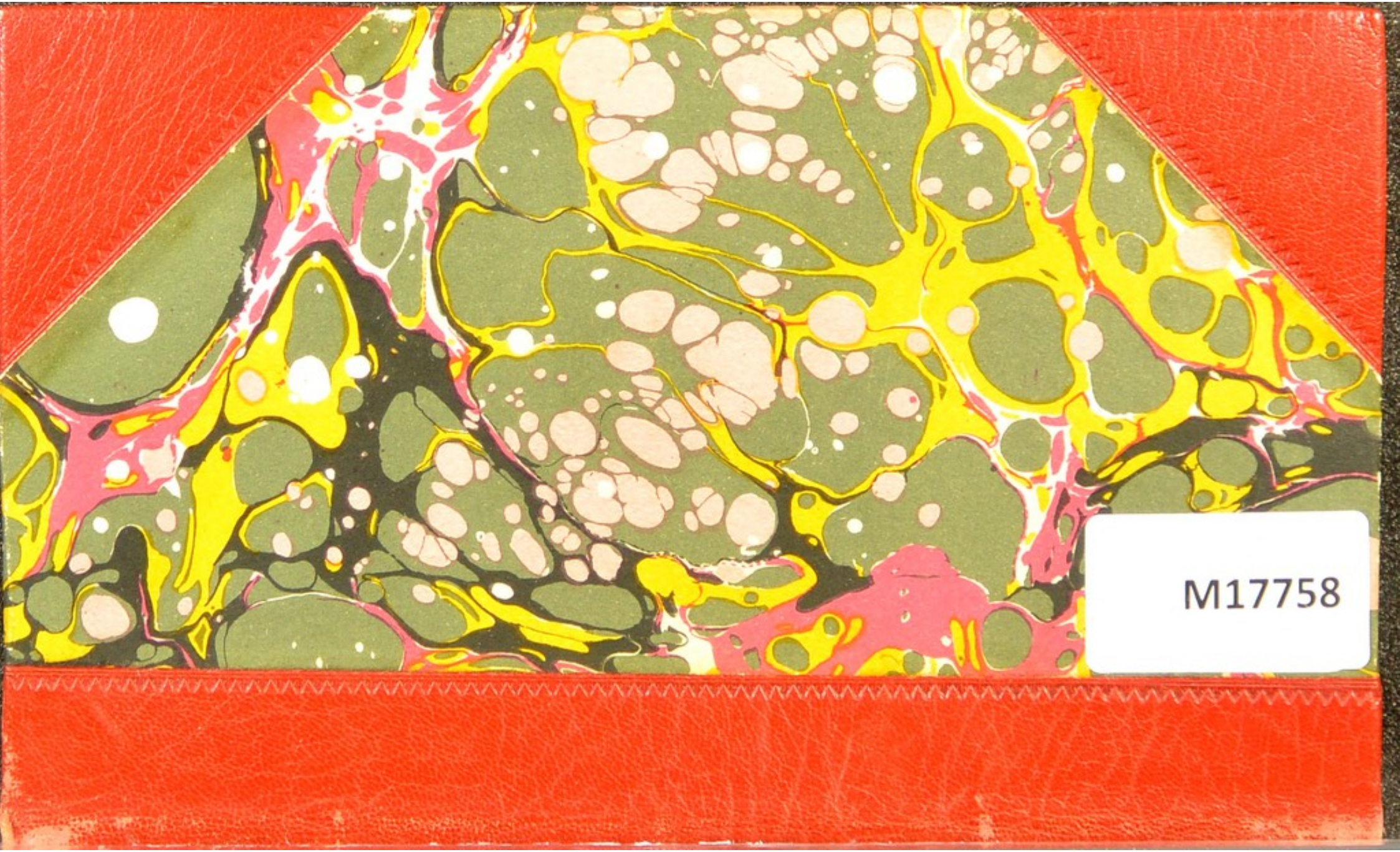
On the mode of propagation of cholera / by John Snow.



ON

THE MODE OF PROPAGATION

OF

CHOLERA.

BY

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CHOLERA, &c.

Although the more severe cases of common English cholera cannot always be distinguished from the malady called Asiatic cholera, yet hardly any one doubts the distinct nature of these diseases, or that the latter was a stranger to Europe prior to the year 1830. A careful consideration of Asiatic cholera shows clearly enough that it is propagated by human intercourse. It has proceeded in various directions along the great channels of intercommunication, never progressing faster than people travel, and generally much more slowly. In extending to an island or a fresh continent, it always makes its first appearance at a seaport, and it never attacks the crew of a ship from a healthy port that is approaching an infected country, till their actual arrival. Many instances have occurred in which quarantine or *cordons sanitaires* have protected places from the cholera, either altogether, or for a time; and the most conclusive part of the evidence, is the number of instances in which the malady has been introduced into healthy localities by persons who have been taken ill after their arrival from places where cholera prevailed. Dr. Bryson related several instances of this kind in the paper that he read before this Society, and a number more might be now related did the time permit: indeed, the cases in which the progress of cholera can be traced in this manner are the rule rather than the exception, and are, at all events, far too numerous to be set down as mere coin-

cidences. It may be remarked, also, that coincidences of this sort are not found to obtain in rheumatism, ague, or indeed in any but epidemic diseases, the whole of which I look upon as communicable from one patient to another, this communication being probably the real feature of distinction between epidemic and other diseases.

