GOULSTONIAN LECTURES

ON

LEAD POISONING IN ITS ACUTE AND CHRONIC MANIFESTATIONS.

Delivered at the Royal College of Physicians of London.

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LECTURE I.

Extent to which Lead Poisoning Prevails.—Early References to the Danger of Contamination of Water by Leaden Pipes.—Immunity of Miners, Liability of Smelters.—Lead Poisoning in Animals.—Trades in which Lead Poisoning is most liable to Occur.—Lead-polluted Water.—Milk and Fermented Beverages.

LET me thank you, Mr. President, for the very great honour which you have conferred upon me in inviting me to become the Goulstonian lecturer for the year. Having accepted the office, I am deeply sensible of the responsibility it involves. Weighty as I feel the duty imposed upon me, it is only equalled by my desire to make these lectures acceptable and instructive.

In searching for a subject I considered that there was one upon which, with the time at my disposal for its preparation and delivery, I might be able, from the opportunities afforded me for its study, to say something that might prove of interest to you and of service to the profession.

Lead poisoning is not only of local but of national importance. The last two years have shown how truly necessary it is for us to realise the dangers that often lurk in the supply of drinking water and of various forms of food. The wholesale poisoning that occurred a short while ago in Sheffield, and which necessitated a scientific inquiry, the poisoning of the inmates of Keighley Workhouse, and the extent to which—in Yorkshire at any rate—it still follows the use of water, and the repeated announcement in the newspapers of coroners' inquests held in London and the North of England upon cases of lead poisoning, all bear testimony to the ruin wrought by lead poisoning, and are my excuse for making it the theme of these lectures. Apart from the epidemics of lead poisoning which have passed over certain towns, owing to the faulty conduction of the water, it is true that the disease usually affects only a small proportion of the labouring classes, but that is one reason why we who are the guardians of the public health should, by increasing our own knowledge, help those who cannot help themselves. Besides, this College is the academic centre from which should issue words of counsel and words of warning upon the dangers of a noxious industry, and the subtle influences of a poison which at any time may be widely diffused. It was in the College of Physicians that in 1767 Sir George Baker, a scientist of celebrity, first drew the attention of the medical profession at once to the production of colica pictonum by the use of cider, and successfully taught how to remedy the evil.

There is a general consensus of opinion that the insidious introduction into the human system of lead in very minute quantities is followed by symptoms of a more serious and persistent character than when taken in larger quantities and for a shorter period. In the latter case we have the symptoms of irritant poisoning, but in the former the symptoms are sometimes so remote that their relationship may escape our attention. So insidiously are the symptoms developed, and so variable, that not only do we as physicians occasionally fail to refer the illness to its proper category, but medical men, the authors of pamphlets on lead poisoning, and who, therefore, have had practical experience of the poison in others, have themselves suffered from the malady without being aware of the nature of their illness.¹ In the cumulative action of the poison lies its danger. Whilst briefly recognising food, water, and fermented liquors as media whereby the poison may be introduced into the system, my experience

has been gained mostly from workers in lead factories. If, therefore, I deal with lead poisoning from the industrial rather than from the accidental side, it is simply because I have in this way seen more of the results arising from exposure of the system to the influence of lead. Lead under any form, if taken for a length of time, will cause poisoning even in the form of its most insoluble compounds, such as the sulphate. The acetate, which is very soluble, and the carbonate and oxide, which are insoluble, as they are acted upon by the gastric juice, are perhaps the most dangerous, unless it be the chromate and arseniate of lead, whose toxic properties would be largely influenced by the chromic and arsenic acid they contain. It is amongst lead workers, however, that we see the metal produce its most disastrous effects, rapidly converting men and women, frequently pictures of health, into human wrecks.

