Dr. S.W. Wheaton's report to the Local Government Board on enteric fever in Barnstaple Borough.

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LOCAL GOVERNMENT BOARD

ON

PUBLIC HEALTH AND MEDICAL SUBJECTS.

(NEW SERIES No. 69.)

Dr. S. W. Wheaton's Report to the Local Government Board on Enteric Fever in Barnstaple Borough.

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Dr. S. W. Wheaton's Report to the Local Government Board on Enteric Fever in Barnstaple Borough.

ARTHUR NEWSHOLME,
Medical Officer,
June 17th, 1912.

For many years past there has been a good deal of enteric fever in the town of Barnstaple. Since 1896, in which year the Infectious Disease Notification Act, 1889, was adopted, a considerable number of attacks have been notified yearly. The annual attack rates per 1,000 of the population, calculated on the population for 1901, were, from 1902 to 1910 inclusive, ·99, ·78, ·28, 1·84, 1·06, ·92, ·28, ·42, ·42.

On September 14th, 1911, the medical officer of health reported to the Board the occurrence of 12 attacks of enteric fever during the previous six weeks; and stated that 28 cases had been notified since the beginning of the year. On September 21st the medical officer of health forwarded a report on the outbreak, in which he stated that he could not explain its origin. He had suspected its spread by water supply, but thought that, on the whole, personal infection had played a large part in the outbreak. On October 24th the medical officer of health reported that 16 further cases had occurred, and that in many instances he had traced direct infection from one case to another. Under these circumstances I was instructed to make enquiry into the outbreak of fever, and I visited the town on November 10th, 1911, and following days.

The borough of Barnstaple lies at the north-western corner of the county of Devon, at the head of the estuary of the river Taw, and is about eight miles distant from the Bristol Channel. In the Preliminary Report on the Census of England and Wales for 1911, the population of the borough is returned as 14,488 persons, that of 1901 having been 14,137 persons, an increase in the intercensal period of 351 persons. The area of the borough is 2,235 acres, of which eight are water. The area consists of the combined parishes of Barnstaple and East Pilton. In 1911 there were 3,540 separate occupiers in the borough. In 1901 the number of inhabited houses was 3,144. In 1901 there were 6,369 males and 7,768 females in the population, an excess of 1,399 females. The greater part of the town is situate on an alluvial area between the rivers Taw and Yeo. The town is enclosed by an amphitheatre of hills, except towards the west, where it faces the estuary. The subsoil on which houses stand is alluvial, consisting of sand, gravel and clay. The site is rather flat and in parts liable to flood from the river Yeo, or from unusually high tides when favoured by high westerly winds. The average yearly rainfall is 36·56 inches. Situate in the centre of the Barnstaple Union, which includes important watering places,

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such as Lynton, Ilfracombe, Combe Martin, and Braunton, all the traffic to which passes through the town, Barnstaple is an important railway centre. It is also a seaport and market town, with two weekly markets and important horse and cattle fairs. The union workhouse is situate here, and the North Devon Infirmary. In addition to the usual industries of a market town situate in the centre of a large agricultural area, there are several local manufactures, such as cabinet works, a lace factory, a glove factory, Barnstaple pottery works, and tanneries. The surrounding Rural District had a population in 1911 of 18,228 persons, an increase of 503 on the census return for 1901.

1.—Sanitary Circumstances.

Condition of Dwellings.—In the greater part of the town the houses are old, there having been little rebuilding in Barnstaple. These old houses fall into two classes, firstly, houses of great age, probably some hundreds of years old, and secondly, houses such as were commonly erected about one hundred years ago for the industrial classes in connection with factories. Houses of the first class are collected for the most part in long narrow lanes, such as Azes Lane, Hardaway Head, and Green Lane, and are occupied by the working classes, while in addition, many shops and other business premises are also included. The framework of these houses is often in great part of timber which is filled in with "cob" (dried clay) or unhewn stone. They are often so irregularly built as to interfere with the access of light and air, have very small windows, no damp-proof courses, and sometimes neither back doors nor windows in the rear. The woodwork is often much decayed and the mortar between the stones has dropped out so that the rain blows through the walls. The houses of the second class, of which there are many, were apparently run up in haste at a time of great industrial expansion, when labour was flocking into the town. They are usually in long rows in streets with small yards in the rear, although there are also not a few in small courts. These houses were erected of unhewn stone, the pieces of which when placed together left large spaces which were filled in with mortar. The mortar has in many instances decayed and dropped out, with the result that the rain blows through the walls, which in wet weather are often streaming with damp. There is no damp-proof course. The window and door frames are often rotten. In many instances the windows are very small and the rooms are dark. The roofs are frequently out of repair and allow the wet to enter. Eaves and down spouting are frequently defective, or absent, from decay and dilapidation. In consequence the rainfall soaks into the walls or falls on the unpaved, or imperfectly paved, back yards and soaks into the ground, thus increasing the dampness of the subsoil. It is evident that many of these houses have never been effectively repaired since they were built, and they have become so dilapidated that it is doubtful whether they are worth repairing. There is only one good feature to be mentioned in connection with these houses and that is the flooring. In many instances, where house drains were laid under the ground floors some years ago, concrete was afterwards sub-

stituted for the then existing floors of rough pieces of rock laid on the soil.