Another circumstance strongly confirmatory of the communication of cholera, is the direct relation which exists between the number of the population and the duration of the disease in different towns and villages. The accompanying figures were compiled by me from Dr. W. Merriman's valuable table of cholera in England in 1832:—(a)

Number of Places.		Duration in Days.		Average Population.
52	.....	0 to 50	.....	6,624
43	.....	50 to 100	.....	12,624
33 or 34	.....	100 and upwards.	.....	38,123 or 78,823

It will be seen, that 52 places are enumerated in which the cholera continued less than 50 days, and that the average population of these places was 6,624; that there are 43 places specified in which the disease lasted 50 days, but less than 100, the average population of these places being nearly twice as great as that of the former; while in the remaining 34 towns, in which the cholera continued for 100 days and upwards, the average population was very much greater still, being 38,000 or 78,000, according as London is omitted from or included in the list. I believe that the same rule has obtained during the recent epidemic, but I have no precise information on the point. It is hardly necessary to remark, that if the cholera cases were not connected one with another, there would be no reason why the few cases which happen in a village should not be scattered over as long a period as the thousands which occur in a great metropolis.

I shall perhaps be thought singular in asserting, that there is no evidence opposed to the propagation of cholera by its communication from individual to individual, or in favour of any other origin of the disease. The chief facts which are believed to be opposed to the extension of cholera by communication are the following: That many persons are

(a) Transactions of Royal Medical and Chirurgical Society, 1844.

placed in close relation with the sick, nurse them, and wait upon them, and sometimes even sleep in the same bed, without becoming infected with the malady; that quarantine and *cordons sanitaires* often fail to arrest its progress; and that persons are often attacked with it who have had no intercourse with the sick or their friends.

These facts are thought to be opposed to the communication of cholera, because it is assumed, that this disease, to be communicated, must extend itself, as the eruptive fevers are believed to do, by means of some emanation given off from the patient into the air; or, if not in that way, then by contact with the patient, or articles of clothing, etc., which have been near him. But, without assuming such hypotheses, the circumstances above mentioned would not in any way oppose the evidence of the communication of cholera. Nearly every one of these facts is equally true of syphilis, as of cholera. Persons nurse and wait on syphilitic patients, and might even sleep in the same bed with them, without contracting the malady; and it is very doubtful, whether quarantine regulations, however strict, would prevent its communication, as they would be evaded. These circumstances are not considered to interfere with the proofs of the contagiousness of syphilis, only because we happen to know the way in which it is communicated; and when we shall know equally well the way in which cholera is communicated, I do not doubt that we shall find them equally inapplicable to that disease.

A consideration of the pathology of cholera is capable of indicating to us the manner in which the disease is communicated. If it were ushered in by fever, or any other general constitutional disorder, then we should be furnished with no clue to the way in which the morbid poison enters the system; but if it commences by a local affection of any particular part, and the system at large only suffers in consequence of the local affection, then it is pretty evident, that the material cause of the disease must have been applied to the part first affected. From all that I have been able to learn of cholera, either by my own observation or that of others, it has appeared, that the illness always commences with the affection of the alimentary canal; and in all the cases that I have seen, the loss of fluid from the stomach

and bowels has been sufficient to account for the collapse, when the previous condition of the patient was taken into account, together with the suddenness of the loss, and the circumstance that the process of absorption appears to be suspended. Certain fatal cases of cholera without evacuations have occurred; but, whenever there has been an examination of the body in such cases, the excretions peculiar to cholera have been found in the bowels. It appears, indeed, that the cholera poison never enters the circulation, and that the blood does not become contaminated in this disease, except when congestion of the kidneys follows as a secondary affection. The irritation of the bowels accounts for the cramps; and the loss of the water and saline constituents of the blood is the cause of the collapse and the symptoms of asphyxia. The careful analyses of the blood by Dr. Garrod have confirmed the fact, that its solid constituents are relatively much increased by the loss of water. On this account, it becomes so thick that it circulates with difficulty through the capillaries of the lungs, while the diminished quantity of salts renders it still further unfitted to undergo the usual changes in respiration. The injection of a weak saline solution into the veins of cholera patients in the state of collapse has often been attended with the most surprising effects of a temporary nature, at once restoring the patient, who the minute before was nearly dead, to a state of apparent health and strength. It was justly remarked by Dr. Budd, in a clinical lecture delivered at King's College Hospital, that, if the patient's symptoms depended on a poison circulating in the blood, they could not be removed by the injection of a simple saline solution. The saline solution merely restores the water which has become deficient, and supplies salts analogous to those which have been lost.

If the poison which communicates cholera from person to person does not enter the blood, it is evident that it must multiply itself on the surface of the alimentary canal, and must be contained in the evacuations from the stomach and bowels. The proofs that the cholera poison is contained in these discharges, and that the disease is communicated by their being accidentally swallowed, are of a general as well as a particular kind.

It has been constantly observed, that the want of personal

cleanliness aided very much the propagation of cholera, although no explanation could be given of the circumstance; it is very evident, however, that without habits of strict cleanliness persons waiting on the sick must get their hands soiled with the cholera discharges, and must unknowingly contaminate the provisions they handle, in eating their own food or preparing that of others. The sudden discharge of the evacuations, which often soil the clothing or bed linen, and the little colour or odour they possess, very much increase the liability to their being swallowed in this way, and under some circumstances render it almost certain. For instance, when a large family, or more than one family are crowded into a single room, and when the same persons have to attend to the patient, and also to prepare and serve the meals for the rest of the inmates, without the materials for washing the hands, even if the inclination should exist, it is next to impossible that the provisions should be eaten without being contaminated with the peculiar discharges of the patient; and these are the circumstances under which the disease is found most frequently to spread among the inmates of a room. Mr. Baker, of Staines, who attended 260 cases of cholera and diarrhœa in the late epidemic, chiefly among the poor, informed me in a letter, with which he favoured me in December, 1849, that "where the patients passed their stools involuntarily the disease evidently spread." Deficiency of light is a great obstacle to cleanliness, as it prevents dirt from being seen, and it must aid very much the contamination of the food with the cholera evacuations.

