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ON THE
PATHOLOGY AND MODE OF COMMUNICATION
OF
CHOLERA.

BY JOHN SNOW, M.D.

[FROM THE LONDON MEDICAL GAZETTE.]

Reasons for considering cholera a local affection of the alimentary canal—proofs of its communicability—difficulties in the way of the ordinary doctrine of contagion. Cholera poison is contained in the evacuations, and communicates the disease by being swallowed: illustrations of this in the houses of the working classes—in mining districts. Cholera communicated by drinking water: cases illustrating this. Difference of elevation in London influences cholera only through the drinking water. Communication of cholera through the water in York, Exeter, Hull.

WRITERS on cholera, however much they may have differed in their views concerning the nature of the disease, have generally considered it to be an affection of the whole body, and consequently due to some cause which acts either on the blood or the nervous system. The following are the reasons which have led me to entertain the opinion that cholera is, in the first instance at least, a local affection of the mucous membrane of the alimentary canal; an opinion which I thought almost peculiar to myself when I was first led to adopt it, but which, as I have since been informed, others were beginning to entertain.

In those diseases in which there is reason to conclude that a morbid poison has entered the blood, there are symptoms of general illness, usually of

a febrile character, before any local affection manifests itself; but so far as I have been able to observe or to learn from carefully recorded cases, it is not so in cholera. On the contrary, the disease begins with the affection of the bowels, which often proceeds with so little feeling of general illness, that the patient does not consider himself in danger, or apply for advice till the malady is far advanced. It is true that, in a few cases, there are dizziness and faintness before discharges from the bowels actually take place, but there can be no doubt that these symptoms depend on the exudation from the mucous membrane, which is soon afterwards copiously evacuated. With respect to certain rare cases of cholera without purging, Dr. Watson has remarked in his Lectures, that when the bodies of such patients have been opened, the characteristic fluid was found in the bowels. Another reason for looking on cholera as a local disease is, that the affection of the stomach and bowels is sufficient to explain all the general symptoms. The evacuations, in the cases I have witnessed, have always appeared sufficient to account for the collapse, when the suddenness of the attack is considered, and the circumstance that absorption is probably suspended. The thickened state of the blood arising from the loss of fluid accounts for the symptoms of asphyxia, by the obstruction it must occasion in the pulmonary circulation.

The recent analyses of the blood of cholera patients, by Dr. Garrod, afford the strongest confirmation of this view ; for he found it to contain a much greater amount of solid materials in proportion to the water, than in health or other diseases. If there has been more purging in some of the less severe cases than in the rapidly fatal ones, it only shows that, in the former, absorption has been still going on, or else that some of the fluids which have been swallowed have passed through the bowels. The drain of fluid into the alimentary canal suspends the urinary secretion, either totally or in great part, and the kidneys become congested from the altered state of the blood : hence any little urine that is secreted is albuminous ; and if the kidneys do not soon recover from the congestion, urea accumulates in the blood in those cases in which the patient survives the stage of collapse. Although in a great number of cases the symptoms of cholera manifest themselves suddenly, and are not amenable to any known treatment, yet in other cases the disease commences gradually with diarrhœa, and in this stage there is evidence to show that it can usually be cured by the ordinary remedies for diarrhœa. Now this circumstance is a strong reason for concluding that the mischief in cholera is at first confined to the mucous membrane ; for it is not easy to conceive that chalk, and opium, and catechu, could neutralize or suspend the action of a poison in the blood. Indeed, diseases caused by a morbid poison in the blood, such as the eruptive fevers, cannot be cut short, either by local or general means, but run a definite course.

An important part of the pathology of every disease is the knowledge of its cause. To ascertain the cause of cholera, we must consider it not only in individual cases, but also in its more general character as an epidemic. On examining the history of cholera, one feature immediately strikes the inquirer—viz. the evidence of its communication by human intercourse. In its progress from place to place it has nearly always followed the great channels of human intercourse. In spreading along the highways in India, it often spared the villages that were situated at a little distance from the main road, on either side. When a

body of troops were attacked with it on their march, it often remained with them through countries having a very different climate and physical character from that in which they contracted the malady ; and they often communicated it to towns and villages previously free from it. In extending itself to a fresh island or continent, the cholera has always made its appearance first at a sea-port, and not till ships had arrived from some infected place. Crews of ships approaching a country in which the disease was prevailing, have never been attacked until they have had communication with the shore. The cholera, moreover, in progressing from one place to another, has never travelled faster than the means of human transit, and usually much slower. Such are the general considerations which show that cholera is communicated by human intercourse ; and there are besides instances so numerous of persons being attacked with the disease within a day or two after immediate proximity to the sick, that it seems impossible to attribute the circumstance to mere coincidence. On the other hand, there are a number of facts which have been thought to oppose this evidence : numerous persons hold intercourse with the sick without becoming affected, and a great number take the disease who have had no apparent connection with other patients. These facts, however, have always been examined with the conviction that cholera, if communicable, must be contagious in the same way that the eruptive fevers are believed to be—viz. by effluvia given off from the patient into the surrounding air, and acting on other persons either directly or through the medium of fomites. But with a fresh pathology of the disease this opposing evidence requires to be reconsidered, and will, in the sequel, be found to afford the strongest confirmation of the communication of the disease.

In the meantime we have arrived at two conclusions—first, that cholera is a local affection of the alimentary canal ; and secondly, that it is communicated from one person to another. The induction from these data is that the disease must be caused by something which passes from the mucous membrane of the alimentary canal of one patient to that of the other, which it can only do by being swallowed ;

and as the disease grows in a community by what it feeds upon, attacking a few people in a town first, and then becoming more prevalent, it is clear that the cholera poison must multiply itself by a kind of growth, changing surrounding materials to its own nature like any other morbid poison; this increase is the case of the *materies morbi* of cholera taking place in the alimentary canal.

