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ON

ENTERIC FEVER

IN

DUNDEE AND NEIGHBOURHOOD.

BY

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ON ENTERIC FEVER.

ENTERIC FEVER is endemic in Dundee and neighbourhood. At the commencement of the winter of 1864, a sudden and remarkable increase in the number of admissions into the Infirmary of patients labouring under this disease took place, and during the winter months of 1864-65, this form of fever was so prevalent that two wards had to be specially set apart for the reception of the cases.

The object of this paper is, first, to give a short account of the cases, and, secondly, to give the result of investigations made at the time with the object of finding out the cause of its more than usual prevalence.

From July 1864 to July 1866, there were treated in the wards of the Dundee Infirmary 127 cases of undoubted enteric fever, of which 46 were males and 81 females; the preponderance of females is due to the employment of so many young women in the mills,—they are absolutely more numerous than young men, and hence their greater numbers in these statistics.

The following table shows the sex, ages, and mortality of the cases:—

TABLE I.

	Total.	Recovered.		Died.		Percentage of Deaths in Males.	Percentage of Deaths in Females.	General Percentage
		M.	F.	M.	F.			
Under 5, . . .	2	1	1	...	...	...	...	...
5 to 10, . . .	2	...	2	...	...	...	...	...
10 „ 15, . . .	11	5	4	1	1	16·6	20·0	18·18
15 „ 20, . . .	34	6	24	1	3	14·2	11·1	11·7
20 „ 25, . . .	34	12	20	...	2	...	10·0	5·8
25 „ 30, . . .	23	11	11	1	...	8·3	...	4·3
30 „ 35, . . .	11	5	5	...	1	...	16·6	9·09
35 „ 40, . . .	1	1	...	...	...	...	...	...
40 „ 45, . . .	3	...	3	...	...	...	...	...
45 „ 50, . . .	3	1	2	...	...	...	...	...
50 „ 55, . . .	...	...	...	...	...	...	...	...
55 „ 60, . . .	3	...	2	1	...	100·0	...	33·3
Total, . . .	127	42	74	4	7	8·6	8·6	8·6

The mass of the cases, 71·6 per cent., are of ages ranging from 15 to 30,—only 7·8 per cent. are above 40. The average age was 21·5 years. The large mortality at the early periods of life contrasts very strongly with the low death-rate in typhus at the same periods. The 3 cases noted in the last quinquenniad were well marked,—two of them, husband and wife, came from one house; the man died, and, on making a *sectio*, there was found extensive ulceration of Peyer's patches.

As seen from the following statement, a much larger number of cases occurred during the autumn and winter months than during those of spring and summer:—In January were admitted 16; February 10; March 6; April 4; May 8; June 9; July 9; August 12; September 9; October 16; November 16; December 12.—Total, 127. This point will be more fully referred to in an after part of the paper.

The eruption was present in 92, or in 72·4 per cent., of the cases. Of the 35 cases in which no eruption appeared, 4 proved fatal, and showed all the usual post mortem appearances of enteric fever; in those which recovered, the symptoms were so well marked as to leave no doubt of the nature of the case.

In 25 cases there was no diarrhoea, in 46 it was slight, in 49 troublesome, and in 7 severe; in 3 of these 7 cases there was hæmorrhage from the bowel. In no case did perforation take place.

In 11 cases a relapse occurred, and in 1 of these two relapses; in 5 cases the relapse was accompanied by a fresh eruption; in the case which twice relapsed, the eruption reappeared during the first, but not during the second recurrence of the symptoms; in 1 case the eruption was noted only during the relapse. Of the 11 cases, 10 occurred during the autumn and winter months of 1864-65, since then only 1 case has relapsed. So common an event was it at the time referred to, that the first few weeks of convalescence were watched with some anxiety.¹ The mean period of intermission was 10 days, the shortest being 6, and the longest 15. Of those cases in which the day of commencement of illness was ascertained, 2 showed the first symptoms of relapse on the 28th day, 1 on the 38th, 1 on the 44th, 1 on the 46th, 1 on the 55th, and 1 on the 59th. Of the 11 cases, 8 were females, aged respectively 17, 18, 19, 20, 21, 26, 28, and 32, and 3 males, aged 12, 27, and 30. In no case did the relapse prove fatal.

¹ One case not included in the 11 was peculiar. The patient, a female, had been treated in the Aberdeen Infirmary for what, Dr Harvey informs me, was well-marked enteric fever, with eruption and general symptoms proper to that disease. She was discharged on March 28th; a week afterwards she came to Dundee; two days afterwards, or on the 10th from the date of discharge from the Aberdeen Infirmary, rigors and general febrile symptoms recurred. She was then admitted into the Dundee Infirmary, where she went through an ordeal similar to that which she had passed in Aberdeen, the eruption and other symptoms being well marked.

The following table shows the number of cases complicated, with the complicating malady; in it are included only those cases in which the secondary affection was sufficiently severe to influence unfavourably the prognosis or course of the case:—

		Total.	Recov.	Died.
Complicated with	Albuminuria, . . .	1	...	1
"	" Bed-sores, . . .	3	1	2
"	" Bronchitis, . . .	7	6	1
"	" Broncho-pneumonia, . . .	1	...	1
"	" Epistaxis, . . .	5	5	...
"	" Gangrene, . . .	1	...	1
"	" Hæmorrhage, . . .	3	3	...
"	" Parotid swelling, . . .	2	1	1
"	" Phlegmasia dolens, . . .	1	1	...
"	" Pleurisy, . . .	4	3	1
"	" Tetanus, . . .	1	...	1
Total,		29	20	9

From this it seems that 22·8 per cent. of the whole were complicated; the mortality amongst the complicated cases was 31·03, and amongst the uncomplicated 2·04, per cent.; the mean death-rate being, as seen in Table I., 8·6 per cent.

In 3 cases the typhus and enteric fevers were believed to co-exist.

The patient in whom tetanus formed the complicating malady died of that affection at the end of the 7th week, but before there was any appearance of convalescence. The cause of the tetanus was probably a large bed-sore which existed over the sacrum.