The assistance which crowding lends to the spread of cholera could be explained on the hypothesis of effluvia or miasmata given off from the patient into the surrounding air; but the extension of the disease from want of cleanliness, deficiency of water, and deficiency of light, cannot be explained on such a hypothesis. The non-communication of cholera in cleanly families, where the hand-basin and the towel are in constant use, and where the apartments for cooking and eating are distinct from the sick-room; and also its non-communication, as a general rule, to medical men and other visiters of the sick belonging to the educated classes of society, are fully explained on the doctrine here

laid down, although these circumstances are inexplicable on the supposition of its spread by means of effluvia. Its fearful extension in certain pauper asylums for children and lunatics is also clearly accounted for, together with its non-liability to spread in more commodious and better regulated establishments.

The great fatality of cholera among all the mining populations of this kingdom has been very remarkable in both the epidemics of that disease. The chief reasons of this are as follow:—The miners generally remain eight hours in the pits, and take food with them, which they eat whilst at work. There are neither privies, hand-basins, nor towels in the mines; and when a case of cholera occurs in a pit, the hands of the workmen, in the dark subterranean passages, can hardly fail to become soiled with the discharges. Should we have a return of the cholera, I believe that many thousands of lives might be saved by dividing the time of labour into two periods of four hours, dissuading the workmen from taking food into the mines, and enjoining them to wash their hands on going home before taking any food. There are other causes to be afterwards mentioned which contribute to the extension of cholera in several of the mining districts, viz., the contamination of the wells and brooks with the evacuations of the people.

It can hardly be anticipated, from the nature of the subject, that we should be able to obtain distinct evidence of the cholera evacuations having been taken with the food. The following cases, perhaps, afford as decisive proof of this variety of communication of cholera as can be expected. In the beginning of last year, a letter appeared in the *Provincial Medical and Surgical Journal*, from Mr. John C. Bloxam, in the Isle of Wight, being an answer to the inquiry on cholera by Mr. Hunt. Among other interesting information, Mr. Bloxam stated, that the only cases of cholera that occurred in the village of Carisbrook, happened in persons who ate of some stale cow-heels, which had been the property of a man who died in Newport, after a short and violent attack of cholera. Mr. Bloxam kindly made additional personal inquiries into the case, in consequence of questions I put to him, and the following is a summary of the information contained in his letter:—

The man from whose house the cow-heels were sent for sale died on Monday, the 20th of August. It was the custom in the house to boil these articles on Monday, Wednesday, and Friday; and the cow-heels under consideration were taken to Carisbrook, which is a mile from Newport, ready boiled, on Tuesday, the 21st. Eleven persons in all partook of this food, seven of whom ate it without any additional cooking. Six of these were taken ill within twenty-four hours after eating it, five of whom died, and one recovered. The seventh individual, a child, who ate but a small quantity of the cow-heels, was unaffected by it. Four persons partook of the food after additional cooking. In one case the cow-heels were fried, and the person who ate them was taken ill of cholera within twenty-four hours afterwards, and died. Some of the food was made into broth, of which three persons partook while it was warm; two of them remained well, but the third person partook again of the broth next day, when cold, and, within twenty-four hours after this latter meal, she was taken ill with cholera, of which she died. It may be proper to mention, although it is no unusual circumstance for animal food to be eaten in hot weather when not quite fresh, that some of the persons perceived the cow-heels to be not so fresh as they ought to have been at the time they were eaten, and part of them had to be thrown away a day or two afterwards, in consequence of being quite putrid.

A man living in West-street, Soho, who kept a horse and cart, was employed, in the beginning of September, 1849, to remove some furniture from a house in Lambeth. The furniture had been the property of a woman who died of cholera, and had just been buried. The bedding and night-chair were left just as they were when the patient died. This man was taken with cholera during the night, within thirty-six hours after removing the furniture and other effects, and he died of the attack. I saw him with Mr. Marshall, of Greek-street, and we both remarked that his hands were very dirty, and had apparently not been washed for some days.

If the views here explained be correct, it is evident that the cholera poison may often be conveyed to a distance with provisions, as in the instance of the cow-heels above-men-

tioned, when there is no evidence of personal intercourse. There is also another very important medium for transmitting the cholera poison from the sick to the healthy, without immediate intercourse. It is the water which people drink; and in this case the proofs are often of a more direct and decisive nature.

The deficiency of water had often been spoken of, but the quality of the water had hardly ever been publicly mentioned as contributing to the increase of cholera till August, 1849, when Dr. Lloyd related to the South London Medical Society some occurrences that had taken place in Rotherhithe, and a pamphlet of mine, containing other instances, and some reasoning on the subject, appeared at the same time. Mr. John Grant, Surveyor to the Commissioners of Sewers for Surrey and Kent, also drew up a report in the same month, respecting the contamination of a well in a court in Thomas-street, Horsleydown; and attention having been strongly directed to the matter, several other instances of the connexion between violent outbreaks of cholera and the contamination of the drinking water were related.

One of the most fatal instances of communication of cholera by means of water, is that which occurred at Albion-terrace, Wandsworth-road—a row of seventeen houses, most of them detached a few feet from each other, and constituting the genteel suburban dwellings of a number of professional and tradespeople. All the houses were supplied with water on a uniform plan, from a spring in the neighbourhood, the water being conducted into a tank placed behind each house, from which it was pumped into the kitchen when required. The tanks were all connected together by pipes, and the surplus water flowed away into a drain, which received the contents of the house drains and cesspools. The various drains and pipes were so constructed that the water was liable to become tainted, and it had been occasionally complained of previously; but during a storm of rain on July 26th, the chief drain burst, and its contents became mixed with the water in the tanks. I had an opportunity of finding afterwards in the water, the stones and husks of currants and grapes, and various other substances which had gone through the alimentary canal. The more gross mate-

rials, however, settled to the bottom of the tanks, and the water pumped up was not so bad as to excite suspicion or attract much attention, except in two or three of the houses.

