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### PART I.

#### ORIGINAL COMMUNICATIONS.

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ART. IV.—*Asiatic Cholera and its Invasions of Europe.* By CHARLES A. CAMERON, M.D.; S.Sc.C., Camb.; M.K. & Q.C.P.; F.I.C.; Chairman of Public Health Section, Academy of Medicine; Vice-President, Society of Public Analysts of Great Britain; Hon. Member, Societies of Hygiene, Paris, Bordeaux, &c.; Member of Council and Professor of Hygiene and Chemistry, R.C.S.I.; Medical Officer of Health for Dublin, &c.

THE outbreak of cholera in Egypt has brought once more this formidable disease prominently before the public. The present is, therefore, an opportune time to review the history of Asiatic cholera, especially in relation to its invasions of Europe. It will be seen by the perusal of the following pages that whilst cholera has only invaded the United Kingdom four times, it has more than a dozen times appeared upon the Continent of Europe, and has very frequently extended into various parts of Asia and Africa from its *fons et origo* in the plains of India.

The term cholera occurs in the writings of Hippocrates. The etymology of the word is doubtful. It may be derived either from *χολέρα*, a gutter or water spout, or from *χολή*, bile. If the latter etymology be correct, then the disease described by Hippocrates, Galen, Celsus, and other classical writers on medicine, was probably the disease now known as European cholera (*cholera nostras*), for while bile is absent from the evacuations in Asiatic cholera, it is usually present in those of European cholera.

The Arabian physicians of the middle ages, and Continental

and British writers of the sixteenth and seventeenth centuries, have described epidemics which may have been Asiatic cholera. Two epidemics of "cholera" in England in the latter half of the seventeenth century have been described by Sydenham.

Cholera has probably existed in India since the appearance of man in that country. The earliest writers refer to the disease. Susruta, an author who lived before the Christian era, has left on record a minute account of the symptoms of the disease. Whang-shoo-ho, a Chinese author who flourished 400 years before the Christian era, has described it as well known in his country.

The earliest account of cholera, as observed in India by Europeans, is that given by Gaspar Correa. He states that in 1503 20,000 men of the army of the sovereign of Calicut died from a disease which killed its victims within eight hours. He observed the same complaint in 1543. It was a very swift disease, and but few whom it attacked survived.

#### DIFFUSION OF CHOLERA.

During the last 250 years several widespread epidemics of cholera have occurred in India, and have been described by various authors.

In 1768-71 the disease raged in the French possessions, and, according to Sonnerat, carried off 60,000 persons.

In August, 1817, Dr. Robert Tytler, of Jessore, was called upon to attend a native suffering from symptoms resembling those caused by an irritant poison, and to which cause Dr. Tytler was disposed to assign the speedy death of the patient, when he learned that seventeen other persons were similarly affected. These were amongst the earliest of the cases of the great epidemic of cholera which soon spread over the greater portion of India, and subsequently penetrated to Persia and other adjacent countries. In a short time a large number of British and native soldiers were stricken with the disease, and the camp of the Governor-General, the Marquis of Hastings, at Bundelcund, was converted into a vast hospital (Corbyn's "Treatise on Epidemic Cholera," Calcutta, 1832). This epidemic lasted four years.

In the year 1826 cholera reappeared in many parts of India, and almost immediately invaded Arabia, Tartary, and Persia. It extended from Khiva towards Asiatic Russia, and on the 26th of August, 1829, it appeared in Orenburg, a town on the eastern frontier of European Russia. From the history of the progress of cholera from India in a north-western direction we gather that the

contagion was propagated into Russia both from the northern provinces of Persia and from Tartary. The progress of cholera through Russia was apparently checked by the winter, but in the spring it pushed onwards rapidly, reached Warsaw in April, and soon afterwards attacked Riga, a Baltic town. In June it appeared in St. Petersburg, and, passing through Finland, it reached Sweden in August. The Austrian empire suffered severely. The disease appeared in Pesth in July, but earlier in the month it had spread throughout many parts of Bulgaria, and somewhat earlier still it had broken out in Constantinople. The province of Galicia had the highest mortality from the epidemic; it was computed that 261,000 persons were attacked, of whom 97,770 died. In August Vienna and Berlin were affected, and the disease appeared in various parts of Prussia and other German states, though some of them, notably Bavaria, Saxony, and the Mecklenburgs, escaped the visitation. France, Spain, and Portugal, were spared in 1831.

The advent of cholera into the British Islands took place in August, 1831. The places first attacked were Team, a village near Gateshead, and the town of Sunderland; in the latter place it became epidemic in October. It subsequently appeared in many of the towns on the east coast, and reached London and Edinburgh in February, 1832; its progress had, no doubt, been retarded by the winter. In February the disease made its appearance in Glasgow. In March it broke out in Dublin, and the following month it appeared in Cork. The deaths were very numerous. In London nearly 6,000 perished, and in Dublin 5,632. In Great Britain the deaths up to the end of the year were returned to the Board of Health as amounting to 31,376, which is believed to be under the actual figures. In Ireland up to 1st March, 1833, the deaths numbered 21,171. Many of the towns suffered severely; in Ennis one-tenth of the inhabitants were attacked.

In March, 1832, cholera penetrated to France. In Paris it assumed a most malignant form; the rate of mortality was very high, and nearly 20,000 perished. In that year cholera reappeared in England, and carried off about 15,000 persons.

