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PART I.

ORIGINAL COMMUNICATIONS.

ART. I.—*On an Epidemic of Fever caused by Infected Milk.*^a
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ABOUT Christmas, 1878, several cases of typhoid fever occurred in houses situated in Raglan-road and Elgin-road, Pembroke Township, a suburb of Dublin. Towards the end of January circumstances led me to investigate the cause of the outbreak. I was not long in discovering that all the households affected were supplied with milk from a particular dairy, and also that the owner of the dairy had been ill with fever since the middle of December. I subsequently ascertained that two children had been ill with fever of some kind during December, and that all the patients had remained in a small house attached to the dairy.

THE DAIRY.

An examination of the dairy showed that it was situated under the following conditions:—The proprietor and his family resided in a small two-story house, situated in a court off a street in the eastern part of the city. The front door opened directly into the court; there was no back door, because the house was built against

^a Read before the Medical Society of the King and Queen's College of Physicians, Wednesday, May 7, 1879. [For the discussion on this paper see page 66.]

the wall of other and separate premises. On the right-hand side of the house a door led into a yard in which the cows, to the number (at the date of my visit) of twenty-two, were placed under open sheds.

The following are the dimensions of the yard and sheds:—The yard is 50 feet in length and 12 feet wide. On the right-hand side of it, and extending from the house to the further extremity of the yard, there are sheds 39 feet in length and $8\frac{1}{2}$ feet in width. On the opposite side there are sheds extending from the entrance into the yard to a stable for horses—a length of $29\frac{1}{2}$ feet, with a width of $14\frac{1}{2}$ feet. The stable which terminates the shedding is 24 feet in length and $12\frac{2}{3}$ feet in width. At the end of the yard there is a space for the deposition of manure; it is 9 feet long and $8\frac{1}{2}$ feet wide. Over the gateway there is a hay-loft. A portion of one of the walls of the house constitutes one side of the gateway, and against this wall there are shelves affixed. Upon these shelves, at the date of my visit, I observed several milk-vessels, which were, of course, fully exposed to the atmosphere of the yard. The gateway is 30 feet in length, and the completely open part of the yard is thereby reduced to a length of 20 feet and a breadth of 12 feet—240 square feet. Altogether, the premises are small and confined, as might be expected in a city court.

At the date of my inspection the yard and sheds were, I am bound to say, cleaner than is usual in dairy-yards.

ABSENCE OF SANITARY ACCOMMODATION.

I found that there was neither water-closet nor latrine in connexion with either house or yard. At the end of the yard—most remote from the house, and quite close to the cows—I found an accumulation of cow manure and litter. On the top of this heap I noticed a contribution from the household, consisting of ashes, human ejecta, and the other effete matters which usually are consigned to the water-closet and ashpit. I was informed that the refuse from the dwelling-house was daily deposited upon the dung-heap, and that the admixture of the two compounds was removed once or twice a week.

The milk utensils, or at least some of them, were placed on shelves against the walls—partly of the house, partly of the yard, and close to the gateway. During the removal of the manure, &c., they could hardly escape, especially on a windy day, from particles of solid matter getting into them. There did not seem to be a

regular dairy apartment in the place. Some of the dairy operations were conducted in the kitchen, which opened direct into the yard, but the major portion of the dairy processes appears to have been conducted in the yard and sheds.

ILLNESS IN THE HOUSEHOLD.

I have made inquiries as to the nature of the illness from which three members of the family suffered, and the following are the results at which I have arrived:—

On 15th December, 1878, a little girl, child of the proprietor, was seen for the first time by the physician who subsequently had charge of her father. He informs me that she was suffering from what is commonly termed gastric fever, but that she had neither diarrhœa nor rash. How long she was ill before medical advice was procured for her I am unable to tell. A lady living in Lower Mount-street, and in whose house three cases of fever occurred in December—to be adverted to presently—informs me that early in December she heard that a child of the person who supplied her with milk was ill. It will be conceded that when a patient is first seen in typhoid or allied fever, illness has probably been present for a week or two. In several of the cases of typhoid fever which I purpose referring to further on, the patients were two or three weeks ill before they came under medical treatment. From what I have discovered in connexion with the subject matter of this paper, I am altogether disposed to believe that this child's illness began late in November.

About 30th December, a little boy, who had been ill for a fortnight, "showed symptoms of cerebro-spinal meningitis, which became very severe, but yielded to treatment." There was no diarrhœa or rash.

About the middle of December the father had an attack somewhat similar to that of the boy's, but in a fortnight it was believed to be typhus. There were abundant eruption and delirium. Dr. Harley has given me the following particulars relative to this case:—"Bronchitis was developed, and after seven days the patient began to convalesce, when he relapsed into a low form of fever, accompanied by a few rose spots. No diarrhœa or delirium. A severe attack of double pneumonia, with very abundant expectoration." The man was only able to be removed for change of air in the early part of February. During his illness he drank milk abundantly.

I presume that at least in the latter stages of this man's illness few will doubt but that he suffered from typhoid fever. One thing is very clear—there was no lack of fever-poison of the typhoidal kind in this dairy during the month of December.

HOW DID TYPHOID POISON GET INTO THE MILK ?

The facts which I shall bring forward presently will clearly prove, I think, that fever was spread in December last by means of milk supplied from the dairy which I have now described. The question arises—How did the *materies morbi* get into the milk? I shall endeavour to answer it satisfactorily. The milk may have been contaminated first by actual particles of the dejections of the patient getting into it. A strong wind blowing into the yard would certainly waft particles of coal-ash and similar light substances from the dung-heap, and distribute them throughout the yard. To these particles minute portions of human ejecta might have adhered. The milk-vessels and the milk itself might have had some of these particles deposited therein. If contagia exist at all, we know they must consist of almost infinitely minute portions of organised matter.