A notable fact in several of the cases was the gay, mirthful, and amusing character of the delirium. A woman, aged 38, who went through a well-marked but not very severe attack, sung almost incessantly one verse of the same song for some considerable time; when spoken to, she left off and answered rationally enough any questions that were put to her, but when left she at once resumed her chant. Another female patient, aged 18, whose case was equally well marked, and whose delirium consisted chiefly in carrying on a lively and chaffy conversation with some imaginary individual, gave perfectly rational answers, but had a peculiar habit of profusely interlarding her sentences with the expression "says I;" even in giving the shortest and most simple answer she made use of it; for instance, on asking the following questions (as I frequently did, for no other purpose than to see how she would answer them), the answer given was always the same:—"Are you any better to-day?" "Yes, sir, says I." "You don't think yourself any worse?" "No, sir, says I." In giving a longer answer the "says I" came in on every possible opportunity, and with a frequency which was as ingenious as it was amusing. After the establishment of convalescence the expression was never once used, and I learnt from inquiry, both from herself and her friends, that before her illness she had never been in the habit of using it.

In many of the patients the delirium was of this light, airy character; in some it was of the low muttering type; but in no case did it partake of that fierce and obstinate character so often seen in typhus. The tractability of the enteric cases, even in the midst of their delirium, contrasted remarkably with the difficulty experienced in the management of many of the typhus cases.

Generally, the cases may be said to have been of a mild character, with neither the abdominal nor head symptoms very prominent. The most noteworthy points were the occasional, and at one period frequent, occurrence of relapses, the often protracted duration of the febrile symptoms, and in many a persistently rapid pulse during convalescence. In not a few cases the cardiac action was more frequent during convalescence than during the time of existence of the fever, the condition of the patient in every other respect indicating a satisfactory progress towards health.

In three years three cases originated in the house. The first was my own, which occurred before I had been three months in office, and when, in consequence of the repairing of some of the main pipes, the water supply was rather scanty. The second was that of a convalescent from typhus, of whose attack no satisfactory explanation could be found. Four or five cases of enteric fever were in a neighbouring ward, but no communication took place between the two, otherwise than through the persons of the medical attendants. The third was in a night nurse of the male medical ward, who had two cases of enteric fever under her charge at the time; she had only been in Dundee for a couple of months previous to the date of commencement of her illness. These cases all occurred at wide intervals; in the first and third there existed a possibility of the disease being communicated; in the second that possibility seemed almost excluded. In the summer of 1863 the medical superintendent died of enteric fever; the mode of origin of this case, so far as I could learn, was not ascertained.

Four convalescents from enteric fever contracted typhus in the hospital; three of them had, either during the duration of the fever or during convalescence, come in contact with typhus patients; the fourth case sprung up in a general ward in a patient who had not been exposed to direct contagion. Enteric cases were almost invariably treated in the general medical wards, and were never wittingly put amongst typhus cases. No patient in the general wards ever contracted the disease.

The observations on which the second part of the paper is founded were begun in the autumn of 1864, and continued, with more or less regularity, for nearly two years. During that time but few cases of enteric fever were admitted into the Infirmary whose place of residence before admission was not visited, and its sanitary condition noted. The time at my disposal prevented me in many cases from making that minute examination and house-to-house visitation which I should have wished. I have, however, accumulated a

body of facts sufficiently numerous to admit of legitimate induction; their number is too great to admit of their being individually particularized; I shall, therefore, in giving instances, give only enough to illustrate and justify the inferences drawn from the whole.

I may mention that I commenced these investigations with a leaning towards the pythogenic theory of the origin of enteric fever, but thoroughly sceptical as regards its communicability from one person to another. As I advanced with my investigations, facts in favour of both modes of origin so pressed themselves on my attention, that I was at last thoroughly convinced both of the correctness of the pythogenic theory and of the fact that enteric fever is occasionally communicated.

For the sake of convenience and clearness, I shall divide the cases on which the observations were made into two classes, (a) those in which the *materies morbi* was introduced into the system through the water, and (b) those in which it was introduced directly through the atmosphere.

(a) It has already been mentioned that, in the autumn of 1864, there took place a sudden and notable increase in the number of admissions into the Infirmary of patients suffering from enteric fever. It was then that my investigations commenced, and I had not proceeded far with them before I was struck with the fact that the vast majority of the cases came from a village called Lochee, in the immediate neighbourhood of the town; as time advanced, and admissions increased, this fact became more and more evident, plainly indicating that in Lochee there must be some local cause at work. A very few inquiries led to the discovery of two important facts:—first, that the drainage of the town extended only to the commencement of, but did not enter, the village, whose only drainage was on the surface; and, second, that the Water Company which supplied the town had no pipes in Lochee—the inhabitants drawing their water from wells, either by pumps or by buckets. Here, then, were two conditions affecting the whole village, and subjecting its inhabitants to the influence of external sanitary conditions quite different from those surrounding the inhabitants of the town.

The village is a large one, containing about two or three thousand inhabitants; the southern and eastern portion has a tolerable elevation; the northern and western lies low. It was in the latter part that the fever was so prevalent; here the houses are generally built in blocks or "lands," each of which is, as a rule, named after the party who built it, generally a millowner, whose operatives inhabit the houses. When a land is put up, a well is sunk in the neighbourhood; from this the inhabitants draw their water. Somewhere in the vicinity, generally at the back of the land, in as convenient a position as possible for all parties, is erected a privy and midden, into which latter are poured the slops and refuse from all the houses in the block. Occasionally the lands are built so as to form two or three sides of a square, whilst others consist of a single

block. The result of this system of putting up the houses is an irregularity in the general arrangement, and a want of properly paved streets and courts, which tend much to encourage and foster sanitary defects. The above general description is applicable to all the lands. With the object of illustrating their exact state, I shall give a more minute description of one of them. For this purpose I shall select that which, to all external appearance, was the cleanest and most free from sanitary defects.