The instances in which minute quantities of the ejections and dejections of cholera patients must be swallowed are sufficiently numerous to account for the spread of the disease; and on examination it is found to spread most where the facilities for this mode of communication are greatest. Nothing has been found to favour the extension of cholera more than want of personal cleanliness, whether arising from habit or scarcity of water, although the circumstance hitherto remained unexplained. The bed linen nearly always becomes wetted by the cholera evacuations, and as these are devoid of the usual colour and odour, the hands of persons waiting on the patient become soiled, and unless these persons are scrupulously cleanly in their habits, and wash their hands upon taking food, they must accidentally swallow some of the excretion, and leave some on the food they handle or prepare, which has to be eaten by the rest of the family, who amongst the working classes often have to take their meals in the sick room: hence the thousands of instances in which, amongst this class of the population, a case of cholera in one member of the family is followed by other cases; whilst medical men and others, who merely visit the patients, generally escape. The post-mortem inspection of the bodies of cholera patients has hardly ever been followed by the disease that I am aware, this being a duty that is necessarily followed by careful washing of the hands; and it is not the habit of medical men to be taking food on such an occasion. On the other hand, the duties performed about the body, such as laying it out, when done by women of the working class, who make the occasion one of eating and drinking, are often followed by an attack of cholera; and persons who merely attend the funeral, and have no connection with the body, fre-

quently contract the disease; in consequence, apparently, of partaking of food which has been prepared or handled by those having duties about the cholera patient, or his linen and bedding.

It has been found that the mining population of this country has suffered more from cholera than any other, and there is a reason for this. There are no privies in the coalpits,* and I believe that this is true of other mines: as the workmen stay down the pit about eight hours at a time, they take food down with them, which they eat, of course, with unwashed hands, and as soon as one pitman gets the cholera, there must be great liability of others working in the gloomy subterranean passages to get their hands contaminated, and to acquire the malady; and the crowded state in which they often live affords every opportunity for it to spread to other members of their families. There is also another cause which favours the spread of cholera amongst many of the mining populations, to which I shall have to allude shortly, in treating of the water.

With only the means of communication which we have been considering, the cholera would be constrained to confine itself chiefly to poor and crowded dwellings, and would be continually liable to die out accidentally in a place, for want of the opportunity to reach fresh victims; but there is often a way open for it to extend itself more widely, and that is by the mixture of the cholera evacuations with the water used for drinking and culinary purposes, either by permeating the ground and getting into wells, or by running along channels and sewers into the rivers.†

The part of the metropolis most severely visited by cholera in 1832, was the Borough of Southwark, in which 97 persons in each 10,000 of the population were carried off, being nearly three times the proportion of deaths that occurred in the rest of London. Now the population of Southwark at that time (such of them as did not use pump-water), were sup-

* Dr. D. B. Reid, in Second Report of Commissioners for inquiring into the state of large towns and populous districts. Appendix, Part ii. p. 122.

† See review in MED. GAZ. present vol. p. 466.

plied by the Southwark Water Works with Thames water obtained at London Bridge, and sent direct to their dwellings without the intervention of any reservoir. The Thames has since become more polluted by the gradual abolition of numbers of cesspools in the metropolis, and the Southwark Water Works have been removed to Battersea, a little further from the sewers. I am endeavouring to compile a full account of the recent epidemic in London, in its relation to the water, but as it is not yet complete I must here be content with citing certain instances of severe visitation, or of exemption from its ravages.

There are two courts in Thomas Street, Horsleydown, exactly resembling each other; the small houses which occupy one side of each court being placed back to back, and the privies for both courts being placed in the intervening back areas, and emptied into the same drain which communicated with an open sewer passing the end of both the courts. In Trusscott's Court, as one of them is called, there was but one death from cholera, whilst in the other, named Surrey Buildings, there were eleven deaths. In this latter court the refuse water from the houses got into the well from which the people obtained their water. The succession of the cases illustrates the mode of communication. There were first two cases in Surrey Buildings, the evacuations of these patients being passed into the bed, as I was informed by Mr. Vinen, of Tooley Street, who attended them; in a few days after, when the water in which the soiled linen had been washed must have become mixed with that in the well, a number of cases commenced nearly together in all parts of the small court. The instance of Albion Terrace, Wandsworth Road, was a still more striking one of the communication of cholera by means of water. As the account of the occurrence was quoted in a review in the *MEDICAL GAZETTE*,* and some further particulars supplied by me in a note,† I need not now relate the particulars, but will briefly state that, owing to a storm of rain and thunder, such a connection was established between the drains

and water, that, on a case of cholera occurring in any one of seventeen houses, the evacuations might enter the water supplied to all the others. Such a case did occur, and in a short time the prevalence of cholera was such as I believe had not before been known in this country; whilst at the same time there was but little of the disease at the time, or I believe since, in the surrounding streets and houses. I will take this occasion to remark that we have now an explanation of the reason why the cholera has on some occasions increased very much immediately after a thunder storm, and on other occasions has very much diminished. The cause of this lies in the rain, and not in the thunder. In some places drains containing cholera discharges would be made to overflow into a brook or river, or other source from which water was obtained, whilst in other places drinking-water already contaminated would be nearly altogether washed away, and replaced by a fresh supply.

Dr. Lloyd mentioned some instances of the effects of impure water at the South London Medical Society, on August 30th.* In Silver Street, Rotherhithe, there were eighty cases, and thirty-eight deaths, in the course of a fortnight early in July last, 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 has informed me that the foetid water from the drain could be seen dribbling through the side of the well, above the surface of the water. Amongst 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 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

* Present vol. p. 468.

† Ibid, p. 504.