Immediately after milk has been withdrawn from the cow it is strained through muslin, and a sediment, often rather considerable in quantity, is separated from the liquid. I have carefully examined this sediment with the microscope, and I find that it consists of a great variety of substances—epithelial *débris*, hairs of the cow, cow-dung, straw, hay, vegetable fibres of various kinds, soot, clay, ashes, wool, linen, cotton, and other substances—mostly, of course, in fine dust. If mixed ashes and excrement deposited in a small yard be thrown up upon an open cart by pitchfork and shovel, it is evident that fine particles therefrom must be discharged into the air, and float about in it for some time before subsiding to the ground or attaching themselves to walls, &c. The beautiful experiments of our great countryman, Tyndall, have shown us that the air teems with solid particles—mineral, vegetable, and animal.

With respect to the dairy-yard—which in the following pages will be referred to as Mr. X.'s—there is nothing far-fetched in the theory that solid particles of a contagious nature floated about in its atmosphere during the month of December, and that some of them were deposited in the vessels which contained the milk, and which we have seen were generally kept in the yard. All who are acquainted with dairy management are well aware how readily milk

absorbs foul gases and vapours. In well arranged dairies great precautions are taken to ensure the purity of their atmosphere; for it has been established that effluvia from a manure-heap, &c., if admitted into a dairy, are likely to injure the quality of the butter produced therein. That potable water is a vehicle for the transmission of typhoid poison I firmly believe, in common with the immense majority of physicians and sanitarians. If I were of a contrary opinion I should not have written this paper. If it be conceded that water can take up typhoid poison, why not milk? There is strong evidence to show that the water in the cisterns which supply water-closets often becomes impregnated with the poison of typhoid. If this be true, then the water must be contaminated by gases and vapours from the water-closet carrying mechanically up with them solid particles from the soil-pipe or pan of the closet. The gases which result from the decomposition of organic matter do not give typhoid, but they are the vehicles upon which the contagium is conveyed. I have no doubt, therefore, but that milk exposed to the air of a confined place in which the stools of a typhoid patient are undergoing putrefactive changes is just as likely to absorb the solid particles carried into the air from these stools as is the water in the cistern over the water-closet. An eminent pathologist attributed an outbreak of typhoid in Caius' College, Cambridge, to the use of pipe-water, which had absorbed whilst still in the main pipe, sewer gases. If in a high-pressure main there be a small hole, the water will pass out through it in the form of a long fine jet. The opening of a tap near the hole will cause the jet to cease, and will produce an insuction of air into the pipe, which may be, as was the case at Caius' College, from a foul source. How much more likely is it not that milk exposed to the air of a yard in which excrement is decomposing would absorb foul gases! The family of the sick man were the persons who managed the dairy. They tended the three patients and manipulated the milk. Trade and domestic operations were simultaneously conducted in premises of very limited size. It is certain that some of the vessels which contained the milk entered the house through the kitchen door, which aperture gave passage outwards to the vessels which contained the slops of the house. Let us hope that the two sets of vessels never came into actual contact during these operations!

WAS POLLUTED WATER PUT INTO THE MILK?

This question can be easily answered in the negative. In the first place, there was no pump or well on the premises; secondly, the Vartry pipe-water was available, and the tap was in good order; and, lastly, Mr. X. was noted for the good quality of his milk supply. Indeed, my analysis of it proved its freedom from adulteration.

NUMBER OF PERSONS WHO DRANK THE INFECTED MILK.

Although there were twenty-two cows in the dairy, fully one-third of the animals were not giving milk. The person in charge of the place informed me that only about two dozen households were supplied with milk from this dairy, but I subsequently ascertained that during December about forty households obtained their milk from it. How many more were supplied I am unable to state. In some of the households more than one gallon of milk was daily taken. It is certain that the fourteen cows could not have supplied a very much larger number of families than forty or fifty; but on this point I have no positive evidence to give. The quantity of milk sent out from the dairy is a point of great importance in connexion with the subject of this paper. Some of the great milk purveying establishments of England supply hundreds of families. If amongst 500 families using milk from a particular dairy typhoid occurred almost simultaneously amongst a dozen of them, the circumstance might perhaps be fairly regarded as a mere coincidence, or at most a suspicious occurrence. When, however, we find the majority of the customers of a particular dairy becoming much about the same time affected with fever of the typhoid nature, whilst their neighbours who are supplied with milk from other sources escape, the inference that the milk is the proximate *origo mali* is almost irresistible; and further, when we learn that fever had existed for many weeks in the suspected dairy, that the dejections of the patients were allowed to decompose close to the cows and the milk vessels, and that the dissemination of the fever was *pari passu* with the distribution of the milk, the inference may not unfairly become a certain belief.

I have already given evidence as to the insanitary state of the dairy under discussion, of the existence of fever therein, and of the total absence of sanitary accommodation. I shall now offer the further and, as I think, conclusive evidence as to the large

number of persons who, having used the milk from Mr. X.'s dairy, became ill in consequence thereof.

DISTRIBUTION OF THE MILK.

The houses supplied by Mr. X. were of the best class, and a large proportion of his customers appear to have lived on two fashionable roads—namely, Elgin-road and Raglan-road. He also supplied houses situated in Fitzwilliam-square, and in a few other places in the south-eastern part of the city and in Pembroke Township.

I might have extorted from the persons in charge of the dairy a list of their customers; but as I do not approve of the principle of forcing people to give evidence against themselves, I did not resort to that measure.

As very many of Mr. X.'s customers were in Raglan-road, Elgin-road, and Fitzwilliam-square—the localities, too, noted for the amount of typhoid disease which appeared in them lately—I endeavoured to ascertain in relation to every house in these localities—

1. Whether or not fever of the typhoidal kind had occurred in it since November.
2. The source of its milk supply.
3. Any other particulars I could gather in the cases where fever had occurred.

I did not take the same amount of trouble in the other localities, as the customers of Mr. X. in them were very few. As it was I found the inquiry a very laborious one, involving much correspondence and visiting.

ELGIN-ROAD CASES.

