

Dr. S.W. Wheaton's report to the Local Government Board on diphtheria in the borough of Wrexham / [S.W. Wheaton].

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Wheaton, S. W.
Great Britain. Local Government Board.

Publication/Creation

London : Printed for H.M.S.O. by Eyre and Spottiswoode, 1897.

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**Dr. S. W. Wheaton's Report to the Local Government
Board on Diphtheria in the Borough of Wrexham.**

RICH^d. THORNE THORNE,
Medical Officer,

August 12th, 1897.

On May 6th, 1897, the Town Council of the borough of Wrexham wrote to the Board, enclosing a copy of a Report by the Medical Officer of Health on prevalence of diphtheria in the borough, and asking that a local investigation might be made by one of the Board's Medical Inspectors as to the cause of the outbreak in question. I was accordingly instructed to visit Wrexham, and to report upon the circumstances of the outbreak of diphtheria. I visited the town on May 15th and following days.

(a.) General sanitary condition of the Borough of Wrexham.

The district under the control of the Town Council of the borough of Wrexham has an area of 1,306 acres, and had, in 1891, a population of 12,552 persons, living in 2,353 houses. The population in 1881 consisted of 10,978 persons only. At the present time the population is estimated at 14,500 persons.

The inhabitants of Wrexham are chiefly engaged in the ordinary industries of a market town. There are also breweries, tanneries, and flour mills, which give employment to a large number of persons. The town of Wrexham is situate upon a site which has a general slope towards the River Dee, which is about five miles distant, and which also has a more pronounced fall on each side towards a small stream, the Gwenfro, which flows through the centre of the town. The situation of the town is favourable to the free circulation of air, since there are no hills in the immediate neighbourhood to check the force of the winds; and the whole of the town is situated at a considerable elevation above the sea-level. As is the case with many ancient towns, the central portion contains a number of streets which are narrow and crooked for the most part, the intervening space being occupied by collections of courts, and dwellings which are irregularly grouped, so as to obstruct the lighting and ventilation.

In the outlying portions of the town are many dwellings of the villa type, which are detached or semi-detached; and of late many new streets, containing dwellings for the working classes, have been formed in the outskirts of the town.

Owing to its position as an important market town, and as the centre of a large and populous coal-mining district, Wrexham is very liable to the risk of importation of infectious disease from a large number of surrounding towns and villages. There are three weekly markets, on which occasions large

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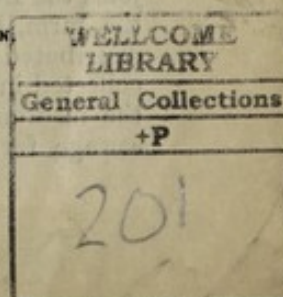
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numbers of strangers enter and leave the town. On Saturdays, in particular, several thousand persons flock into the town from the neighbouring colliery districts. The courts in the central portions of the town, where also the common lodging-houses are situated, are largely occupied by persons of the hawker class, who make Wrexham a centre from which to visit the populous colliery villages around.

The soil upon which the town is situated consists largely of drift, composed of gravel and boulders; sand and clay are also found in places.

Condition of Dwellings.—In many of the courts of the town the dwellings have no means of through ventilation, and are without windows in their rear. Frequently, owing to the proximity of neighbouring buildings, which obstruct the access of light, dwellings are very dark. The courts in the town are generally approached by narrow passages passing underneath the upper rooms of houses fronting the main thoroughfare. These passages, as also the courts, are laid with rough cobble stones; or, as is not unfrequently the case, are unpaved. The down-spouting from roofs of dwellings in these courts is, as a rule, unconnected with the drains, so that rain water is discharged on the surface of the court, and soaks into the ground in the neighbourhood of dwellings, owing to the imperfect covering of the surface. Other matters, such as slops thrown on the surface of the court, liquid refuse from overfull or dilapidated ashpits, or from manure heaps, also soak into the ground in these courts. The surface of courts and yards is also frequently very irregular, so that after rainfall, water stands in pools. Sink pipes from dwellings frequently discharge into a rough, uneven, surface channel, leading to a gully which is usually placed in the centre of the yard. Consequently a considerable portion of the slop water escapes into the soil in the neighbourhood of houses. This last-mentioned defect is found, even in the case of newly-built dwellings, the yards of which are also frequently laid with cobble stones only, or are imperfectly paved with bricks.