The emigrant ship "Carricks," which left Dublin in April, 1832, for Quebec, is believed to have imported cholera into America. During the voyage 42 of the passengers died from cholera; and shortly after the arrival of the vessel in port cases of the disease began to appear. Before the end of the year the malady was epidemic throughout Canada and the United States.

In 1833 cholera invaded Portugal, and shortly afterwards passed into Spain. It is stated that the contagion was first introduced into the Iberian peninsula by the merchant steamer "London," which had cholera on board during the voyage from London to Oporto, and landed troops at that port. In this year cholera, generally of a comparatively mild form, appeared in a great many parts of Europe and America. In 1834 very few cases occurred in Europe; but in the following year it became epidemic in the south of France. In 1836-7 Italy suffered cruelly from it; in Rome about 10,000 persons were attacked. The disease reappeared in Prussia in 1837; and in the same year it ravaged Northern Africa and Malta. In the latter place more than 4,000 persons died. In 1838 cholera caused but few deaths in Europe, and in the following year it completely disappeared.

In 1841-4 cholera was diffused through many parts of India and the adjacent countries. By the autumn of 1846 it had advanced north-westwards, to Bagdad and Damascus. In November it appeared at Mecca, where it caused the deaths of about 15,000 pilgrims. Early in 1847 it extended to Tartary and Persia, and spreading along the coast of the Caspian sea reached Trebizonde. By the autumn it had appeared at Taganrog—entering Europe, as it had done in 1829, by the Province of Orenburg—and had nearly reached Moscow when apparently the winter arrested its progress.

In the spring of 1848 cholera spread rapidly over a large portion of Russia, the Danubian Principalities, Scandinavia, and parts of Northern and Eastern Germany, and of Southern Austria. It broke out in London in September, in Edinburgh during the following month, and in Belfast in December.

In October, 1848, cholera broke out in England, and in the following year raged throughout Great Britain and Ireland. In London the pestilence carried off more than 14,000 persons. In England and Wales 53,273 deaths were caused by it. Ireland suffered severely; in Dublin alone 1,664 deaths occurred. The disease appeared in France; in Paris, out of 33,274 attacked by the disease, 15,677 succumbed. In this year and the one following many towns in North America had epidemic cholera. The deaths from cholera registered in England and Wales in 1850 were 887; in 1851, 1,132; in 1852, 1,381. The disease was not widely spread throughout Europe.

From 1849 to 1852 cholera was widely spread throughout India, and burst out from that country in several directions. It

appeared in Persia, Asiatic Turkey, and Asiatic Russia; and in 1853 the malady was epidemic throughout European Russia. The disease imported in former years had not, however, died out; for in 1852 Poland was heavily visited by this plague.

A large portion of Europe had cholera in 1853-4. France was one of the heaviest sufferers, having lost, according to Dr. M. Barth, 140,000 of its inhabitants. Southern Europe, from Portugal to Turkey, was harassed with this scourge. In Naples 10,000 corpses were the mute witnesses of the destroying power of the modern plague. In Sardinia 24,000 persons perished. In Russia 100,000 died in 1853, and 14,000 in 1854. The allied troops at Varna and the hostile forces contending in the Crimea sustained large losses from cholera. In these years the disease visited North America and the West Indies.

In October, 1853, England was for the third time seriously invaded by cholera. Newcastle-upon-Tyne suffered very severely, losing 1,922 of its citizens, whilst the total deaths in England and Wales numbered only 4,419. In 1854 the deaths in England and Wales amounted to 20,097, half of which occurred in London.

In 1855 the deaths caused by cholera in England and Wales were set down at 837, and in the following year 762. During the years 1857-1864 the deaths ascribed to this disease varied from 1,150 in 1857, to 327 in 1860.

In 1855 the cholera epidemic reached a fearful *crescendo*. According to Drasche, 666,814 persons were attacked, of whom 270,915 died. In Russia in Europe 131,327 persons died from cholera in 1855.

During the great epidemic of cholera of 1852-5 nearly 1,100,000 persons were killed by this scourge in Europe alone. Enormous as this mortality from a single disease is, it is small compared with the cholera death-rate in India. In 1877, 357,430 persons died from cholera in the Presidency of Madras (Report of Surgeon-Major W. R. Cornish, Sanitary Commissioner, Madras, 1878).

In 1861 cholera continued in Russia, in the Iberian peninsula, and in a few parts of the United Kingdom, France, and Germany. It prevailed in Mexico and South America, and it was introduced by coolies into the Mauritius. But few places in Europe were affected with cholera in 1857-8, but in the following year it became locally epidemic in some points in Northern Germany, Finland, Sweden, and Spain. From 1861 to 1864, inclusive, cholera was practically absent from Europe.

On the 28th February, 1865, the British ship, "North Wind," landed a large number of pilgrims, chiefly Javanese, in Jidda, and a week later the "Persia" brought another consignment, *en route* for Mecca. Both vessels had touched at Makallah, where water of very bad quality was shipped on board. Shortly after leaving this port cholera broke out, and carried off 52 out of a total of 632 of the crew and passengers of the "North Wind," and 93 out of the 530 persons on board the "Persia." The first victims on board the "Persia" were passengers from Makallah, 70 of whom had come from Hadramant, in Arabia, where cholera was prevalent. The epidemic of cholera which ensued at Mecca and its neighbourhood was of the worst type. About 15,000 out of 90,000 pilgrims are computed to have perished, most of whom died within a week. In May a steamer carried 1,500 pilgrims from Jidda to Suez, and immediately after cholera appeared in Egypt. The pilgrims, who returned from Mecca to various parts of the Turkish Empire in Asia and Europe, carried contagion with them. Late in June the disease reached Constantinople (where it caused 50,000 deaths), and early in July, Beyrout, Jaffa, Cyprus, and other places.