The houses on this road number thirty-three, and of these two were vacant during last December. Twelve of the households were supplied with milk from Mr. X.'s dairy, eighteen from ten other dairies, and one from a cow kept on the premises. Out of the twelve households supplied by Mr. X. with milk, six were invaded by typhoid shortly before or after Christmas, 1878. In not one of the twenty households supplied with milk from other sources did fever of any kind occur for a period of some months before Christmas till the date of my inquiries, which were not completed till April, 1879.

CASE I.—A little girl, the daughter of the Rev. Mr. Weldon (who kindly permits me to publish his name in this paper), became seriously

ill on the 26th December, and was attended by Dr. Chapman. The case was severe and long-continued, and it appears was clearly one of typhoid. Both diarrhœa and rash were present, but the diarrhœa was not persistent. Mr. Weldon informs me that this child was the only member of his family who liked to drink raw milk—his other children having rather a dislike towards that article. Mr. Weldon mentioned to me that the man who delivered the milk remarked upon one occasion that it was an extraordinary circumstance that there was sickness in all the families he was distributing milk to !

CASE II.—Mr. Travers Smith, a student of medicine of Trinity College, resided with his uncle at 7, Elgin-road. He drank the milk from X.'s dairy constantly. On the 20th December he left town for Belfast. At Christmas he got a headache, and felt very ill and unpleasantly hot at night—symptoms which he had rarely suffered from before. On the 1st of January he became very ill, and was placed under the care of Dr. James Cuming, of Belfast. No doubt poison had been taken into his system in Dublin. Dr. Cuming, writing to me relative to this case, says:—"He certainly used the milk, and he certainly had fever; but that he had typhoid I cannot say. If you think everything continued which is not typhus is typhoid, then the case is clear, but there was constipation throughout; there were no spots, and the temperature was altogether unlike the typical remittent course of typhoid."

CASE III.—Mrs. W., of No. 38, Elgin-road, has kindly furnished me with the following information:—"Our household was supplied with milk for six or nine months, ending about Feb. 1st, from * * * Eliza Armstrong had been in my service about six weeks, when she took to her bed on Christmas Day. She was suffering all the time I knew her from severe bronchial cold, and said she had been subject to a cough for three years. Her appetite was not good, and I ordered her a glass of milk daily with her dinner. She took this for some time, until one day she told me 'her stomach turned against the milk,' adding she thought the cook must have put it into a dirty glass. I thought it might have been fancy, and took no further notice of her remark at the time. This was, of course, previous to her illness. I had myself a bad attack of sickness and diarrhœa at the same time, and thought I had taken it from the servant, having been many times a day into her sick room. Dr. Chapman attended me at the time for it. The milk I took was always cooked. I have no reason for wishing this information to be kept private." This girl was admitted into the Meath Hospital upon the 4th of January, and upon what was believed to be the thirteenth day of a severe attack of typhoid fever. She died upon the 25th day of January. Dr. John William Moore informs me that there was constipation throughout the illness, which terminated in catarrhal pneumonia.

CASE IV.—On the 3rd of January a girl was admitted into Mercer's Hospital. She had a severe attack of typhoid fever, but was discharged well on the 5th of February. She had been a kitchen-maid in a house on Elgin-road, and had been using milk from X.'s dairy. From a letter which I received from the girl's mistress I learned that the lady was of opinion that the fever had not commenced in her house, as it was merely a cold which the girl had when she left her situation to go home. Dr. Duffey, however, kindly inquired into this case, and is of opinion that she must have been ill with typhoid fever two or three weeks before her admission into hospital. The chest symptoms, which were mistaken for a mere cold, were, of course, very ordinary features of the malady. I have not the slightest doubt but that this girl got fever from drinking the infected milk. It is worth noting that in September another girl got fever in the same house on Elgin-road, and died.

CASE V.—A servant girl was admitted into Sir Patrick Dun's Hospital from the house, 24, Elgin-road, on the 2nd of January. She was treated in hospital for typhoid fever. She had been in the habit of drinking the milk from X.'s dairy.

CASE VI.—A lady who used the milk got a low, feverish attack at Christmas. She was confined to bed only for a few days, and it is doubtful whether or not the milk from X.'s dairy was the cause of her illness. The case is, however, worth noting.

CASES IN WHICH THE MILK CAUSED NO ILLNESS.

In six houses where the milk from X.'s dairy was used no fever appeared during December or January.

First house.—In this house the milk "was only used in tea; very seldom in cooking." There were no children in the house.

Second house.—Here the milk was taken cooked and uncooked by four or five persons, none of whom were young children. "Most of those who took the uncooked milk had gone through typhoid fever four and a half years ago." These previous attacks may account for their escape.

Third house.—The milk was used both cooked and uncooked by the family, but there were no children in the house.

Fourth house.—The whole family in this house drank the milk both raw and cooked, until it was known that fever was in the vendor's family—that was in the latter part of January.

Fifth house.—No one was ill in this house in December or January, though it was supplied with milk from X.'s dairy. In October, however, a housemaid died from typhoid fever in this house, and I shall have occasion further on to refer to the case.

"There were two children in the house, aged fourteen and twelve, but they did not drink the milk by itself. The servants being English, they did not, I fancy, drink the milk at all, except with tea." This is the information given to me by the head of the family.

Sixth house.—I could get no answer to my inquiries addressed to the head of this house, and as it was the only one on either Elgin or Raglan-road of whose milk supply I was ignorant, I gave X. the credit of supplying it with that article.

RAGLAN-ROAD CASES.

32 of the 34 houses on Raglan-road were occupied last December; 9 of these were supplied by Mr. X. with milk, and 23 were furnished with milk from 13 other vendors. No cases of fever of any kind occurred in any houses on this road, with four exceptions. In these four houses fever appeared about Christmas, and to each of them milk was supplied from X.'s dairy.