Luis' Land is not in the lowest portion of the village, but is very close to it; it consists of two blocks of houses two storeys high, and forming nearly three sides of a square; one block, running east and west, forms the south side, the other forms the west and incomplete north side; at the open east side is a byre,¹ and at the incomplete part of the north side a school; in the centre of the square is a closet and midden built of stone, and forming a receptacle for the slops and refuse of all the inhabitants; just at the back of the south row of houses, and in dangerous proximity to the midden, is a well, from which the inhabitants get their water by means of a pump. The whole court, forming the hollow of the square, was in a rude, untidy state; liquid filth running in streams from the midden over the unpaved court, which in wet weather is said to be in a dreadful mess. The supply of water is generally, and especially in dry weather, scanty and insufficient, and at no time is the water itself, according to the inhabitants, of good quality. Many of them are in the habit of getting water from other wells, from choice as well as from necessity. The midden seems to be frequently emptied. A slight variety of opinion existed regarding the exact time which elapsed between each emptying; probably three times a week is correct; at all events, no complaints were made, every one agreeing that it was done regularly and often enough. The houses themselves were good, and most of them pretty clean and tidy; there were, however, several exceptions to this. The inhabitants seemed comfortable and well nourished; they had abundance of work and good wages; they were not overcrowded, and showed neither in their persons nor in their dwellings anything likely to produce fever.

This block of houses may be taken as a sample of the whole: the sanitary defects generally observed consisted in the existence of closets and middens in the neighbourhood of the houses and in proximity to the wells, and in the absence of drains to carry off the filth, which soaked into the ground and contaminated the water, as I shall now proceed to show.

After the facts noted above had forced themselves on my attention, and led to the belief that the water was likely to be rendered unwholesome, I made a qualitative analysis of the water derived from the wells in the neighbourhoods in which the fever most prevailed, and found in every case clear and abundant evidence of the

¹ This byre has been removed since the time at which this note was made.

existence of organic matter in a state of decomposition. The tests used were those given in Dr Parkes' Practical Hygiene. As an example, I shall give in an abridged form my notes of the analysis of the water taken from the well at Luis' Land, where we have seen that so much enteric fever existed. I choose this one, in the first place, because this land has already been instanced and described; and, in the second place, because it is not included in an analysis of the water of most of the other wells made two years afterwards by Dr Stevenson Macadam of Edinburgh, on the occasion of an outbreak of cholera, and to which more detailed reference will be made in an after part of this paper. Suffice it to say, that at the time of my analysis they all resembled very much the one which is here given as an example:—

Water from the well at back of Luis' Land was odourless, colourless, tasteless, and threw down on standing a scanty deposit, seen under the microscope to consist of amorphous and angular particles. The chloride of gold test gave evidence of the presence of a considerable amount of organic matter. On applying the tests for nitric and nitrous acids the reactions characteristic of the presence of these acids were instantly produced: in testing for the latter, the blue coloration was at once caused by the iodide of potassium starch paste without any previous concentration of the water. There was also distinct evidence of the presence of lime, chlorine, and sulphuric acid. Here, then, we have direct and undeniable proof of the contamination by organic impurities of the water supply of the localities in which the fever prevailed. Regarding the mode in which this contamination was produced there can be no doubt: the want of a proper system of drainage led to the retention in the neighbourhood of filth whose decomposing particles were carried along with the water into the wells. It is quite possible that some of the cases may have been due to the emanation of noxious vapours from the surface of the ground, or to direct communication of the disease from a previously affected individual; it is also possible, nay, highly probable, that in many of the cases the disease was due to indirect communication consequent on the passage into the water of matters derived from the stools of those previously affected—an agency which doubtless had the effect of considerably prolonging the duration of the disease in the locality. How far each of these conditions operated, it is obviously impossible to determine, as the cases were all exposed to the influence of the one morbid agent common to all the affected localities.

It has already been remarked that the fever was almost entirely confined to the low-lying part of the village, and that the eastern portion was nearly, if not altogether, free from it. Under these circumstances it may not be uninteresting to contrast the hygienic conditions of the two localities: of that in which the fever prevailed I have endeavoured to convey some idea; the other eastern part has the advantage of being situated on the slope of the hill, and of

being more regularly built; there are regularly formed "gutters" or surface drains for carrying off the slops, and in consequence of the slope, these act pretty effectually. Altogether, the general aspect of the place is much more cleanly and tidy than that of its fever-haunted neighbour. Besides all this, the water supply is different, its chief source being a well, called the East Well, away from all likelihood of sewage contamination, and which enjoyed the reputation of yielding a good and abundant supply. The water got from this source was submitted to the same tests as the others, and gave no evidence of the existence of organic impurities.

From the above facts it is justifiable to draw the conclusion that the outbreak of the malady was due to the contamination of the water by sewage matter; that its spread and continued prevalence were due to the same cause, and to the further pollution of the water by matter derived from enteric stools; and that a few cases may have been caused by inhalation of the poison derived either from the stools of an enteric patient, or from other decomposing faecal matter. But the question will naturally be asked, "Why should the disease have shown such a marked increase in the winter months of 1864—why should the contamination of the water by sewage matter have produced an outbreak of enteric fever at that particular time in preference to any other?" The answer to this question goes far to justify the conclusion which has been drawn. Granting, and taking as a starting point the fact that the fever was due to the contamination of the water in the manner explained (by infiltration through the soil), it would be natural to suppose that the greater the quantity of organic impurities which entered the water, the more prevalent would be the fever: it would be equally natural to suppose that the drier the weather and the scantier the water supply, the less would be the amount of sewage matter carried into the wells; and the longer the continuance of this drought and the greater the succeeding rainfall, the larger would be the quantity of decomposing matter carried into them when once a good supply returned. In other words, a dry season would lead to the retention in the soil of sewage impurities which a succeeding wet season would cause to be conveyed into the wells; and directly as the extent to which these conditions of the seasons prevailed, would be the likelihood of an outbreak of enteric fever in the latter of the two. Of course, the seasons in which these states of the weather are most likely to occur are, on the one hand, summer and early autumn, and on the other, the latter part of autumn and winter.