Cholera made its entry into Europe on the 18th June; the place first attacked was Marseilles. It effected a lodgment in Italy on the 7th July, and the following day appeared in Spain. Gibraltar was attacked on the 18th, and several parts of Southern Russia were affected later in the month. The disease appeared at Brahamov, on the Danube, 31st July, and soon spread throughout Roumania. In all these cases no difficulty was found in tracing the contagion to persons who had come from infected places.

On the 27th August cholera suddenly made its appearance in the very centre of Europe—namely, at Altenburg, in Saxony. It was, however, discovered that the first victim was a woman who had left Odessa after the disease had been imported into that town, and whose child had been ill with diarrhoea since they had left Odessa. Dr. Rudolf Günther\* states that the infection brought by this woman extended the disease to 25 localities, and caused nearly 500 deaths.

A few cases of cholera occurred in England in September, but the origin of them was not ascertained, and they did not spread. The disease appeared in epidemic form at Southampton. A woman died from it on the 24th September, and, within three weeks, 60

\* Die indische Cholera in Sachsen im Jahre 1865. Leipzig.

cases of the malady occurred. Professor Parkes investigated the outbreak, but was only able to discover that the persons first attacked were more liable, from their occupations, to contagion introduced from the port into the town, but he was not able to connect it with any particular ships. At that time, however, Alexandria was infected, and the ships which plied between that port and Southampton, no doubt, introduced the cholera contagion into the latter.

During the winter of 1865-6 cholera was almost quiescent, except in Southern Russia; but it awoke with vigour early in 1866. It appeared at Bristol in April, at Liverpool in May, at Southampton and Sunderland in June, and in London in July. The Liverpool outbreak was traced to Rotterdam, and it was considered that the contagion was introduced into other seaports from Dutch and Belgian towns. In Southampton the disease appears clearly to have been imported by the crew of the "Poonah," from Alexandria, as cholera was actually on board the vessel when she entered the harbour.

The first case of cholera in Ireland, in 1866, occurred on the 26th July in Dublin. The victim was a girl who had arrived that day from Liverpool, where the disease was epidemic. The malady immediately spread, and before the end of the year had carried off 923 persons. In this year a great many parts of the United Kingdom were cruelly ravaged by cholera. The deaths which it caused were—in England, 14,378; in Ireland, 2,501; and in Scotland, 1,270 = 18,149.

In 1866 cholera caused 20,000 deaths in Italy, 33,000 in Belgium, 20,000 in Holland, 115,000 in Prussia, 4,500 in Sweden, in Austro-Hungary 235,000 (this estimate is probably an exaggerated one), in Poland 18,000, in Russia 73,000, in Saxony 6,000, in Roumania, 29,000. No returns of the deaths in France have been published. In Paris, in 1866, 5,509 persons died from the disease. In Denmark and Norway the mortality from cholera was trifling. Portugal suffered but slightly. As to Spain, no statistics or reference to the deaths caused by cholera have been published; but some Spanish towns were ravaged by the disease.

In 1868 cholera continued in Prussia, but did not do so much damage as in the previous year. It ravaged Italy, the deaths from it amounting to 128,000. The disease prevailed, but not largely, in France, Spain, and Switzerland. In Holland it caused 1,500 deaths. It was somewhat severely felt in Poland and parts

of Russia, and the north-western parts of European Turkey. In Austro-Hungary it was comparatively infrequent in its attacks. The Prussian armies suffered from it during the Austro-Prussian war.

In 1866 cholera appeared in only two points in Russia, and one in Germany. The disease appeared to have died out. It, however, made its appearance at Kiev in 1869, and spread over several districts, causing only between 600 and 700 deaths. In the following year it diffused over a wider area, and penetrated to Poland. This year the deaths from cholera in Russia amounted to 9,910.\*

In 1871 nearly 5,000 deaths from cholera were recorded in Russia. The disease was severely felt in Austro-Hungary, especially in Hungary, where—out of a population of 8,675,517—443,641 were attacked (of whom 187,407 died), from September, 1872, till the end of 1873. In Austria more than 100,000 persons perished in 1872–3.

In 1871 and 1872 cholera was somewhat widely spread throughout Prussia; the deaths which it caused were under 4,000. There were not many cases in this kingdom in 1872; but in 1873, 23,242 persons succumbed to the epidemic. In this year cholera spread over the greater part of Germany, and appeared in France, Belgium, Holland, and Scandinavia. Denmark and Norway had but few cases. In 1874 cholera died out in Europe.