CASE I.—A young lady became very ill about New-year's Day. She was in the habit of drinking the milk supplied to the house both cooked and uncooked, especially in the latter state. Dr. Robert M'Donnell, F.R.S., who attended her, states that "she had no spots, nor diarrhœa. She had, for an unusual length of time, high temperature and very rapid pulse, and acute bronchitis." This young lady was confined to her bed for nearly two months. A servant in the same house, who also drank the milk, got what I am informed was considered to be typhoid fever. Dr. M'Donnell did not see her, and I believe she was sent into hospital.

CASE II.—Several of the family residing in No. 5, Raglan-road became ill at Christmas; four children, and young persons, and a female servant, were affected. All drank the milk. Dr. James Little saw some of the patients, and he informs me that they had so-called gastric fever, but not severely. The servant, however, was pronounced to have unmistakable typhoid, and one of the children was seriously ill for several weeks. There was no diarrhœa in these cases.

CASE III.—The family of Mr. C., residing at No. 37, were invaded with typhoid fever at the end of December. A little girl and four adult servants became ill. All drank the milk uncooked—the little girl largely. One of the servants went home, and the others were admitted into Baggot-street Hospital at the following dates:—Mrs. O'B. on December 23, Mrs. J. on December 26, William J. on December 28. Dr. J. Hawtrey Benson informs me that these cases were typhoid; that there was absolutely no diarrhœa in any of them, but that, on the

contrary, the bowels of the patients had to be relieved by enema or purgative. Mr. C. informed me that the child was exceedingly ill for several weeks, and that at one time her recovery was very doubtful. There was no diarrhœa in her case.

CASE IV.—The family living in No. 7 used the milk. Mrs. C. took it in tea, and at second course, but there is now no evidence to show whether or not she drank it raw. A little boy took it uncooked. On the 23rd December the family left Dublin and went to a house in the county of Meath. On that day the boy did not, his father informed me, feel well. His mother became ill on the 28th December, exactly a week after she had left Dublin. Clearly she had taken the poison into her system in Dublin. Both patients died in January, 1879.

Dr. Ringwood, of Kells, has, with the sanction of the lady's husband, been good enough to furnish me with a detailed account of the symptoms in these cases, and from this account the following are passages:—

"In every case there was profound blood-poisoning, giving rise to symptoms differing in each case from any standard disease. We had the perspirations, rash, sore throat, foul dejections of septicæmia. In Mrs. C.'s case, low erysipelas of foot, with sloughing of integument over metatarsal bones; low pyæmic pneumonia, lobular; desquamatory, greasy skin; sunk eyeballs; clammy strawberry-tongue, with the purple congestion of under-surface, and green duckweed slime of upper part; papilla congested, enlarged, prominent; urine loaded with albumen and casts—in last stage pus and blood; no diarrhœa; hepatic phlebitis. Temperature normal in the morning; high at night— 103° to 104° .

"In boy's case, localised peritonitis; no spontaneous diarrhœa; high fever; brain congestion; large abscess in mastoid cells.

"I had not the slightest doubt that Mrs. C. and her child had some latent blood-poison in their systems when they reached L.—spurious scarlatina, or some typhoid poison, changed in some way or other, so as to give rise to all the symptoms of scarlatina and pyæmia combined.

"Your researches in the case have cleared up the whole matter: the poisoned milk conveyed this poison, without the slightest doubt. I know that cases of scarlet fever have been set down to the escape of gases from slaughter-yards and dairies. These cases, I think, we may now look on as a new form of poisoning, in which the kidneys and skin, acting as eliminators, suffer in the same way as in scarlatina, the great tendency being towards pyæmic clots and abscess in mastoid cells and liver."

Unfortunately for Mrs. C. and her son, the country-house to which they went was in a very unsanitary condition; and, as Dr. Ringwood states, sewage gas making way into the house was the "fatal climax."

HOUSES IN WHICH THE MILK CAUSED NO DISEASE.

In five households on Raglan-road supplied with milk from X.'s dairy, no case of fever occurred about Christmas.

First household.—The family in No. 27 used the milk largely and uncooked. In December and January no sickness visited the household. Mr. H., however, informs me that his "son took ill of gastric on the 10th February, 1879; and was confined to the house for about a fortnight." As the dairy was not put into a proper sanitary state until the beginning of February, I can hardly avoid regarding Mr. H., junior, as the last of the cases caused by the milk. I have not, however, included him in the 67 cases.

Second household.—The family used the milk in tea and puddings, &c.

Third household.—The milk was used in tea and in custards, &c.

Fourth household.—The milk was not used by any of the family, or the servants, except in tea, and there were no young persons in the house.

Fifth household.—The milk was drank only in tea or cooked by the family in this household.

FITZWILLIAM-SQUARE CASES.

There are 69 houses in Fitzwilliam-square, and in December last 7 of them were uninhabited. Of the 62 inhabited houses, 4 were supplied with milk by Mr. X., 50 with milk from 15 different dairy-owners, and 3 from cows kept on the premises. One gentleman declined to state where his milk was obtained from, as by so doing "great injury might be done to innocent traders!" I learned through other sources that no fever had occurred in this household in December or January last. I was not able to ascertain the names of the persons who supplied milk to 4 houses. I made inquiries amongst the persons residing near these houses and amongst the medical men of the district, but no one had heard of the occurrence of illness in any one of them.

CASE I.—A child and two servants became ill early in January. Mr. William Colles, Surgeon to Her Majesty in Ireland, attended the child. There was a high temperature, but no diarrhœa or rash. The fever

lasted about a month. Mr. Colles saw only one of the servants—a man—and but upon one occasion. He had a rash upon him, which was neither that of typhus nor smallpox. He had no diarrhœa. He went into Sir Patrick Dun's Hospital, where he was treated for typhoid. The other servant was a female; she was, I am informed, very ill with fever, but I have not obtained any definite information concerning the symptoms of her attack. I am informed that all these persons drank the milk.