That the agencies thus hypothetically indicated were those which gave rise to the prevalence of the fever at Lochee towards the end of 1864, is proved almost to demonstration by a reference to the following table, in which is given the rainfall for each month of that year, together with the number of days and hours on which rain fell; the last column shows the average fall for the eight years immediately preceding 1864. The observations were made at

Barry, a village about five miles from Dundee, by Mr Proctor, Cor. Mem. Met. Soc. Scot., than whom, I believe, a more accurate observer does not exist; they are, therefore, thoroughly reliable.

Months.	Days.	Hours.	Inches.	Mean Fall for 8 Years.
January, . .	19	55	2.28	2.33
February, .	23	105	3.86	1.65
March, . . .	23	86	3.02	2.
April, . . .	14	71	1.21	1.76
May,	16	50 $\frac{3}{4}$	2.	1.94
June,	24	56 $\frac{1}{2}$	1.88	3.03
July,	16	58	2.60	2.5
August, . . .	17	29	.79	2.89
September, .	24	65 $\frac{1}{2}$	3.29	3.27
October, . . .	19	137 $\frac{1}{2}$	8.95	2.58
November, . .	20	90	3.75	2.65
December, . .	23	117	3.20	2.48
Total, . . .	238	921 $\frac{1}{4}$	36.83	230.87

From this it will be seen that the rainfall for the whole year was 36.83 inches, being an average for each month of 3.07. During November, December, January, February, and March, the fall is about the general average (3.2 inches); during April, May, June, July, and August, it is much below the average,—the mean fall for these months being 1.69 inch; in September it again comes up to the mean standard; and in October, the same month in which the fever began to increase so rapidly, there fell 8.95 inches of rain, being nearly three times the general average for the year, more than four times the average of the six preceding months, and more than double the fall of any other two months put together. Notwithstanding this, the number of days on which rain fell in October (19) is rather below the average for all the months of the year (19.83), whilst the number of hours (137 $\frac{1}{2}$) is greatly above it (76.7), two facts which, taken together, indicate a rainfall more than usually continuous and copious, and one more likely to act efficiently in dissolving and carrying with it any impurities which might be in the soil. The facts of the case are as follows:—A locality having no drainage gets its water supply from wells, into which it is proved that sewage matter enters. During the months of April, May, June, July, and August, the rainfall is small, in the last month particularly so; under these circumstances it is probable that both in the soil and on its surface there is, by the end of summer, a considerable collection of organic matter undergoing decomposition, and waiting only for a copious fall of rain to carry it off. In September the drought is not so great, the quantity of rain which falls being about the average; still, it has fallen on a dry and parched soil, which probably soaks it rapidly up, allowing very little to permeate into the wells; it has the effect, however, of relieving the parched condition of the earth. In October (whilst the soil is in this apt state

for its reception and ready permeation) there comes a copious and heavy rainfall, which is likely to carry into the wells a large quantity of the impurities which had been collecting during the summer months. That it did so act in the present case is proved by the circumstance, that in the same month in which this great and remarkable increase in the rainfall took place, there was observed a correspondingly sudden and notable increase in the prevalence of enteric fever in the locality, two circumstances which, when taken in conjunction with the facts already given, can scarcely be regarded otherwise than as cause and effect. The greater prevalence of enteric fever during the autumn and winter months has almost constantly been noted by observers; and especially has this been the case after unusually dry and hot summers. The explanation which has been given of its prevalence at Lochee in the early winter months of 1864, would probably apply equally well to many similar outbreaks.

(b) Those cases in which the *materies morbi* was introduced directly into the system through the atmosphere, were less numerous and more scattered than those in which the water was at fault. Many of the localities from which they came presented external sanitary conditions very similar to those already noted as belonging to the tenements in Lochee; their only points of distinction being that they were supplied with good wholesome water, and had an efficient system of drainage. The water was derived from the pipes of the Water Company, and was quite free from sewage impurities.

The first fact to be noted in these cases is, that very few of them came from the low-lying parts of the town where typhus was so prevalent; the elevated north-eastern portion, called Maxwelltown, supplied the largest number; next in frequency came the cases from the courts and lanes at the upper end of the Scouringburn, towards the western extremity of the town. When first this fact declared itself, I was inclined to look on it as indicative of some defect in the construction of the drains, some error in the mode of trapping them permitting of the return of noxious effluvia; it being natural to suppose that, if this were the case, the gases would be more likely to ascend in force where the elevation was greatest. I could get no facts, however, to support this theory, and was therefore driven back on the details of my notes to look for some other explanation; at the same time, for the sake of contrast, many of the courts, closes, and alleys in which enteric fever had not occurred, were visited, and their general sanitary condition noted; the result was as follows:—

In the low-lying and more densely populated parts of the town there were comparatively few courts, and those which did exist were paved throughout. The usual mode of access to the houses was by stairs leading off from long narrow closes. In all, there was found either a lamentable deficiency or total want of water-closets—the refuse and filth from all the houses being, as a rule,

carried by the inhabitants to the streets, whence it was carted away early in the morning by the authorities. In one or two courts there was found a large stone or iron box, which served as a receptacle for the accumulated filth of the neighbourhood, and which was generally emptied every morning, but in some cases only three or four times a week. The liquid state of much of the filth in these, rendered it impossible to clean them out thoroughly. This could only have been done by having a hole in the bottom, and washing them. This plan, however, was not adopted. Wherever these tanks existed, the inhabitants complained much of the bad smell which came from them, especially when they were being emptied. It has already been mentioned that, whilst these low-lying portions of the town (chiefly the closes running off the Overgate) supplied the majority of the cases of typhus which were treated in the hospital, it was exceedingly rare to get a case of enteric fever from that locality. One or two cases, however, did occur; and, for the sake of example, I shall give a description of the place whence one of them came, and which also supplied many typhus cases:—

Methodist Close runs off the north side of the Overgate, one of the most densely populated parts of the town. It is a dark narrow alley, completely roofed over, and terminating in a small paved court or *cul de sac*, whose only opening is the close which leads into it. At the farther end of the court is a winding stair, forming the means of access to the houses. Close to this stair, and in a corner of the court, is a large iron box, into which is emptied all the filth of the inhabitants, who frequently perceive bad smells coming from it, chiefly in the morning when it is being emptied—a matter of daily occurrence. At time of visit, the box was one-fourth full of a horrid mixture of ashes and ordure. The case of enteric fever occurred on the second floor of the winding stair already alluded to. The whole aspect of the place was dank and dingy. This may be taken as a sample of the closes which have a court attached to them. The majority have no such court, but consist simply of an alley, having stairs leading off. Wherever a court existed, there was certain to be an ash-heap or box (such as I have described), leading to the retention of filth in the locality. Not one case of enteric fever came from one of those closes having no court, and, therefore, no convenient spot for the deposition of filth. Let us contrast with this the state of those portions of the town in which enteric fever was much more common.