Water Supply.—This is in the hands of a private company. Water is obtained from springs and adits in the neighbouring hills, and is supplied from a reservoir in pipes by gravitation, having previously been filtered through sand. The supply is, as a rule, a constant one; there are few supply-cisterns in houses. Water-closets are, as a rule, supplied with water each from a separate cistern. The town-water is also used for flushing the sewers and for watering the streets.

Sewerage.—The town was sewered about 30 years ago, according to plans prepared by Sir R. Rawlinson. The main sewers were formed of brick, and the smaller sewers of socketed glazed pipes. All the sewers discharge into an outfall sewer, which is of brick and 30 inches in diameter. The greater part of the rain water enters the sewers. The sewers of the town are ventilated by open gratings in the middle of the streets, and by iron shafts. The sewers are flushed by a tank water cart. The condition of the sewers appears to be satisfactory; there is a good fall in most instances, and the flushing appears to be efficiently performed. The outfall sewer follows the course of the Gwenfro stream for a short distance, and there is a storm overflow from the sewer into this stream at a point just above the two settling tanks into which the outfall sewer discharges. The settling tanks are each 180 feet long by 12 feet wide and $4\frac{1}{2}$ feet in depth, and are used alternately. In the tanks the heavier matters in the sewage are deposited. The settling tanks are about 300 yards from any considerable collection of dwellings. The material deposited in these tanks is removed, placed in the neighbourhood of the tanks to dry, and is subsequently sold as manure to farmers. After passing through one of the tanks, the sewage is conveyed in a brick outfall sewer to the sewage farm, which is about four miles distant from the town. The farm is 210 acres in extent. It consists of land bordering the Clywedog river, and having a general fall towards this river. The River Clywedog joins the Dee about $2\frac{1}{2}$ miles below this sewage farm. Of the land comprising the farm, 180 acres can be used for reception of sewage. The sewage is distributed on the land by broad irrigation. The effluent from the land is collected in open ditches, by which it is discharged either directly, or through the medium of highway drains, into the Clywedog. The condition of the sewage farm, and of the effluents from it, is not satisfactory. At several



points on the farm sewage collects in hollows on the surface, forming ponds of sewage, from which it overflows directly into the ditches without passing through the soil. In this manner the effluents are fouled by unfiltered sewage. The soil of the sewage farm is for the greater part composed of drift gravel and sand, and appears to be well suited for the treatment of sewage.

House Drainage.—When the town was sewered the then existing house drains were for the most part retained, and connected to the new sewers. I am informed that the house drains are frequently found to be of too large a diameter, or of unsuitable fall, or with uncemented joints. There appear to be a number of old disused house drains in different parts of the town. The house drains of the newly-built houses are formed of socketed glazed pipes, with properly cemented joints; and in many instances are ventilated by a shaft connected to the drain near its junction with the sewer. The inlets to the greater number of the yard drains are fitted with an old-fashioned D-trap with a thin lip. This trap is composed of thin iron, and holds only a very small amount of water, consequently in dry weather it is frequently found to be unsealed. The lip, which forms the seal of the trap by dipping into the water, is often found to be broken, or partially dissolved by the action of sewage, so that the trap is useless. These traps have another drawback, inasmuch as it is necessary to fit them on to the top of a brick chamber, from the lower portion of which the house drain leads. This chamber is uncemented, as a rule, and thus may allow of soakage of sewage into the ground. Deposited matters also collect at the bottom of the brick chamber, and there decomposing may give rise to nuisance. Since the trap is merely dropped into position on the top of the brick chamber, the chamber is never tightly sealed. These traps are soon blocked by a small amount of débris washed into them. After a shower of rain, yards and courts are often found partially covered with water, owing to the blocking of the trap from this cause. These objectionable traps are in use both for the newly-built and for the older dwellings. There are suitable earthenware, syphon trapped, gullies in use for the newly-built dwellings in some instances.