The usual rent of these houses is three shillings weekly, while, in some instances, it is less than this. Many are said to belong to owners who are very poor, and cannot possibly afford to repair them. At the same time these cheap, but unwholesome, houses attract to the town a large number of people of the more or less casual worker class. These people are employed as outworkers at the factories, or are cattle drivers, hawkers, costermongers, casual labourers, fishermen and boatmen not in regular work. In the summer many of them pick up a living in various casual occupations at the neighbouring watering places. They usually have large families and a large amount of over-crowding exists. In many instances lodgers are taken when there is already not sufficient accommodation for the tenant's family.

The Town Council have closed a few houses of this description in insanitary courts; and in one long street, the houses in which are of this description, many of the dwellings have become so dilapidated that they cannot be occupied.

There are but few satisfactory houses for the poorer labouring classes in the town, and I saw no houses of this description unlet which were fit for occupation.

In the outskirts a considerable number of new houses have been built of late years which are well constructed, and situated so as to allow free exposure to light and air. Unfortunately these new dwellings have in some instances been erected on low-lying sites liable to flooding, and present difficulties in respect of drainage and sewerage. For example, the lower part of the river Yeo has been straightened, a number of loops formerly made by the river in its course have been reclaimed, and about 150 houses suitable for occupation by the upper artisan class have been erected on the land. The site is, however, still liable to flood, and in order to keep the houses above flood level many are elevated for about 10 feet on cellars, which however cannot, owing to liability to flooding, be made useful for any purpose. In addition, in order to secure a fall, the sewers in some of the streets are carried on the tops of the garden walls. There are already signs of settlement of these houses and of walls built on the site.

Water Supply.—The water supply of the Borough is derived almost entirely from the works of the Barnstaple Water Works Company. This company obtained an Act of Parliament in 1888, under which they are empowered to take water from the river Yeo at Bratton Cross, five miles above the town. The water is conveyed in an open cemented culvert for two miles, and then carried by pipe to a settling tank of 46,000 gallons capacity at Raleigh. From this it passes to four filtering beds having a total area of 8,800 square feet. The filters consist of a basis of pebbles, overlaid by gravel, rough and medium size, and finally by a layer of river sand. At intervals of five or six weeks, varying with the condition of the water, the filtering surface of sand is scraped and two inches are removed. The whole of the sand is renewed every two years. From the filters the water passes to a covered service reservoir of 400,000 gallons capacity. This reservoir supplies the larger part of the

town by gravitation, furnishing the water for the low level service. The higher portions of the town are supplied by water pumped into a separate reservoir which furnishes the water of the high level service. From this service also some houses in the village of Bishops Tawton and, since June 12th, 1911, the neighbouring village of Instow are supplied. The high level is usually quite separate from the low level supply, but the mains can be put into communication if necessary. The daily consumption is 677,000 gallons and for all purposes 40 gallons per head are consumed daily. About 15,000 people are consumers of the low level supply, and 1,000 are consumers of the high level supply. In both instances a number of the consumers are outside the Borough.

Water fittings of the houses occupied by the working classes are often very defective, and there is consequently much waste of water. Long service pipes of lead, of small diameter, are often carried beneath the floors of houses in loose earth and in close proximity to the house drains, which are frequently found to be defective and leaking. Lead pipes are not infrequently laid on the ground without any covering, or covered with a thin layer of soft earth only, so that they are liable to damage when trodden under foot. Flushing cisterns of water closets are often of the plunger type giving a very inefficient flush.

Taps on supply pipes are usually not of screw-down pattern, and commonly allow of constant waste.

There are not a few fire-hydrants with ball valves which are placed on the footways or in the road. These are in boxes with movable iron covers flush with the surface of the footway or road, which children frequently raise, and throw filth into the box. A number of these ball hydrants, which I examined, were covered with a deposit of solid and liquid filth which filled the boxes. It is well known that there is risk of insuction from a ball hydrant when the water supply is intermitted from any cause.