* See Report in *MED. GAZ.* p. 429.

these houses there were twenty-five cases of cholera, and fourteen 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. The people in Rotherhithe, where the mortality from cholera has been greater than in any other part of the metropolis, are supplied with water to a great extent from certain tidal ditches communicating with the Thames, and receiving besides the refuse of the houses in the neighbourhood; and Dr. Lloyd informs me that a line may be drawn between the places where ditch-water is used, and those supplied from the Water Works, and that the cholera has been many times more prevalent in the first-mentioned places; although, in my opinion, the water supplied from the water works is itself not free from suspicion of having conveyed cholera poison, being obtained from the Thames. Rotherhithe is less densely populated than many parts of the metropolis which have been comparatively free from cholera, and those ditches, it should be remembered, are not very offensive to the smell; being only Thames water rendered a little richer in manure; being, in short, probably equal to what Thames water would be if certain of our sanitary advisers could succeed in having the contents of all the cesspools washed into the river. In Bermondsey, the district in which next to Rotherhithe the cholera has been most fatal, the people also have to drink ditch water to a great extent.

The Registrar-General has very ably pointed out the connection between the higher rate of mortality from cholera on the south side of the Thames, and the lower level of the ground; but when this division of the metropolis is examined in detail, and compared with certain other parts of London, it will be found that the relation is not one simply of level, or of the state of the air in connection with it, but that it depends altogether on the water used by the people. Not because the water carries the poison to every individual case, but because it supplies a number of scattered cases which diffuse the disease more generally. The water works supplying the south of London take water from the Thames mostly at places near which

the chief sewers run into it. Moreover, the wells in this part of London are very liable to be contaminated by the contents of cesspools. Mr. Quick, engineer of the Southwark waterworks, in his evidence before the Sanitary Commissioners in 1844, said* that in the south side of the Thames the wells are often so contaminated owing to the cesspools and the wells being often about the same depth—viz. from eight to twelve feet, whilst on the north of the Thames the wells require to be from thirty to seventy, or eighty feet deep. These, together with the water from the ditches mentioned above, are the chief sources of the high mortality on the south of the Thames, and where they are not in operation there has been comparative immunity from the disease. Bethlem Hospital is very copiously supplied with water from an Artesian well on the premises, and I am informed that that there have been but two or three cases of cholera out of a population of about seven hundred. Mr. Morton, Surgeon to the Queen's Prison, informs me that, although there has been a good deal of diarrhoea, there have been but two cases of cholera in that establishment, containing a population, with the officers and attendants, of 300 and upwards, and one of the cases (the only fatal one) occurred in a patient who had been about a week in the prison, had suffered from an attack of cholera just before he entered, and had lost some members of his family by it. Now, the Queen's Prison is supplied with very good water from various wells within the walls. Bethlem Hospital is situated in Lambeth, where one in every eighty-eight of the population have been carried off by cholera; and the Queen's Prison in Southwark, where one in every sixty persons have died of it: and the latter establishment is closely surrounded by houses, in numbers of which the cholera has been very fatal. In another institution in London, situated at the same elevation as those just mentioned, there has been, together with a difference of water, a difference in the relative prevalence and fatality of cholera amongst its inmates and the surrounding population; but here it has been against the institution and in favour of

* First Report, p. 396.

those outside : I allude to the Millbank Prison. The cholera showed itself there soon after its appearance in London last autumn ; and during the summer of the present year it became very prevalent, and the greater number of the prisoners were sent away. Dr. Baly stated before the coroner that the cases occurred in different parts of the prison, amongst persons having no connection with each other, and that the strongest and most healthy men were often its victims. The water used in the Millbank Prison is obtained from the Thames at the spot, and is filtered through sand and charcoal, and looks very clear. Before these investigations there could be no objection to such water ; but it would appear by the result that the filtration was not an effectual safeguard. I cannot help suggesting that the water used here may have had some connection with the dysentery which has been often prevalent in this prison, for dysentery has apparently been kept up in India by water containing human excrement ; and the same circumstance was observed in the old barracks at Cork, by Mr. Bell, surgeon of that town.*

The greater part of Westminster abounds in nuisances, and is crowded with very poor and destitute people. The average elevation of it is exactly the same as that of St. Saviour's and St. Olave's, Southwark, but the mortality from cholera in Westminster to the end of September has been but 69 in the 10,000 ; whilst in St. Saviour's it has been 162, and in St. Olave's 152 or 179, according as the deaths in St. Thomas's Hospital are left out or included. The greater part of Pimlico and Chelsea have the same elevation as the Borough, but the mortality in them has been less than one-third as great as in the Borough. Westminster, Chelsea, and Pimlico are supplied with Thames water from the Chelsea water-works ; but as the same water is supplied to the Court and a great part of the aristocracy, the Company have large settling reservoirs and very expensive filters, by means of which, probably, the greater part of the cholera poison has been got rid of. The registrar's district of Brixton is situated on rising ground, the elevation

of which varies from 12 to 140 feet above Trinity high-water mark, giving an average elevation at least equal to that part of London situated on the north of the Thames ; and it is inhabited very much by people in comfortable circumstances, occupying wide and open streets, and scattered rows of houses, or even detached villas ; yet in looking over the registrar's reports, I find eighty-three deaths from cholera since May last. The population in 1841 was 10,175 ; this would yield 81 deaths in the 10,000, or twice as many as have occurred on the north of the Thames ; but the population of Brixton has probably increased since 1841, by the building of new houses, more than in London generally. Still there can be no doubt that the mortality there from cholera has been much higher than in many of the worst parts to the north of the river ; and the reason is not far to seek, for the greater part of the Brixton district is supplied by the Lambeth water-works with water obtained from the Thames near the Hungerford Suspension Bridge.