The north-eastern part of the town (Maxweltown) and the upper part of the Scouringburn have already been indicated as enjoying notoriety in this respect. As compared with the lower parts of the town, these (and especially Maxweltown, where the fever was most prevalent) seem to possess many advantages. They are of more recent construction, the houses are less densely packed together, the courts are more airy, the closes are less dingy, and their general

aspect gives one to a much less extent the idea of a dense population. They have one characteristic, however, which is wanting in the densely populated typhus haunts: they abound in unpaved courts, possessing closets and middens such as have been already described as existing at Lochee. Here I find it difficult to make a selection from my notes, the cases are all so much alike. I shall give, as shortly as possible, a description of two blocks of houses, one from the eastern, the other from the western, portion of the town:—

From a court off Union Street, Maxweltown, four cases came to the Infirmary during the winter of 1864-65. In the same house from which one of them came, the landlady had had five children ill with what seems to have been enteric fever; but as no medical man saw them, and as one or two cases of typhus had occurred in the locality, there exists some doubt as to the real nature of their illness. The court was entered by a short close leading off the street. The houses were two storeys high, those on the upper storey being reached by outside stairs leading from the court, in the centre of which was the usual midden, with closet attached. This dustbin was said to be emptied three or four times a week, the filth on these occasions being conveyed in barrows to the front street, and then put into a cart and carried off. A few months before the time of my visit, the midden had been roofed over, in consequence, I was given to understand, of the bad smells so frequently complained of by the inhabitants, some of whom informed me that the stench was at times so bad that they were compelled to stuff up the keyholes of the doors, in their endeavours to keep it out. On every occasion on which this place was visited, a disagreeable odour was felt in the neighbourhood of the midden, and a good deal of loose filth was found about the court. The inhabitants were of the better class of work-people: as a rule, their houses were well and tidily kept.

Brown's Buildings, Scouringburn, is a densely populated block of houses, forming a hollow square, from which exit is had by a covered pend, and having in its centre a closet and filth receptacle of the usual style, which was said to be cleaned out only once or twice a week. The court was unpaved, and had a good deal of filth lying about. On the north side, the rooms on the ground floor were below the level of the court, only the upper third of the windows of the back rooms being above ground. Close to these windows were a large number of filth deposits, doubtless due to the presence of the number of children constantly playing about in the court. From this land, six cases of enteric fever were sent to the Infirmary in the winter of 1864-65: three of them slept in that part of the buildings in which the rooms were under the level of the ground.

These two instances may be taken as samples. They show very well the sanitary defects common to the localities in town which

yielded most of the cases of enteric fever. The number sent to the Infirmary forms only a portion of the total which occurred in each locality; a great many (chiefly children) were treated at home.

It seems, then, that in the low, densely populated parts of the town, where the courts and closes were paved, and in which there were few convenient places for the deposition and retention of filth, enteric fever was rare; whilst in the upper and less densely populated districts, where the courts were not paved, and where there existed every convenience for the deposition and retention of filth, it was of frequent occurrence. The inference is inevitable, that the presence of accumulations of filth, combined with the unpaved state of the courts, has something to do with the prevalence of the disease in these localities. But how could these conditions tend to such a result? One of the tenets of the pythogenic theory is, that the fæcal matter must be undergoing a change,—must be in a state of fermentation, before there is generated that particular substance which is the direct exciting cause of enteric fever. In those parts of the town in which accumulations of filth did not exist,—in which the slops and refuse were carried at once to the street and carted away, and in which the courts and alleys were paved, so as to admit of the ready removal of any filth which was deposited, and so as to prevent soakage into the soil,—the fæcal matter was not allowed to remain long enough for the establishment of the process of fermentation: it was removed before it became pestilentially injurious. In those unpaved courts, on the other hand, in which there was a constant collection of filth, every facility was afforded for the production of enteric fever—so far as this could be done in a locality having a good water supply and an efficient system of drainage. The closets and middens were never thoroughly cleaned out; something always remained at the bottom, which was not cemented, and thus both that which was in the midden and that which was spilt on the surface were constantly soaking into the ground. Decomposition and fermentation would take place with more or less rapidity, according to the state of the weather. In the warm weather of summer, these processes would be more active; noxious vapours would be given off from the surface, cases of enteric fever would spring up in the neighbourhood, the stools of these would be thrown into the common filth receptacle, another agent would be added to that already in operation, and the usual autumnal fever would result. Here, as at Lochee, indirect communication of the disease through the stools of those previously affected was probably of not infrequent occurrence. How far this agency acted cannot be determined.

Such is what appears to me the most feasible explanation of the prevalence of the fever in those localities in which the water and drainage were good, and whose only sanitary defect consisted in the retention of filth in an unpaved court.

Of the means to be adopted in order to prevent the occurrence

of the disease, it is unnecessary to say anything. A mere statement of the causes which gave rise to it, both in Lochee and Dundee, is sufficient to show that the malady is quite preventable, and that the means of attaining this end are simple in the extreme.

A very remarkable outbreak of fever took place several miles out of town. This case is so interesting in itself, so pregnant with useful facts, and so free from all sources of fallacy, that I shall give a description of it in full; and, in the first place, shall try to convey some idea of the locality in which it occurred.

