly act
on the lead. „ „W. Rimington, the Borough
Analyst for Bradford, tells me that the acids
usually found free in water are, Carbonic,
Sulphureic, and in a small extent, Cremic
and Hypo-cremic Acids. The Sulphureic Acid

6. Smeepratt, Chemistry
5. Appendix to Translation of Jangneus’s work
in Lead Diseases. p. 306
arising from decomposition of pyrites. Alluding to the water of Bradford he says "though it is very soft, it does not act on lead. This is attributed to the fact that the pipes are protected by a coal chiefly made up of organic matter of which peat is the chief ingredient." He regards peat water as the safest for transmission through lead pipe, on this account, but I am inclined to think that in hot weather, or under other conditions favourable to decomposition, there will be a risk of the coal becoming not only removed, but of the products of its decomposition actually favouring solution of the lead.

According to De Dana, iron salts in solution hasten the action of water on lead, the peroxide is reduced by the lead and lead oxide is formed. The free chromic acid that might form a protective coat of lead carbonate under other circumstances, is taken up by the iron. Hence it has been considered that water, which has passed through iron pipes, may convey iron rust into the lead pipe, and to facilitate the formation of the lead trioxide. The most dangerous water, according to most authorities, is a soft one in which organic matter or nitrates abound, and

2 "Report on the use of lead & cast iron to convey & distribute the waters of Dulcie" by B. Silliman Jr.
3 Appendix to Translation of Serrezeul p. 392
an intermittent supply adds to the danger, the air acting upon the damp and empty pipes. According to Dana, though a cast is found on such pipes, erosion goes on beneath, pipes, having been perforated in six months by such water. In answer to the question is the lead suspended or dissolved in water? Geminus appears to say, that Thomas Spencer maintains that hard water holds the lead oxide in solution, whereas in soft water it is deposited as such, or as the Carbonate. All hard waters are not alike in this respect, this solution of the lead. For instance, where the hardness is due to Sulphate, or Silicate, solution of the lead oxide is not assisted; it will then form a coat on the pipe. Water that is hard through Carbonate of Magnesia is more dangerous than water containing chiefly Carbonate of Lime, Chloride of Sodium, Chloride of Magnesia, or Calcium.

Most lead pipes after being used sometime become coated more or less. A bluish coat is chiefly due to the Suloxide of Lead; a reddish coat to a combination of organic matter, oxide of iron, & carbonate of Lead. If water is "Report of the General Board of Health on the supply of water to the metropolis 1850" in a paper repeating the action of water on lead 1850.
will be chiefly caused by Carbonate and Sulphates. The action of water on lead is said (to be feared) when no indication is found from tarnishing the metal.

Concerning "protective coats" on lead pipes, Mr. Horatio Adams 6 says: "Then the three theories. First, that of Christians, certain salts in water produce a compound of lead insoluble in water, a protective coat being formed. Second, that of Boston, an insoluble coat of Sulfide of lead is formed after a few days or weeks contact. Third, the so-called "London" doctrine, that protection is due to the presence of a limited amount of Carbonic acid in the water, forming Carbonate of lead. Though these protective coats are insoluble in pure water, they are decomposed and rendered soluble by the salts contained in natural water, hence the first and second doctrines have been given up. As to the third doctrine, if too much Carbonic acid is present, the coat of Carbonate of lead is dissolved. Hence, the doctrines of protection must be abandoned."

As to the best material for distribution water pipes, the water commissioners of Boston drew

2 "An investigation into Service pipes for water by E. N. Horsford

up a Report in which cast and wrought iron pipes are recommended as safe, but, on account of the rapid oxidation and the resulting blockage, they could not be recommended for general use. "Lined copper pipes were considered just so long as the internal coat kept good. Block the were thought best, but their cost and the fact that even these were acted upon by water to a certain extent, stood in the way of their general utility."

Bragg Smith has patented a preparation to protect iron pipe, there have been specially recommended for use in Kentucky. Considering however, the almost general use of lead pipe, and the apparent small amount of injury resulting from their use, the commissioners came to the conclusion that they were best after all." Taylor recommends well-lined pipe, glass or earthenware to be used where lead is unavailible.

Water will take up about one grain of the suboxide of lead in the pint. If it contained more than one grain in fifteen gallons Christensen holds that it was unsafe. Henkel maintains that contained introduction rather than quantity.

has to be considered. If much is taken, little is absorbed, and it is almost immaterial if the salt is little soluble or very so.

To estimate the quantity of lead per gallon of water, Mr. John Smith of Marischall College recommended the following plan:

First, through a gallon of the water to be examined, slightly acidified with hydrochloric acid (to dissolve any sulphide of iron that might be present), pass a stream of sulphur-dioxide gas, and note the colour.

Secondly, make the following standard solution: 1.6 grain nitrate of lead to 1000 grains of distilled water ( = 1 grain metal in 1000). From a graduated measure drop this into pure water till, on transmission of sulphur-dioxide gas, the same colour as the sample is produced.