I will now proceed to narrate some circumstances that have occurred in the provinces. The drainage from the cesspools found its way into the well attached to some houses at Locksbrook, near Bath, and the cholera making its appearance there this present autumn became very fatal. The people complained of the water to the gentleman belonging to the property, who lived at Weston, in Bath, and he sent a surveyor, who reported that nothing was the matter. The tenants still complaining, the owner went himself, and on looking at the water and smelling it, he said that he could perceive nothing the matter with it. He was asked if he would taste it, and he drank a glass of it. This occurred on a Wednesday ; he went home, was taken ill with the cholera, and died on the Saturday following, there being no cholera in his own neighbourhood at the time.

When the cholera made its appearance at York, about the middle of July last, it was at first chiefly prevalent in some narrow streets near the river, called the Water Lanes. The inhabitants of this spot had been in the habit from time immemorial of fetching their water from the river at a place near which one of the chief sewers of the

* Dr. Cheyne on Dysentery, Dublin Hospital Reports, vol. iii.

town empties itself; and recently a public necessary had been built, the contents of which were washed every morning into the river just above the spot at which they got the water. In a short time from twenty to thirty deaths occurred in this locality; but the medical men considering the impure water injurious, the people were supplied from the water-works, with water obtained from the river at a point some distance above the town, and the cholera soon almost ceased in this part of the city, but continued to spread in some other parts. The cholera having thus abated in the Water Lanes, the gratuitous supply of water was cut off, and the people went to the river as before. There were still cases of cholera in the town, and it soon broke out again in this locality, and in the first few days of September eight deaths occurred among the persons who used water obtained direct from the river. The tap for general use was again opened, and the river water interdicted, and the cholera again ceased, and has not recurred. These circumstances were communicated to me by a friend on whose accuracy I can rely, and an extract from his notes on the subject afterwards appeared in the *Yorshireman Newspaper*.

The first cases of cholera in Exeter, in 1832, were three in the same day, besides one in St. Thomas's, a suburb of Exeter, in a gentleman just arrived from London, where the disease was prevailing. The other three were a woman and her two children; the former, with one of her children, had returned from Plymouth the previous day, where she had been nursing a child that had died of the cholera. Within five days from this time, there were seven fresh cases in as many different parts of the town, amongst persons having no intercourse with each other or the first cases. The disease soon became very prevalent, and in three months there were 1,135 cases, and 345 deaths. Exeter is situated on ground which rises from the edge of the river to an elevation of 150 feet. In 1832 the inhabitants were chiefly supplied with river water by water-carriers, who conveyed it in carts and pails. Dr. Shapter, from whose work the above particulars are obtained, has kindly furnished me with information concerning the sewers, and maps of

their position. The water-carriers, by whom Exeter was very greatly supplied, obtained their water almost exclusively from certain streams of water, diverted from the river in order to turn water-mills; and one of the chief sewers of the town, which receives such sewage as might come from North Street, in which the first cases of cholera occurred, empties itself into the branch from the river which divides into the two mill-streams just mentioned. It must be remarked that the parish of St. Edmund, in which these streams of water were situated, had a lower mortality from cholera than other parts of the town like it densely populated and on low ground near the river. Dr. Shapter attributes this lower rate of mortality, and I believe rightly, to St. Edmund's being freely intersected by running streams of water. The people would probably not drink more of the water than in parts of the town where it was less plentiful, and had to be paid for, but they would have much better opportunities for personal cleanliness: so that whilst they would be exposed to only the same number of scattered cases, they would be less likely to have the malady spreading through families, and by personal intercourse. After the cholera of 1832 measures were taken to afford a better supply of water to Exeter; not, so far as I can find by Dr. Shapter's work, that its impurity was complained of, but because of its scarcity and cost. Water-works were established on the river Exe, two miles above the town, and more than two miles above the influence of the tide. Exeter is now very plentifully supplied with this water, and Dr. Shapter has informed me that this year there have only been about twenty cases of cholera, nearly half of which have occurred in strangers coming into the town, and dying within two or three days after their arrival.

We will now consider the town of Hull, in which, together with other sanitary measures adopted since 1832, there has been a new and more plentiful supply of water, but with a far different result to that at Exeter. In 1832 Hull was scantily supplied with water conveyed in pipes from springs at Anlaby, three miles from the town. About five years ago new water-works were established to afford a more plentiful supply. These works are situated

on the river Hull, at Stoneferry, two miles and three quarters from the confluence of that river with the Humber. About half the sewage of the town is delivered into the river of the same name, the rest being discharged into the Humber, as appears from information and a map kindly furnished me by Dr. Horner, of Hull, who has been making great efforts to have better water obtained for the town. The tide flows up the river many miles past the water-works, carrying up with it the filth from the sewers. The supply of water is, to be sure, obtained when the tide is down, but as the banks of the river are clothed with sedges in many parts, and its bottom deep with mud, the water can never be free from sewage. Moreover, there are some parts of the river above Stoneferry much deeper than the rest, and where the deeper water is, according to the testimony of boatmen, nearly stagnant; thus allowing the water carried up by the tide to remain and gradually mix

with that afterwards flowing down. There are also boats, with families on board, passing up the river to the extent of 5,000 voyages in the year. The water when taken from the river is allowed to settle in the reservoir for twenty four hours, and is then said to be filtered before being sent to the town. In 1832 the cholera was confined almost exclusively to the poor, and the deaths amounted to 300.

This year, according to what I have gathered from the weekly reports, they have been six times as numerous. Dr. Horner informs me that they have occurred amongst all classes of the community; that he thinks one in every thirty-three of the population have been carried off, although 8,000 or 10,000 are said to have left the town to escape the ravages of the pestilence. All this has happened notwithstanding that the town is much better drained now than in 1832, and the drains in Hull proper are flushed frequently with water from the Docks.

PART II.