There are other trades besides lead making which are notorious for a high death-rate, and in not a few of them lead is manipulated in some way or other. It is upon those engaged in the manufacture of lead that the poison produces greatest havoc; and yet amongst those engaged in other industries symptoms of a slower but not less severe form of poisoning are also met with. Lead poisoning amongst printers is a thing that has practically gone out of existence. Under any circumstances, amongst printers it would be difficult to attribute death directly to lead poisoning. It can only be done by appreciating the number of deaths due to diseases of organs that are known to suffer in lead poisoning—for example, the kidneys and the nervous system. At the present time scarcely a case of lead poisoning occurs amongst printers. The high death-rate amongst plumbers, painters, and glaziers—who show a comparative mortality figure of 1,202 against 1,000—is mainly determined by their liability to lead poisoning.² Associated with this mortality directly attributed to lead there is an excessively high mortality from diseases of the urinary organs, diseases of the nervous system and circulatory organs. The tendency to diseases of the kidneys in painters has long been known, and by English physicians has been properly regarded as the result of lead. Amongst the file makers of Sheffield lead poisoning is frequently met with. Dr. Porter,³ in his thesis, draws attention to the unhealthy nature of their occupation. Exposed during their work as these men are to all the dangers arising from metallic dust, and in this way with a high death-rate from phthisis—a circumstance which is opposed to the opinion expressed by Tanquerel des Planches as to the protective influence of lead in this disease—they are prone to suffer from lead poisoning. This arises from the fact that these men are obliged to use a cushion of lead on which they strike the file, and thus they are daily inhaling metallic dust. Their high death-rate comes from diseases of the urinary organs: they suffer also from diseases of the nervous system and of the circulation. The next trades on the list with a high mortality from this cause are plumbers and painters.

The employment of the word "plumbism" for lead poisoning needs no explanation, and, beyond the fact that Saturn was the alchemical name for lead, I need only mention that saturnine poisoning, plumbism, and lead poisoning are synonymous.

Lead poisoning has long been known: Galen, in his *De Medicinâ*, condemns the use of leaden pipes, stating that the water which was transmitted through them contracted a mudiness from the lead, and created a kind of dysentery in those who drank it. Nicander—a century before the birth of Christ—described acute poisoning by ceruse, and in his poetic fantasies can be detected an accurate description of details relating to lead poisoning. The Roman architect, Vitruvius, who lived in the time of Cæsar Augustus, forbade the use of lead for conducting water, owing to the ceruse which is formed upon it being hurtful to the human body. Close to the Roman wall, which stretches from Newcastle to the south of Carlisle, built, as many of my hearers know, in the time of Hadrian, there are the remains of Roman camps. Some time ago, in passing over Cilurnum, one of the most perfectly preserved of these camps, I was much interested in finding a leaden pipe jutting out from the wall in a perfect state of preservation, not at all crusted, exactly similar in appearance to

¹ Case of Dr. Norris, quoted by Harrison, *Contamination of Water by Lead*, p. 119.

² Registrar-General's Reports, p. 25.

³ Porter, Thesis for the Degree of M.D., Durham University.

that in use at the present day, except that it had been rolled and not moulded. Dr. Bruce, an authority on the Roman wall, informs me that in the station of Cilurnum lead had been largely used for soldering purposes. I regard these two facts as interesting from the point of view of the antiquary. As a matter of fact, lead would be very little used on the Continent by the ancients. Their reservoirs for holding water were made either of marble or of cement, and their domestic utensils were made of pottery or of copper. In their decorative painting their pure atmosphere encouraged the use of fresco. The oxides of lead, so essential in oil painting, would be readily dispensed with, and thus, whereas at the present time the victims of lead poisoning in this country are numbered by the hundreds or thousands, plumbism must have been, in days long gone by, only an occasional phenomenon. How it fared in this respect with the soldiers of the Roman legions, transferred from the plains of southern Europe to the more uncertain climate of Britain, we have now no means of knowing.