The Town Council are taking steps to replace these fire hydrants by others of an improved type.

The water supplied by the Company is derived from the river Yeo, which above the intake drains an area of about 36 square miles, principally included in the parishes of Shirwell, Loxhore, Arlington, Eastdown, and Kentisbury. These parishes are in Barnstaple Rural District, for which Dr. J. Harper is Medical Officer of Health. Dr. Harper, until he was recently elected Mayor, was Medical Officer of Health for the Borough. Under his direction and with the assistance of the Inspector of Nuisances, a careful watch is kept over the various places where pollution of the river and its various tributaries is to be feared, and the Inspector of Nuisances for the Rural District keeps a book of plans showing points at which there is risk of this sort. Various alterations of drainage and improvements of excrement disposal have under his direction been carried out at farmsteads and houses with a view to prevention of possible pollution. At the same time constant vigilance is required for this purpose. There has been no case of enteric fever notified within the area from which the water is derived for many years.

The water was thought of as a possible source of the occurrence

of enteric fever in the borough by Dr. Harper and he had an analysis made of the water from one of the mains from which the water supply of the earlier cases of fever was drawn early in the year 1911. This showed no evidence of any pollution. An analysis of the water had also been made by Messrs. J. C. Thresh and J. F. Beale in May, 1910. The result showed no evidence of contamination. The water was said "to be of very good quality both from the bacteriological and chemical point of view."

Drainage and sewerage.—A large number of house drains have been reconstructed of late years, but many old drains still remain which are constructed of unglazed pipes, with uncemented joints, which allow of soakage into the subsoil. Since, in some cases, the drains pass under the houses their condition is a matter of much importance. Gullies are usually outside houses in yards. Many old fashioned iron dip traps remain which cannot be properly cleansed, and give rise to nuisance from decomposition of retained matters. That portion of the yard surrounding the gully is often unpaved, or very imperfectly paved, so that liquid refuse thrown to the gully lies in pools around it and soaks into the subsoil. In the poorer class of house slop sinks are absent, or an objectionable arrangement obtains in the form of a square trough of brick or stone built on the floor of the kitchen at the bottom of which is a gully.

A good many defective gullies have been removed of late and replaced by suitable ones of glazed pottery. Intercepting traps are placed between the house drains and the sewer in many instances, and where drains are relaid, or new drains constructed, are in most cases required to be provided by the Borough Council.

The sewers are for the most part of glazed pipes, but there are lengths of brick culvert in the older streets. The manholes are in some cases roughly constructed without proper glazed channels, consequently filth drying and adhering to the brick or concrete in the manholes gives rise to nuisance. In the newer parts of the town the sewers are ventilated by iron standards, in other localities no means of ventilation are provided. A good many complaints of offensive smells from the sewer manholes were made to me, particularly in that part of the town in which enteric fever was most prevalent. The sewers are flushed from the street hydrants through the manholes only.

The contents of the sewers are discharged in a crude state, by three main outfalls, into the river Taw in close proximity to the town. The greater part of the sewage passes through a large sewer which discharges on the north bank of the river close to the town railway station. A sewer conveying sewage from the Pilton district discharges to the river a few yards lower down, and the sewer from the southern portion of the town discharges on the south side of the river at a point nearly opposite to the last named.

The water of the river in the neighbourhood of the town is thus highly polluted by sewage. The tide extends to a point nearly five miles above the town, and the sewage is carried to and fro with it, a large quantity becoming deposited on the banks of the river.

Excrement disposal, and refuse removal and disposal.—Water closets are universally in use in the town. Usually there is one for each house, and nearly all have a separate water supply for flushing. Owing to inefficiency in this respect already referred to, and to neglect of occupiers of houses, the pans of closets are often found to be in a very filthy condition. Closet buildings, as well as other outbuildings, are often found to be extremely dilapidated.

House refuse is collected in receptacles which are placed in the streets by occupiers and emptied twice weekly by the Council's staff. The material is removed in carts with canvas covers, and is used to fill up disused clay-pits and other hollows in the borough. No nuisance appears to arise at the present time from this method of disposal, but there have been complaints formerly. The receptacles in use are in many instances unsatisfactory. They are rough boxes, tins, pans, and such like. Their interiors are often caked with filth and very offensive, and when they are lifted up for tipping into the cart a great deal of the lighter refuse is blown about the street by the wind. Suitable covered bins are greatly needed.

Slaughter-houses.—There are seven registered slaughter-houses, of which all but one are licensed. Two of these are public, *i.e.*, anyone can slaughter there on payment. A very large amount of business is done at one of these. The slaughter-houses are fairly well kept, but nearly all are in close proximity to dwellings.