Communication of Cholera through the water at Dumfries—at Newburn-on-the-Tyne—at Biston—Exemption of Birmingham and other towns from cholera—Propagation of cholera by means of water in India—The materies morbi probably sometimes destroyed by the digestive powers—Proof of communication of cholera derived from the period of its duration—Its decline explained—Measures for preventing the propagation of cholera by means of either food or water.

THE former part of this paper concluded with the instances of Exeter and Hull, in both of which towns there had been, amongst other sanitary measures, a new and increased supply of water between 1832 and the present year; and in connection with this change was an immense difference in the prevalence of cholera for the better or the worse, according as the evacuations of the patients were shut out from, or admitted to, the water. In the next town I have to mention the drinking-water has remained the same, and the two epidemics have been almost equally fatal.

The inhabitants of Dumfries drink the water of the river Nith, which flows through the town, and into which the sewers discharge their contents, which float afterwards to and fro with the tide. In 1832 there were 418 deaths from cholera out of a population of 11,606, being at the rate of 360 in 10,000, or 1 in every 28 of the inhabitants. The present epidemic visited Dumfries at the close of last year, and carried off 431 persons, or 1 in every 32, out of a population now numbering 14,000; so that the mortality has been excessive on both occasions.

There is no spot in this country in which the cholera was more fatal during the epidemic of 1832 than the village of Newburn, near Newcastle-upon-Tyne. We are informed, in an excellent paper on the subject by Dr. David Craigie,* that exactly one-tenth of the population died. The number

of the inhabitants was 550; of these, 320 suffered from the epidemic, either in the form of diarrhœa or the more confirmed disease, and the deaths amounted to 55. Being aware of this mortality, I wrote, about the beginning of the present year, to a friend in Newcastle—Dr. Embleton—to make inquiries respecting the water used at Newburn, and he kindly procured me some information from the Rev. John Reed, of Newburn Vicarage, which I received in February, as well as an answer from Mr. Davison, surgeon, of Newburn, to whom I had written in the meantime. I learnt from these communications that the people were supplied with water in 1832, as at present, from three wells, two of which were very little used, and that the water in the third well is derived from the workings of an old coal mine near the village. The water of this well, as I was informed, although generally good when first drawn, becomes putrid after being kept two days. It was considered that the evacuations of the people could not get into any of the wells; but the vicar thought that the water of a little brook which runs past the village, and falls into the Tyne immediately afterwards, might find its way into that well which is chiefly resorted to. Putrefaction, on being kept a day or two, is so much the character of water containing animal matter, that, after receiving confirmation of my views respecting the communication of cholera by water from many other places, I recently wrote to Mr. Davison again on the subject, and he has kindly taken a great deal of trouble to investigate the matter further. He informs me that the brook is principally formed by water which is constantly pumped from coal pits in the neighbourhood. About half a mile before reaching Newburn it receives the refuse of a small village, and between that village and Newburn it runs through a privy used by the workmen of a steel factory. In Newburn this brook receives the contents of the open drains or gutters from the houses. The drain which conveys water from

* Edin. Med. and Sur. Jour. vol. xxxvii.

a coal mine or drift not worked for a great number of years, to the well mentioned above, passes underneath the brook at one part of its course, and from that point runs alongside of the brook to the well,—a distance of about 300 yards. Mr. Davison says that it is disputed whether there is any communication between the drain and the brook, but that it is highly probable that there may be, and that an occurrence which took place a few months ago seems to prove that there is. Some gas-water from the steel manufactory mentioned above got by accident into the brook, and some of the people affirm that the water in the well was strongly impregnated with it.

The first case of cholera in Newburn was that of a young man living close to the brook, about 100 yards above the place at which it passes the well. He was taken ill on the 29th December, 1831, and died, in the stage of consecutive fever, on Jan. 4th, 1832. There were some cases of diarrhœa in the village, but no new cases of cholera till the night of January the 9th, during which night and the following morning thirteen persons were taken ill. During the night of the 12th four persons were attacked; by the 15th there were fourteen new cases, and on this day the late vicar died—the Rev. John Edmonston. By the next day at noon there were at least fifty new cases. A few days after this the disease began to subside, and by the 2d of February had almost disappeared. As several days elapsed between the first case of cholera and the great outbreak, it is probable that the water in which the soiled linen must have been washed, and which would necessarily run into the brook, was the means of communicating the disease to the thirteen persons taken ill on the night between the 9th and 10th of January; unless, indeed, the intermediate cases of diarrhœa could transmit the disease. There have been a few cases of cholera at Newburn the present year, and five deaths, but I have not yet ascertained whether any of them occurred in houses the gutters from which enter the brook above the well; if so, probably some accidental circumstance has intervened to prevent a catastrophe like that which took place in the former epidemic.

The state of the water is often a

means of the spread of cholera in mining districts, in addition to the more constant cause pointed out in the former part of this paper. In some places the mines divert the springs, and cause a great scarcity of water, thus limiting the means of personal cleanliness; in other places the people have to use water pumped out of the pits, which of course is liable to be contaminated by the fæces of the miners: this is the case to some extent in the neighbourhood of Bilston, in Staffordshire, as I learn from Dr. Ogier Ward, and also from the Health of Towns Report.* In other districts, again, the ground is so saturated with the refuse of a large population congregated in spots which have neither sewers nor drainage of any kind, and often not even privies, that the impurities get into the wells. This is the state of Merthyr Tydvil, as we are informed by Sir H. T. de la Beche.†

When the cholera was at Kendal in 1832, the only place in which it was particularly prevalent was a spot called Robinson's Yard, in which there were 20 cases and 6 deaths, out of a population of 96. "From the dunghill and privies" in this yard, "there is every reason to believe that moisture percolated the earth and vitiated the water in the well, as they were more elevated, and consequently the moisture, except by evaporation, could escape in no other direction. The water, moreover, seemed impure, and was nauseous to the taste."‡

In a court, also, in Windsor, in which the cholera was lately prevailing, it was found that the contents of the drains had got into the well from which the people obtained their water.