"The first case of cholera occurred at No. 13, on July 28, (two days after the bursting of the drain,) in a lady who had had premonitory symptoms for three or four days. It was fatal in fourteen hours. There was an accumulation of rubbish in the cellar of this house, which was said to be offensive by the person who removed it; but the proprietor of the house denied this. A lady at No. 8 was attacked with choleraic diarrhœa on July 30; she recovered. On August 1, a lady, aged 81, at No. 6, who had had some diarrhœa eight or ten days before, which had yielded to her own treatment, was attacked with cholera; she died on the 4th, with congestion of the brain. Diarrhœa commenced on August 1, in a lady, aged 60, at No. 3; collapse took place on the 5th, and death on the 6th. On August 3 there were three or four cases in different parts of the row of houses, and two of them terminated fatally on the same day. The attacks were numerous during the following three or four days, and after that time they diminished in number. More than half the inhabitants of the part of the terrace in which the cholera prevailed were attacked with it, and upwards of half the cases were fatal. The deaths occurred as follow; but as some of the patients lingered a few days, and died in the consecutive fever, the deaths were less closely grouped than the seizures. There was 1 death on July 28, 2 on August 3, 4 on the 4th, 2 on the 6th, 2 on the 7th, 4 on the 8th, 3 on the 9th, 1 on the 11th, and 1 on the 13th. These make 20 fatal cases; and there were 4 or 5 deaths besides amongst those who were attacked after flying from the place." The fatal cases were distributed over ten of the seventeen houses, and cases occurred also in the other seven houses, with the exception of one or two that were empty, or nearly so. In short, the cholera extended to all the houses supplied by the contaminated water, and to no others; for there were hardly any cases in the immediate neighbourhood at the time.

There are no data for showing how the disease was communicated to the first patient, at No. 13, on July 28; but it was two or three days afterwards, when the evacuations

from this patient must have entered the drains having a communication with the water supplied to all the houses, that other persons were attacked, and in two days more the disease prevailed to an alarming extent.

A similar instance of communication of cholera through the water occurred nearly at the same time "in Thomas-street, Horsleydown, where there are two courts close together, consisting of a number of small houses or cottages inhabited by poor people. The houses occupy one side of each court or alley, the south side of Trusscott's-court, and the north side of the other, which is called Surrey-buildings, being placed back to back, with an intervening space, divided into small back areas, in which are situated the privies of both the courts, communicating with the same drain; and there is an open sewer which passes the further end of both the courts. Now, in Surrey-buildings, the cholera committed fearful devastation, whilst in the adjoining court there was but one fatal case, and another that ended in recovery. In the former court the slops of dirty water, poured down by the inhabitants into a channel in front of the houses, got into the well from which they obtained their water, this being the only difference that Mr. Grant, the Assistant-Surveyor for the Commissioners of Sewers, could find between the circumstances of the two courts, as he stated in his report to the Commissioners. The well in question was supplied from the pipes of the South London Waterworks, and was covered in on a level with the adjoining ground; and the inhabitants obtained the water by a pump placed over the well. The channel mentioned above commenced close by the pump. Owing to something being out of order, the water for some time past occasionally burst out at the top of the well, and overflowed into the gutter or channel, afterwards flowing back again mixed with the impurities; and crevices were left in the ground or pavement, allowing part of the contents of the gutter to flow at all times into the well, and when it was afterwards emptied, a large quantity of black and highly offensive deposit was found in it.

"The first case of cholera in this court occurred on July 20th, in a little girl, who had been labouring under diarrhœa for four days. This case ended favourably. On

the 21st July, the next day, an elderly female was attacked with the disease, and was in a state of collapse at ten o'clock the same night. Mr. Vinen, of Tooley-street, who attended these cases, states that the evacuations were passed into the beds, and that the water in which the foul linen would be washed would inevitably be emptied into the channel mentioned above. Mr. Russell, of Thornton-street, Horsleydown, who attended many of the subsequent cases in the court, and who, along with another medical gentleman, was the first to call the attention of the authorities to the state of the well, says that such water was invariably emptied there, and the people admit the circumstance. About a week after the above two cases commenced, a number of patients were taken ill nearly together: four on Saturday, July 28th, seven or eight on the 29th, and several on the following day. Eleven of the cases were fatal. The deaths occurred in seven out of the fourteen small houses in the court.

"The two first cases on the 20th and 21st may be considered to represent about the average amount of cases for the neighbourhood, there having been just that number in the adjoining court about the same time. But, in a few days, when the dejections of these patients must have become mixed with the water the people drank, a number of additional cases commenced nearly together." (a)

The following instances were made known by Dr. Lloyd: —In Silver-street, Rotherhithe, there were 80 cases and 38 deaths in the course of a fortnight, early in July, 1849, at a time when there was very little cholera in any other part of Rotherhithe. The contents of all the privies in this street ran into a drain which had once had a communication with the Thames; and the people got their supply of water from a well situated very near the end of the drain, with the contents of which the water got contaminated. Dr. Lloyd informed me, that the fetid water from the drain could be seen dribbling through the side of the well, above the surface of the water. Among other sanitary measures recommended by Dr. Lloyd, was the filling up of the well; and the cholera ceased in Silver-street as soon as the people gave over

(a) The passages in the above account, included within inverted commas, are quoted from a pamphlet, by the Author, "On the Communication of Cholera."

using the water. Another instance alluded to by Dr. Lloyd was Charlotte-place, in Rotherhithe, consisting of seven houses, the inhabitants of which, excepting those of one house, obtained their water from a ditch communicating with the Thames, and receiving the contents of the privies of all the seven houses. In these houses there were 25 cases of cholera, and 14 deaths; one of the houses had a pump railed off, to which the inhabitants of the other houses had no access, and there was but one case in that house. (a)

The following instance, as well as some others of a similar kind, is related in the Report on Cholera by the General Board of Health:—

"In Manchester, a sudden and violent outbreak of cholera occurred in Hope-street, Salford. The inhabitants used water from a particular pump-well. This well had been repaired, and a sewer which passes within nine inches of the edge of it became accidentally stopped up, and leaked into the well. The inhabitants of 30 houses used the water from this well; among them there occurred 19 cases of diarrhœa, 26 cases of cholera, and 25 deaths. The inhabitants of 60 houses in the same immediate neighbourhood used other water; among these there occurred 11 cases of diarrhœa, but not a single case of cholera, nor one death. It is remarkable, that, in this instance, out of the 26 persons attacked with cholera, the whole perished except one."—P. 62.