Pathology & Morbid Anatomy

Christian affirmed that lead was a natural constituent of the body. Sarcoy denied this. He found it seeping into the body through the skin, lungs and alimentary canal. Taken into the stomach, lead salts of lead are

* A Report on "The composition of the water of the Dee and Don at Aberdeen", their action on lead pipes at various
rendered soluble. According to Sarrold and Nannyn, it is probably absorbed into the system as albuminates; in this form it is found in the tissues. Concerning its elimination, little is positively known. When it has been searched for, it has been found in small quantities, and not chiefly in the urine. Many theories have been offered of lead poisoning. Naunyn says there is no satisfactory explanation. It has been maintained that the symptoms were due to deficient elimination of the poison, but Naunyn observes, in cases of chronic lead poisoning, very little lead indeed is found in the tissues. Trousseau speaks of lead colic as a neuralgia of the sympathetic, Enkeberg, as a mixed neurosis of the iliac and coeliac plexuses. Hoffmann, Heumann and others regard the colic as due to spasmotic contraction of the bowel. This is probably the true explanation; and it may be that this contraction is induced by the lead deposited in the wall of the bowel, which, acting as an irritant, induces reflex contraction. Hiltner Tagge.

<sup>6</sup> Ziemmen, Encyclopaedia Vol. xvii p. 573

<sup>6</sup> Lancel March 12, 1881.

<sup>6</sup> Ziemmen Vol. xvii p. 562.

<sup>6</sup> Ziemmen Vol. xvii p. 587.
holds his view, and also that the blue line on the gums is due to the action of sulphated hydrogen from the tartar around the teeth fixing the lead in the tissues of the gum. No explanation of the arthralgia is known. As in the paralysis, three views have been advanced in explanation of it. Harnack and Fussereon of Berlin adopted the view that the muscles were at fault. 'But, as Plisson remarks,  if it were muscular, not only should we find the muscular fibres degenerated in proportion to their loss of power, but we should find Faradie con-tractility surviving as long as any healthy muscle was left. On the other hand, the rapid shrinking of the muscles without degeneration and their speedy loss of Faradie contractility obviously point to lesion either of the nervous limbs or of their nuclei of origin."

This view has been pretty generally given up and a nervous origin for the disease held in its stead. Duchenne holds this view. Eber, Remak and Bernhardt consider it dependent on an anterior poliomyelitis, of a chronic character. This view is strongly supported by the condition of the muscles, their state of atrophy.

5 Practice of Medicine
6 Ziemssen, Vol. XIII, p. 715
The electrical relations, and the absence of disturbed sensibility. The symmetry of the disease and the localization of the paralysis point to spinal, rather than to peripheral, mischief. A third view, adopted by Charcot, Lanceaume, and others, regards the paralysis as due to peripheral neuritis without spinal lesion. Lanceaume was the first to observe such a condition. The question has still to be settled.

The convulsions, according to Naunyn, may be due to uraemia in some cases, not in all. Like in chronic alcoholism, an abnormal nutrition of the whole system is developed as consequence of the long continued circulation of the foreign poison in the blood. The poison is therefore only indirectly the cause of the disease.

Taylor draws attention to the following post mortem appearances: "The blue line on the gums, thickened coat of the stomach, irregular distension and contraction of the large intestine, spots of congestion on the mucous coat, enlarged salivary glands, blood blisters, liquid, bierisch, and mesenteric glands enlarged, coats of bowel.

Naunyn in "Ziemssen, Encyclopädie."

On Poisons
Thickened, especially of colon; lungs congested, muscles pale and matted.

In many cases, no distinctive lesion is traceable, indeed it may be said that no lesion or group of lesions is known to be associated solely with lead disease, but in a well-marked case you may expect to find some if not all, of the following conditions present:

The blue line on the gums; irregular dislocation and contraction of the colon with thickening of its coat. This condition was seen in the colon of a man who died in Reigate last year (1882) from what was supposed to be lead poisoning. In this case the colon would only admit the passage of the forefinger in one or two places.

Rumer's glands and Kupffer's patches are sometimes hypertrophied. In sixteen of forty-nine cases of uncomplicated lead colic reported by Sanguezol, contraction of the intestinal canal was present; in six cases there was partial or general thickening of the digestive tube. The kidneys may be congested, but the contracted papular kidney is most likely to be met with in a very chronic case.
Nervous System. Here are few records of definite lesions being found. Dr. Austin records one case where there was much engorgement of the cerebral vessels, and coining of the brain; the brain and cord were much congested. Colloidal bodies were seen, and grey degeneration and pallid sclerosis with increasing frequency were met with from below upwards. Dr. Melville gives the details of a post-mortem of a patient who had died of convulsions and coma where no naked eye change were seen in the brain. In this case, Dr. Tidy of London found five grains of lead in the brain. The blood was healthy. Christie quotes from several instances of four deaths from coma in which the head presented no abnormal appearance.

Where there has been paralysis the muscle, though pale, cream-coloured, twirled and may be soft or tough (Tauquard). In the Lancet in the report of the microscopic examination of muscle from a case that died about eight weeks after the first appearance of drop attack, portions of the paralysed muscle were hardened in alcohol and chronic acid, bleached and a extract of Lancet for June 5th 1878.
Stained with hæmoglobin. Some fibres were found
narrow in groups, the transverse striæ were
absent or disappearing. The nuclei were
more numerous in the paralysed muscles
both in the ordinary sized, and attenuated
fibres. Some cylinders had a fatty appear-
ance, similar to the colloid degeneration of
TYPHOID FEVER. This atrophy and degen-
eration of muscle is the only condition
that Vanneyn considers at all characteristic
of the disease, the degeneration only setting in some
time after atrophy has existed.