During the latter years of the last European epidemic of cholera cases now and then occurred in England, but the disease never assumed the proportions of an epidemic. The great waves of cholera which moved out of India in 1865, extended (renewed, perhaps, occasionally from the fountain-heads of the pestiferous streams in India) over a large portion of the world. The disease devastated Northern and Eastern Africa, and extended inland so far as the Victoria Nyanza Lake. It attacked the armies of King Theodore of Abyssinia. It ravaged Nubia, Somali, Arabia, Syria, Persia, Afghanistan, Turkistan, Kurdistan, Armenia, and Asiatic Russia. In 1873 a vessel from Stettin introduced cholera into Halifax. About the same time cholera was prevalent at New Orleans and in the basin of the Mississippi.

Since the first appearance of cholera in Europe, in 1831, it has spared some places altogether, and repeatedly visited others. For example, there have been no fewer than thirteen distinct epidemics

\* J. Netten Radcliffe in "Reports of Medical Officer of the Privy Council" for 1875, p. 142. Mr. Radcliffe's paper details the spread of the last epidemic of cholera throughout the world.

of this disease in Stettin. It is stated that the disease is most virulent in low-lying situations—and this as a rule appears to be the case—but, according to Dr. Blane, the disease in 1866 decimated the army of King Theodore at a height of several thousand feet above Lake Tzana (“Story of the Captives”).

#### SYMPTOMS AND DIAGNOSIS.

Malaise is very frequently indeed the precursor of an attack of cholera, while diarrhœa, attended with but little pain, is generally the earliest symptom noticed; it may continue without other symptoms for several days, or be immediately followed by severe disturbance of the system. The alvine evacuation is thin, light yellow, or brown, and alkaline. It is characteristic of the disease, and from its appearance is termed “rice water” evacuation. The patient soon becomes pale, and his face wears an anxious expression. His tongue is white and clammy. Nausea is early felt, and is often followed by vomiting, which sometimes becomes mere regurgitation of everything swallowed. In some instances the symptoms are not more severe than these, and were it not that cholera was epidemic, would be regarded as those of cholera morbus, or even simple gastric derangement. During epidemics of cholera, diarrhœa, however simple and painless, should be promptly checked, as it has a tendency to run into cholera.

In the second stage of the disease the diarrhœa suddenly increases, vomiting becomes frequent and severe, there is intense thirst; and severe cramps of the muscles, especially those of the extremities, are experienced. There is great restlessness and sleeplessness. A burning sensation is felt in the stomach, and the patient often complains of heat, though his temperature is below the normal point.

It is somewhat remarkable that the discharges from the bowels and from the stomach are so often attended with little or no pain; they require no effort on the part of the patient, and appear to be accomplished, as it were, automatically.

The temperature falls in severe cases to 95° F. (35° C.), or 94° F. (34·4° C.), whilst the pulse rises to from 100 to 112 beats per minute. The respiration in the graver cases is hurried and shallow, and occasionally there is dyspnœa. The face becomes shrunk and livid, and the skin over the hands wrinkles. The voice sinks into a hoarse whisper (*vox cholericæ*.)

In the third stage the symptoms become more urgent; the

surface temperature falls; the face becomes cyanotic; the patient is more or less stupefied. This stage may last from two to twenty-four hours, and most frequently terminates in death.

The fourth stage of cholera is characterised by the almost complete absence of purging or vomiting; the patient often becomes comatose; the skin is clammy and cold; the face acquires a purple or dark blue hue; the eyes are dry and shrunken; the pulse is no longer to be felt at the wrists.

In the fifth stage, should the patient reach it, the temperature rises, the pulsation is lowered; the evacuations resemble typhoid stools; the urine is secreted; the appearance of the face and skin rapidly improves, and in a day or two the patient enters the stage of convalescence.

Occasionally persons are carried off by cholera within a few hours, and without having suffered from diarrhœa or vomiting. This form of the disease is termed *cholera sicca*; but Lebert considers that *cholera siderans* is a more appropriate term for it.

The characteristic symptoms of cholera are as follow:—The absence of fever, the want of warmth in the air expired from the lungs, suppression of urine, the vomiting, the “rice water” evacuations, the low temperature of the body, the cramps, the livid skin, the collapse, and, lastly, the rapid course of the disease.

*Cholera nostras*, *Cholera morbus*, or European cholera, resembles Asiatic cholera, and is liable to be confounded with the latter when it is epidemic. It comes on suddenly with vomiting and diarrhœa; the abdomen is often painful and distended, the evacuations rarely resemble the “rice water” discharges of Asiatic cholera. The absence of premonitory diarrhœa, and the comparative mildness of the symptoms, suffice in the great majority of the cases to discriminate it from its more formidable Asiatic namesake.

#### ÆTIOLOGY OF CHOLERA.

*Endemic in India.*—There is strong proof adduced by Dr. C. Macnamara, in his valuable work on Cholera (London, Churchill, 1870), that cholera is endemic not only in the valley of the Ganges but also throughout a large portion of the Presidency of Bombay and Madras, and that it is probably endemic in nearly all the Indian seaboard cities. The strongholds of the disease are the cities of Dacca and Calcutta. The disease declines north-west from an imaginary line drawn north-east through Saugor, Allahabad, and Gorruckpore, to the foot of the

Himalayas, and increases to the eastward of this line. It is not endemic in the Punjâb, Rajputana, or Sinde. The evidence collected by the Cholera Congress at Constantinople appears to prove that cholera is not endemic in Persia or Arabia; nor does it appear to have an abiding place in China or Central Asia. It is not likely, therefore, that it is endemic anywhere out of India.