Cowsheds, Dairies, and Milkshops.—These are all registered. There are 22 cowsheds and dairies, and six milkshops.

The condition of cowsheds is often unsatisfactory in the matters of lighting, ventilation, cleanliness, drainage, and flooring. That of dairies varies; some are very good, others unsatisfactory. Milkshops, in some instances, are merely the front rooms of four-roomed houses, and quite unsuited for the purpose; in other cases they are more suitably conditioned.

Common Lodging-houses.—These are two in number and are registered. One is a very old building, quite unsuited for the purpose at the time when I visited it. The bedding was filthy, and on enquiry I found that in some instances two male lodgers slept in one bed. The other was a more modern building, cleaner, and fairly well kept.

Bakehouses.—There are twenty bakehouses. Many of those situate in the older parts of the town are old, dilapidated buildings, placed in situations such that good lighting and ventilation are not obtainable. None is underground. The floors are in some instances worn, dusty, and dirty; in others there is no separate flour store.

Offensive Trades.—There are in the borough two tanneries, two fellmongers, and a tallow melter. Complaints have been made of nuisance from the premises of the tallow melter, and the Town Council are considering the question of granting a licence, the business not having been established with their consent.

2.—Enteric Fever in Barnstaple.

In the following table is shown year by year the number of cases of enteric fever notified in the borough together with the number of deaths from this disease since 1896 up to November 8th, 1911 :—

TABLE I.

—	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
Cases	3	20	3	17	13	9	14	11	4	26	15	13	4	6	6	49
Deaths	1	1	1	2	1	3	—	2	—	3	0	2	3	—	—	9

Thus during the period of nearly 16 years covered by this table there have been 213 cases of enteric fever, with 28 deaths from this disease in the borough. In each year, up to and including 1906, cases of this disease were admitted to the North Devon Infirmary, there being no hospital for isolation of infectious diseases, and 36 cases have been treated in this Infirmary, which is a general hospital. Ten cases undoubtedly contracted their infection while in the Infirmary, having been nurses, or patients admitted for other diseases, or for injuries. In 1906 the practice of taking cases of enteric fever into the Infirmary was discontinued, and the drainage of the building was entirely reconstructed. Since this date no further cases have arisen in connection with this institution.

In all 49 cases were notified during 1911. The first case was notified on January 18th; and cases were notified in each month, with the exception of May and December, as shown in the following table:—

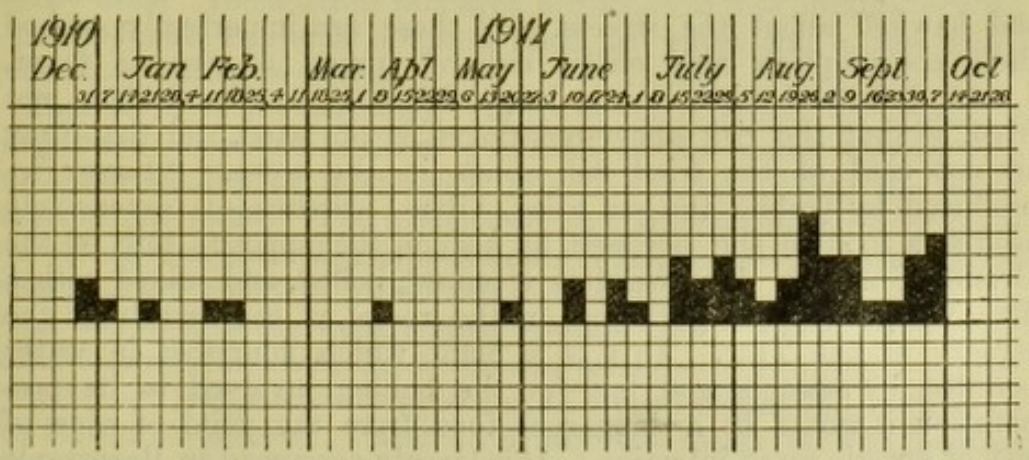
TABLE II.

——	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Number of cases notified.	3	3	1	1	—	2	5	8	14	10	2	—

I visited all the invaded households, and, with three exceptions, was able to ascertain the date of onset of the disease, and thence, by deducting 14 days for the period of incubation, to arrive at the date at which the infection was received. The results are set out in the diagram below:—

DIAGRAM I.

Showing, week by week, the date of onset of the disease in 46 of 49 persons attacked by enteric fever in 1910–1911.