There are several large and populous towns which nearly altogether escaped the cholera in 1832, and have had a like exemption from the epide-

* Appendix. Part 1, p. 35. Since the above was written I have received, through the Rev. J. Wm. Owen, a note from Mr. Wm. M. Hancox, surgeon, of Bilston, from which I likewise learn that the cholera first made its appearance there this year in a street parallel with the course of a brook which receives the refuse of the whole town; and that "in a small square of buildings consisting of about ten houses, ten persons died of the disease. Most of the inhabitants of this range of houses were in the habit of using water that filtered itself into wells from this stream."

† Ibid. p. 145.

‡ Dr. Proudfoot on the Epidemic Cholera of Kendal, Edin. Med. and Surg. Journ. Vol. xxxix., p. 79.

mic that is now subsiding. There have been a few cases in these towns, it is true, and this makes the evidence to be derived from them more instructive; for as these cases were chiefly those of persons newly arrived from places where the disease was prevailing, and of a few individuals who were in close proximity with them after their arrival and illness, we learn that though the cholera was imported to these places and capable of affecting others, yet some means of communication necessary for its diffusion was wanting, or failed to operate. We shall find that in all these towns there was no connection between the sewers and drinking water by which the cholera could be propagated. Birmingham being a very large town, its freedom from cholera has attracted a great deal of attention, and not a few attempts have been made to solve what was thought to be a singularity, though, as we shall find, it is not really so. Birmingham possesses an advantage in point of salubrity in its elevated position, but Walsall, in the neighbourhood, which is as much elevated above the level of the sea, suffered rather severely from cholera both recently and in 1832; and Dowlais, in South Wales, at twice the elevation, was severely visited with cholera during the epidemic of 17 years ago. Birmingham is drained into the River Rea and its tributaries. "The state of the river Rea, which may be regarded as the cloaca or main sewer of the town, is very bad. The stream is sluggish, and the quantity of water which it supplies is not sufficient to dilute and wash away the refuse which it receives in its passage through the town. In hot weather it is consequently often very offensive, and in some situations it is at these seasons covered with a thick scum of decomposing matters."* From this quotation it appears that if effluvia from sewers caused the prevalence of cholera, Birmingham ought not to have escaped. The state of the river may, indeed, have since been altered, but the description would, at all events, apply to 1832. There is one good property about the river which has escaped the observation of the reporters—viz., that the water is rendered too impure for any one to think

of drinking it. The inhabitants are supplied with water from springs and wells, and by water-works, from the river Taine, which is quite uncontaminated by the sewers. In Birmingham, consequently, there is no opportunity for the communication of cholera through the water, and the activity of the local Board of Health, in paying attention to every case amongst the poor, has no doubt been the means of preventing the spread of the disease from one individual to another by contamination of the hands and the food.

Bath has enjoyed an almost total exemption from cholera both recently and in 1832, although Bristol has on both occasions suffered rather severely, and this year the epidemic has prevailed in some villages still nearer than Bristol. Bath is supplied with water conveyed in pipes from the hills surrounding the town, whilst the sewers empty themselves into the river Avon, from which but a very few of the poor people ever obtain water. Cheltenham has enjoyed a like immunity from cholera with Bath, and the drinking-water there is quite free from connection with the sewers.

The above-mentioned three towns possess some physical advantages, in addition to the purity of the water, over some of the places in which cholera has been prevalent; but such is not the state of Leicester. It is situated in a low elevation, and entire quarters of the town are liable, after heavy rains, to be covered with offensive water from the overflowing of the open sewers and badly constructed drains; and it contains a large population of underfed operatives; yet there has been scarcely any cholera there either in 1832 or the present year. Leicester is supplied with water from springs and pumps, and partly by spring water conveyed in pipes; and the river which flows through the town and receives the sewage, is so much altered by the refuse of dye works, that the water is quite undrinkable.

Preston and Oldham, in Lancashire, are supplied with water from surface drainage on the neighbouring hills, and there has been scarcely any cholera at either of these places. The greater part of the town of Paisley is supplied in a similar way; and I am informed that the cases of cholera which have occurred there in the recent epidemic

* Local Reports on the Sanitary Condition of the Labouring Population of England. 8vo. 1842, p. 194.

were confined to a quarter of the town to which this supply of water does not extend. Nottingham is supplied with filtered water obtained from the river Trent, some distance above the town. In 1832 this supply did not extend to all the inhabitants, and the cholera was somewhat prevalent amongst the poor, of whom it carried off 289; the population of the town being 53,000. Since that time the water has been extended copiously to all the inhabitants, and there have been but six deaths from the epidemic in the present year. The local Sanitary Committee place the supply of water amongst the chief causes of this immunity from cholera,* and I believe justly.

However injurious impure water must be to the health, there is no reason to suppose that it can assist in the spreading of cholera unless it contain the excretions of the patients. Stafford is an illustration of this. In that town, as I learn through the kindness of Dr. Harland, there is not a single sewer, and the liquid refuse from the houses runs down the channels on each side of the streets. It is common at the poorer houses to have holes dug in the ground to allow the waste and refuse water to run into. The town is built on a bed of sand, and water is everywhere found at 8 or 10 feet below the surface, and the whole of the inhabitants have pumps convenient to their dwellings. Dr. Harland, from whom I have these particulars, says he has no doubt that in many cases the refuse liquid must percolate through the sand and get into the pump water; and he has known some instances in which the filthy surface water was allowed to get into the wells. There has been scarcely a case of cholera at Stafford at any time, although the disease has been very prevalent at Bilston, and many other places in Staffordshire, both recently and seventeen years ago. As almost every house has its own well, it is evident that the water does not afford the means of disseminating the cholera in Stafford; but if the disease had been introduced to any extent by other means, the pollution of the wells would no doubt have rendered it more prevalent amongst the limited number of people using the water of such wells.