Upon analysing the organs and tissues of animi-
alæ that Heidel had experimented upon, he
found most lead in the bones, next in the kidneys,
Liver, Spleen, Brain, Muscles and Intestines,
trace in lungs and blood — the experiment is
thought to dispose that colic is due to deposi-
tion of lead in the intestine or muscles.
The lead is apt to remain in the tissues for some
time, Orfila has detected it eight months after
its reception into the system had been discontinued.
In the detection of it in the fluid or tissues of
the body, it must be remembered that sulphu-
retted hydrogen gas will not separate lead from it.

Ziemssen Vol xvi. p. 585
6. 30 p. 558
compounds with albuminous substances, not from the secretions. To obtain the lead, either burn off the organic matter or treat it with hydrochloric acid and chlorate of potash. From the filtrate, lead can be obtained by the ordinary rules of inorganic analysis.

Symptoms

According to Sauvageau, before you get well-marked symptoms of the disease, in many cases, the Scurvonic Diabetes is developed. The patient begins to lose flesh, the skin gets yellow, bluish, or purplish line is formed on the gums, especially on the upper jaw and near tartar. According to Taylor, mercury, silver also cause a bluish line on the gums. Instead of the blue line, the gums may present a spongy appearance. Of all the early symptoms, the blue or purple line is the most characteristic. It is not known how soon the line may appear. Dr. Burton mentions one case where it appeared twenty-four hours after giving four five grain doses of Acetate of Lead. Once produced, the appearance lasts long. Rarely, a diffused bluish colouration of the buccal mucous membrane is produced.


C. Tanner
A patient having some or all of the above symptoms may show no further evidence of the disease though he remain exposed to the poison ( annoyance). As a rule however the more specific symptoms of lead poisoning show themselves. These are colic, arthralgia, paralysis, and neurological.

After suffering slightly for a long time, a person may become suddenly ill with colic, and he may be the only one of the family exposed to the same influence who may so suffer. The colic is associated usually with vomiting and constipation. The attacks of pain last a few minutes, some duration of pain remaining after they have passed.

Harrison on "Contamination of Water by Lead" p. 37

Flemming Vol 17 p. 566
a spasm or cramp of the abdomen. This
pain is usually relieved by pressure; it is
frequently referred to the umbilical region or some-
where in the median line; and during the attack
the abdomen is retracted. The colic is associ-
ated with considerable tenderness in some,
in others there will be straining or retention of
urine; shooting pains in the breasts, and
other symptoms. Harriam calls attention to
pain in the lower part of the spine, sometimes,
and also to the limbs, as associated with
attacks, or between them coming on between
them. In Dr. Kelly's cases at Claremont
hysterical symptoms showed themselves.
The tongue is white and flabby. Thirst great. Appetite
poor. The general expression is anxious.
Christison says the pain remits rather than
intensifies, the exacerbations and remissions being
longer than in ordinary colic. Nausea and
vomiting of bilious matter are frequently pres-
cent, the vomiting coming on between the attacks
of colic. Slight jaundice will often show itself. The pulse is slow, full and hard, sometimes
irregular, during an attack. The respiration
is hurried. The temperature is rarely above the
on contamination of water by lead p. 45
normal, though A. Murchison mentions two
cases of lead colic where the temperature rose
alone 102° F. The urine is concentrated and
not unfrequently contains albumen. The colic
may be associated with other forms of lead poison-
ing.

The duration of the attack, if left to nature, and the
cause has been eliminated, will be from two days
to several years. The average duration of the treat-
ment has commenced is from three to four days.
The prognosis is good on the whole, though it
must be remembered that those who have long
suffered from lead poisoning are peculiarly suscepti-
able to other disease. Garrod drew attention to the
remarkable fact that one-fourth of the hospital
cases of foul has suffered from lead poisoning.

Next to Colic, Arthralgia or Lead Rheumatism
or Neuralgia, must be considered. This condi-
tion may appear with or without any other symp-
toms of lead poisoning, and consists of tearing
or burning pains in or near the joints, or in
the muscles over them. There are violent exacer-
bating and remitting, not following the lines of
nerves (therefore not neuralgic). There are no
pressure points like in joint nerves. The

= canceled Aug 15th 1868
6 Namyn in Ziemansch's Euphysic p. 570 Vol. xvi
8 p. 565 Vol. xvi; p. 574.
Exacerbation are accompanied by cramps. The attacks are brought on by exercise and cold. The pain of them is caused by pressure. There are no signs of inflammation. The knees and other joints of the lower limbs often suffer. The flexors suffer most from the cramps. The muscles of the neck may be affected as well as those of the body generally. There is sometimes tremor of the affected muscles. Constipation and slow pulse are generally absent. Hiccough in colic, these are apt to be relapses, and the attacks are often associated with colic.

The prognosis is better than in colic. Concerning this form of lead disease, Laguesse says "it is next to colic in frequency," and that "those who work among red lead suffer most." Night is the time when the pain oftenest gives trouble. The pulse is slow.

Paralysis is usually preceded by colic and other symptoms of chronic lead poisoning. It has been known to occur as soon as the third day after exposure to the lead, but it usually comes on after months or years, especially when the disease has been caused by drinking contaminated water.