Inspection of the diagram shows that the incidence of the fever in 1911 was mainly in July, August and September, ceasing altogether after the first week in October. The course of the fever thus antedated the usual seasonal prevalence.

As to the incidence of the fever on age and sex, of the 49 cases 26 were under, and 23 were 15 years of age and over; 3 were under 5, 23 were 5 and under 15, 10 were 15 and under 25, 11 were 25 and under 45, and 2 were 45 and over. Of the sufferers 21 were males, 28 females. Nearly all the persons attacked by the fever belonged to the factory, operative and labouring classes.

Causation of the Enteric Fever at Barnstaple in 1911.

Pollution of the River Taw by Sewage. — There are many circumstances in Barnstaple such as would favour the spread of enteric fever when introduced. Some of these are especially related to the polluted condition of the river Taw. Shellfish, principally cockles and mussels, are gathered in the estuary of the Taw, and are at times hawked about the streets for sale, or offered for sale in the market. When the factories are working short time, as has been frequently the case of late, the youths go off on days when they are not working and collect shellfish lower down the estuary of the river. In addition to the sewage from Barnstaple Borough, the estuary of the Taw receives the untreated sewage of the large village of Braunton, the village of Instow, the towns of Appledore and Bideford, and also of a number of smaller places. There can be no doubt that shellfish gathered from the vicinity of the sewer outfalls at any of these places must be unsafe for consumption. According to the local fisheries regulations mussels can only be collected between March 1st and July 31st, but it is almost impossible to prevent their collection in small quantities for local use during the close season. Cockles can be gathered at any time. In each year from 1906 inclusive there have been one or more cases of enteric fever in Barnstaple which have been attributed to eating uncooked cockles. It is evident that there is a possibility of the circulation of enteric fever if uncooked shellfish are consumed, the infection being carried in the town sewage to the shellfish and brought back again into the town through their agency.

The same remarks apply to fish (dabs and flounders), which are caught in numbers in the vicinity of the sewage outfalls of the town and hawked about the streets. If these are imperfectly cooked their consumption may entail risk of spread of enteric fever. I am informed that these local fish are usually boiled, not fried, so that the risk above-mentioned is obviated, and that they are not used at the fried fish shops in the town. "Laver"—produced by boiling the sea weed, Ulva Latissima—is extensively used as a food in the borough, as also on the opposite side of the Bristol Channel. The weed is cleansed, boiled, and mixed with a little vinegar. It is gathered on the rocks at the mouth of the estuary of the Taw. This is a plant which flourishes in water polluted by sewage, and but for the boiling involved in its preparation it would be a dangerous food from the point of view of risk of enteric fever infection. It is largely consumed in Barnstaple but only in the months which have an "r" in their names, so that it

does not come into use between April and September. It is usually spread upon bread, largely eaten by children, and has a taste somewhat like sauer kraut.

Bathing in the river is greatly indulged in during the summer. The principal bathing place is opposite the principal sewage outfall. There can be no doubt that it is dangerous to bathe in the river in the neighbourhood of the town, since at times its waters contain a large quantity of sewage. In the case of one sufferer who died from enteric fever, his parents informed me that he had been engaged in a swimming contest in the river a week before he first complained of feeling ill; that on that occasion he wore clothing whilst swimming; and that when this clothing was brought home it smelt so strongly of sewage that it could not be kept indoors.

Water Supply.—The continued prevalence of the fever, particularly during the months of July, August and September, with the absence of any sudden increase of cases in any particular week made it improbable that the water supply was a factor of any importance in the spread of the enteric fever. It was obvious that the water supply as a whole could not have been the medium of infection. Those parts of the town, with at least 1,000 consumers, which were supplied by the high-level reservoir, had entirely escaped fever, as also the village of Instow which has been supplied with this water since June 12th of the present year. The fever was restricted to parts of the town supplied from the low-level reservoir, in connection with which there are about 15,000 consumers. When the infected houses were marked upon a plan of the town it was seen that here again there could be no general infection of the low-level supply, because the fever was not distributed over the whole of the area supplied, but was chiefly confined to one locality of the town, known as the Derby, and, as has already been mentioned, to one class of the population. It was found that 30 out of the 49 cases had resided in this area, in three small parallel streets with the connecting streets at their ends, and adjacent portions of four small streets joining one of these connecting streets. Fourteen cases were in one of these three streets, Lower Maudlin Street. This collection of streets includes Princes Street, Lower and Higher Maudlin Streets, their cross-connecting streets, Portland Buildings and Vicarage Street, and portions of Newington, Union, Reform, and Corser Streets, opening into Vicarage Street. This area will be afterwards spoken of as the Derby area. Included in this area are a mixed and infants' school, a public-house, two milk shops, a fried fish shop, and a few small general and grocers' shops.