Lead is introduced into the system in many forms. The lead miner never suffers. Dr. Montgomery, of Blanchland, and Dr. Robertson, of Stanhope, both of whom have practised for many years in the dales of Durham, have never met with a case of lead poisoning in the miner. The danger arises, in the first instance, during the smelting of the ore. A few years ago the smelting of lead was a dangerous process, but since manufacturers have introduced a hood in front of the furnace, all the fumes are carried up the chimney, and the smelter to a great extent escapes. The men engaged in this work are generally strong, but most of them are pale, and show a well marked blue line on the gums. So injurious are the fumes which escape from the molten metal that cattle grazing in the neighbourhood suffer severely from symptoms of lead poisoning. This has occurred at Leadhills, in Scotland, and in some of the dales in the county of Durham, where the animals are said to be "bellond," an old term taken from the French *bellon*.

Frequently lead poisoning thus introduced amongst animals, has proved of a wholesale character, and been the cause of litigation. Cattle grazing in the fields in proximity to the smelting furnaces have died, the symptoms having been pain in the abdomen and constipation. Dogs, too, which have lapped the water trickling from lead works, have also suffered. These animals exhibited very peculiar symptoms. The subjects of circus movements, they kept wheeling round and round, and were then seen to fall. Dogs which had simply slept on the coats or jackets of their masters who were lead smelters also became "bellond." A few years ago a very peculiar epidemic occurred in France, where women who had simply washed the clothes of their husbands, who were workers in lead factories, suffered from saturnine poisoning.

Some interesting facts bearing upon this point have recently come to light from Germany. Schroeder and Reuss, in dealing with the influence of forge smoke upon the animals of the forest, state that by the road sides and in the meadows and parks near to the forges are to be found many mountain-ash trees. Their berries are a favourite food with thrushes and some species of finches in autumn, and are used as food by nearly all the birds which remain there during the winter. Below and close to these trees were often found birds sickly or dead. Those that were alive had their extremities contracted, and their power of flight appeared paralysed. In a few days they also died, powerless in their attempt to flutter. Without doubt, they say, here is lead poisoning. The birds eat the berries upon which are deposited the particles of oxide of lead, and thus poison themselves. The wild animals which roam around these forges do not appear to suffer from paralysis of their extremities, but a very peculiar circumstance has been noticed by these observers in regard to stags. Their antlers exhibit certain monstrosities: the branches are short and stunted; the pedicles are small, and sometimes are altogether absent, the rosettes in this case being flat and almost touching the cranium; the branches, too, are not shed, or only one is shed, and as a consequence double crowns appear. These monstrosities are most apt to occur amongst stags whose sexual organs have been injured; for stags, like men, have their reproductive organs affected in lead poisoning. On the meadow hay in the neighbourhood of the Altenau

forges Freytag found a deposit of lead oxide equal to 0.0027 per cent. Since the introduction of the hood in front of the furnace, to which I have already alluded, other arrangements have been made whereby the fumes from the furnace are prevented from escaping, and lead to the extent of 33 per cent. is obtained from the deposit of these fumes. Gamgee, in his work on the *Domestic Animals in Health and Disease*, draws attention to the fact⁴ that cattle have frequently died from drinking water contaminated by lead and from eating grass impregnated with the oxide of lead, and he has shown that the deposition upon land of town manure which contains the refuse of paint, sheet lead from tea chests, and pieces of painted oilcloth has been followed by an outbreak of what is known as "staggers" in the animals that have been allowed to graze in the fields. Additional interest attaches to the fact that certain fields are known by graziers to be dangerous to animals; several crops may even have been raised in rotation before the animals have been placed upon them, and yet death has occurred. The process of working the land and bringing up to the surface lead long buried, and thus allowing it to be influenced by the atmospheric air and rain, explains the danger. Two forms of poisoning, according to Gamgee, occur: the slow form attended by paralysis, and the other acute and due to solid lead having been eaten in large quantities, paralysing the stomach and inducing symptoms such as are met with where animals have filled themselves to repletion, causing obstruction of the third stomach.