*Transit of Cholera.*—Cholera has rarely appeared in any part of the world distant from India without having made its presence felt in the intervening regions. No doubt in two or three instances the disease has broken out under circumstances which appeared to indicate a sporadic origin; but in nearly all those very exceptional cases it was not found impossible to account for its occurrence. An outbreak happened in Syria in 1875, at a time when the nearest point at which cholera existed was Western India; how the disease was introduced was not ascertained. In 1873 cholera appeared, apparently sporadically, in New Orleans. Inquiries were made, the results of which appeared to show that no ship from a cholera-infected port or country had come into New Orleans that year. Subsequent investigations, undertaken by a Commission appointed by the United States Government, led to the conclusion that quarantine regulations were so lax that it was quite possible for a ship to have been admitted with cholera virus on board.

It would not be difficult to trace every extensive outbreak of cholera which occurred during the epidemics of the present century in Great Britain and Ireland to contagion imported from abroad. All the local outbreaks in Ireland during the epidemic of 1849 were traced to three English *foci*—namely, Liverpool, Sheffield, and Cardiff. I have shown that in 1830–2 a chain of cholera links connected Scandinavia with India. A careful study of the history of cholera epidemics must convince every unprejudiced inquirer that India is the native *habitat* of cholera, and that it never originates in any other country. It will be seen, too, that the disease has never travelled from the East faster than man has travelled.

*Is Cholera Contagious?*—The question—Is cholera contagious? has been debated with much warmth. In 1832 the directly contagious character of the malady was all but universally admitted. In 1849 the majority of physicians held that cholera was not propagated from person to person. During both epidemics not a few writers maintained that the disease was caused by an abnormal alteration in the constitution of the air due to the occurrence of

“pandemic waves” in the atmosphere. At present the most eminent epidemiologists class cholera with the miasmatic contagious diseases. It is not, as a rule, directly contagious in the same way that smallpox or scarlatina is, but matter ejected from the bowels of a cholera patient is capable of producing the disease if taken into the body of a healthy person. In short, cholera is propagated from person to person in the same indirect manner that typhoid fever is communicated. As, however, typhoid fever appears to be occasionally, though rarely, propagated direct from person to person, so cholera may in like manner be transmitted from the sick to the sound.

*Pettenkofer's Theory.*—This eminent authority considers that the virus of cholera is an organised substance, produced in the soil of regions in which the disease is endemic. This virus is contained in the intestinal discharges of persons affected with the disease, but it is not a product of the intestines—that is, the germs of the disease do not multiply within the human organism. When choleraic discharges pass into certain soils the seeds of the contagium germinate and produce a new crop of infectious organisms of a miasmatic nature. An attack of the disease is caused by these miasms ascending into the air and becoming absorbed into the body. In India the production of cholera requires a moderate degree of humidity of the soil; when the latter is either very dry or saturated with moisture the cholera miasm is not generated. He gives numerous instances showing that when the condition of soil was favourable in the way indicated cholera was generally developed. Porosity of soil appears to be very favourable to the production of the cholera germs. Isolated cases may happen in houses built on rocks or on impervious clays, but epidemics of the disease cannot occur in such places.

Professor Vogt, of Berne, in his work “*Trink Wasser oder Bodengase*,” 1875, announces that having carefully studied all the theories in reference to cholera, he gives the first place to that propounded by Pettenkofer.

The case of the Limehouse School for pauper children has often been quoted in support of Pettenkofer's theory. The institution stands upon a bed of clay, surrounded on all sides by gravel. Although cholera raged all round the school, not one of its 400 inmates caught the malady. It must, however, be noted that the most extraordinary precautions were adopted to exclude cholera, and even quarantine regulations were adopted.

During the sitting of the "Cholera Conference" at Weimar, in 1867, a map of Thuringia was shown in which the places ravaged by cholera were depicted. The fact that the disease was confined to a particular geological formation, such as that held by Pettenkofer to be essential for the wide diffusion of cholera virus, was regarded as a strong piece of evidence in favour of the Munich Professor.

In London, in the 1866 epidemic, cholera was rife on the gravels on both sides of the River Lea, but according to Radcliffe the disease did not extend largely over the same kind of soil which was contiguous. He noticed that the limits of the epidemic were determined by a contour which bore an evident relation to houses and not to soil. Dr. Weir observes that in Bombay cholera is distributed without any relation to the nature of the soil (Report of Municipal Commissioner for Bombay, 1875, p. 164).

Dr. Pettenkofer considers that potable water plays no part in the propagation of cholera, and contends that the disease is not directly communicable. As in the case of typhoid fever, the condition of the ground water is a factor in the spreading of the malady. As the water sinks, so the miasms increase in the partially dry soil, and extend therefrom to the atmosphere. To cause an epidemic there must be—(1) a specific germ; (2) certain local conditions; (3) certain seasonal conditions; (4) certain individual conditions (*receptivity* or unusual susceptibility to contract the disease).

Dr. Mapother has ascertained that three-fourths of the deaths from cholera in Dublin in 1866 occurred close to old watercourses, some of which had been converted into sewers, and others filled up with loose soil.