Therefore, if the outbreak were due to infection by water, it must have been due to local pollution of the water serving this particular locality by insuction of infective material into the water mains or otherwise. The absence of any sudden outburst of fever was strongly against this supposition. The greatest number of cases whose illness could be attributed to infection contracted in any one week was five, in the week ending August 26th. Each of the three parallel streets in which the fever was principally localised is served by a branch water main terminating in a dead end at the bottom of the respective streets. Careful enquiry was made by the medical officer of health, who suspected some local pollution of the water, and who had a sample taken for analysis from the main in Princes

Street, the result of which has been already mentioned, but no source of pollution could be made out. It could not be, however, eliminated, since the water fittings and connections in the street are very unsatisfactory, and there is a ball hydrant on the footway. I also made careful enquiry but could find no actual source of contamination of the water in the main.

Since the water main in each street terminates in a dead end, it is difficult to see how the infection, if introduced into one main, could be conveyed to the others; and it seems still more improbable that it could be conveyed to the rest of the water in the low-level service so as to produce the scattered cases which occurred outside the Derby area in the parts of the town supplied from this service. These considerations, taken together with the absence of any explosive outburst of fever, appear sufficient to exclude local contamination of the water supply as a cause of the outbreak.

Housing Conditions.—Although the condition of most of the dwellings in the Derby area is very unsatisfactory, from age, general dilapidation, dampness, and the existence of unpaved, or badly paved yards, yet there are parts of the town in which these conditions are similar and where enteric fever, had been almost, or nearly absent. Some of the invaded houses were found to be in a filthy condition, some were also greatly overcrowded. On the other hand enteric fever occurred in a considerable proportion of houses in which unwholesome conditions were not pronounced.

Sewerage and drainage.—The sewerage of the Derby area is unsatisfactory, especially that of Princes Street. There are two parallel pipe sewers in this street. These sewers are not sufficient to carry off the flood water entering them from higher levels at times of heavy rainfall, and there is a storm overflow from them to a mill leet. This overflow has, however, on several occasions proved insufficient, and the lower end of the street has been flooded to a depth of one or two feet by sewage twice during the year 1911, on August 2nd and 22nd. It was suggested that by means of this flooding infective material had been washed out of the sewer and deposited on the ground at the lower end of the street, and that persons walking about in this street had conveyed the infective material on their feet into the houses.

Cases of enteric fever were notified in Princes Street on August 4th, on which date two were reported, and a further case was notified on August 24th. There were no other cases notified from this street. Investigation showed that the dates of probable infection of these cases were July 11th, 19th and 25th respectively, so that they contracted the disease before the flooding occurred. It was found that out of the 49 cases that occurred in the whole borough at least 22 had contracted their infection before the date of the first flooding on August 2nd. If the flooding in Princes Street was responsible for the further extension of the outbreak, it is difficult to see how the persons living in this street should have almost entirely escaped whilst those in the neighbouring streets and distant parts of the town were affected. It is possible that a few cases subsequent to August 2nd might have been caused in this way, but it is evident that this flooding could have played but a very small part in the production of the outbreak.

The two streets, Lower and Higher Maudlin, which are parallel to Princes Street, are each drained by sewers which join the Princes Street sewer and terminate at their other extremities in dead ends. There is no means of examining the condition of these sewers, but I heard many complaints of foul odours from them escaping from the manholes and street gullies during the dry summer of 1911. All the sewers in the Derby area are without special means of ventilation and flushing. Fourteen cases of enteric fever occurred in the 37 houses comprised in Lower Maudlin Street, including the first reported case of the outbreak. Four cases also occurred in the eight houses comprised in a short cross-street between Lower and Higher Maudlin Street known as Portland Buildings. The connecting sewer which receives the sewers from Princes Street and Lower and Higher Maudlin Streets passes down this street. In all, 30 cases had occurred in houses connected to the sewer draining the Derby area which passes down Portland Buildings. There was, therefore, a very heavy incidence on houses connected to this sewer. Most of the house drains in this area are unventilated, but the gullies in which they terminate are usually situate in the yards, so that emanations from the sewers by way of the house drains would, in most instances, have escaped into the open air. I heard of many complaints of offensive smells from the gullies in the yards during the summer, but these may have been caused by the decomposition of matters retained in the gullies. The house drains of invaded houses, when examined, were in a number of instances found to be defective, with clay joints, allowing the escape of their liquid contents into the subsoil beneath the floors of the houses.