Dr. Thomas King Chambers informed me, that at Ilford, in Essex, in the summer of 1849, the cholera prevailed very severely in a row of houses a little way from the main part of the town. It had visited every house in the row but one. The refuse which overflowed from the privies and a pigsty could be seen running into the well over the surface of the ground, and the water was very fetid; yet it was used by the people in all the houses except that which had escaped cholera. That house was inhabited by a woman who took linen to wash, and she, finding that the water gave the linen an offensive smell, paid a person to fetch water for her from the pump in the town, and this water she used for culinary purposes, as well as for washing.

The time does not permit of my relating any more of the

(a) See Med. Gaz., 1849, Vol. II., p. 429.

numerous instances in which severe outbreaks of cholera have been connected with adulteration of the water with the contents of drains and cesspools; and this is the less to be regretted, as the influence of this kind of water over the increase of cholera is now generally admitted.

In the seventh notification of the General Board of Health, on September 18, 1849, soon after attention had been first prominently drawn to this matter, the following passage occurs:—"The ascertained fact, that the use of vitiated water acts as a poison on the stomach and bowels, producing sickness, diarrhœa, and other symptoms resembling those of cholera, has recently received melancholy confirmation in numerous instances."

Now, in these instances, the disease induced is admitted to have been actual cholera in the same notification, and in the subsequent report of the Board, and there is no evidence to show that vitiated water generally acts as a poison; on the contrary, in many of the instances in which these outbreaks of cholera occurred, the people had been drinking the same vitiated water since the cholera of 1832. However repulsive to the feelings the swallowing of human excrement may be, it does not appear to be very injurious so long as it comes from healthy persons, but when it proceeds from cholera patients, and probably patients with some other maladies, it is a means of communicating disease.

Although, as I have observed, the influence of vitiated water in aiding the spread of cholera is now generally admitted, it must be stated that it is not usually understood to act in the way I have explained; but the contaminated water is thought by many to predispose persons, so that an unknown cause of cholera may act upon them in some inexplicable way. The manner in which these outbreaks occur, when caused by the contamination of a local supply of water, shows, however, that it does not act by merely inducing a predisposition. The water in many of the instances had been contaminated for months or even years, when a case or two of cholera occurring amongst the people on the spot, whose evacuations entered the water through the drains or otherwise, in a day or two afterwards there was a simultaneous outbreak of the malady amongst a number of the persons using the water; whereas, if the water had merely caused a predisposition, and was not acting as the exciting cause,

the cases of cholera, however numerous in the locality, might be expected to be distributed over the period that the disease prevailed in the town or district in which the locality was situated. In a review in the *Medical Gazette*, in 1849, the remark was made, that as the communication of cholera to the first case in Albion-terrace could not be traced, and was of course not attributable to the water, which did not yet contain the cholera evacuations, the same cause which would produce that case would produce others in the immediate vicinity. This must be admitted to be possible; and in the same way, if a fire had taken place from some unknown cause in No. 13, and the whole row had been burned down, it must also be admitted that a fire might possibly have originated from the same unknown cause in all the other houses about the same time, and that the burning of the one had no connexion with that of the others. No one, however, would believe this to have been the case.

Besides the local outbreaks already alluded to, it can be shown, that the cholera was often communicated through the water, on a more extensive scale, by means of the sewers which empty themselves into various rivers, from which the population of many towns derive their supply of water. In several towns of this country, among which are Birmingham, Leicester, Bath, and Cheltenham, there were only a few cases of cholera, either in 1832 or 1849, and those chiefly in persons who had arrived from other places in which the cholera was prevailing, or among the immediate attendants of these patients. Now, all these towns were supplied with water from sources quite uncontaminated with the contents of sewers. In some towns so circumstanced, there has been a good deal of cholera, but then it was confined to the poor, and to particular localities in the towns; but, on the other hand, in all those towns in which the malady extended generally, and was not confined to the poor and dirty, this connexion between the sewers and drinking-water existed. A great part of London was in this condition in both epidemics; Exeter was so in 1832, and Hull in 1849. The difference between the two epidemics in Exeter and Hull, in connexion with an altered supply of water, is very remarkable. In 1832, the people of Exeter were supplied with water by water-carriers, who obtained it from two mill-streams diverted from the river; and one of the chief sewers

of the town emptied into a branch of the river which divided into the two mill-streams. Cholera commenced with a woman and child who had just arrived from Plymouth, where the former had been nursing another child that had died of the same disease. It soon became very prevalent and severe for the size of the town. There were 1135 cases, and 345 deaths. (a) Subsequently to 1832, Exeter has been supplied by waterworks, with water derived from the river Exe, at a point two miles above the town, and more than that distance above the influence of the tide. In 1849, there were only about 20 cases of cholera in Exeter, nearly half of which occurred in strangers coming into the town, and dying within two or three days after their arrival.