*Johnson's Theory.*—Dr. George Johnson<sup>a</sup> holds that cholera is produced by a morbid poison, not a parasite, which enters the blood either through the lungs or through the gastro-intestinal canal. This poison irritates the muscular tissues and causes the cramps, and impedes the flow of blood. A strong argument in favour of this theory is, the author believes, to be found in the fact that patients often die without having suffered from much vomiting or purging, the fatal result in such cases being due to the retention of the poison in the blood which brisk evacuations would otherwise have eliminated. Mr. Simon is opposed to Dr. Johnson's theory, as is also Dr. Thudichum, who, after careful

<sup>a</sup> Notes on Cholera, p. 35. London, 1866.

and laborious examinations, declares that there is no chemical evidence of the presence of any particular poison in the blood.

*Bryden's Theory.*—Dr. Bryden, an eminent Indian sanitarian, holds that cholera virus is generated in the soil of many districts in the lower provinces of India, and is indigenous in those localities. From time to time this virus is transported by moist air to the upper provinces, where, however, it is unable to maintain itself, but dies out in periods usually of four years. It becomes dormant for a certain interval, but without losing its vitality. By observation of its natural laws the life-history of the virus may be sufficiently known to enable the time at which it becomes active after a dormant period to be predicted with accuracy. Certain areas are annually free from cholera and certain areas affected by it, and the geographical distribution of the disease may be foretold by the study of these parallels, which are the result of meteorological influences. Dr. Bryden also contends that epidemic cholera does not result from human intercourse, nor can it be spread out of its natural province by human agency. A moist atmosphere is the invariable vehicle of cholera, and the direction of its movement depends upon the prevailing wind. Still it is admitted that individual cases of cholera can occur by transmission from those affected with the disease, or from fomites charged with cholera virus, but that no aggregation of such cases ever produce a “provincial manifestation of cholera.” Bryden's theory seems to be in favour by the Indian Government. It differs but little from Pettenkofer's.

*Water Carriage Theory.*—The subject as to the influence which potable water has exercised in connexion with the epidemics of cholera has been much debated.

In 1849 Dr. J. Snow attributed several localised outbreaks of cholera in the outskirts of London to the use of water containing cholera-dejecta. In 1854 the London College of Physicians expressed their dissent from the opinion that the disease was propagated through the medium of water. Nevertheless the proofs of the water-carriage of cholera virus that have been accumulated appear to be irresistible, though I am not satisfied that they demonstrate that the disease is only, or even chiefly, communicated in that way.

In 1855 Dr. Snow,\* of London, attributed a severe local outbreak of cholera, which had occurred the previous year, to the use of

\* Mode of Communicating Cholera. Pp. 44. Second Edition. London. 1854.

water taken from a favourite pump in Broad-street. About 500 persons who drank the water died within a week. The water was analysed by Dr. Dundas Thompson, who reported that it contained the large amount of six grains of organic matter per gallon. Dr. Lankester subjected it to microscopic scrutiny, and detected in it great numbers of a peculiar fungus.

So soon as the use of this water was discontinued the local epidemic, which had been previously declining, utterly ceased. Attempts have been made to prove that the cessation of the epidemic and the disuse of the water were mere coincidences ; but Dr. Snow's conclusion that the foul water spread the disease is generally accepted.

A lady who had been in the habit of drinking the water whilst a resident in the neighbourhood of the pump, continued to send for it after she had removed to Hampstead, three miles distant. She and her niece were seized with cholera, although the disease was not at the time prevalent in the district. A similar case came under my observation in 1866. Many persons who were using the water of a pump in Duke-lane, Dublin, contracted cholera. A shopkeeper, whose business establishment was close to the pump, daily brought out a small jar of the water which it furnished for the use of his family, who lived in the country. Four of his children died from cholera, though no other persons in their neighbourhood was affected with the disease. This water was cool and sparkling, but my analysis of it proved that it was polluted with sewage. The pump was consequently closed by the Corporation.

Dr. D. Thompson states that two companies supplied the water to certain districts in London during the cholera epidemic of 1854. One of the waters was exceedingly impure, and was found to contain excremental matter ; the other was comparatively pure. They were supplied to a population placed under identical conditions ; but it was found that of those who used the polluted water 130 per 10,000 persons died, whilst only 37 persons per 10,000 died from cholera amongst those to whom the purer water was supplied. Dr. Thompson concluded that 2,500 persons had lost their lives through the use of the impure water. During the epidemic of 1866 I attributed many local outbreaks of cholera to the use of polluted water. In Mallow, where there was very pure water in one part of the town, and extremely impure in another, the disease raged only where the water-supply was tainted. In Arklow, where the

disease was very severe, I found nearly all the local wells highly polluted. I could give many similar instances.

A serious outbreak of cholera at Newcastle-upon-Tyne, in 1865, was apparently traced to the use of the water of the Tyne (Report on the Epidemic Cholera of 1866 in England, by the Registrar-General, p. 33). In 1865 Mr. Radcliffe attributed an outbreak at Theydon Bors to the use of poisoned water. In 1866 Dr. Farr and Mr. Radcliffe published numerous facts in relation to the epidemic in East London, which appeared to prove that the disease was caused by the use of impure water supplied by the East London Waterworks Company (Report of the Medical Officer of the Privy Council for 1866, and also Supplement thereto). Dr. Letheby and others have expressed a contrary opinion as to the proximate cause of this epidemic; but the facts of the case strongly favour the water-carriage theory.