A number of cases occurred among scholars at the St. Mary's mixed and infants' school, situate in the Derby area, the drain from which is connected to the sewer in Portland Buildings. This drain receives the discharge from the school latrines, which are flushed automatically, but on examination—early in the course of the fever outbreak—it was found to be defective, partially blocked, and leaking in the playground. This drain has since been reconstructed. In attendance at this school are 154 mixed scholars and 61 infants, among whom 10 cases of enteric fever occurred in 1911. The children at this school are mainly drawn from the Derby area.

Milk.—Inquiries showed that the 49 infected persons had obtained their milk from no less than 14 different milk sellers, but, as was to be expected, a large proportion had obtained milk from milk shops in the Derby area. There are two milk shops in this area which are situate a short distance apart. One milk seller, A, had supplied 21 out of the 49 persons affected by fever within a period compatible with their having been infected through the milk as a medium. The other milk seller, B, had supplied nine sufferers, five of whom had also had milk from A. Three of A's customers also had milk from other sources apart from B. Of the remaining 12 milk sellers only one had supplied as many as 5 sufferers. A's business was much larger than B's, and, therefore, it was to be expected that a large proportion of sufferers would be taking milk from him, but the proportion 21 to 5 appeared to be excessive and therefore further inquiry was made into the source of his milk. The farm from

which it was derived was visited, but nothing was found there to cast suspicion on it. On further inquiry it was found that the invaded families were accustomed for the most part to send for their milk to the shop, and that of 66 customers who were supplied on the rounds which embraced a number of streets outside the Derby area, only two were attacked by fever. Therefore, if the milk were the medium of infection it must have been almost entirely that portion which was sold at the shop. Enquiries were accordingly made to see if there was any special risk of contamination to which this milk was exposed. A's shop consists of the front room of a small four-roomed house. This room is entered directly from the street and communicates directly with a living room in the rear. The floor of the room used as the milk shop is of concrete and was dirty and dusty at the time of my visit. Thirteen gallons of milk are sold daily, the greater part of which is sold directly to customers coming to the shop. The larger portion of the milk on receipt is poured into earthenware pans which are uncovered, and the greater number of which are placed on the floor. The room is rather dark and there is no special provision for ventilating it. Nothing was found about the premises which would be likely to lead to any specific contamination of the milk. There are three persons in the household, the dairyman, who is about 60 years of age, his adult daughter and an infant grandson. There was no history of recent illness in the household, but the dairyman had some obscure illness three years ago, and since he had served the customers who came into the shop, whilst his daughter served those on the round; an examination was made of his excreta. This examination could not be completed until January 31st, 1912, but Dr. J. E. Ledingham, of Lister Institute, reported that at that date the results were negative as regards the presence of the bacillus of typhoid fever. Evidence, therefore, as to special risk of contamination of the milk at the milk shop was lacking.

In considering the possibility of A's milk having played a part in the dissemination of the fever, it is to be borne in mind that there was no special incidence of the fever on consumers of this supply except as regards persons who purchased it at the shop. The value of this latter fact, as incriminating evidence, is largely discounted by consideration of the probability that the inhabitants of the Derby area, on which there was special incidence of the fever—due, it may well be, to other causes than milk infection—would naturally resort to a neighbouring milk shop for their supply.

In view of all the circumstances, it did not appear likely that milk had played any material part in the spread of the fever.

Ice Cream.—A considerable number of the persons attacked by the fever had partaken of ice cream within a period compatible with infection from this source, but it appeared that ice cream was consumed to a very large extent by the working classes in Barnstaple throughout the hot summer of 1911. There are two itinerant vendors of ice cream in the borough, and a number of shops at which it is sold. One itinerant vendor is said not to be at all cleanly. This latter, however, during the whole summer sold his cream in Ilfracombe, and no occurrence of enteric fever was reported from this Urban District. Both of the itinerant vendors

prepared their cream in small sheds in a court, but there was no history of illness in their families, and I found that none of the sufferers from enteric fever had obtained ice cream from them, having had recourse to the many small shops at which it was prepared and sold. There did not appear to be any probability that ice creams had been a source of infection.

Cockles and other Shellfish.—During the summer of 1911 the sea bank of the estuary of the Taw was under repair and a number of labourers were employed on this work, returning to their homes at Barnstaple from Saturday to Monday only. These men spent their evenings in getting shellfish (cockles and mussels), in the estuary. It appears that several were attacked with illness after eating shellfish, but recovered, with the exception of one who died in Barnstaple from a severe attack of enteric fever a few days after his return home. The date of onset of his illness was compatible with infection from the shellfish. Enteric fever is known to have been present in the village of Braunton in Barnstaple Rural District in the summer of 1911. The sewage from this place escapes in a crude state into several water courses, which discharge on the shore near where this man and his companions were working, This was the only instance in which it could be clearly made out that shellfish had been eaten at a time compatible with the receipt of infection from this source; although in several instances suspicion of this kind arose, the sufferers, or their relatives, could not definitely fix the date at which shellfish had been taken.