In 1832, Hull was scantily supplied with water, conveyed in pipes from some springs situated three miles from the town; in the epidemic of that year the cholera was confined almost exclusively to the poor, and the deaths amounted to 300. Between that time and 1849, Hull, besides an improved system of drainage, obtained a more abundant supply of water. The waterworks, however, are situated on the river Hull, two miles and three quarters from its confluence with the Humber. About half the sewage of the town is delivered into the river Hull, and the tide flows up this river for many miles past the waterworks, carrying with it the filth from the sewers. In the late epidemic the deaths from cholera and diarrhœa in Hull amounted to nearly 3000, and occurred among all classes of the community.

In London the cholera was most prevalent during both epidemics in those districts supplied with water vitiated by the contents of sewers and cesspools, and indeed it generally bore an exact relation to the amount of vitiation. The map from the second Report on the Health of Towns, which is suspended in the room, shows the districts of the metropolis supplied by the different Water Companies; and the other map, from Mr. Grainger's Appendix to the Report of the Board of Health on Cholera, is coloured to show the relative prevalence of the late epidemic in different parts of London. A large district on the north of the Thames is supplied with

(a) See "History of the Cholera in Exeter in 1832" by Dr. Shapter, to whose kindness the writer is indebted for additional information.

the New River water, which is not contaminated by the sewers; another district on the same side of the river is supplied by the East London Waterworks Company, with water obtained from the Lea, above the influence of the tide, and nearly, if not altogether, free from contamination. These districts are not much tinged with the blue of cholera in Mr. Grainger's map, except in particular spots in which there was generally a local supply of contaminated water, as, for instance, in the neighbourhood of Bridge-street, Blackfriars, where many of the inhabitants obtained water for drinking from St. Bride's pump, which was afterwards closed in consequence of its being ascertained that the well had a communication with a sewer which emptied into the Fleet ditch; and in the vicinity of Shoreditch and at Hackney, where Dr. Gavin found the contents of the privies overflowing or percolating into the wells in certain courts and allies. The north-west districts of the metropolis are supplied with water by the West Middlesex and Grand Junction Water Companies, who obtain the water from the Thames, near Hammersmith and Brentford, where the river is in a great measure free from sewage at particular times of the tide, and the water is also purified by subsidence in large reservoirs. The districts so supplied were not severely visited by cholera.

The district supplied by the Chelsea Waterworks, was not severely visited by cholera during the late epidemic, as appears by the cholera map, except in particular spots where contaminated water was used, as in the neighbourhood of Duke-street, Chelsea, where many of the people obtained water by dipping a pail into the Thames. Now, the Chelsea Company derive their supply of water from the Thames at Chelsea, where it is very foul; but having till lately to supply the Court and a great part of the nobility, they have large and expensive filters, and also very capacious settling reservoirs, in which the water is kept for a considerable time before its distribution. Dr. Hassall found the Chelsea Company's water to contain much less organic matter than that of the Companies supplying the districts on the south of the Thames; and he found it to be free from the hairs of the down of wheat, yellow ochreous substance, (believed to be partially-digested muscular fibre,) and other substances

which had passed through the alimentary canal, and were found in the Vauxhall and Lambeth Companies' water.(a)

The districts of London, on the south side of the river, are supplied with water obtained from the Thames near the Hungerford Suspension Bridge, and at Vauxhall, by the Lambeth, the Vauxhall, and the South London Companies. The water is very imperfectly filtered through coarse gravel, and has little or no opportunity to subside; and according to the evidence of Dr. Hassall, mentioned above, it contains a great deal of excrementitious matter. The cholera was very much more severe on the south side of the Thames than on the north, as appears by the map. There were other causes for this besides the water supplied by the Companies. The wells in this part of the town are very shallow, and are often vitiated by the contents of the cesspools, which percolate through the ground; and a yet more important cause of the great prevalence and fatality of cholera was the existence of certain tidal ditches in Bermondsey and Rotherhithe, the places in which the mortality was greater than in any other part of the Metropolis in the late epidemic. These ditches were the direct receptacles of the excrementitious matters of a large population, and furnished at the same time the only supply of water that could be obtained by a great number of the inhabitants. I was furnished by Mr. Grant with the result of a house-to-house visitation in Jacob's Island, which is surrounded by one of these ditches, and it shows that the mortality from cholera was much higher among the people who had no supply of water except from the ditches, than among those who had access to the pipe-water of the Company.

In the epidemic of 1832, the part of this Metropolis most severely visited by cholera was the Borough of Southwark, in which ninety-seven persons in each 10,000 of the population were carried off, being nearly three times the proportion of those that died in the rest of London. Now, the Borough at that time was supplied by the Southwark Waterworks with Thames water obtained at London-bridge, and sent direct to the houses without the intervention of any reservoir.

The communication of cholera by means of the water is well illustrated by the instance of Moscow, which was

(a) A Microscopic Examination of the Water supplied to the Inhabitants of London.

severely visited by that disease in 1830, but much less severely in the second epidemic. Subsequently to 1830 the greater part of the town, which is situated to the north of the Moscow river, obtained a supply of excellent water conducted in pipes from springs at a distance; and the cholera in 1847 was chiefly confined to those parts of the town which lie to the south of the river, to which the new supply of water did not extend, and where the people had still only impure river water to drink. (a)

The Table [copied and suspended in the room] from the Weekly Report of the Registrar-General of January 12, 1850, shows the mortality from cholera in the different districts of London supplied by the various Water Companies; and if the purification of the Chelsea water, and certain local contaminations of the water before mentioned be taken into account, the mortality will be found to bear a very close relation to the absence or presence of connexion between the sewers and the water supplied. It also appears from the same table that the average mortality from all causes in a series of years bears a relation to the quality of the drinking water. There is great reason to believe that typhoid fever and some other epidemic diseases are communicated occasionally through the drinking water; and there are a great number of facts in the history of the Plague that have led me to believe that it is communicated in exactly the same way as cholera. There are also many circumstances which render it probable that the cause of one disease not epidemic and communicable from person to person, but endemic, viz., ague—often exists in the water of marshy districts, and is acquired by drinking the water; but there is not space to enter on these subjects at present. (b)

(a) Report of Swedish Commissioners, quoted in the Second Report of the Metropolitan Sanitary Commission. 1848.