Cholera has often broken out on board ship. In 1866 Professor Parkes attributed to the impure water used on board a steamer at Southampton the occurrence of many cases of cholera on board the vessel (Army Medical Report for 1866). In the same year I found that the water on board the "Olive"—a vessel lying in Dublin, some of the crew of which contracted cholera—had very impure water on board. It contained ten grains of organic and volatile matter per gallon, and was teeming with infusorial animalcules. Professor Frankland, in his paper on "The Water Supply of London and the Cholera," in the *Quarterly Journal of Science* for 1876, gives many proofs that water is a vehicle for cholera poison.

In Germany opinions are divided in reference to potable water being a vehicle for the distribution of cholera. The great authority which Pettenkofer exercises in sanitary matters no doubt has had much weight in influencing his countrymen against the water-carriage theory. Dr. Günther<sup>a</sup> denies that cholera was in any instance spread by water in Saxony. Volze, Witlacil, and other writers, have advanced similar opinions. On the other hand, Richter, Dinger, Foerster, and Lebert, consider that polluted water propagates the disease. Schieffendecker states that during the six epidemics of cholera which raged in Königsberg it has been noticed that the people who drank water from a source known to be pure escaped from the disease to a far greater extent than those who used the water furnished by the other Pregel and superficial town wells, which was proved to be impure. Lebert cites the following

<sup>a</sup> Die indische Cholera in Sachsen im Jahre 1865.

case reported by Graetzer:—In a house at Breslau the contents of a privy escaped into a well, from which the water supply of the house was obtained. In the beginning of the cholera epidemic of 1867 twelve of the inhabitants of the house were attacked and eleven of them died. Other persons in the locality who drank water from this well were also affected (“Ziemssen’s Cyclopædia of Medicine,” Vol. I., p. 381).

An elaborate Report upon the last epidemic of cholera in Holland was published by Dr. A. M. Ballot of Rotterdam. He states that the Netherlands suffered greatly during each of the epidemics of cholera which visited that country, but chiefly in those places where the water used was derived from canals or from ground saturated with sewage matters. In the places where rain water was generally drunk the disease was comparatively infrequent, and wherever rain water alone was used the disease never became epidemic—the single cases which occurred were imported ones. It was found that the substitution of a pure supply of water for the foul kind in use in some districts caused the immediate cessation of the disease. The voluminous evidence collected by Dr. Ballot shows that in Holland cholera followed the course of the canals. Another Dutch physician, Dr. Smellen, attributed many cases of cholera in Utrecht to the use of vitiated water.

In the United States army, during the last epidemic of cholera, the use of pure water was found most efficacious in arresting the progress of the malady. So well was it known to some medical officers that foul river and well water propagated the disease, that when rain water could not be procured the troops were furnished with distilled water (*vide* Report of Dr. J. J. Woodward, U. S. Army).

Dr. C. Macnamara, in his valuable treatise on “Asiatic Cholera,” already referred to, has strongly maintained the water-carriage theory of the disease. He considers that cholera dejections are the most virulent when quite recent. If in this state they are mixed with water, the mixture will be found to swarm with vibriones, but in about three days (in India) ciliated infusoria make their appearance, and five days later bubbles of gas ascend to the surface and coniferous growths line the sides of the vessel. Dr. Macnamara considers that the water containing cholera dejecta becomes innocuous when the organic matter has passed through its vibrio stage of decomposition, but he is positive that the infective properties of the mixture no longer exist when the organic matter

in the contaminated water reaches the third stage of decomposition—*i.e.*, when the coniferous growths are present.

Dr. Macnamara attributes several outbreaks of cholera in India to the use of polluted water. The water used at Mean Meer, in which there was a severe epidemic in 1861, was found to be impregnated with organic matter and to have an alkaline reaction—the latter circumstance is significant, seeing that choleraic evacuations are alkaline. Amongst other cases which he cites, the following appears to be a strong one:—Cholera *dejecta* entered a potable water which during the day was exposed to the direct heat of an Indian sun. The following day nineteen persons drank in small quantity this water, which presented nothing peculiar in flavour or odour. Within seventy-two hours five out of the nineteen persons contracted cholera, though cholera was not at the time prevalent at the place.

Dr. De Renzy,<sup>a</sup> in his Reports on the Sanitary Administration of the Punjâb for 1868 and 1869, is a strong advocate of the water-carriage theory. He concludes, from an examination of Pettenkofer's theory, that it gives no assistance in interpreting the phenomena of cholera in the Punjâb. He mentions many cases where the evidence in favour of the propagation of cholera contagion in potable water appeared to be irresistibly strong.

In Northern India, during the epidemic of 1866–68, it was noticed, that whilst the water-tanks were fouled by dipping clothes into them and bathing in them, and that the supplies were drying up, the disease rapidly increased. On the other hand, when the tanks were cleansed and re-filled with pure water, cholera vanished, and did not reappear during the time that rain kept the tank full of water.

Dr. J. Payne<sup>b</sup> Health Officer for Calcutta, informs us that cholera declined greatly and suddenly after the introduction of pure water into the city in 1870. The mortality from the disease remained low until the water, which at first was a continuous, became an intermittent, supply, necessitating the use of tanks; thereupon cholera production immediately increased.

Colonel James Puckle shows that the contamination of water is the most common cause of the spread of cholera. Several outbreaks occurred at Bangalore, 3,000 feet above the level of the sea, and at Toomkoor and Mysore; in every case after droughts and when the wells and tanks were very low. So soon as rain fell

<sup>a</sup> Lawrence Press, Calcutta.