Six miles to the north-east of Dundee is a short range of hills called the Sidlaws. At their southern base are several farms, two of which, named Prieston and Balletheron (the only ones with which we shall have to do), are a mile and a quarter apart. On the other side of the hills is situated the Glen of Ogilvie,—a short glen, from two to three miles in length, and opening at its eastern extremity on the vale of Strathmore. At the bottom of the glen is a small village, called Milltown, consisting of fifteen or sixteen cottages. About a mile and a half further up the glen resides a small farmer, named Duff, whose household, at the time to which I allude, consisted of himself, wife, and seven children, of ages ranging from 3 to 20. Besides these, he had a son and daughter out at service,—the former at Prieston, the latter at Balletheron, the two farms already referred to, situated at the other side of the hills, and about two or three miles from Duff's house. All the places here indicated had the reputation of being very healthy. With the exception of scarlatina, fever was unknown in the neighbourhood. The water, supplied by streams from the hills, was good and abundant.

Balletheron is an ordinary farm, with nothing particularly noteworthy about it. The whole place was in tolerable order, and the house tidy and comfortable. The back door opened directly into an open court, which separated the dwelling-house from the stable and other out-houses pertaining to a farm. The front door opened into a garden, in which were a good many young fir trees. Close to the kitchen door was an iron grating leading into a covered drain, by which all the slops and refuse from the house were carried away. This drain originally passed westward, beneath the front garden, and lost itself in the fields. In the course of time, the roots of the trees in the garden forced their way into and so obstructed it, that it was found necessary to fill it up and make another. The new one, which, like the former, was untrapped, ran in the opposite direction,—eastward—passed under the reed and cattle pen, and finally emptied itself into a stagnant pool of liquid manure. At the time of visit, the mouth of the drain was flush with the surface of the liquid. The filling up of the old drain and the formation of the new one took place about the middle of October 1864. In the first week of November, the maid (Duff's daughter) sickened, but continued to perform her duties for several days. She gradually got worse, however, and on the 11th or 12th of November was driven

home in a gig by her master's son. Ten days afterwards she died. She had no regular medical attendance. Shortly before death she was seen by a medical man residing some miles away, who informed me that the general symptoms were very much those of typhus. Careful inquiry, and the light thrown on the case by subsequent events, leave no doubt that she died of enteric fever.

A week after she went home, the young man who had driven her over took ill, and was confined to bed for several weeks. He was attended by Dr Christie of Dundee, who informed me that the case was a typical one of enteric fever, with eruption of rose-coloured spots coming out in successive crops, and other symptoms well marked. He made a good recovery.

About ten days or a fortnight after the commencement of the last case, the shepherd was seized, and went home to his parents, who lived some fifty or sixty miles off. Here he was attended by Dr Reid of Aberfeldy, who informed me that the man had a smart attack of enteric fever, with moderate head symptoms, marked, and somewhat persistent enteric symptoms, but no eruption at any period. He made a good recovery. The only other occupants of the house in which he was treated were his father and mother, aged between 50 and 60. No other case occurred in the neighbourhood.

About the same time (shortly after the death of the first case), the fever attacked some of the members of Duff's household in the Glen of Ogilvie, and one after another was seized, until the whole family, except the father, was prostrated, and one child, aged 3 years, died. The Duffs were nursed by a woman aged 61, who, with a sister aged 46, resided in one of the cottages in the village of Milltown, at the bottom of the glen. This younger sister, on one or two occasions, went to see the nurse at Duff's, where, she says, she perceived a very offensive smell. About a fortnight after the time at which she paid her first visit, she herself took ill, and was confined to bed for eight weeks. Before she got better, three children, aged respectively 5, 7, and 9 years, residing in the next cottage, fell ill with symptoms of enteric fever, and were confined to bed for three or four weeks. In another cottage, ten yards distant, two children, aged 5 and 12 years, had the same illness. In a cottage immediately opposite, a child, aged 9 years, was similarly affected. About thirty yards from the cottage in which the first case occurred, a child, aged 7, was ill for a month with symptoms which differed in no respect from those of the other cases. In all, eight cases occurred in this little village, or rather in these few scattered cottages. The description given of all the cases was sufficiently clear, and plainly pointed to enteric fever. I afterwards learnt from Dr Wright of Glamis, who attended both the Duffs and the cases at Milltown, that all the cases in the latter locality were undoubtedly enteric fever, and that the only one of the Duffs regarding whose case he had any doubts was the child who died. There was

in its case so much bronchitis, that he thought it possible that its febrile symptoms and death might have been due to that affection. The others, however, were true enteric fever.

Duff's son, who, as already mentioned, was a farm servant at Prieston, was in the habit of going over to see his brothers and sisters during their illness, staying generally for an hour or two on each occasion. About the middle of January 1865, or two months after his sister's death, but before the fever had ceased to exist in his father's house, he also was seized, and was seen by Dr Nimmo of Dundee, who ordered his removal to the hospital, where he came under my own observation, and where he went through a smart attack of enteric fever, both the eruption and abdominal symptoms being well marked. He made a good recovery. No other case occurred at Prieston. I made careful inquiry at most of the farms and cottages in the vicinity, but found no cases of fever in any other locality besides those mentioned, and no evidence of its existence at any former period.

Here, then, in an isolated farm-house, situated in a locality in which enteric fever was formerly unknown, we have the direction and course of a drain altered, so that, instead of emptying itself on a field, as formerly, it pours its contents into a stagnant cesspool, and within three weeks afterwards enteric fever breaks out. Can the two events be regarded otherwise than as cause and effect? To my mind it seems impossible to regard them in any other light. The possibility of importation of the disease seemed excluded; all the servants and residents had been there for some months at least, no one had been in any locality in which the fever existed, and no person had visited the place who was in the least degree likely to have brought infection with them (supposing such a thing possible). Not only is the formation of such a drain *prima facie* likely to lead to such a result, but its existence is positively the only feasible explanation that can be found of the occurrence of the fever. Three cases occurred at Balletheron, in two of which the disease may possibly have been acquired from the first; but it is infinitely more probable, seeing that they all sprung up within such a short time of each other, that in each case the poison came from the same source. It is noteworthy that the first case occurred in the maid whose duties frequently led her to empty articles into the drain, and who slept in a closet off the kitchen, the window and door of which were very close to the grating leading to the drain. That the second case occurred in the son, who, more than any other person, had frequent occasion to pass from the house to the farm-yard, and who always went in and out by the back door, thus passing over or in the immediate vicinity of the grating, and whose bedroom window (on a higher floor than the kitchen) looked directly over the grating; and that the third case was in one of three men who slept in another building, and who were similarly situated in all respects, except that the one who took the fever was

a stranger in the locality, having only been there about three months.