Excrement Disposal is effected almost entirely by water-closets. There are only 15 midden privies in the borough. Water closets as a rule are furnished with a separate supply of water for flushing. A few water-closets are hand-flushed. The closet-pans are usually of the long hopper type. Closets which serve the dwellings of the labouring classes are situated out of doors. In the case of such closets, the soil pipe is usually unventilated. In houses of a superior class, fitted with indoor water-closets, the soil-pipe is in most instances ventilated by its prolongation upwards above the level of the eaves of the roof. Defects are frequently found in connexion with the water-closets in the courts and yards owing to the rough habits of the inhabitants of these places. For instance, the fittings are frequently broken or stolen, pans are broken, and soil-pipes are blocked by large articles thrown down the closet.

Refuse Disposal is by means of receptacles the majority of which are uncovered. As a consequence of this want of covering rain-water causes dampness of their contents, and hastens the decomposition of refuse contained in them. The ash-pits, which are usually of brick, are frequently so much dilapidated that their contents escape. Ash-pits are nearly always too large; many of them will hold several cartloads. Ash-pits are frequently situated too close to dwellings. In two instances ash-pits were observed which were situated beneath the floors of bedrooms. The collection of refuse is carried out by the staff of the Town Council, under the superintendence of the Inspector of Nuisances. The ash-pits are emptied on notice being given by householders. As the result of this system ash-pits are usually emptied from three to four times yearly, sometimes at longer intervals. Ash-pits are frequently used jointly by several households, consequently there is no one person upon whom the duty of sending notice devolves, and the refuse accumulates until the attention of the Inspector of Nuisances is called to it as productive of nuisance. Overful ash-pits were not unfrequently noted by me in the borough, and it is evident that the present system does not work

satisfactorily. The greater part of the refuse from ashpits is removed to a depôt situated on land belonging to the Town Council. On the same site are the public slaughter-houses, seven in number, a knacker's establishment, a piggery, at which 60 pigs are frequently kept at one time, and a tripe boiling shed. The blood and other matters from the slaughter-houses, the drainage from the pig-sties, and liquid matters from the knacker's and from the tripe boiler's are collected in a cesspool. The contents of this cesspool are pumped on to the ashpit refuse, which is collected in mounds after mixing with road-sweepings and the refuse and sweepings from the markets. The offal from the slaughter-houses, and the offal from the knacker's and tripe-boiler's, are also added to these mounds. The matters mixed together in these mounds are allowed to ferment, liquid from the cesspool being pumped on them from time to time. Subsequently, when fermentation has almost ceased, the material is sold as manure. In the process of fermentation an offensive effluvium escapes from the mounds of refuse.

Nuisances arising from the keeping of animals.—Nuisances of this description are common in Wrexham, a number of horse fairs being held here. The town is a centre for dealing in horses of all descriptions. Several hundred horses are brought into the town three times weekly, on market days, and accommodation is provided for these at various places in the town. One set of stables affords accommodation for 600 horses, and there are many very large stables attached to several of the inns. Many of the stables are in proximity to dwellings. The structure and condition of stables is satisfactory in some instances, but in others very unsatisfactory. Many stables are mere sheds, and are undrained, without proper flooring, and imperfectly ventilated. There are frequently no proper pits for manure, and where manure pits are provided they are uncovered. In many instances, drainage from stables and the liquid matters washed from manure heaps by rainfall flow over the imperfectly paved yards, or, standing in pools, percolate into the ground in the neighbourhood of dwellings. There are no regulations for the periodical removal of manure. As a consequence of absence of such regulations, manure from stables is allowed to accumulate until large amounts have collected, in order to save expense in cartage. Where, as is frequently the case, such accumulations are in proximity to dwellings, a nuisance cannot fail to arise.

A very large number of pigs are kept in the town. There are two piggeries at each of which 60 or more pigs are at times kept, and, as well, numerous smaller ones. In some instances sties are without means of drainage, in others the drainage from pigsties flows in roughly-made channels in yards for some distance before reaching the yard gully, thus giving rise to nuisance. Sometimes the drainage from sties is collected in cesspools.

Fowls are frequently kept in yards or courts, in proximity to dwellings, and in such a manner as to give rise to nuisance.

Slaughter-Houses.—There are nine slaughter-houses in the town, which are registered. Seven of these are public slaughter-houses, and adjoin the refuse depôt belonging to the Town Council. The condition of the slaughter-houses is fairly satisfactory.