Thackrah, in his book on the *Effects of Trades on Health and Longevity*, gives no place to lead-making as a dangerous employment. He introduces the subject in his remarks upon plumbers and painters.⁵ Plumbers suffer, he says, from inhalation of the volatilised oxide of lead arising during a process of casting; they frequently complain of a sweet taste in the mouth during the beating of lead and the application of solder; their occupation undermines the constitution. Plumbers are short lived. In Leeds, at the time he wrote his monograph, only two individuals had regularly pursued their employment beyond the age of 40. His book was written in 1831 and, speaking now sixty years afterwards, I think we can safely say that plumbers appear to be a longer lived class than formerly. Painters follow an unhealthy occupation; lead in their case gains entrance into the system partly through the skin and partly through the lungs. Of the occupations in which lead poisoning is apt to arise by absorption through the skin, that of potters, but only the dippers, suffer most. It is their duty to dip the pots into a solution containing lead; it is this which gives the glaze to the ware. Those who have been long engaged frequently suffer from symptoms of lead poisoning, for example, vomiting, constipation, colic, double wrist-drop and tremors. In industrial occupations, as in things in general, it would appear as if customs die hard. We advance slowly. An old author, Ramazzini, represents the potters of his day as affected with tremors, paralysis, cachexia, and he remarks that almost every man thus employed has a cadaverous face. This remark equally applies to the potters of to-day. Amongst other trades in which symptoms of lead poisoning are met with I would mention leather cutters. Dr. Frederic Taylor, of Guy's Hospital, has recently met with cases of lead poisoning amongst men thus employed. These men cut the leather upon leaden slabs, and come to hospital complaining of colic and constipation, and nearly all of them exhibit a well marked blue line upon their gums.

Lindt⁶ relates a fatal case of plumbism in a woman who had only been employed for half a year in a type foundry. In spite of warning, she ate her food with unwashed hands; there was no paralysis, but anæmia, jaundice, constipation, colic, blue line on gums, and headache, followed by convulsions and coma, death supervening on the fourth day. Women engaged in gumming bands on to cardboard boxes have also suffered from plumbism.

It is amongst lead workers that the worst types of plumbism are met with. So far as the working of lead is concerned, we have seen that the producer of the raw material never suffers; it is the smelter. The next danger arises during the process of the conversion of the metal into

P. 179, vol. i.

⁵ Page 55.

⁶ Sajous, *Med. Annual*, 1889, vol. ii, A. 50.

white lead or carbonate. There is no process of preparation of white lead so far known that is equal to the old Dutch or dry method; it is a simple but dangerous procedure. It was introduced into this country about the year 1780, and is briefly this: Thin sheets of lead are placed upon the top of small earthenware pots, which contain strong acetic acid; the pots are arranged side by side in ordinary tan from the currier, and covered with planks; another layer of pots similarly arranged in tan is placed over these, and over these again another, and thus a "stack" is formed of alternations of planks and layers of pots. This is known as the "blue beds," and is of itself not dangerous. The acetic acid slowly volatilises by the heat induced through fermentation of the tan, and the lead is converted into a subacetate, and subsequently into a carbonate. When the conversion has become complete, girls enter the stack—now known as "white beds"—and remove the layers of carbonate of lead, carrying it in little trays on their heads, first to the rolling mills, where the white is separated from the metallic lead, and subsequently it is taken to the stoves—a chamber not unlike a dairy, shelved all round for the trays to rest upon, and always at a high temperature, seldom less than 190° F. It usually takes about fourteen weeks for the lead in a stack to be completely converted into lead carbonate or white lead. Mr. Forster, of Messrs. James's lead works, tells me that if girls are allowed to enter the stack too soon—that is, before the lead acetate is fully converted into lead carbonate—they suffer very readily and severely from colic. The readiness with which girls suffer in the white beds is always an indication to him of the incompleteness of the conversion of the lead acetate. These two—the "white beds" and "stoves"—constitute, in my opinion, the most dangerous part of lead making. Nothing injures a young girl more quickly than a few weeks of work in the white beds and stoves. After being thoroughly dried the lead is ground and washed, then dried as a fine powder. In this form it is packed in casks, a process attended by a certain amount of danger owing to the dispersion of particles in the atmosphere. It was the opinion, when Sir James Alderson delivered the Lumleian Lectures in this College in 1852, that women were less frequently affected by lead than men; but such is not my opinion. Women suffer far more frequently and more severely than men.