There is first of all a double numb feeling.

Laguesse p. 173
of the skin of the fingers and forearm. Then trembling and weakness, followed by actual loss of power, which may become absolute in a few days. In the only case of this disease I have met with throughout, sharp prickling pains were complained of in the arms or shoulders a day or two before paralysis set in. In a day or two after the first sign of paralysis, the patient almost entirely lost the use of his arms or hands; he could not raise his shoulders nor even dress himself. Bristowe says "Dipha Eagle is the commonest form of paralysis. Both wrists are usually affected, but unequally; in some cases only one of them is usually the right. The patient can't extend the hand upon the arm or the first phalanges upon the metacarpal bones, to adduct or abduct the hand or abduct the thumb. The paralyzed muscles, rapidly waste and while retaining their electro-sensibility, they speedily lose more or less their passive contractility, with an unchanged or increased reaction to salvarsan or mechanical irritation.

It is a remarkable fact that the paralysis is limited, as a rule, to muscles supplied by the muscles-spiral nerve, especially by its posterior interosseous branch."

Harrison 176
P. Pauverel
According to Thaunyn, the paralysis differs from the arthralgia in selecting oftenest the upper extremities and the extensors for its first appearance. The extensors of the fingers suffer earliest, then the triceps, then the deltoid and muscles of the back. It is rare to get paralysis of the muscles of the face and eyeballs, where tremor is oftener seen.

The paralysis is unsteady in not corresponding with the distribution of a peripheral nerve. Usually both arms suffer. D'Auriol mentions the case of a painter with paralysis of only one arm, with absence of pain in the head or face, and he maintains that the disease starts at the periphery. Such a case favours this view, at any rate in the case of those who get the disease from handling lead, but there still remains the difficulty of understanding why the extensors suffer more than the flexors, for general sensibility is usually unaffected. At the commencement pains are felt in the muscles and bone. Where the disease becomes advanced, atrophy sets in, this fact taken with the localization of the paralysis is characteristic of lead poisoning. Side by side with the paralyzed will be healthy muscles. Tremor, if present, a lecture, on the Nervous System, late in 1872.
is usually found at the appearance or passing off of the paralysis. Dr. Rutherfort Sanders says that "lead tremors have rarely been observed in any one except where the poison had been inhaled—then the upper extremities mostly suffer, especially during effort or emotion. The tremor may become general. The paralysis may last any length of time. Recovery from it is slow, the atrophied muscle being replaced by new. The longer the disease has lasted, the more extensive the atrophy and the more unfavourable the prognosis." Vanuyten, the pulse in paralysis is weak to close (Tanguent). When the muscles of the chest become paralyzed, you get difficult breathing. Death has ensued from this cause.

Under the name of Encephalopathia Saturnina, Vanuyten describes all the brain affections due to lead poisoning. Convulsions are most important and most frequent. They usually appear in those who have absorbed much lead, and often come on early. There may be no preceding sign of lead poisoning, but it usually follows colic. Just before an attack, the following symptoms have been noticed: shortness of breath, intense headache, stiffness, sleeplessness.

6. Reynolds' System of Medicine

Amaurosis now then appears, and when it does so, it is developed suddenly. Then either delirium or stupor lead up to the attacks of convulsions which may be general or partial. Harrison speaks of them as being "very terrible, wild and uncertain as from poison." The pulse gets quicker and the tongue dry. The temperature also goes up. Dr. Dower mentions a case in which the temperature went up to 110° during the last twelve hours of life. Between the fits, there may be mere restlessness, delirium or coma. They may recur every few minutes or be a week apart. Handfield Jones, speaking of the fits, says they are more violent and last longer than of ordinary epilepsy, nor does consciousness return so quickly, a confusion of speech and intellect lasting for days; one in four dying from asphyxia or apoplexy.

When coma occupies the whole interval between convulsions, death usually takes place within three days. When amaurosis comes on, as a rule, nothing can be detected with the ophthalmoscope. W. Atkinson in one case found double optic neuritis. All these may be usually associated with convulsions, and renders

\[\text{\textcopyright Landau, April 17/75}\]
\[\text{\textcopyright Landau, Jan 3/67}\]
\[\text{\textcopyright Landau, June 175}\]
\[\text{\textcopyright P. 80}\]
of the beforementioned Symptoms usually the colic appears first. Later on, interchanges of symptoms may occur or some symptom may continuously recur. Should paralysis exist, and an attack of colic come on, the former will set worse. As a rule, the disease is purely fatal, and when it is so, it is from exsanguination. Should the patient remain exposed to the poison, relapses are common.

Obstinate dyspepsia is developed, anaemia replaces the yellow coloration and there may be a temporary asthenia, locomotion becomes difficult from their weakness, and the patient is apathetic and probably tremulous. This state may last for years, death usually resulting from some complication, of which nephritis is the commonest.

Dr. Farrod drew attention to the remarkable fact that lead in the system favoured the development of gout, by preventing excretion of uric acid.

**General Progress**

depends upon the constitution, manner of living and the susceptibility of each case, and in both it is impossible to get out of the reach of the poison. Colic is the least to be feared.