Cowsheds, Dairies, and Milkshops.—There are 51 persons who are registered as milk sellers in the borough. The condition of cowsheds in the borough is not satisfactory. Their flooring is frequently defective, their means of drainage faulty or absent, and their ventilation imperfect. These sheds are frequently situated in proximity to dwellings. There are a few cowsheds which are not registered. The dairies in the town are not satisfactory; and they frequently are small rooms in dwellings, often imperfectly ventilated. There are, in addition, a few shops at which milk is sold, for instance, a confectioner's and a butcher's. The Town Council have regulations for dairies, cowsheds, and milkshops.

Bakehouses.—There are 29 in the borough. In the more newly built parts of the town the bakehouses are satisfactory, but in the older parts of the town a few are situated underground, and are imperfectly ventilated. Others in the older parts of the town are in proximity to ashpits or other possible sources of noxious effluvium.

Common Lodging Houses.—There are seven registered common lodging-houses in the town. Their condition is in some instances fairly satisfactory.

In other instances they are old buildings, which are not suitable for the purpose to which they are put, owing to defective lighting and ventilation.

Isolation Provision.—The Town Council have the use, jointly with the Wrexham Rural District Council, of an isolation hospital. This hospital, which provides accommodation for 41 cases of infectious sickness, is situated just outside the borough boundary. The buildings are of one storey only and are arranged in two blocks, each consisting of two wards, each ward providing eight beds. There is in addition a third block, which consists of three wards, providing two, four, and three beds respectively for the isolation of cases the exact nature of which may be for the time doubtful. The matron and nurses are also provided with accommodation at the hospital.

Disinfection.—There is a disinfecting apparatus in connexion with the isolation hospital, to which bedding and other articles are removed from dwellings in the town for disinfection by hot air.

From the foregoing account it will be seen that there are many conditions tending to cause foulness of the air in the neighbourhood of dwellings in Wrexham. There are too, many circumstances leading to pollution of the ground in the neighbourhood of dwellings by filth of animal origin. Also circumstances tending to cause dampness of the ground around dwellings, more particularly in the older and more central parts of the town.

(b.) *Prevalence of Diphtheria at Wrexham.*

For many years past there has been no extensive prevalence of diphtheria at Wrexham. During the year 1895 two attacks were notified of which one terminated fatally. The first of these attacks occurred in January, the second in October. In the early part of 1896, however, a prevalence of diphtheria commenced which, with the exception of a short period limited to the month of June 1896, during which month no attacks of diphtheria were notified, continued up to the end of April, 1897. During 1896, 91 attacks of diphtheria were notified and 3 attacks of croup. During 1897, up to April 30th, 31 attacks of diphtheria have been notified, with 1 attack of croup. The attacks of diphtheria during 1896 were notified as follows: 1 in January, 4 in February, 7 in March, 2 in April, 3 in May, 8 in July, 6 in August, 11 in September, 20 in October, 16 in November, and 13 in December. One attack of croup was notified in March, 1 in May, and 1 in October. The notified attacks of diphtheria in 1897 were distributed as follows: 5 in January, 6 in February, 6 in March, and 14 in April. One attack of membranous croup was notified in April. There were thus in the period from January 1st, 1896, to April 30th, 1897, 122 attacks of diphtheria notified, and 4 attacks of croup (membranous or diphtheritic). Of the 122 attacks of diphtheria, 36 are known to have terminated fatally, and of the 4 attacks of croup, 3 have had a fatal termination. The fatality rate of the diphtheria has thus been very high, 29.5 per cent. Five additional attacks have also occurred among the staff of the Isolation Hospital, and one in the person of the mother of a child who remained at the hospital in order to tend her infant.

I made personal inquiries into the circumstances attending 118 attacks of diphtheria, and visited the dwellings in which these attacks had occurred. The suggestion that the diphtheria had been of severe type was confirmed by my inquiries. I also found that paralytic symptoms of marked severity had occurred subsequently to the attack of diphtheria in many instances. There was also no doubt that the four attacks of croup notified were diphtheritic in nature, as evidenced by their fatality rate and by the presence of paralytic symptoms. I found that the diphtheria in question had not been limited to any particular part of the town, that the invaded households were distributed more or less all over it. The disease had been chiefly confined to the households of the working classes, the households of a few only of the tradespeople and commercial classes had been invaded. With respect to the age incidence of the disease, out of 122 attacks of diphtheria, 63 or 51.6 per cent. were under 5 years of age; 45, or 36.9 per cent., from 5 to 14 years of age; and only 14 or 11.5 per cent. above the age of 14 years.