Inquiry was made as to the consumption of fried fish, laver, watercress, and as to various products from pigs' offal and such like sold in the market, but nothing was found tending to cast suspicion on any of these as an agency of spread of the fever.

Personal Infection.—There could be little doubt that personal infection had played a part in the production of the outbreak, an opinion arrived at by Dr. Harper early in its course, although multiple attacks in households were not a marked feature. A nurse who was attacked whilst in attendance on cases of enteric fever at the fever hospital almost certainly became infected in this way, but in many other instances where this method of spread was suspected other possible influences were also in operation. The people in the Derby area are frequently in and out of one another's houses, and when illness occurs there is a still greater tendency for visits to be made to the affected household. It was found that at least twenty sufferers had visited infected households at a period compatible with their having become infected by personal contact. At the same time it was found that in most cases food was taken in the invaded house at the time of the visit, so that possibly infection had been received through this medium. The removal of the sufferers to hospital was as a rule effected soon after the receipt of notification. Eleven were nursed at their own homes.

The cases which occurred among scholars at the infants' department at St. Mary's schools could not be definitely attributed to personal infection received at the schools, since, as before mentioned, there were defects of drainage at the schools, and the children might also have been infected in some instances by personal infection at their own homes.

Four cases which occurred at the neighbouring town of Torrington appeared to be due to the importation of infection from Barnstaple. The sister, brother, and brother-in-law of the first sufferer in the Barnstaple outbreak became infected, possibly through personal infection, or by the taking of food in the infected house. The brother's wife also became infected, presumably by personal infection from her husband. When the husband was taken ill the wife went to stay with relatives at Torrington and fell ill there with enteric fever. Her advent at Torrington was followed within a period compatible with infection received from her, by three cases in the family which she joined there, the town of Torrington having been previously free from fever, so far as known, during 1911. A girl who helped in the house of the first sufferer in the Barnstaple outbreak also contracted fever, and her sister became infected at a much later date. In the case of the first girl the date of her attack was compatible with personal infection received from the first case, but her sister was not notified until seven weeks after her return home from the hospital.

From the foregoing account it will be seen that there were so many possible sources of enteric fever in operation in Barnstaple at the same time that it is impossible to fix upon any of them as the principal one concerned in the causation of the outbreak. The main fact that emerges is the insanitary condition of the Derby area, in which the majority of the cases occurred. That there is something in this locality which favours the occurrence of enteric fever is indicated by the presence of the fever there in former years. In 1900, 1902, 1906, 1907, 1909 and 1910, cases of enteric fever occurred in the limited area comprised in the four streets there which also have been principally affected during the outbreak under consideration.

3.—Administration by the Borough Council for Preventing the Spread of Fever.

There is a hospital to which nearly all the cases of fever were removed. The hospital has been formed out of the old county gaol, which is the property of the council. It is not satisfactory. The building has no curtilage, and projects into the cattle market. The ground floor is used as a store-house for the Town Council's property, and also contains a steam disinfector. The upper floor, which consists of several halls with cells opening into them, has been limewashed and supplied with beds, a bath and w.c.'s, also a kitchen and scullery. As many as thirteen patients have been received at one time. All the rooms used as wards are intercommunicating, and even the kitchen communicates directly with the wards, so that at most only one form of infectious disease can be accommodated at a time with safety. There is no administrative block. The nurses' rooms communicate directly with the wards. There is a suitable ambulance.

All infected houses were visited by the medical officer of health on receipt of notification of fever, and also by the inspector of nuisances. There is a zinc-lined van for the removal of infected

articles to the disinfector at the hospital. Infected premises are disinfected with formalin vapour, and liquid disinfectants are also supplied. As the result of visits to houses where enteric fever had occurred, a good deal has been done in the matter of relaying defective house drains; but many other defects remain to be dealt with, especially unpaved or badly paved yards, dampness, dilapidation of houses, and dirty dwellings. I visited some houses where enteric fever had occurred in former years, and found that sanitary defects which had been reported then had not yet been remedied.

For much assistance in this inquiry I am indebted to Dr. J. R. Harper, to Dr. H. C. Jonas, acting medical officer of health, to Mr. J. Hill, the inspector of nuisances, to the officials of the water company, and others.

S. W. WHEATON.