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Death or prolonged state of illness may follow
the extreme cachexia. Taylor says "chronic
lead poisoning often kills." Tancock's
experience led him to think the disease
was rarely fatal. Of his ten fatal cases,
six died from cerebral affection, colic t.
two from intercostal paralysis. Most die
of complications. Of all his cases one died
in every forty-three.

Diagnosis

Very easily provided you are on the look out
for it; otherwise one is very apt to overlook
even marked cases of the disease, not because
diagnosis is so difficult, but because the
disease is usually looked upon as a rarity,
and as its symptoms are very like those of
more ordinary complaints. These are usually
diagnosed and treated.

From Biliary Colic it is very difficult to
distinguish from Lead Poisoning in which
colic is the chief symptom. Perhaps the best
guide to a diagnosis is the fact that in Lead Colic
the abdomen is retracted during a paroxysm
of the pain is relieved somewhat by firm pressure.
The pale, flabby tongue, the peculiar breath and
taste, the location of pain mostly at the umbilicus, the constipation, the slow pulse, the usual absence of headache and, provided you think to look for it, the blue line on the gums seldom absent in well-marked lead colic, form a tolerably well defined group of symptoms by which you may diagnose the case. Further, if the patient recover and be again exposed to the poison, he will most likely appeal again and again for relief of his colic at pretty regular intervals, the periodic recurrence is also a help to diagnose.

From Copper Colic, Frequerel professes to form a distinction, inasmuch as the colic due to copper is generally more diffused over and confined to the abdomen, and increased by pressure. The abdomen is softer and less retracted, and there is no nausea nor vomiting. There is further, discharge of green stools and tenderness.

The rheumatic or heat rheumatic, according to Harrison, is to be distinguished from true rheumatism in the absence of fibrile temperature or pulse, of redness, swelling and tenderness to touch of the affected parts.

The paralysis in its peculiar distribution, colic,
apt to lead to error in diagnosis.

The convulsions, unlike those of Epilepsy, are not usually preceded by an aura and are more violent and last longer. Between the fits, there will be delirium, stupor or coma. Recovery from the fit is slower than in the case of Epilepsy.

To diagnose from Wasting Palsy, O'Sandars gives the following rule. In lead poisoning the paralysis usually comes on suddenly, being fully developed in a day or two, at most a fortnight; whereas in Wasting Palsy, the paralysis comes on gradually. Besides, in lead paralysis you have the usual precursory phenomena, and in Wasting Palsy you have no loss of electric contractility, the wasting of the muscles antecedent the Paralysis.

In diagnosing from Wister's Palsy it is to be remembered that in lead poisoning paralysis rather than Spasm prevails, certain muscles of both arms suffering; there are also the precursory phenomena.

**Treatment**

First of all, avoid the source of poisoning. In many cases the patient will recover rapidly without medicine. If the poisoning has been going on for some time, treatment will be necessary.

With a view of eliminating the lead, Mr. Melson's *Reynold's System of Medicine*
suggested the employment of Jodide of Potassium, on the supposition that the Jodide made, with the insoluble salts of lead deposited in the tissues, a double soluble salt, capable of being removed by the Kidneys. That patient improved, and his rapidly, under this treatment, novel are agreed. Dr. Dobie in his Town assures me that he has seen the blue line on the gums disappear in a week under its influence, but another local practitioner who had a distinct blue line on his own gums, failed to make an impression on it, though he took five grains of the Jodide three times a day for a fortnight. Taylor says there is no satisfactory evidence that Jodide of Potassium has hastened a cure. Mr. Wm. Hank Smith of Sheffield records a case of lead palsy where there was no blue line when the case came under treatment. Ten grains of the Jodide were given three times a day. In about five days a blue line appeared, disappearing again six weeks after treatment. This case is instructive as affording evidence of the possibility of a considerable amount of lead poisoning exists being present without the coexistence of a blue line on the gums, and it further teaches caution in ascribing to the

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remedy any power to remove the lead from the system by simply trusting to clinical facts. If the iodide has the power to set free the lead imprisoned in the tissues of the gums, how came it that in this case the blue appeared in spite of the remedy? Further, knowing however that under the influence of the iodide, the disease so often is cured, and further, that direct experiment has shown that the amount of lead eliminated by the skin and urine is increased under its use, I think it not unreasonable to suppose that the increased elimination of the lead is due to the influence of the remedy. Whether it performs the rôle usually assigned to it may fairly be allowed to be an unsettled question.

According to many there is no certain antidote. Sulphuric Acid Lemonade is a commonly advised remedy, under the notion that the insoluble lead sulphate will be formed in the system. But even if such were the case, the salt is itself poisonous.

For the colic. To relieve this symptom, one of the best combinations is a mixture containing Spirit of Belladonna, Spirits of Chloroform, Sulphate.
of magnesia and Syrup of Senna. Morphia,
morphia hypodermically can also be relied upon for
affording immediate relief, but a purgative must
be used afterwards, or the pain will surely
return. In many cases permanent relief is
afforded after a free action of the bowels, in
others the pain returns again and again, and in
such cases it is advisable to give the lodide, or
better still, the Bromide of Aluminium, in four
to ten pain doses three times a day until
the pain is quite gone. I have known Opium
relieve whenever administered, but to some
its effect had passed off the pains returned, and
in such a case I have found good results follow
persistent use of the Bromide. Dr. Austen
recommends Ether and Barbitery Lignes Opio sedation
in half drachm doses, with Camphor mixture, followed
by a large water enema. Hot fomentations externally.
If no relief after a few hours give one thirtieth
of a grain of Atropine subcutaneously every three hours
and the constant current through the body, and
lodide in ten to twenty grain doses three times a
day. Sir Thomas Watson prescribed ten grains of
Colonial with ten of Opium, to be followed by a
large dose of neutral salt or castor oil. Alum.
in small or half-gram doses three times a day has been highly recommended. Chloral has its advocates. Of aperients, Salk and Semen are to be relied upon. Tincture used Croton Oil, with occasional emetics, anodynes, and sedatives.