Prevalence of Anomalous Throat Affections.—During the year 1896 there was a remarkable prevalence of throat affections of one and another sort

among children at Wrexham. From my inquiries I found that throat affections existed early in January 1896, and were at that time prevalent among the children of the working classes. This incidence of throat affections was so marked that I was informed that there was scarcely a single family in the town the children of which had not suffered therefrom. I was not able to ascertain that these throat affections were prevalent in the town prior to January 1896. The prevalence of throat malady diminished during the summer time, but recurred again with especial prominence in the autumn and disappeared before the beginning of the winter of 1896-97. The Medical Officer of Health, Mr. R. W. J. Evans, in his annual report for the year 1896, remarks as follows:—"there has been during the year a very large number of throat diseases among the children of the town, more so in fact than at any time during the last 25 years of my medical experience in the borough, mumps, sore throat, enlargement of glands in the neck, and other kindred affections." With regard to the precise character of the throat affections in question, I could not obtain very much information, since it was seldom that a medical man had been called to see the sufferers. The disease had been generally called mumps by the parents of the children, and not thought sufficiently grave to require medical treatment. Children suffering from these throat affections were not withdrawn from attendance at school. What information I could obtain with regard to the character of the sore throat which had been so prevalent was to the effect that the lymphatic glands of the neck were swollen in almost all instances, but not the parotid glands, thus showing that the disease in many instances was not mumps. Accompanying the swelling of the glands of the neck was, in some instances, a moderate amount of swelling of the tonsils, with redness of their surface, followed by the formation of a superficial "slough." This "slough" on the surface of the tonsils soon disappeared, vanishing as a rule in three or four days without any special treatment. From my own inquiries, and from information which I obtained, I found that paralytic symptoms had not been known to follow the sore throat so prevalent in the town. As the result of my inquiries in the town, I could find no evidence of any prevalence of sore throat among children in any part of the town at the time of my visit; it was evident that these throat affections had disappeared. I visited the public elementary schools in the town, which are three in number, the Madeira Hill School, the British School, and the Roman Catholic School. All three schools have departments for infants. I could not find any indication of throat affections among the children then attending the schools, and the children for the most part presented a healthy and robust appearance.

No bacterial examination of the prevalent throat affections had been made. In some instances of diphtheria which occurred during prevalence of these throat affections, bacteriological examination of the secretions from the fauces had been made by competent observers with positive results.

As to the Diphtheria.—With regard to the possibility of milk acting as a source of infection, it was found that the invaded households had been supplied from no less than 28 different milk-sellers, and that there had been no special incidence upon the families consuming the milk of any particular milk-seller. No information was obtained of any outbreak of disease among dairy cows. No instance of the selling of milk which had been kept for sale upon premises where an attack of diphtheria had occurred came to my notice. There was, therefore, nothing to suggest that milk had acted as a source or medium of infection. No information of any disease having any resemblance to diphtheria among fowls, cats, or other domestic animals could be obtained.

It had been suggested to the Town Council that emanations from the sewers had been concerned in the outbreak. Careful inquiry was made as to this. At the time of my visit I did not find any evidence of emanations from the sewers; the sewers also appeared to be free from deposit, and efficiently flushed. Dwellings in which attacks of diphtheria had occurred were not in connexion with any particular sewer. In five instances only did it appear that emanations from the sewers had been escaping directly into dwellings in which diphtheria had occurred. Into two of these dwellings sewer gas had escaped from the

soil pipe of waterclosets; in two the sink pipe terminated inside the house, and was not disconnected from the sewer; and, in one instance, a disused drain in connexion with a sewer terminated beneath the floor of a passage. Six attacks of diphtheria had, moreover, occurred in a row of 16 cottages which were not connected with any sewer. There was, therefore, nothing to suggest that emanations from the sewers had acted in the manner before-mentioned.

Accumulations of refuse in ashpits in proximity to dwellings did not appear to have had any special concern in the diphtheria, since in certain courts and yards where such accumulations were greatest, and where they were found very close to dwellings, diphtheria had been absent. In many instances also the ashpits of dwellings in which diphtheria had occurred were small, and had been emptied at frequent intervals, so that they could not retain large accumulations of refuse. In other instances the ashpits were situated far from dwellings.