There are several towns in which the

cholera has prevailed to a considerable extent, although the water cannot be blamed, so far as I have been able to learn. But under those circumstances it appears that the malady has been confined almost exclusively to the poor, and has spread chiefly by personal communication. So far as my inquiries have extended respecting the more considerable provincial towns, the results of them has been as follows:—In those towns supplied with water from a river where it contains the sewage of the town, the disease on making its appearance has become very prevalent. All those towns that have enjoyed a comparative immunity from cholera are supplied with water that is uncontaminated; and lastly, the cholera has prevailed to a considerable extent in some towns in which the water can have had no share in the extension of it. The profession may expect to receive a considerable amount of information on this subject shortly, from the replies that will be made to the questions lately issued by the cholera Committee of the College of Physicians.

As we are never informed in works on cholera what water the people drink, I have scarcely been able to collect any information on this point, respecting foreign countries. There are, however, one or two circumstances that I may mention. In 1831, when the cholera had extended itself across Poland, the Hungarians placed a strong cordon of military posts to guard all the passes and defiles of the Carpathian mountains. The epidemic, however, soon showed itself on the south-west side of the chain of mountains; it first appeared in the town of Eperies, situated on one of the streams issuing from the Carpathian mountains, and two days afterwards it appeared at Tockay, a town situated about 70 miles farther south, at the junction of this stream, named the Bodrod, with the Theiss.*

Dr. Parkes informs us in his valuable work on cholera, that in the epidemic at Moulmein, in 1842-3, this disease was confined for many months almost entirely to the houses situated on or over the river; and that "one side of the main street runs close to the river, and the great majority of

* See MED. GAZ., p. 672.

* Dr. Craigie in Edin. Med. and Surg. Journ. Supplement, Feb. 1832, p. 150.

cases occurred on this side : comparatively few on the other." Dr. Parkes has informed me that he has no doubt that the people living near the river drank the water obtained from it ; and the river of course received the refuse of the houses near to it. The circumstances detailed in the following passage from the same page (161) of his work, seem to illustrate very well the communication of cholera through the drinking-water, and are at all events better explained by this view of their cause than any other. "The only Europeans attacked at the commencement of the epidemic were the sailors belonging to the ships in the river : the ships nearest the shore suffered most. Thus nine cases occurred on board H. M. brig Britomarte, lying close in shore ; she was moved about a mile away, into the centre of the river, and no more cases occurred. Three cases occurred on board H. M. brig Syren, also lying in shore : she was also moved into the centre of the river, and the cholera immediately ceased. The 63d regiment sailed in September and October, 1842, for Madras. One transport being accidentally detained three days in the river, had fourteen cases of cholera during the voyage ; the other transports, four in number, got to sea at once, and had no cholera. A few cases occurred during this time among the Europeans on shore, but these consisted only of those who lived close to the river."

On some occasions in India the cholera has increased in prevalence with such rapidity that it has been thought that contagion would not account for the immense number of new cases : if, however, any of the discharges from the patients accidentally found admission to a limited source of water, we can perceive how that circumstance might account for these sudden outbreaks of the malady, in a warm climate where the drinking of water must be frequent and universal. Whether they have been really due to this cause can only be determined by persons resident in the country.

Many medical men to whom the above circumstances respecting the water have been mentioned, admit the influence of the water, without admitting the special effect of the new element introduced into it—viz., the cholera evacuations, in communicating the dis-

ease. They look upon the bad water as only a predisposing cause, making the disease more prevalent amongst those who use it—a view which, in a hygienic sense, is calculated to be to some extent as useful as the admission of what I believe to be the real truth, but which, I think, will be found to be untenable, when the circumstances are closely examined. If the bad water merely predisposed persons to be acted on by some occult cause of cholera to which it is supposed that all are exposed, those using such water ought to become more subject to the disease from the time it enters a town or neighbourhood ; instead of which it has been shown in many of the above instances that no particular effect was observed amongst those using the water, until by the occurrence of a case or two of cholera, the evacuations entered the water, when, after a short period of incubation, there were several persons attacked nearly together.

The above evidence of the communication of cholera through the drinking-water, confirms the view of the disease being propagated by the swallowing of the *materies morbi* in the cases resulting from personal intercourse ; for if the evacuations can produce the disease when largely diluted, *a fortiori* must they be capable of causing it when undiluted.

The only circumstance of which I am aware that offers any material opposition to the views on the communication of cholera here explained, is that two or three members of a medical commission in Berlin, in 1831, are related to have swallowed a portion of the cholera evacuations experimentally. The reply that must be made to this is that the stomach has most likely the power of sometimes destroying the poison. There are many reasons for concluding that this is the case. Persons are more liable to the disease in proportion as they advance in age, as is shown by comparing the attacks at different ages with the numbers living of those ages,* and as people advance in life the powers of digestion diminish. Whatever has a tendency to produce indigestion, increases the liability to an attack ; as fear, anxiety and excesses in eating or drinking. To that part of

* See Dr. Budd's Lecture, *Med. Times*, Oct. 20, p. 315.

the subject which refers to the communication of cholera through the water of a river, two objections naturally arise—1st, that the large dilution might be expected to render the poison innocuous; and 2d, that the whole, or nearly so, of the people using the water ought to be affected by it. One answer applies to both the objections: it is, that a poison capable of multiplying in the body must, one would conclude, be organized, and therefore consist of particles, however minute, any one of which happening to reach its suitable habitation without being destroyed, might induce the disease. Or if the poison be really a chemical compound, capable of complete solution without losing its properties, it might yet be imbibed by minute cells, such as mucous globules or epithelial cells*, and be thus conveyed without being much diluted.