Alderson says there is an impression amongst the workers that the fineness of the pores of the female skin in some way protects them. This is a very doubtful supposition; it rather explains their susceptibility, a susceptibility not only of the female lead worker but of females generally. It has been shown that when the two sexes are exposed equally, as in the epidemics of plumbism from water pollution, the fair sex is weaker, and that their nerve centres are more easily undermined by lead. Of accidental lead poisoning water may be regarded as the principal medium by which the metal is carried into the system. It was towards the end of last century that in this country medical men began to study the connection of lead poisoning with the drinking of water. Dr. Lambe, of Warwick, was amongst the first to examine this subject. He regarded spring water as particularly dangerous and unfit for man, owing to its solvent action upon lead, a power due to the saline ingredients which it contained. Guiton Morveau regarded distilled water as even more dangerous. All the relationship that need be dwelt upon now is the fact that some waters act upon lead, whilst others are destitute of that power. The use of some waters is followed by widespread symptoms of poisoning, as witness the outbreak in Sheffield little more than a year ago, where 129 cases are recorded as coming under the observation of six medical men within twelve months.

It is scarcely within the scope of these lectures to enter into the details respecting the chemistry of lead poisoning and drinking water. Those who are interested in this will find it ably discussed in Christison's treatise on *Poisons*, and by Dr. Brown, of Bacup, in his observations on *Plumbism due to Lead-polluted Water*. Water containing acids produced by vegetable decomposition is prone to act upon lead, and especially that which penetrates peaty soils. In this way, I apprehend, are explained the epidemics of lead poisoning which have recently scourged various towns in Yorkshire. Dr. Downes, in his report to the Keighley Board of Guardians,

found 68 per cent. of the inmates suffering from lead poisoning traceable, as in Sheffield, to the fact that Keighley had a moorland supply of drinking water which had become acid, the acid having been increased by the preceding drought. Bradford and Huddersfield have also experienced lead poisoning, and in Bacup they suffered severely. Dr. Brown found lead to the extent of two-thirds of a grain in each gallon of water.

The account published by Tronchin of an outbreak of lead colic in Amsterdam more than a century ago lends considerable weight to the view here stated. Until that period lead colic was unknown in Amsterdam. Meanwhile, the residents had been substituting lead for tiles on the roofs of their dwellinghouses, and they collected for culinary purposes the water from the house tops. The rain water was of itself sufficient to act upon the lead, but Tronchin showed that as the epidemic was most severe in its ravages in the autumn, the rain water had become impregnated with acid caused by the decay of leaves from the trees which abounded in the city. Acids generated from decomposing matter and acid emanations from manufactories exert a powerful influence in increasing the solvency of water upon lead. Dr. Herbert, of Whitby, thinks that a danger arises from sportsmen shooting over the moors and leaving behind them tons of lead all over the land. Small shot is composed of lead, arsenic, and antimony, and in some places he maintains the ground is simply paved with lead. The effects of this are terrible to contemplate when we know that much of the water on the moors, which becomes impregnated, finds its way into the towns.

A very interesting case of lead poisoning from drinking water came under my notice a few months ago. Last year I was asked by Dr. Smith, of Ryton, to see, in consultation with him, a gentleman, aged 50, who, a few months previously, whilst in the hay field, became suddenly unconscious and fell. The attack was regarded as syncope, but from that date he was never well. He complained of severe pain in the abdomen just above the umbilicus and became extremely depressed in spirits. When I saw him, a few months afterwards, he had all the symptoms of a general paralytic. He still complained of abdominal pain and constipation. He had delusions and fibrillary tremor of the tongue and lips; his right pupil was dilated compared to the left; he was extremely cachectic, complained of a disagreeable taste in the mouth, and a blue line was noticed on his gums. His heart and lungs were healthy. He was sent to the seaside for a few weeks, where all his symptoms diminished, but, on returning home, most of them reappeared, the blue line deepening, and his delusions and depression came back again. There was no albumen in the urine. There was, however, a trace of lead in it. The drinking water was analysed, and analysis disclosed lead to the extent of only 0.0028 grain per gallon. This patient died of an intercurrent disease. He retained many of the symptoms of lead poisoning. At the *post-mortem* examination the principal thing noticed was a very marked accumulation of fluid in the subarachnoid space over the fronto-parietal convolutions, slight thickening of the arachnoid and of the pia mater, extreme pallor and hydræmia of brain, with fluid in the ventricles. His wife had also a blue-line on her gums, but none of the children. The water from the well passed through several feet of lead piping into his house.