Residence in unwholesome dwellings, in dwellings for instance which being situated in courts and yards, were imperfectly lighted and ventilated, did not appear to have any marked influence in predisposing to diphtheria. In many instances dwellings which were especially unwholesome, owing to defects of their structure and surroundings, were not invaded by diphtheria; whereas many newly-built dwellings, with a sufficient amount of light and of surrounding air-space, were invaded by the disease. Indeed, of 94 dwellings which were invaded by diphtheria, in nine only was especial unwholesomeness noted.

The diphtheria, therefore, could not be attributed to any one especially unwholesome condition existing in the town, and it would appear either that the disease had been introduced from without, or that it had arisen out of some previous conditions, such as, for instance, the sore throat which has been already mentioned.

The first attack, which was notified on January 16th, 1896, did not appear to have had any connexion with the attacks which occurred in the town subsequently. This attack occurred in the person of a lad aged 15 years, living in a large villa residence, which is detached, situated some distance out of the town, and considerably removed from any other houses. This lad had, on a former occasion, suffered from diphtheria when seven years of age. On the present occasion he had returned from a holiday spent at Birmingham, and had been at home for some days before he was found to be suffering from diphtheria. This lad's younger brother contracted the disease subsequently, but no further attacks could be traced to this source. Both these lads recovered from their illness. Neither of these children had attended a public elementary school in Wrexham. The first sufferer had not been to the private school which he usually attended there for one month before the onset of his illness, and the younger lad had not attended any school for several months before his illness. In the dwelling occupied by the family to which these sufferers belonged, the soil-pipe from the watercloset was carried down through the kitchen, and a free escape of sewer air had taken place from the joints in the pipe, which were faulty, into the house; so much so that a foul smell was said to have been perceptible on entering the door.

The second attack was notified on February 4th, 1896, in one of a row of 16 cottages in Holt Road. These cottages have been already mentioned as illustrating the occurrence of diphtheria in dwellings which were not connected with the sewers. The dwellings in question adjoin the plot of land on which is situated the refuse depôt, and also the public slaughter-houses, a knacker's establishment, premises occupied for tripe boiling purposes, and a large piggery. The 16 dwellings composing this block are newly built, and there is sufficient surrounding space for their efficient lighting and ventilation. With the exception of the house occupied by the inspector of nuisances, these are the only dwellings in the vicinity of the refuse depôt. Of these dwellings, the nearest is situated about 200 yards from the collection of refuse at the depôt. When the wind blows in a certain direction the inhabitants of these dwellings are exposed to emanations from refuse at the depôt. The site is a low-lying one, and, in consequence, there is not sufficient fall to allow of the connexion of the house drains with the sewers. The slop sewage from the dwellings is conducted to a cesspool, from which, I was informed,

it occasionally overflows into a neighbouring ditch. These are the only dwellings in the borough which are served by midden privies. The midden privies are situate a few yards from the houses and are covered in. At the time of my visit the contents of some of these privies were wet and offensive, owing to the occupiers of the dwellings throwing slop water into them. At the rear of each dwelling is a small yard, paved with brick, in which is situated a gully of the objectionable D shape, which serves as the inlet to the yard drain. I heard complaints from the inhabitants of these dwellings respecting offensive odours proceeding from the yard gullies. From my observation it was evident that such offensive emanations could have been produced in several ways. Such emanations might have been caused by escape of foul gases from the cesspool in which the slop drains discharged. On the other hand offensive effluvium may have arisen from the gullies, the defective character of which has been before referred to; or the sewage flowing upon the surface of the yard in its course from the sink pipes to the gully may have caused nuisance by soaking into the ground between the bricks with which the yards were laid. In the rear of the smaller yards is a large yard common to all the dwellings. In this large yard the children from the different dwellings played together, so that there were abundant opportunities for the conveyance of infection from one child to another living in the same block.