So much for Balletheron. Let us now follow the maid to her father's house in the Glen of Ogilvie. Here, also, in an isolated house, where fever was before unknown, and which presented no sanitary defects likely to lead to its production, we find a case of enteric fever imported; and within a few weeks afterwards, no fewer than seven, probably eight, cases spring up in the same house. We find, also, that two people residing some miles away, one the brother of those already affected, the other the sister of the nurse, after visiting this house, go home and pass through an attack of the same disease; and that in the immediate neighbourhood of the latter, seven other cases spring up before she has well recovered. We find, in short, that immediately consequent on the introduction of one case of enteric fever into a thinly populated and healthy glen, no fewer than 16, probably 17, other cases spring up, all in persons who were in the immediate vicinity of those previously affected. With such facts before us, it seems to me impossible to come to any other conclusion than that the disease was communicated from one to the other. How was this communication effected? Was it by contagion, in the strict sense of the term, or did it take place through the medium of the alvine dejections? This is a point on which a diversity of opinion may exist in almost every case in which enteric fever is communicated. It is obviously impossible to separate entirely the two questions, inasmuch as in every case in which direct contagion is possible, communication of the disease by the stools is equally probable. Wherever there is a case of enteric fever, there are also stools; and to say, under these circumstances, whether, in a given case, the disease was due to direct contagion or to indirect communication through the alvine dejections, would require a more minute knowledge of the exciting cause than we as yet possess. A review of the hygienic conditions affecting the places in the Glen of Ogilvie, during the time at which the above outbreak occurred, may give some facts in favour of one or the other opinion. Duff's house consisted of only two rooms, each of which had two box-beds in it, in which the cases were treated. The stools of all were taken outside, and thrown on a manure-heap close to the house. Here each theory has an equal amount of evidence in its favour. Equal scope was given in all the cases for the operation of each mode of origin. In the cases of the son at Prieston, and of the woman living at Milltown, who visited Duff's, each theory has also an equal amount of support, as on each visit they came both in contact with the patients, and were subjected to the morbid influence of the stools. It is just possible that the three children residing in the cottage next to that which the sister of the nurse occupied may have contracted the disease by coming in contact with her before she took to bed. It is much more likely, however, that it was communicated to them through the medium of her

stools, which were thrown on a dust-heap close to the house, and in the neighbourhood of which they were constantly in the habit of running about. They all sickened so nearly about the same time, that the *materies morbi* was, in all probability, derived from the same source in each. The same reasoning applies to all the other cases which occurred at Milltown. There is in each (granting the theory of direct contagion to be tenable) a possibility of the malady having been contracted by direct personal communication with the others, either during the period of incubation, or during the first few days of the illness, before confinement to bed; but there is a much greater likelihood of the disease having been derived from the stools, which, in all the cases, were thrown on the dust-heaps in the immediate vicinity of the dwellings. The facts are in favour of the opinion that in the stools was contained the *materies morbi*; and my own opinion is, that to emanations from them, and not to direct contagion, must be ascribed this limited outbreak. But, it may be argued, if the stools are of such a deadly nature, there would certainly have sprung up many cases in the hospital during the time at which so many patients were under treatment in it; whereas it has been shown, in a former part of the paper, that this did not occur. It has already been stated, that fermentation of faecal matter seems essential to the production of enteric fever; and it is a well-known fact that the dejections of patients suffering from that disease differ from healthy stools, in being alkaline instead of acid, and in being peculiarly liable to undergo rapid decomposition and fermentation: their speedy removal is therefore desirable. In the hospital, the stools were at once removed, and every care taken, by the use of disinfectants, and by the most strict cleanliness, to do away with the chance of harm resulting either to patients or attendants. At the Glen of Ogilvie, no such precautions were used, the stools being in every case thrown on a dust-heap close to the house, and in the vicinity of which the inhabitants, especially the children, were constantly going about.

One or two other points of interest are worthy of note here. The mass of the cases which came from Dundee and Lochee occurred in persons who were comparative strangers to the locality; few had been more than two or three years in the neighbourhood, many only a few months, and several only a few weeks; it was very rare to get a native. Of the scattered sporadic cases which came from parts of the town not noted as yielding an unusual number, nearly all were servant girls who had recently come from other parts of the country. This liability of strangers to enteric fever has very constantly been noted by observers, and is of itself sufficient to lead one to suspect the existence of some local cause to which the system may become habituated by exposure (Murchison). It seems to me, however, that this is not a very satisfactory explanation, and I am more inclined to adopt the view advocated by Dr Parkes, and to think that this immunity of the regular inhabitants is due in great

part to the protecting influence of a prior attack, the proof of which is wanting, because it is only within a comparatively few years that enteric fever has been generally recognised and diagnosed as a separate and specific form of fever; and because it was even at a more recent period that it was shown to be the same disease with which physicians had so long been familiar under the name of infantile remittent fever; not indeed till 1848, when Dr West demonstrated the fact, was this identity fully recognised in this country; and even now, with a full knowledge of all the symptoms, and a thorough conviction of the identity of the two diseases, it is, in some cases, very difficult to say whether or not the patient is really suffering from this form of fever; and this difficulty is especially great in children, in whom the disease may exist in so slight a form that nothing more definite can be observed than that the child is generally out of sorts, gives evidence of some gastric derangement, and is restless and feverish at night. The fact so often noted that children are particularly liable to be attacked (of which we have a good instance in the outbreak at Milltown), may be partly explained in the same way; there is a possibility of the parents having had a similar attack in childhood. There are undoubtedly many instances on record in which the fever has broken out in a locality in which it was previously unknown, and has attacked those of all ages indiscriminately, showing no particular preference for strangers. In most of these cases there has been found some local defect of recent origin, giving rise to pollution either of the water or atmosphere; the outbreak at Balletheron, due to alteration of the course of a drain, is a case in point. Whilst holding the opinion that much of the apparent immunity enjoyed by the regular inhabitants of a locality is to be explained by the occurrence of a previous attack, I am also prepared to believe that, to some extent, recent residence may act as a predisposing cause, especially when accompanied by that mental depression and general want of vigour and elasticity which is so apt to take possession of those separated for the first time from the friends and associations of childhood, and cast amongst strangers in an unknown locality.