CASE II.—Three children were attended by Dr. William Moore, King's Professor of Medicine. A housemaid in the same house had fever, and was admitted into hospital. Professor Moore informs me that all four had undoubted typhoid fever. The father of the children informed me that they drank the milk uncooked daily, and that two other children who only used the milk in tea had no sickness. The illness in this household occurred shortly after Christmas. Dr. Moore paid his first visit on the 5th of January.

CASE III.—In this household two cases occurred at the end of December. The patients were a young lady and a man-servant. Dr. Robert M'Donnell, F.R.S., attended the former. She "had no spots; she had repeated bleedings from the nose, and some diarrhœa." The young lady used the milk uncooked. The man was admitted into Baggot-street Hospital, where he died upon the 10th day of January. He had neither diarrhœa nor rash; but his disease was pronounced to be typhoid.

CASE IV.—In this household a housemaid contracted fever, and was admitted into Sir Patrick Dun's Hospital early in January. I could not learn any particulars relative to her symptoms, but her case was described in the hospital books as typhoid. I have ascertained that she had used the milk raw.

UPPER MOUNT-STREET CASES.

In three households in Upper Mount-street supplied from Mr. X.'s dairy, fever broke out in December.

CASE I.—On the 28th of December a kitchen-maid was admitted from a house in Upper Mount-street into the epidemic ward of the Meath Hospital. She stated, on being asked, that she had habitually drank the milk supplied by Mr. X. There were no children in this house. In this case Dr. John William Moore informs me that the "tendency to constipation was well marked." She had a severe consecutive attack of otitis, followed by bubo and abscess in the parotid and mastoid regions on the left side.

CASE II.—Dr. M'Clintock attended a family who had been using the milk from X.'s dairy. "Six cases of typhoid occurred, four being

adults. The children only had diarrhœa. The cases extended from the 18th December to the 10th January." There were eight persons residing in this house and all drank the milk. Mr. M., two children, and three female servants, took it uncooked, Mr. M. using it with soda-water. All got typhoid. Mrs. M. was not ill, but she told Dr. M'Clintock that she made it a point never to drink milk without boiling it. The eighth person was the butler, who stated that he rarely tasted the milk except in tea.

CASE III.—The family used the milk raw and cooked. Two adults did not suffer any illness. Three children had fever; they had "great weakness, furred tongue, inability to take food, and a high pulse. There was no diarrhœa." The first case occurred early in December—the last early in January. The children were attended by Dr. Denham.

LOWER MOUNT-STREET CASES.

CASE I.—Dr. Walter G. Smith was called in to see a little girl in a house in Lower Mount-street. He pronounced her case to be one of typhoid. He found that two women-servants in the house were also ill—one with unmistakable typhoid, the other with a gastric attack of the typhoidal character. The child had a long illness, and her convalescence was slow. The illness in this house commenced about the third week in December. One of the servants was admitted into Sir Patrick Dun's Hospital, where she remained for three weeks. In none of these cases was there diarrhœa. All the patients had been in the habit of drinking the milk raw; this information was given to me by the lady who presided over the household.

CASE II.—On the opposite side of the street a little boy who had been using the milk in question was attacked about Christmas with typhoid, and was ill for some weeks. He had both diarrhœa and rash. He was attended by Dr. Richardson.

THE UPPER BAGGOT-STREET CASES.

So far as I can learn X. supplied only three households in Upper Baggot-street.

First household.—This is an institution, and the inmates—all adults—only used the milk in tea. None of them had fever.

Second household.—There were no children in this household. Two adults drank the milk uncooked; the rest of the family used it only in tea. One of the milk-drinkers had typhoid some years previously, and was not therefore a likely subject for a fresh attack. The other, Mr. Lyne, a student of medicine of Trinity College (he kindly permits me to refer to him by name), became ill upon the

18th December. He had for some time previously been using the milk, especially at dinner, at which meal he drank no other liquid. He had great prostration and a high temperature, but neither diarrhoea nor rash. He continued drinking the milk for a long time after his illness began, and did not become better until he gave up using it. He began to convalesce about the beginning of February. His attack was a very severe and prolonged one.

Third household.—The family of Mr. D. were good customers of Mr. X.'s dairy. They used large quantities of milk. Mrs. D. said to me that she and one of her children almost subsisted upon it, and all the family used it largely, chiefly raw. Early in December one member of the family became very ill, and was for some days treated for gastric fever, which, however, ran into tubercular meningitis, from which disease Dr. George Kidd informs me the child died on the 15th December. In cases of tubercular meningitis the earlier symptoms would be similar to those of so-called simple gastric fever. This child was undoubtedly treated for the latter disease, and I have but little doubt, from the history of the illness of the other members of the family, and from the poisonous character of the milk which the child used so largely, that her illness was in part at least due to the milk. It ended in tubercular meningitis, probably because the child's diathesis was a scrofulous one, as I have reason to believe was really the case. Mrs. D. was very ill from the middle of December until the middle of January, when she gave up the use of the infected milk owing to a temporary change of abode. She had constant sick stomach, and severe and continued diarrhoea. Two of her children beside the one who died were ill with gastric fever, and one of them is still not quite restored to health. Mr. D. was very ill with a feverish attack at Christmas, and got severe abscesses in his legs, which were healed with difficulty. A female servant (who also used the milk raw) was ill for six weeks, though she did not give up her situation. Mrs. D. informs me that this girl had severe gastric symptoms, and that she could barely "keep on her feet." The sewerage arrangements in this house were found to be very defective, but they had been so for an unknown period previous to the December outbreak of sickness in the household. I may add that Dr. Kidd questioned Mrs. D. as to the nature of the milk used by the family, and suggested that as they were all drinking milk and were all ill, there might be something wrong with the article. The family now attribute all their illness to the use of the milk.

WATERLOO-PLACE CASE.