The result of my inquiries showed that the occupants of these dwellings frequently suffered from sore throat, and that in the months of January and February 1896 there was a more or less extensive prevalence of sore throat among the children of the families occupying them. This sore throat was not confined to the members of households in which recognised diphtheria subsequently occurred. Five attacks of diphtheria and one attack of membranous croup have been notified as occurring in these cottages. The six attacks of illness occurred in three households. I found on inquiry that the attacks of diphtheria were preceded and accompanied by attacks of sore throat, which affected other members of the invaded households. The first sufferer here by diphtheria was a girl aged seven years. She was taken ill with diphtheria on February 1st, 1896, though her attack was not notified until February 4th. The child had been ailing for several days before a medical man was called in, and had been attending the Madeira Hill School whilst so ailing. She was removed to hospital and died there five days later; her sister, aged four years, who was also attending the Madeira Hill School, was, on February 9th, found to be suffering from diphtheria, and was also removed to hospital. The third attack in these dwellings was in the person of a girl aged four years who had attended the Madeira Hill School, but had been kept at home for some months preceding her illness. This child was attacked on March 21st, and was removed to hospital; on the same day her sister, aged two years, was removed to hospital, having been notified as suffering from membranous croup. Both these children died in the Isolation Hospital. Other members of this family who were attending the Madeira Hill School suffered from sore throats. On March 22nd a male infant, aged one year, living in the dwelling next but one to that occupied by previous sufferers, was attacked by diphtheria and removed to hospital, on April 7th. A sister of this infant, aged three years, was also found to be suffering from diphtheria, and was similarly removed to hospital.

On consideration of all the circumstances it appeared probable that the epidemic of diphtheria commenced in these dwellings, and that the infection was carried by children from these dwellings to the Madeira Hill School, which they were attending. The source of the diphtheria in these Holt Road cottages is, however, obscure. There was no information obtained which would suggest that the diphtheria was brought there from elsewhere by personal infection; but it is possible that the infection of diphtheria might have been brought with refuse to the refuse depôt, and that it might have been conveyed thence to the dwellings by wind-blown dust. Very possibly, too, emanations from the adjoining refuse, and from the midden privies, together with the unwholesome character of their surroundings, predisposed the inhabitants of these dwellings to attacks of sore throat. Whilst suffering

from such sore throat they were likely to be especially susceptible to infection from diphtheria.

With regard to the spread of diphtheria after the disease had once become established in Wrexham, there is abundant evidence to show that this occurred chiefly by personal infection, and mainly by personal infection received while attending school.

The infection was undoubtedly present in the Madeira Hill School at the beginning of February, since the second child who was attacked in the course of the outbreak was attending these schools for several days whilst suffering from illness which, when a medical man was called in, was found to be diphtheria. This child's sister, who was subsequently attacked with diphtheria, was also attending the same school, and many children from the block of dwellings in Holt Road, which has been referred to as the probable place of commencement of the outbreak, were attending this school whilst suffering from sore throats. As is well known, persons suffering from sore throat during diphtheria prevalence, although their sore throat may not have the characters associated with true diphtheria, have yet apparently ability to convey the infection of diphtheria to other persons who may be susceptible to infection.

In 88 invaded households in which the 118 attacks of diphtheria occurred, the first individual to be affected was attending one of two public elementary schools in 55 instances, or 62.5 per cent. The two schools which thus appear to have been instrumental in the dissemination of diphtheria are the Madeira Hill School and the British School.

In 13 households in which the first person attacked by diphtheria was either below or above school age, and, therefore, was not attending school, other members of the family were in the habit of attending school. Of these 13 households in 7 instances other members of the family were attending the British School, in 5 the Madeira Hill School. In the remaining household, where a child 3 years of age was attacked by diphtheria, another member of the family was attending the Roman Catholic School. This is the only instance in which any attack of recognised diphtheria occurred in relation with the Roman Catholic School; indeed the infection of diphtheria does not appear to have reached this school, although about 300 children attend it.

It is noteworthy also that, as I am informed by Dr. E. Davies, there has been no diphtheria at the workhouse. There are on an average about 50 children at the workhouse. These children do not mix with the children of the town, and attend a separate school at the workhouse.