For the arthralgia. A warm bath, if at hand, can be tried, or hot fomentations. Naunyn recommends salicylasin locally and of the sym- pathetic, purgative, being avoided. With these measures combine the internal use of the遂事 of Potassium. Tincture employed Sulphurious Baths, seven or eight a day, each containing five or six cures of Potassium Sulphate. Dr. Pereira recommended these baths. Sedative liniments may be used for the cramps.

Concerning the use of the Sulphurous baths Dr. Birch inveighs against the belief that the lead escaping on the surface of the skin would thereby be converted into the insoluble Sulphide. But then he concludes, "there is no reason whatever for suspecting that the baths promote the escape of lead in any important degree."

For the paralysis. The lodice should be given
for a time, together with tonics and the use of
baths, I have employed massage with advant-
gage, to assist in restoring the paralysed or
weakened muscles. Electricity, either faradaic or gal-
vanic, can be relied upon if persevered with.

Dr. Russell Reynolds says that "the paralysed mus-
cles, on being slowly exposed to galvanic cur-
cents, and exhibiting slightly diminished contractility to faradisation and
galvanism, will be found to unduly respond to slowly
interrupted galvanic currents, and exhibit steadily
diminished contractility to faradisation and
rapidly interrupted galvanism. As the paral-
lysis goes away, you require more cells to get con-
traction, the muscles are less sensitive to the galvanic
current and approach the condition of healthy muscle.

If the faradaic current fail in restoring the use
of the muscles, Dr. Anstie advises recourse to
galvanism until the muscles will respond to the
faradaic current, when this should be used until a
cure is effected. Thomas Duchenne employs
galvanisation and recommends that a powerful
current should be used three times a week for
as long a period as may be necessary, each
sitting lasting from ten to fifteen minutes. He
recommends also that each muscle should be
separately treated, and says that though you may
fail to get response to a faradaic current in the

— Lanceet, p.15, 1870 "Lectures on the Clinical Uses of Electricity"
paralyzed muscles, they may regain their power. Bristow prefers the slowly interrupted constant current. Dauquened recommends strychnia to be given until tetanic spasms appeared.
Clinical Cases, with Remarks.

Case 1. F. B. a tall, spare man aged 56. He enjoyed good health up to two years ago when he began to suffer from constipation, want of appetite, nausea and occasional abdominal cramps. He went from home and in two days felt himself "another man." This was in the spring of 1881. In the following October he had a recurrence of his former condition. Besides aperient pills for the constipation he took no other remedy. These attacks of colic gained in strength and occurred pretty regularly every fortnight. Towards the end of the year he consulted my predecessor. He reported himself as then suffering from what he thought was a bilious attack, associated with great thirst, for which he drank freely of water. At night he made a practice of taking up to bed with him a pint of water to drink during the night. In the morning he was greatly annoyed by a disagreeable taste in his mouth. Urticaria this time his attacks did not keep him from work. Then he had his first attack of pain, followed in three weeks by a severer attack. He noticed that after the first passed off he felt better in all other respects.
In the beginning of last year (1882) he had two severe attacks of colic, each attack confining him to bed for a few days.

In April I first saw him. His condition was as follows:—His complexion was pallid, his cheeks sunken, his eyes heavy-looking. Tongue white and flabby, breath disagreeable, appetite bad. He occasionally vomited bilious matter and was habitually constipated. His abdomen was flat and not tender to touch. The pain came on in paroxysms and was worst over the free margin of the liver. The temperature and pulse were normal. Believing colic was diagnosed, treated. He was able to resume work in about a week. Another attack came on in three weeks and was similarly treated, but the patient was sent from home for a short time and was greatly improved.