A girl was admitted into Baggot-street Hospital on the 28th January, 1879. She had been a house- and parlour-maid in a house in Waterloo-place, Upper Leeson-street. On the 17th January she felt so ill that she was obliged to leave her situation; and she stated that she had felt unwell for some weeks previously. Clearly her illness dates from Christmas. Dr. Benson states that she had enteric fever, and that there was no diarrhœa, but rather a tendency to constipation, in the case.

I have every reason to believe that no other house in Waterloo-place was supplied with milk from Mr. X.'s dairy save that in which this girl lived as housemaid. She stated that she drank the milk. There were no children in the house.

BURLINGTON-ROAD CASE.

A lady and her child residing on Burlington-road were attended for typhoid fever by Professor William Moore. They became ill during the last week of December, and had each a severe attack. In the mother's case there were both eruption and diarrhœa; in the child's, bronchitis and diarrhœa. The lady's husband informed me that both his wife and child used, uncooked and as a staple food, the milk supplied from Mr. X.'s dairy. The child was under eighteen months of age—a period of life not very liable to attacks of undoubted typhoid. He lived in an airy nursery at the top of the house, and remote from sewers and water-closets. The sanitary appliances in the house were overhauled, but no defects were found to exist.

NORTHUMBERLAND-ROAD CASES.

CASE I.—On the 7th January, 1879, Professor Moore was called in to see a young lady who resided with her aunt on Northumberland-road. She had been ill for a week previously, and her case was pronounced to be typhoid. There was no persistent diarrhœa. A servant girl in the house was also found to be affected with typhoid; she had no diarrhœa. The young lady's aunt informed me that both the patients drank, uncooked, the milk supplied from Mr. X.'s dairy, and that the young lady used it as a substantial article of diet.

CASE II.—Doctor Arthur V. Macan attended, during an attack of typhoid, two children, a boy and a girl, aged ten and seven years respectively. They resided in a house on Northumberland-road supplied with milk by Mr. X. The first case occurred on the 2nd December, and the

second upon the 7th of the same month. There were two other children in the house, who were promptly removed from it, and did not contract the malady.

These cases occurred so early in December that it is doubtful whether or not they can be properly included in the group of cases which may be termed the Christmas epidemic. I have already stated that I strongly suspect that the illness of one of X.'s children began in November; and if my surmise be correct it is likely that the milk may have first become infected late in November.

ST. MARY'S ROAD CASE.

St. Mary's road is off Northumberland-road, and consists of only eighteen houses, all newly built, and in an excellent sanitary condition. I have ascertained the source of milk supply in only eleven of these houses, and find that X. supplied only one of these eleven households. In this household three children became ill in the last week of November and beginning of December. I am informed by the father of these children that X. supplied the house with milk for "a few days prior to the sickness," and for about two months afterwards. He says that the illness "would be more correctly termed gastric than typhoid." The mother of the children became ill with gastric fever in December. In these cases there was no eruption, but two of the children "had considerable diarrhoea, and one of them lost her hair in combfuls," for which her head was shaved three times as a remedy. The illness in this family lasted for seven weeks, and the patients were attended by Dr. Harley.

MARK-STREET CASE.

A man, aged twenty-one, was admitted from 13, Mark-street, into Cork-street Fever Hospital upon the 4th of January. He had well-marked and severe typhoid. He stated, as Dr. John William Moore informs me, that he had been in the habit of drinking milk from X.'s dairy. I made careful inquiries as to the existence of typhoid fever in Mark-street, but could not discover that any other case had occurred in it for some months previous.

CASES CLOSE TO X.'S DAIRY.

Mr. X. does not keep a shop, and I presume the sales of milk in his house are unimportant. Almost next door to him there is a small

dairy, which I learn does a brisk local business. It is probable that the people in the court chiefly get their milk from the latter establishment. A woman who stated that she was in the habit of getting milk from X.'s dairy became very unwell about Christmas. Some person wrote an anonymous letter to me calling attention to this woman, and asserting that she had been laid up with typhoid fever for more than a month, and had got no medical advice. I asked my colleague, Dr. Mapother, to visit her, and he found her suffering from bronchitis; this visit was, however, paid in February, and on personally inquiring into the case I find that the woman had no cough for the first fortnight of her illness, but simply a feverish attack which closely resembled some of the cases I have already described. I have no doubt but that her illness was as likely to have been caused by the milk as was that of any of the other cases which I have referred to. In the court, however, another and unmistakable case of typhoid fever occurred. It was that of a young woman who sickened early in January, and was attended by Dr. Byrne, of Upper Baggot-street. There was no diarrhœa in this case, but the throat and chest symptoms were severe, and the typhoidal character of the attack was, Dr. Byrne states, unmistakable. The patient had been in the habit of drinking the milk from X.'s dairy, and did not convalesce until she gave up its use. Dr. Byrne saw another case of typhoid close to X.'s dairy. It terminated fatally. From inquiries which I have made I feel satisfied that the patient (a man) had used the milk. The information obtained from the dispensary physicians and the local practitioners as to the existence of other cases of typhoid in the neighbourhood of X.'s dairy during the latter part of 1878 was in the negative.

WAS THE MILK FROM X.'S DAIRY REALLY THE INFECTING
MEDIUM ?

I have now shown that at 30 distinct points at which the milk from X.'s dairy was distributed, sickness appeared in December and the early part of January, and that 67 persons were affected. Now, the total number of points at which the milk, so far as I have been able to learn, was distributed, was 42; therefore, illness appeared at 71 per cent. of these points.