It may not be unimportant to observe here that danger from drinking water is mainly when it has become impregnated with vegetable acids. Acetic, citric, tartaric, and malic acids all act with various degrees of solvency upon lead. To the presence of these acids is ascribed the lead poisoning which follows the use of wines and ciders. Many of these beverages have doubtless become accidentally contaminated with lead, as in the case of the Seltzer water now supplied in Paris. Others, again, have been intentionally adulterated. Wine growers have long known how wine that is acid and harsh can be materially improved in taste by the addition of litharge. This is an old-established fraud, and, as far back as the fifteenth century, was sternly prohibited in Germany. The endemic colic of Poitou, which broke out in 1572 and which lasted from sixty to seventy years, has been ascribed, in modern times and with justice, to the wines having been adulterated with lead. I may remind you that it is from this association with a locality that lead colic was described by Citois as *colica Poitou*.

Milk that is sour may easily become impregnated with lead. Cider, ginger beer, and lemonade have also been the vehicles for the introduction of lead into the system.

One of the most interesting cases of lead poisoning from the use of fermented liquors that has recently come under my observation is that which occurred in the practice of Dr. Cromie, of Blyth, in Northumberland. In September of last year he was called to see a "botanic beer" manufacturer. The man, aged 44, had been quite well until two years previously, when he lost his appetite. He had never had colic nor sickness, but he had suffered from constipation and dyspepsia. In February, 1890, he had "wrist-drop;" the paralysis appeared first in the right forefinger, which felt at first stiff and numb, and this gradually extended to the other fingers and then to the wrists. When seen by Dr. Cromie at the end of August he had well-developed double wrist-drop, was very anæmic, had blue line on gums and inner surface of the lower lip. The patient had a convulsion, but soon recovered consciousness. For some time afterwards his speech was slow. With the exception of headache, no warning preceded this fit, which was followed by vomiting and convulsions, sometimes one daily, sometimes two reappeared every second or third day. In his last fit, the seventh, patient remained in a state of coma until death. The interesting point in this case is that the "botanic beer" was carried through forty feet of leaden pipe into the shop, and that every morning before breakfast the man took a good draught of the beer straight from the pipe. He died undoubtedly from lead poisoning. The history of his household is soon told. His wife, aged 28, had formerly a good deal of colour; she is now anæmic. This woman has two children, one aged 5, and the other a little over three. Since the birth of the younger she has had a miscarriage; her menses are regular, but rather profuse. At her husband's instigation she has taken "botanic beer" every day for nearly two years. She was seized with colic twelve months ago, had vomiting, headache, and was constipated, but made a good recovery. Shortly after her husband's death she was again seized with colic, the order of symptoms being first constipation, then vomiting and headache, accompanied by pain in the bowels. When I saw her the colic had disappeared, but she was pale, had well-marked blue line along the gums; her pulse was 80, not unduly hard; there was no cardiac bruit and no albuminuria. Living in the house with her two children was a domestic servant. The maid, though frequently pressed to take the "botanic beer," refused, as she did not like the taste of it. She has remained quite well, has no blue line, and is not anæmic. The elder child has been living most of the time with his grandmother, and has, therefore, not had many opportunities of taking the "botanic beer." He is not distinctly anæmic, is not constipated, and has only the faintest trace of a blue line on his upper gums. His sister, a child of over 3 years, has lived always at home, and since early infancy has received daily a small quantity of this beer; she is very anæmic, and has a blue line on the upper gum. This child when I saw her could not talk nor even walk well. Her knee-jerks were absent. There was a good deal of staggering, as in locomotor ataxia, with much restlessness and fidgetiness; there was no history of colic, constipation, or of vomiting. Three months afterwards this child died of convulsions, which began on October 13th, and lasted until the 24th. The convulsions were never severe, were more of the nature of tremors, and always attended by profuse perspiration; the urine contained a small quantity of albumen. The temperature throughout was normal, except that on the night before her death it reached 100.8°. It is interesting to note that this child had involuntary micturition and defæcation—a circumstance of interest when we know how very frequently in animals poisoned by lead the bladder is found empty, and is seen to contract in convulsive crises.⁷