At the time at which this outbreak of enteric fever occurred, typhus was also epidemic; and it is worthy of note that those localities in which the latter most prevailed, were exactly those in which fewest cases of the former occurred, and *vice versa*. Enteric fever was most prevalent in Lochee, and in the higher, less densely populated parts of the town; whilst typhus found its favourite abode in the low-lying, densely populated closes of the Overgate, Nethergate, and surrounding localities. Lochee, which supplied the majority of the enteric cases, sent into the hospital only 2·7 per cent. of the total typhus admissions.

Another remarkable fact is, that Lochee, which was the principal seat of enteric fever, the chief agent in the production of which we have seen to have been impure water, was, at the commencement of

last winter, the seat of an outbreak of cholera, presenting in a well-marked form all the symptoms of that disease. The outbreak was a sharp one, and was confined to the same locality which furnished so many cases of enteric fever, the low-lying part of the village called the Bog. The upper part of Lochee and Dundee almost, if not quite entirely, escaped. At this time (after an interval of two years) I repeated my analysis, and found the water in much the same condition as on the former occasion. At the request of the authorities, Dr Stevenson Macadam, of Edinburgh, made a minute analysis of the water from four of the wells in the cholera locality; the result was as follows:—

	No. 1.	No. 2.	No. 3.	No. 4.
Saline matter dissolved in one imperial gallon of the water, principally carbonate of lime, sulphate of lime, and chloride of sodium,	Grains. 52·32	Grains. 41·60	Grains. 30·80	Grains. 41·44
Organic matter and nitrates dissolved in one imperial gallon,	12·22	4·90	8·68	10·34
Total matter in solution in one imperial gallon,	64·54	46·50	39·48	51·78

When the state of the water was made known, the wells were closed, water was supplied to the inhabitants from another source, and the disease speedily declined. One fact struck me. Luis' Land, which was one of the chief seats of enteric fever, escaped cholera, or had it to only a very slight extent, and yet the water which I got from it for examination was as fully charged as formerly with nitrates and nitrites. It was, however, got with greater difficulty, and, on making inquiry, I found the explanation of the exemption of this locality from cholera to be as follows:—The land, as formerly mentioned, is not at the lowest part of the village, but close to it. It seems that, as wells have been sunk in connexion with other lands in the lower lying Bog, the water supply to the well at Luis' Land has been drained off by the new ones, until latterly very little could be got, and that with so much trouble that the inhabitants were in the habit of getting almost their entire supply from other sources, chiefly the east well,—their own well at the time of the cholera outbreak being almost deserted.

The history of this limited outbreak of cholera is by no means singular. In many other villages of Scotland the disease appeared about the same time; and in all regarding which I could get information, this impure state of the water was found. In the Edinburgh Medical Journal for last February, Dr J. Balfour gives an account of an outbreak which occurred at Slateford, near Edinburgh. The water on analysis was found largely impregnated with organic impurities. The history of last winter's visitation forms another link in the chain of evidence which goes to show the

intimate connexion existing between cholera and impure water. It seems, at first sight, a remarkable fact, that the large towns which, on all former occasions on which cholera visited this country, suffered so severely, should have escaped on this; but when we bear in mind the facts, that since the last great epidemic their drainage has been so much improved, and that their water supply, instead of being got from streams polluted by sewage, is brought from localities far removed from the possibility of such contamination, our surprise ceases; and when we regard these facts in the light which more recent and extended experience has given us, we may, I think, indulge the hope, if not the expectation, that our towns are not likely to be again the seat of such wide-spread and fatal epidemics as devastated them on former occasions. Such limited outbreaks as those which occurred in so many villages last winter would probably never have taken place if the water supply had been pure and wholesome.

I have referred to this matter simply for the sake of indicating the similarity which exists between the sanitary defects leading to the production of enteric fever and those which tend to give rise to cholera, showing, so far as mode of origin is concerned, a closer connexion betwixt these two maladies than betwixt typhus and enteric fevers. Of course, an increased rainfall would have the effect of carrying into the wells a greater quantity of impurities. Last autumn was more than usually wet; the wells situated in the low-lying Bog (the cholera and enteric fever locality) would receive the water which had entered the ground on the slope of the hill, and would carry along with it the refuse derived from localities farther up, as well as those in the immediate neighbourhood, as was shown by the failure of the supply at Luis' Land.

The inferences drawn from the foregoing facts may be briefly summed up as follows:—(a) That most of the cases which occurred in Lochee were caused by contamination of the water by sewage matter; (b) that those in the courts of Dundee were due chiefly to the inhalation of noxious vapours emanating from the soil; (c) that the outbreak at Balletheron was produced by foul air passing from a stagnant cesspool along a drain leading to the door of the house; (d) that the prevalence of the fever at the Glen of Ogilvie, immediately consequent on the importation of a case, was due to communication of the disease through the stools of those previously affected, an agency which likewise tended to increase the number of cases, and to prolong the duration of the disease in Lochee and Dundee; and (e) that in no case is there the least necessity for calling to our aid the agency of an epidemic influence, all the facts being fully explained by tangible causes; the greater prevalence of the fever at the end of 1864 being quite explicable by the nature of the weather which prevailed during the summer and autumn months. The occurrence of the outbreak at Balletheron in November was, of course, accidental; the alteration of the course

of the drain at another time would probably have led to the same result.

It may also, I think, be generally inferred, that when enteric fever becomes unusually prevalent in a locality whose water supply and drainage are known to be good, and about which no filth is allowed to remain, the probable cause of this unusual prevalence is likely to be some accidental contamination of the water or derangement of the system of drainage,—an agency which may come into play as readily in spring or summer as in autumn or winter.