About a fortnight after his return he had another attack and a month later another. Just when this attack of colic was passing off, the patient experienced severe pricking pains in the right arm and hand, followed in a day or two by loss of power. This condition was partially recovered from when, a month later, another severe
attack of colic came on, and one morning the patient found both arms partially paralysed to a greater extent in the right arm, which was affected before, but associated with pain in the left arm. In a day or two he could not extend the wrist, nor raise the shoulder and required to be dressed and undressed. Yet under the paralytic appeared this attack was put down to bilious colic, now the question of lead poisoning was entertained. Upon examining the tap water, it was found to contain lead. The patient was then cautioned against further use of it. At this time, when the patient was stripped down to the waist, one saw, almost with the wasted look of the muscles of the back, shoulders, and arms. The back was arched, the supra- and infra-epicondyle fossa of the scapulae were very evident, the shoulders were flat. All the muscles of the body were more or less flabby and wasted, but not in any marked way, and the paralysis was confined to those before mentioned. The treatment adopted was, the internal use, first of Oxides of Potassium, for a few weeks; then of Strychnia. To assist the restoration of the muscles, the Faradic current was used for two
minute to each arm and shoulder on every other day, and "massage" on the intervening days. For nine months he used the electricity, though at somewhat irregular intervals, as he gained in strength. After the discontinuance of the formal water, he had no return of the colic, and though for a few weeks the paralysis did not improve and the wasting of the muscles seemed to increase, a turn for the better came, and at the present time the only muscles that are still unrestored are the common extensors of the fingers. He can extend the wrist, but not the fingers, these are curled up in the palms. A short time ago he was troubled with twitches in one of his heels, but upon getting a warm footbath this passed away. A week later, he was seized one night with severe pain in the left ankle, followed shortly after by pain, redness, and swelling of the first joint of the great toe. The next day, the other great toe was similarly affected also the left knee. Joint was diagnosed and treated. The patient upon being questioned acknowledged he had been in the habit of taking once or twice a day sometimes, at a public house for gin and water, and as the water was
drawn from the town's supply, he had of course taken a little more of the poison.

At this time his urine was clear, but contained a faint trace of albumen and had a specific gravity of only 1015, and he did not make much of it. Whether similar kidney already existed I would hardly venture to say, but the possibility and probability of such a condition must make the prognosis less hopeful than if otherwise would have been.

Case 2. A brother of Case 1. had suffered similarly. From the attack of colic were most severe and he ultimately used hypodermic injections of morphia on himself whenever an attack came on. He got into a wretched state of health, suffering greatly from constipation. On two occasions, he appeared at death's door, and an eminent Leeds surgeon was called on the point of opening his abdomen to see if there was organic cause for the obstinate constipation. Sometime afterward lead poisoning was suspected, and the treatment for this disease and the avoidance of the water established a cure. Though this case did not occur in my
practice I seldom it as affording testimony to the difficulty of diagnosis, to the serious measures resorted to for its relief when a correct diagnosis is not made, and to the almost certain favourable result to be expected from treatment when the nature of the disease has been determined.

Case 3. A married lady, aged 23, who for several years had suffered from Chlorosis periodic and severe attack, of neuralgia and general ill-health, was at last brought to low that it was thought advisable to have a consultation over her. The diagnosis of Chlorosis was confirmed, but it was considered advisable to have a branch line on the lower jaw, a history of crampy abdominal pains and constipation besides the intense neuralgia, that the patient should discontinue drinking the tap-water or only after being filtered in a charcoal filter. From this time the patient gradually improved and the tea began to have its beneficial effect on the chlorosis, which from some cause or other it failed to have before. The consultant suggested the possibility of the lead having interfered with the function of the blood-
of the red corpuscles. In any case, I think our patient owes her recovery to the recognition of the possibility of lead in the drinking water having something to do with her condition, and the subsequent steps taken to prevent a recurrence of that possibility.

Case 4. A chemist, who lived in the same street as Case 3, had, with his wife and servant, suffered considerably from recurrent attacks of colic, until, the water being suspected, because it had to the use of a charcoal filter for the drinking water.

Case 5. At the present time I have under case at the Workhouse Infirmary a man aged 27 who is in a state of stupor. Before he became insane he had only been known to be seriously ill once, and that was just before his insanity came on; when for a week or two he had a most severe attack of colic which nothing seemed to relieve. As he recovered from the colic he became low in spirits, the melancholy deepening into stupor. Except when he has an attack of excitement, his pulse is very slow, about forty beats a minute. There is no hereditary tendency to insanity, and the usual causes for this particular kind of...
Insanity are absent. That chronic lead poisoning had something to do with this man's mental state I think is within the bounds of probability. He lived in the same street as Cases 3 + 4.

Case 6 occurred in the practice of Dr. McDoatie of this Town. The man died, and an inquest was held. The medical history of the case in brief is as follows: For about eight years the patient, a sharp left hand man aged about 37, had suffered from repeated attacks of colic. About two years before his fatal illness he had consulted Dr. McDoatie for this colic, which was referred to his bladder or treated. Subsequently, he came under treatment for a similar condition, but this time his urine was slightly albuminous. In August of last year he was again seized with colic followed by colic attacks, which occurred again and again until his death a fortnight after the first. The only trace of paralysis was a slight amount of drop wrist in, I believe, the right wrist. The blue line on the gums, which was quite obvious when he began with his fatal attack, disappeared shortly before death. Inside of Potassium has been steadily given for drying
Dr Dobie certified the death as due to chronic lead poisoning. An inquest was held, and the following particulars of interest transpired:

Some water taken from the tap in the house of the patient, after standing in the pipe all night, was found to contain three-fifths of a grain of lead in the gallon, a highly injurious quantity. The water from the mains contained no lead, but it was slightly acid, and by allowing a strip of clean lead to lie in contact with it for eighteen hours, the water became contaminated to the extent of half a grain to the gallon. By rendering this water somewhat alkaline with lime water, it was deprived of its solvent power to a considerable extent, dissolving only about a quarter as much lead as before.