As already stated, the milk supply of three places was fully inquired into—namely, Raglan-road, Elgin-road, and Fitzwilliam-square. The total number of occupied houses in these places last

December was 125. I was unable to ascertain any particulars pertinent to the subject of this paper in the cases of 5^a of these houses, except, as I have already stated, that about Christinas there was no fever in any of them. Concerning the 120 houses of which I have procured exact information, the following are the statistical details:—Mr. X. supplied 25 of them with milk, and 25 other vendors furnished milk to 91 of them; in 4 of them cows were kept by the families. In 14 of the 25 households supplied by X. fever attacked no fewer than 31 persons within the space of one fortnight—most of them within one week. In the 95 households supplied with milk from other sources, not a single case of fever or serious illness of any kind occurred during December or January. Applying the theory of probabilities to this case, it seems in the highest degree improbable that, by a mere set of coincidences, the milk from X.'s dairy should happen to be that supplied to every one of the 14 houses out of the 120 in which fever occurred. Even if we had no evidence at all with respect to the existence of fever at his dairy, we could not avoid coming to the conclusion that the milk sent out from it was in some way concerned in the introduction of fever into these 14 houses. It may be asked—Why did not every one who drank the milk sicken? The zymotic poisons are not like arsenic or strychnine—they are not so certain in their action. Water known to have given typhoid or Asiatic cholera to some persons, has been drank with impunity by others. Some persons cannot be vaccinated. Perhaps, too, the milk may have had infected matter in it on two or three occasions only.

MATHEMATICAL PROOF THAT THE MILK FROM X.'S DAIRY
CAUSED THE EPIDEMIC.

I have stated that X. supplied milk to 25 out of the 120 houses composing Fitzwilliam-square and Raglan and Elgin roads. There is no evidence to prove that X.'s 25 houses differed in any respect other than in the sources of the milk supply from the other 95 houses supplied from 25 other dairies. Fourteen of the houses were invaded by fever within a period of about ten days. Now, if only 1 case of fever were to occur in a group of 120 houses, the chances that it would appear in 1 of 25 selected houses would be only as 25:95; but the probability of the conjoint occurrence of

* Exclusive of one on Elgin-road, which I have assumed X. supplied.

any number of independent events is the product of the several probabilities. That is—

$$\text{The probability of one case} = \frac{25}{120} \quad (1)$$

$$,, \quad ,, \quad \text{a second case} = \frac{24}{119} \quad (2)$$

$$,, \quad ,, \quad \text{two cases, } \frac{25 \times 24}{120 \times 119} = \text{products (1) (2)}$$

$$,, \quad ,, \quad \text{three } ,, = \frac{25 \times 24 \times 23}{120 \times 119 \times 118}$$

The probability that the second should occur is $\frac{24}{119}$; that is, after account has been taken that the probability of the first is $\frac{25}{120}$; therefore that the two should occur is—

$$\begin{aligned} \frac{25 \times 24}{120 \times 119} \cdot \frac{25}{120} &= \frac{1}{4\frac{2}{3}} \cdot \frac{24}{119} = \frac{1}{4\frac{2}{3}\frac{3}{4}} \\ \frac{25 \times 24}{120 \times 119} &= \frac{600}{14280} = \frac{1}{23\frac{4}{3}} \end{aligned}$$

The probability of one event is $1:4\frac{2}{3}$.

The probability of *both* events, $1:23\frac{4}{3}$.

It will, therefore, be seen that as soon as the product of the probabilities of the separate events has to be taken that the probability decreases in a multiple ratio, as illustrated by the case already stated in which the probability of the event occurring once is only $1:4\frac{2}{3}$; but the probability of its occurring *twice* (not a *second* time) is $1:23\frac{4}{3}$.

The statement for finding the probability of 14 cases occurring in X.'s 25 houses is therefore:—

$$\frac{25 \times 24 \times 23 \times 22 \times 21 \times 20 \times 19 \times 18 \times 17 \times 16 \times 15 \times 14 \times 13 \times 12}{120 \times 119 \times 118 \times 117 \times 116 \times 115 \times 114 \times 113 \times 112 \times 111 \times 110 \times 109 \times 108 \times 107}$$

which, when cancelled, gives—

$$\frac{5}{59 \times 29 \times 113 \times 37 \times 109 \times 9 \times 107} = \frac{5}{750,901,483,197}$$

which, when reduced, gives—

$$\frac{1}{150,180,296,639}$$

That is, the probability of fever occurring 14 times the same way, when the probability that it would occur once in that way is $\frac{25}{120}$, is as 1 chance in 150,180,296,639 chances.

The chances that the 14 cases would occur in X's houses might also be considered under the head of the mathematical theory of "Combination," and in which the result would be arrived at by estimating the number of combinations of 14 cases that could occur in 25 houses compared with the number of combinations of 14 cases that could occur in 120 houses. Without working this out it is evident to the mathematician that it would produce almost as great numbers as the method which I have used.

CHARACTERISTICS OF THE EPIDEMIC.

I have stated that only a few of the 67 persons whose illness I have endeavoured to account for had either diarrhœa or rash. Dr. Benson remarks with reference to the five cases treated in his hospital, to which I have already referred:—"Diarrhœa was not a conspicuous symptom in any of the cases I have treated either in public or private for some months past; but its complete absence in the five cases I name suggests placing them in a separate group." It will be conceded that in a very large majority of typhoid cases there is diarrhœa. Dr. James Little informs me that in about 90 per cent. of the cases which he has seen there was diarrhœa. Now, Dr. Chapman, from his private practice and his experience as a medical officer in Pembroke Township, is in a position to give evidence as to the general character of typhoid fever in that district for some months past. He has kindly given me an account of his cases, of which the following is a summary:—He saw from the 10th October, 1878, to the 20th March, 1879, 27 cases. Of these 16 had rash and diarrhœa, and 7 had diarrhœa but no rash. Dr. Harley, who enjoys a large practice in the township, also assures me that in the great majority of his cases of typhoid there was diarrhœa. I have received the same assurance from Dr. Powell, who also has a large local practice. Mr. X. and his two children had no diarrhœa, though the latter had spots; and it is worth recording—though, perhaps, nothing but a mere coincidence—that the cases of fever which apparently were caused by the use of the milk sent out from this dairy should also, with few exceptions, have been non-diarrhœal.