It has been asked how these views explain the cessation or decline of the disease; and whilst it must be at once admitted that we cannot actually tell why the cholera begins to decline in a place just when it does, it will appear on sufficient examination that the period of prevalence and declension of the malady are such as afford strong evidence of its communication—evidence even of this being its sole cause. The duration of cholera in a place is usually in a direct proportion to the number of the population. The disease remains but two or three weeks in a village, two or three months in a good-sized town, but in a great metropolis it often remains a whole year or longer. I find from an analysis of the valuable table of Dr. Wm. Merriman, of the cholera in England in 1832,† that 52 places are enumerated in which the disease continued less than 50 days, and that the average population of these places is 6,624. 43 places are likewise down in which the cholera lasted 50 days, but less than 100; the average population of these is 12,624. And there are, without including London, 33 places in which the epidemic continued 100 days and upwards, the average population of which is 38,123; or if London be included, 34 places, with an average of 78,823. The following short table will

show these figures in a more convenient form:—

No. 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

This difference in the duration of cholera points clearly to its propagation from patient to patient. If each case were not connected with a previous one, but depended on some unknown atmospheric or telluric state, why should not the twenty cases that happen in a village be distributed over as long a period as the twenty hundred cases which occur in a large town? The views propounded in this paper offer a more ready explanation of the decline of the disease for want of fresh victims, than the usual theory of contagion or infection; for all the members of the community are not liable to be reached by a poison which must be swallowed, as they would be by one in the form of an effluvium.

The recognised physical conditions of the season do undoubtedly influence cholera. Although it can flourish in every temperature, warm weather is usually most congenial to its progress. In September last the number of cases began to decrease, both in London and many parts of the provinces, immediately after a considerable diminution in the temperature of the weather. This circumstance, however, is quite compatible with almost every theory of the cause of cholera. It certainly does not oppose the view of the communication of the disease; for whilst temperature modifies the habits as well as the constitution of man, it might also be expected materially to influence the cholera poison, when it has to remain any time out of the body between quitting one patient and entering another, for the lower forms of organisms to which the special animal poisons bear a marked analogy, are greatly influenced by heat and cold.

The fact of cholera having spread from India over the greater part of the world, and then having retired within its former bounds to extend again after a number of years, is thought by many to have no kind of analogy amongst the more familiar diseases; but it is only a more marked instance of what

* I am indebted for the idea of the epithelium cells conveying the poison, to Dr. Lankester, who indeed thought that I had suggested it.

† Trans. of Roy. Med. and Chir. Soc., 1844.

occurs constantly on a smaller scale, in all diseases in which each case owes its origin to a previous one. It is only in a great metropolis that the eruptive fevers are all constantly present; in a village or small town they each disappear, and remain absent for a longer or shorter period either till they be re-introduced from some distant place, or by poison accidentally preserved. Small islands often remain free from some of these diseases for very long periods at a time.

Assuming the views here entertained to be correct, it is not to be expected that we should be able to trace the communication of every case of cholera. The very nature of the mode of propagation of disease above explained must render it obscure and difficult of detection. And the difficulty is probably increased by the poison being conveyed by persons in whom the disease proceeds no further than diarrhoea. The communication of intestinal worms from one patient to another has never been detected, and yet we are obliged to conclude that their minute ova are swallowed, unless we not only adopt the hypothesis of spontaneous generation, but apply it to creatures much higher in the scale of development than do the usual advocates of the doctrine. If there really be such a disease as Asiatic cholera, distinct from the ordinary English cholera which prevails in autumn, with which it is confounded by the Registrar-General, who says that the deaths from cholera are now approaching the average,—a disease imported from Hamburgh after being absent fifteen years, and evidently spreading by communication in very numerous instances; we ought not to conclude that part of the cases must depend on some other occult cause, but rather, first to examine the one sufficient cause we have found, to ascertain whether it will not explain more and more of the facts the further they are inquired into; and to search whether the localities which are favourable to cholera do not promote it through physical conditions which favour its communication.

In concluding this paper it is necessary to point out the measures which, according to the opinions and evidence above detailed, might be expected to prevent the communication, and thus stay the ravages of cholera. They are

fortunately of a kind that would not interfere with commercial intercourse, and which medical men would probably be willing to make trial of, whether they do or do not entirely concur in the absolute necessity of them. The most scrupulous attention to cleanliness should be inculcated on those waiting on the sick, who ought especially to be careful to wash their hands before touching food. When cholera shews itself in a family having but one room, the patient should either be removed, or the other members of the family, except those required as nurses, should be provided with an asylum elsewhere, especially for cooking and eating their meals. As the evacuations might fly about as a fine dust whenever linen should be disturbed on which they had been allowed to become dry, it is desirable that the soiled linen and blankets should be immersed in water as soon as removed, and afterwards exposed to a boiling heat. The fruit that is hawked about the streets is kept at night in the rooms (and generally under the bed, if there be a bedstead) in which a crowd of people sleep, and in those courts and alleys into which contagious diseases are often first introduced by vagrants: hence people should be dissuaded from buying such fruit. When the cholera makes its appearance in a mining district it would be advisable that the men should work during two "shifts" in the twenty-four hours, of four hours each, instead of one "shift" of eight hours; and should be dissuaded from taking food to their work, and recommended to wash themselves on going home, as I believe they usually do. And, lastly, whilst cholera remains in the country, people should avoid using water which receives the contents of drains or sewers, or the refuse of persons navigating the water. Since anything touched by the hands may enter the mouth, it would be desirable to avoid even washing with such water; and at all events, when no other water can be obtained, so much of it as is used for drinking and culinary purposes should be filtered and well boiled.

I take the opportunity of expressing the obligation I am under to several medical gentlemen, to some of whom I was previously unknown, for the trouble they have kindly taken in answering my enquiries.