(b) Mr. Wm. Blower, surgeon of Bedford, speaking of Wooton, near Bedford, says, "A few wells have been dug lately, and good water has been obtained, and there is every probability, that if the water pits were filled up, and more wells dug, and the draining completed, that sporadic typhus and ague which have so long infested this village, and occasioned so much distress and expense, might be entirely eradicated. A respectable farmer informed me that, in the neighbourhood of Houghton, a few years ago, his was the only family that used well water, and almost the only one that escaped ague."—General Report of Poor-law Commissioners on the Sanitary Condition of Great Britain, 8vo. 1842. P. 66.

Mr. Grainger also quotes some instances, at page 94 of his recent Appendix to the Cholera Report, in which a number of persons contracted intermittent fever by drinking marsh water, while others, exposed to the same atmosphere, who did not drink the water, altogether escaped.

The large public institutions of London, in which the inmates are shut up from the rest of the community, showed the influence of the water, or the absence of that influence, in a remarkable manner during the late epidemic of cholera. Bethlem Hospital and the Queen's Prison are both supplied with water from deep wells on the premises, and, although situated on the south of the Thames, in a district in which the cholera was very fatal, there was not a death from that disease in Bethlem Hospital, with a population of more than 400, and only one death in the Queen's Prison, with a population of 300 and upwards. In Milbank Prison, on the contrary, the cholera was very prevalent until the greater number of the prisoners were sent away. It was considerably worse, in fact, than among the population outside in the same neighbourhood. There were 113 cases and 48 deaths; the deaths amounting to 4·3 per cent. of the average number of prisoners. The water used in the Milbank Prison was obtained from the Thames at the spot: it was filtered, indeed, through sand and charcoal, but not kept for a while in large reservoirs like that sent from the Chelsea Waterworks to the rest of Pimlico and Westminster. In Tothill-fields Prison, supplied by the waterworks just mentioned, there were 13 deaths from cholera among 800 prisoners, but in all the other prisons on the north of the Thames which are supplied with water into which the sewage cannot enter, there was but one death from cholera; that death took place in Newgate.

The first cases of cholera which occurred in London in the autumn of 1848 are particularly interesting with reference to the influence of the water of the Thames. According to the valuable Report of Dr. Parkes on the subject, subsequently corrected by him in one or two particulars, in consequence of some information which I received from Mr. Russell, surgeon, of Horsleydown, the first case of cholera in London (when the disease was introduced into this country from Hamburg, the greatest commercial town on the continent of Europe, as it had been just seventeen years before) occurred on September 22nd, in a seaman named John Harnold, newly arrived by the Elbe steamer. It is, indeed, said that cases of cholera occurred in London prior to this; and Dr. Copland mentioned one in the *Medical Gazette* as having happened on July 11th, in a man who

had been employed on board of a steam-vessel from St. Petersburgh, where the pestilence was then prevailing. But, looking on the case of John Harnold as the first, then the next case occurred in the same room, on September 30th—eight days afterwards—in the person of a workman, named Blenkinsopp. These cases occurred in New-lane, Gainsford-street, Horsleydown, close to the Thames. In the evening of the day on which the second case occurred in Horsleydown, a man was taken ill in Lower Fore-street, Lambeth, and died on the following morning. At the same time that this case occurred in Lambeth, the first of a series of cases occurred in White Hart-court, Duke-street, Chelsea, near the river. A day or two afterwards, there was a case at 3, Harp-court, Fleet-street. The next case occurred on October 2nd, on board the hulk Justitia, lying off Woolwich; and the next to this in Lower Fore-street, Lambeth, three doors from where a previous case had occurred. The first thirteen cases were all situated in the localities just mentioned; and on October 5th there were two cases in Spitalfields.

Now, the people in Lower Fore-street, Lambeth, obtained their water by dipping a pail into the Thames, there being no other supply in the street. In White Hart-court, Chelsea, the inhabitants obtained water for all purposes in a similar way. A well was afterwards sunk in the court; but at the time these cases occurred the people had no other means of obtaining water, as I ascertained by inquiry on the spot. The inhabitants of Harp-court, Fleet-street, were in the habit, at that time of procuring water from St. Bride's pump, which was afterwards closed on the representation of Mr. Hutchinson, surgeon, of Farringdon-street, in consequence of its having been found that the well had a communication with the Fleet-ditch sewer, up which the tide flows from the Thames. I was informed by Dr. Dabbs, that the hulk Justitia was supplied with spring-water from the Woolwich Arsenal; but it is not improbable that water was occasionally taken from the Thames alongside, as was constantly the practice in some of the other hulks, and amongst the shipping generally.

It must no doubt seem very unlikely to many that the materies morbi of a disease should pass for a distance of two or three miles through the water; but the propagation of

plants and the lower forms of animals by seeds and ova, which can be transported to a distance, would appear equally improbable, were it propounded for the first time. Analogy leads to the belief that, however minute the particles which propagate cholera, they must yet have a definite structure, (probably that of a microscopic cell), and must therefore not be capable of dilution, so as to be rendered inert.

In the autumn of 1849, Drs. Brittan and Swayne, of Bristol, considered that they had discovered the cause of cholera in a minute fungus; and Dr. Wm. Budd, of the same city, met with the supposed fungus in various specimens of water used as drink, in places where the cholera was very prevalent. It was, perhaps, too much to expect, that we should obtain a knowledge of cholera more exact than that which we possess of syphilis, small-pox, and other better known diseases; and the supposed fungi were resolved into other things. As many of these, however, were particles of bran and other matters which had passed through human intestines, the labours of these gentlemen confirm the fact of the water in various places being a medium of communication between the alimentary canals of cholera patients and those of other people.