There is little doubt but that if the dairy was really a focus of infection, the *materies morbi* which caused the outbreak now being discussed came from X.'s daughter. He did not get typhoid himself until many of his customers were laid up with the disease. I have long been a believer in the theory that there is a specific

virus of typhoid, and that an attack of the disease is always a result of an antecedent one. But I have also long been of opinion that there are many fevers of unascertained origin, and that perhaps some of them are sporadic. Some of these fevers simulate one or more of the characters of typhoid. Some years ago about thirty boys in a large school became suddenly ill. They had furred tongue and a high temperature, and a few of them had diarrhœa. Most of them recovered perfectly within one week, and all within a fortnight. I found that the water used in the school was highly polluted with sewage; and the report of an architect who examined the drains stated that a rat-hole of very recent formation had established a direct communication between a sewer and the well which furnished water to the school. In this case it is probable that the exciting cause of the outbreak was simply a large amount of decomposing animal matter in the water. The history of the spread of typhoid by infected milk from X.'s dairy, and some cases in which potable water was the vehicle of typhoid poison, lead me to the conclusion that the infective matter thrown off from the body of a typhoid patient suffering from diarrhœa, and covered with the characteristic rash of the disease, may, when taken into the body of another person, give rise to simple fever without either diarrhœa or spots. Conversely, the infective matter from a patient suffering from apparently simple fever may give rise in other subjects to typhoid, in which all the most characteristic symptoms of the disease may appear. In several limited and purely local outbreaks of typhoid fever which have come under my notice, and each of which was traced to the use of contaminated water, the symptoms varied in individual cases—many having apparently a mere feverish cold, others sore throat, sick stomach, or diarrhœa, &c., whilst some were struck down with the most malignant typhoid. About four years ago a person feeling unwell paid a visit to a relative who resided at Clontarf. In a day or two it was found that he had typhoid fever, and diarrhœa and rash made their appearance. In about a week three persons residing in the house became ill. One had a slight attack of fever; a second had severe diarrhœa, but nothing more; whilst the illness of the third developed into the worst form of typhoid. It was found that the soil-pipe of the water-closet leaked, and that its contents escaped into the well which supplied water to the house. In this case it is evident that the three persons differently affected were all infected by an identical virus.

I believe that Mr. X.'s daughter suffered from true typhoid, though she had neither diarrhœa nor rash. The poison generated in her body was therefore capable of originating typhoid of any kind when introduced into the bodies of other persons. It is, however, conceivable that the non-diarrhœal character of the girl's illness may have had some influence in determining the non-diarrhœal character of the whole outbreak. I give the suggestion for what it is worth. Here I may remark that it was urged as an objection to the theory that fever was spread from the dairy that the patients there had no diarrhœa; but that would not prevent their dejections, such as they were, from being infective.

It is evident that the infective matter in the milk must have been very minute in quantity, which leads one to conclude that it was not mere filth but a specific virus which caused the outbreak of fever.

A SMALL TYPHOID OUTBREAK IN OCTOBER.

In October, 1878, there were three cases of typhoid fever in Raglan and Elgin roads, and it is remarkable that they all occurred in houses supplied from X.'s dairy. One case was that of a servant girl who, after six weeks' residence in the house from which a girl was subsequently admitted into Mercer's Hospital, was received into Baggot-street Hospital, and died there of typhoid. Her mistress states that she was ill at the time she entered the house at Elgin-road; but she was able, it appears, to perform her work there for six weeks after her arrival. In another house on Elgin-road, already referred to as the "fifth house," a housemaid died from typhoid fever on the 10th November. She was attended by Dr. H. P. Nolan.

In the house No. 7, Raglan-road, to which I have already referred, a case of typhoid occurred about October last.

These cases of typhoid are the only ones which occurred in these roads from July, 1878, till the outbreak at Christmas; and it is remarkable that they took place in houses supplied with X.'s milk. Professor Moore attended a young gentleman for typhoid fever in the latter part of October and beginning of November. He was a student in Trinity College, but spent much of his time in his mother's house on Northumberland-road, where subsequently Dr. Moore attended two persons in typhoid. Whilst at his mother's house he frequently drank milk from X.'s dairy, being fond of that liquid.

I have no information of any kind in reference to the state of X.'s dairy in October; but it is worth recording that about that time four houses supplied with milk from it had typhoid. These cases came incidentally to my knowledge; I might, if I had hunted up the matter, have discovered others.

SANITARY DEFECTS IN THE HOUSES.

Most of the houses in which typhoid occurred on Raglan and Elgin roads were examined on behalf of the Pembroke Township Urban Sanitary Authority by Dr. Chapman and Mr. Henderson, architect. In all save four serious sanitary defects were found; but Mr. Henderson agrees with me that in all probability an equal number of houses in any other place built about the same time would be found just as defective. In fact, many other houses on these roads in which no sickness had occurred were examined, and the sewerage arrangements found in a very bad condition.

CONCLUSION.

In concluding this paper I thankfully acknowledge having received valuable help in procuring information relative to the subject-matter of it from Professor Moore, Dr. Benson, Dr. J. W. Moore, Dr. Duffey, and Dr. Chapman. Information asked for was also kindly communicated to me by Professor Colles and Drs. Robert M'Donnell, M'Clintock, Harley, Kidd, W. G. Smith, Macan, Powell, Byrne, and Nolan.

ART. II.—*Medical Report of the Fever Hospital and House of Recovery, Cork-street, Dublin, for the Year ending 31st of March, 1879.* By JOHN WILLIAM MOORE, M.D., M.Ch., Univ. Dubl.; Fellow and Ex-Censor of the King and Queen's College of Physicians; Physician to the Hospital and to the Meath Hospital and County Dublin Infirmary; Lecturer on Practice of Medicine in the Carmichael College of Medicine and Surgery, Dublin; Examiner in Materia Medica in the Queen's University in Ireland; Ex-Scholar of Trinity College, Dublin.

THE compilation of the Annual Medical Report of Cork-street Hospital and House of Recovery is on this occasion at once a mournful duty and no easy task.

At any time it is sad to have to chronicle the history of a