(To be continued.)

⁷ Moreau, *L'empoisonnement par le Plomb*, p. 73.

PRESENTATION.—On January 30th, at the Norfolk and Norwich Hospital, Mr. H. C. Nance, on the occasion of his resigning the post of house-surgeon, which he had held for six years, was presented by Mr. Cadge, on behalf of the nursing staff, with a handsome fitted dressing bag, with silver mounts.

ABSTRACTS OF THE MILROY LECTURES

ON

DIPHTHERIA;

ITS NATURAL HISTORY, AND PREVENTION.

Delivered before the Royal College of Physicians of London.

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LECTURE III.

THE third lecture was largely devoted by Dr. Thorne Thorne to the subject of "school influence" in relation to diphtheria. That some such influence obtained had been one of the earliest observations following on inquiry into this disease, and it was assumed that the question was simply one of personal infection under specially favourable circumstances. Beyond this the earlier investigations did not go. Dr. Thorne cited as an example of further progress in this matter the story of the Coggeshall epidemic in 1877, from which it was seen that under 3 years of age school attendance did not materially affect the number of attacks; that between 3 and 12 years the incidence was 50 per cent. greater on those attending school compared with those who did not; and that from 12 to 15 years the school attendants suffered three times as much as those not known to attend school. An outbreak at Radwinter was next adverted to, from which it appeared that school attendance had clearly afforded to healthy children at a particular age the special opportunity of coming in contact with others capable of transmitting throat infection. There was also a marked difference in the incidence of the disease at different ages on school attendants and on others; from 3 to 12 years of age 76 per cent. of school attendants were the first attacked in households, whereas, including all subsequent attacks at those ages, they only amounted to 48 per cent. There was also some evidence to show that attack and death were more common, in the same locality, in the case of schools that were overcrowded and ill-ventilated than in others.

But in 1883 an outbreak at Pirbright, which was investigated by Mr. Power, revealed other features of school influence. It was hereditarily shown that the child from 3 to 12 years of age had for a reason other than its age a susceptibility to contract the disease and to convey it home, school-going being the reason in question. Then, again, each time the school was closed the diphtheria practically came to an end; each time it was reopened the disease recommenced, and this without any source of infection that was obvious, although much care was taken to detect any such cause. And although it became quite clear that school attendance had played an important part in the speciality of the diphtheria amongst children at the ages 3 to 12 years, it seemed clear that faulty sanitary circumstances had had no concern that could be detected in bringing about this result. But a further point was illustrated by reference to the facts observed. Not only did diphtheria break out each time school operations were recommenced, but the disease appeared each time with startling suddenness and with fatal gravity, and this without any known intermediate cases which could have admitted of a process of progressive infectiveness, and it seemed that the mere bringing together of the children was responsible for imparting to the throat affection the serious specific quality in question.

Other cases were also cited in which the commencement of school operations had led, after apparent cessation of diphtheria, to sudden "explosions" of the disease; and one instance was quoted to show that other aggregations of children than those actually in schoolhouses operated much in the same way. The case in question was one recorded by Dr. Bruce Low, in which an outdoor school treat was held on a damp day in a tent, after a prevalence of throat disease, the result being that the disease broke out again within twenty-four hours with a virulence and fatality quite in excess of anything that had gone before. And it was held that such aggregations had, under certain circumstances, the peculi-