In one of the Registration Reports, in the beginning of last year, Mr. Farr pointed out a remarkable connexion between the prevalence of the cholera of 1849 and the temperature of the Thames. The probable reason of this connexion is, that the cholera poison does not so well retain its properties unimpaired in water below 60° Fahr. as at warmer temperatures. Mr. Farr appeared to attribute the influence of temperature to the increased amount of vapour and effluvia given off from the surface of the river; but this would not explain the influence of the water on those who drink it.

It may be here remarked, that it would be unreasonable to expect to trace every case of cholera, either through the water, or by contamination of the food; more especially as it is sufficiently probable that the disease may be communicated by cases which proceed no further than preliminary diarrhœa. If the view here given be found to explain more of the progress of cholera the more it is inquired into, it must be held to account for the cases which cannot be traced, in the same way that generation accounts for the

existence of plants and animals under circumstances in which we cannot always trace their parentage.

With regard to preventive measures, I entirely agree with the Registrar-General, that "internal sanitary arrangements, and not quarantine or sanitary lines, are the safeguards of nations." For I believe that quarantine would often be evaded, and is altogether unnecessary. The presumed sanitary measures, however, should have a particular reference to the mode of communication of cholera, otherwise they may sometimes be prejudicial instead of advantageous. I have given one instance in the case of Hull, where the malady was nearly ten times as fatal in the late as in the former epidemic, on account of a more plentiful supply of water having been obtained without reference to its quality. In London, the late epidemic was three times as fatal as that of 1832. This was, in my opinion, partly owing to the manifestoes of the General Board of Health, which were understood to imply that the cholera was not communicable or catching in any way; and these documents had an immense circulation, by being copied into the newspapers. The effect was also due to presumed sanitary measures employed both in the interval of the two epidemics and during the late one. In the interval a great number of cesspools had been abolished, and a much larger amount of fæces became daily sent into the Thames, whilst a great portion of the people had still to drink the water; and during the epidemic itself, the flushing of the sewers increased the mischief in two ways: first, by driving the cholera evacuations into the river before there was time for the poison to be rendered inert by decomposition; and second, by making increased calls on the various Companies for water to flush the sewers with, so that the water which they sent to their customers remained for a shorter time in the reservoirs before being distributed. It should be remarked, also, that the contents of the sewers were driven into the Thames by the flushing, at low water, and remained flowing up the stream for four or five hours afterwards.

The sanitary measures required for the prevention of cholera, according to the views here explained, suggest themselves at once. They are as follow:—

1. The entire disuse of water into which sewers flow, or which is navigated by persons living in boats, or which is in any other way contaminated by the contents of drains or cesspools.

2. An extended use of hand-basins and towels among the poor, together with sufficient water always in readiness.

3. Strict cleanliness in every one about the patient, or the dead body; and especial care in all such persons to wash their hands before touching food.

4. The separation of the healthy from the sick, and their removal to another abode, when they have no place but the sick room in which to prepare and take their meals.

5. The immersion of all soiled linen in water, until it can be scalded and washed; for if it should become dry, the fæces might be wafted about in the form of dust, and so be swallowed by any one who should come near the linen.

In the way just indicated, it is probable that cholera may be occasionally communicated for a short distance through the air; and when small-pox and other diseases are communicated through the air, it is most likely by organised particles, which are wafted like the seeds of plants and the ova of some animals, and not by anything in the form of gas or vapour. Indeed, there are neither facts nor analogy to show that any kind of epidemic disease whatever can be caused by the air, or even influenced by it, otherwise than indirectly. Epidemics have been attributed to the state of the atmosphere since the time of Hippocrates, and the antiquity of the belief causes it to be received as an indisputable axiom, although our better knowledge of the nature of the air, and of gaseous bodies in general, is capable of entirely disproving it. But the facts which disprove the atmospheric theory of diseases are often pressed into its service, and so handled as to lend it apparent support.

It is a curious circumstance, that the medical men who are most active in advocating the sanitary measures which, as a general rule, would prevent the communication of cholera, for the most part disbelieve in its communicability, probably because the question had never suggested itself to them, except in the form of infection by means of effluvia, or of contagion by contact. What is still more remarkable is, that these gentlemen generally look on the presence of all those circumstances which aid in the communication of

cholera, when found in situations where the pestilence prevails, as proofs that it is not communicable. They speak of these circumstances as something which can explain the increased prevalence of the disease without its being communicable, although it has never been explained in this way, even by a hypothesis. One or two hypotheses have indeed been attempted, but have signally failed. One of the most able and experienced authors on cholera writes, for instance, as follows:—"If we could suppose that certain organic impurities existing in the atmosphere of unhealthy neighbourhoods, passed into the blood through the lungs, so as to follow the circulation, and that similar impurities taken into the stomach with articles of food or drink, were likewise absorbed into the blood; if we could, moreover, suppose that the epidemic influence possessed the power of assimilating such organic matter to its own poisonous nature, we should be enabled to include a number of complex phenomena under a hypothesis which would indicate the requisite measures of prevention." The above quotation is from Dr. Sutherland's Appendix to the Report on Cholera: but the latter part of the supposition is quite incapable of being entertained for various reasons; one of which is, that the assumed epidemic influence, in order to be capable of acting in this way, must consist of some material mixed with the atmosphere, and if so, it would diffuse itself through the air, and would also pass along with the air. It could not travel against the wind, or remain in a spot for weeks, without extending to the next parish, when the air is moving at the rate of one or two hundred miles a day.

There is much evidence on the subject of this paper which I had not room to bring forward, and many important points connected with it that I have not been able even to allude to; but I trust that I have succeeded in drawing the attention of the Society to the views I have endeavoured to explain, in such a way that they will be induced to consider the question carefully for themselves.

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