The above information is extracted from the report of Mr Allaw, the Public Analyst for Sheffield, Augustus Vaclaver of London, in a report upon the Keighley water some twelve months before, said: "an imperial gallon of Keighley water contains only 3.22 grains of solid constituents dried at 230°, consisting chiefly of sulphate of lime, and including Commensal, oxidizable matter 0.672 grain; Oxide of lead in solution and Carbonate of lead in suspension
The hardness amounting to only two degrees. From the foregoing analyses, it is quite evident the water was sufficiently impregnated with lead to be a cause of disease. Mr. Allan further reporting upon his analysis of the viscera says "Lead was found only in the liver and spleen (only 1/3 in half the liver & the spleen). Besides, a doubtful trace in the kidney, lead was found nowhere else.

The Post Mortem examination revealed a contracted state of the descending colon, in one or two places only a finger could pass. There was also considerable thickening of the wall of the colon. The kidneys were said to be in a state of granular degeneration, though it must have been slight. Dr. Dobie told me, the capsules stripped off easily, there was no appreciable diminution in bulk. The granular condition of the surface of the kidney was very slightly, if at all, marked. Besides, considerable hypertrophy of the heart, nothing else of importance was found.

Dr. J. W. London was called to give evidence on behalf of the Local Board of Health. He said he had never come across the record of an undoubted fatal case of chronic lead poisoning, that this fact is worth remembering as Harris in Zeimms's book Vol. 17 p. 586 says: 'It is worthy of notice that there is no hypertrophy of the heart.'
was not a case of death from lead poisoning or there would have been more lead found in the tissues; that if lodide of Potassium was of any use at all in such cases it was in virtue of its power of locking up the lead in the system as lodide, and so preventing its poisonous effects. He based this opinion he said on the fact that if a solution of lodide of Potassium be thrown into water containing lead, insoluble lodide of lead is produced; he further stated that "before death could take place from lead poisoning you must have more evidence of lead poisoning parallel than this case afforded." He concluded by saying that a charcoal filter would remove the lead from water, and could be depended on for the purpose for two years. Dr. Dobie held, that as the man had suffered for so long a time from the symptoms of lead poisoning and as the albuminuria appeared some time after he was known to have suffered from lead poisoning, the man owed the kidney mischief to the lead poisoning. Further, he accounted for the small amount of lead found in the tissues on that hypothesis, that most if it had been eliminated from the body before death, by the lodide.
of Potassium which had been given to him. The verdict of the coroner's jury was "death from disease of the kidneys, probably accelerated by lead poisoning." This in fact was Dr. Ship's opinion.

The questions raised by the evidence in this case are important, but their solution difficult. Is it possible to say, how much lead you must find in the tissues of anyone before it can be asserted that he died of lead poisoning? I think not. In the first place individuals vary greatly in their susceptibility to the poison. In a family exposed to its influence you may only find only one or two who suffer, and much would depend upon the time from first exposure to the poison to the time of death, as well as upon the treatment followed, as to how much lead could be found in the body. If death took place from coma which usually comes on early in the disease, you would not expect to find so much lead in the system as you would, if after years of suffering, the patient has died of convulsions or from other disease setting in. Further, if lead is eliminated by loss of Potassium or by any other plan of treatment, and there is plenty of evidence forthcoming that such is the case, you would naturally expect
the amount left in the tissues would be proportionately less. Dr. Tidy evidently judges the question from a chemical point of view, which is not exacting, for, in estimating the amount of disease by the pains of lead found, no account is taken of the lead that has probably been eliminated nor of the disease, such as an atrophied and degenerated state of the muscles, which, once produced by the lead, remains perhaps after all trace of lead has gone from the body, but still causes it origin to the lead.

Respecting the use of Carbonate of Potassium. There appears to be abundance of reliable evidence as to its value as a remedy in lead poisoning, and to the fact that it increases the elimination of lead. If the lead were merely locked up in the tissues as carbonate of lead, no good would be obtained, for carbonate of lead is itself poisonous. To assume that lead can only kill after it has seriously damaged the nervous system, producing paralysis and so forth, seems to be taking a very narrow view of the question, for it excludes the possibility of death from kidney disease induced by lead anterior to the involvement of the nervous system. Besides, it is quite possible that death might result from

\* see Woodman & Tidy's new work on jurisprudence, page 190
Convulsions and coma from the direct action of the lead on the brain before paralysis of the extremities had taken place, though usually such paralysis precede the convulsions and coma.

How a charcoal filter will remove lead dissolved in water I cannot understand, it has lately been denied that such can be the case. One can understand how suspended lead salt might be removed by the filter. Heavily water contains lead both in solution & suspension. I have tested the water both before & after filtration. Before, I obtained evidence of lead. After, I found none. Further, people who had suffered from poisoning, could drink the same water with impunity after it had been filtered. I conclude therefore that the filter can be relied upon to remove the greater part, if not all, of the lead.

Of nine other cases of lead poisoning that came under my notice, eight consulted me for colic. All had the blue line in the gums and emetophobia, and all recovered under the usual treatment. The ninth case was diagnosed whilst the patient was under treatment for miscarriage. Whether the lead poisoning had caused the miscarriage
I think doubtful, but it is a possible cause. In many of these cases the attacks of colic were worse at night. Opium internally and friction over the abdomen generally relieved at the time, but there was always a tendency to a recurrence of the pain again and again, until the system was under the influence of bromide or conserve of potassim, when the paroxysms got milder, until they disappeared altogether.