Of the 12 invaded households in which the first attack of diphtheria had not occurred in the person of a child attending the British or Madeira Hill Schools, but in which other members of the family were attending these schools, there was in six instances a clear history of throat troubles among members of the family attending school at or about the time at which the first sufferer was attacked by definite diphtheria. It is, therefore, probable that in these instances the infection was conveyed by these children from the school to their homes, either through the medium of minor throat affection from which they were suffering, or by relation with children attending school who were suffering from diphtheria in a mild form. Once the infection of diphtheria had been introduced into the schools, its subsequent spread would be facilitated by the throat troubles which were so prevalent among children in the town during the year 1896. As has been said, there can be little doubt that the existence of throat trouble increases the susceptibility of the sufferer to infection by diphtheria. With regard to the source of these throat troubles, which have been so prevalent among children in the town, I am disposed to attribute their prevalence to the contamination of the air in the neighbourhood of dwellings by conditions which have been mentioned in the first part of this Report. Among the indirect causes of foulness of the atmosphere must be especially mentioned the emanations from a soil polluted by soakage of filth from manure heaps, by washings from overfull or dilapidated ashpits, by soakage of sewage from imperfectly constructed surface channels leading to yard gullies, and by liquid matters from undrained stables, cowsheds, or pigsties. Among the causes of direct pollution of the air in the neighbourhood of dwellings must be especially mentioned accumulations of manure, especially horse manure, and accumulations of refuse in uncovered ashpits.

In addition to the influence of attendance at school in spreading diphtheria it became evident, as I found as the result of inquiry, that the disease had to a certain extent been spread by personal infection in households. This personal infection was due either to close relation with the sufferer or members of the same household, or to mixing together of children who were suffering from mild, or unrecognised, attacks of diphtheria with other children in yards and streets where children played together. The fact that a greater amount of diphtheria did not occur in these circumstances may be accounted for by the activity of the Town Council in removing sufferers to hospital, and in carrying out disinfecting operations.

The usual procedure with regard to disinfection has been as follows:—On the removal of the sufferer to hospital, or on his or her recovery, the room occupied by the sufferer during illness is fumigated by burning sulphur. During the latter part of the diphtheria prevalence the use of sulphur has been discontinued, and oil of *sanitas* has been evaporated by means of heat in the room. All clothing worn by the sufferer during the illness, and the bedding, have been allowed to remain in the room during the fumigation process, and have afterwards been removed for disinfection by heat in the disinfector at the hospital. After fumigation the room, if it appeared to be dirty, has been limewashed and the walls stripped and repapered; but where the room appeared to be clean nothing has been done to the walls and ceiling after the fumigation. Carbolic powder has been supplied to householders of infected dwellings, along with instructions that it should be placed in the water in which the sufferer's clothes were to be washed, and also thrown down drains and water-closets. There has been no flushing or cleansing by disinfectant of yards attached to infected dwellings, nor systematic removal of the contents of ashpits from such dwellings immediately after the occurrence of the infectious illness.

The Medical Officer of Health has in some instances given verbal instructions as to measures to be taken for avoidance of personal infection, where sufferers from diphtheria were cared for in their homes, but chiefly only to those who were his patients. No printed instructions for avoidance of infection in dwellings, and for disinfection, have been issued. The disinfection of dwellings and clothing has been carried out, under the superintendence of the Inspector of Nuisances, by an employé of the Town Council, free of charge to householders.

The Infectious Disease (Notification) Act, 1889, was adopted by the Town Council in 1889. No measures have been taken for the notification to school teachers by the Medical Officer of Health, or by the school teachers to the Medical Officer of Health, of the occurrence of infectious illness among scholars, or in families members of which were attending schools.

The parents of families in which infectious illness has arisen are given verbal notice to withdraw the children from school so long as the infectious illness exists in the household, and as long as the sufferer is not declared free from infection by the medical attendant.

Where a child attending school has suffered from infectious illness, such as diphtheria, the parents are, as a rule, advised not to allow the child to return until seven days have elapsed subsequent to its recovery and declaration of freedom from infection by a medical man.

There was, however, one flaw in the disinfecting operations as carried out. Where sufferers from diphtheria were not removed to hospital, disinfection was only carried out by the officers of the Town Council on the receipt of written notice from the householder or from the medical attendant that the sufferer was convalescent, and that the premises were ready for disinfection. As the result of inquiry I found that in several instances this notice had not been given. Consequently the disinfection was carried out by the householder, or other person in charge of the sufferer, only, and often was imperfectly done.

For assistance in the course of the investigation I am indebted to Mr. R. W. J. Evans, Medical Officer of Health for the Borough of Wrexham, and to Dr. E. Davies, Medical Officer of Health for the Wrexham Rural District; also to Mr. Moore, the Inspector of Nuisances for the Borough of Wrexham.

S. W. WHEATON.

June, 1897.