<sup>b</sup> Indian Medical Gazette, Sept., 1876.

plentifully the disease ceased. The natives throw dejecta on the ground, where they soon dry, and, becoming reduced to dust, are transported by the winds into wells and tanks (*Journal of the Meteorological Society*, April, 1876).

During the terrible epidemic of cholera in Madras, in 1877, Surgeon-Major Cornish, Sanitary Commissioner, noticed that the water supplies were unusually impure. The supply in the City of Madras was so foul in quality and defective in quantity that when it reached the consumer it was like pea-soup, and was offensive in both flavour and odour. This authority is of opinion that the facts of the cholera epidemic of 1877 sustain the theory that the virulence of an epidemic of that disease is dependent upon the state of the water supplies. Dr. H. Blane, in his "Cholera: how to Avoid and Treat it" (London: King and Co., 1873), is also of opinion that cholera is largely propagated through the medium of impure water.

The admirable Report, in 1856, of Mr. Simon on the Cholera Epidemics of 1848-9 and 1853-4, as affected by the consumption of impure water, mentions cases which almost to an absolute certainty demonstrate that form of cholera propagation.

In 1870 cholera broke out on board the Channel Fleet. Donnet, who investigated the cause of the outbreak, considered that it was the result of drinking contaminated water shipped at Vigo and Lisbon. In this instance at least the state of the soil had nothing to do with the outbreak.

*Cholera Contagium in Air.*—It is in the highest degree probable that in the endemic area of cholera its contagium is carried up into the air out of the soil, as well as being diffused throughout water. Where cholera is exotic it is probable that the egesta of patients furnish the poison wholly or in great part. These matters may become desiccated and pulverulent, and in the form of dust enter the body by some channel—most likely by the mouth and œsophagus. Decomposing organic matter generates gases which often mechanically carry up into the air solid particles. When cholera is epidemic, sewer and midden gases are, probably, often the vehicles of the contagium.

An outbreak of cholera took place at the Devon County Lunatic Asylum. It was proved that the disease was introduced into the asylum at the males' side of the institution, forty of whom were soon affected, whilst not a single case occurred amongst the female inmates. Dr. C. Budd discovered that the contagium was communicated from man to man by the medium of the latrines, to

which all the males had access, but who were each provided with a separate apartment to sleep in. It was clear in this case that the emanations from the first deposit of cholera-infected matter in the latrines spread the disease amongst the persons who used them.

The contagium of cholera is believed to be propagated by means of the soiled clothing and bedding of the patients, and even by the hands of persons who attend upon the sick. If the fomites and alvine discharges of the patients are infective, it is easy to understand that there are many ways in which these matters may be conveyed into the bodies of healthy persons. Statistics show that washerwomen are peculiarly liable to contract cholera, evidently from washing the patients' linen, &c.

#### THE MATERIES MORBI OF CHOLERA.

Böhn states\* that cholera is caused by the entry of a micro-fungus into the intestinal canal, where it propagates its species at the expense of the epithelial cells. In 1867 Professor Hallier, of Jena, published a tract entitled, "*Das Cholera-contagion: botanische Untersuchungen Aertzer und Naturforschern mitgetheilt*" (Leipzig, 1867), in which he stated that the dejections of cholera patients contained large numbers of minute fungi and other spores. When placed on pieces of intestine or muscular tissue the latter were quickly disorganised. Soon after, Professors Thorné, of Cologne, and Klob, of Vienna, announced that they had discovered fungi in the stomachs and intestines of cholera patients, which multiplied rapidly. These organisms produced choleraic symptoms in small animals to which they were administered. Lissaner, who experimented with fungi shortly after these announcements, maintained that the fungi found by Hallier were not contagious matter, and that their presence was a mere accident. Several eminent mycologists declare, too, that the fungi in question belonged to a European species. C. Macnamara, after a prolonged search for a fungus or bacterium peculiar to cholera evacuations, is obliged to confess that he has abandoned all his faith in the existence of any such organisms.

Drs. J. R. Lewis and D. D. Cunningham, in an Appendix to the Tenth Annual Report of the Sanitary Commissioner with the Government of India, 1874, gives the results of numerous experiments made to discover the nature of cholera virus; they found no evidence of the presence of bacteria in the blood of cholera patients.

\* *Die kranke Schleimhaut in der asiat. Chol.* Berlin, 1836.

A considerable leucocytosis existed in it; and in some specimens, freshly drawn, minute detached points were observed which moved about actively, showed no evidence of organisation, underwent no development, and disappeared in a few days. In the blood of syphilitic patients no bacteria were detected, although that disease is undeniably inoculable. Two hundred Spanish dogs were experimented with in order to test the effects of choleraic stools. Solution of the stools injected into the veins caused 7 deaths out of 15 animals = a mortality of 46·6 per cent. The same solution boiled produced a mortality of 54 per cent. Solutions of normal fæces caused the deaths of 8 per cent. of the animals to whom it was administered, and a higher mortality (35 per cent.) when the fæcal matter was putrid. The only difference between the effects of choleraic and normal fæces was the higher mortality caused by the former. The *post mortem* examinations of the animals showed that they had suffered from gastro-enteritis.

Messrs. Lewis and Cunningham contend that the experiments which appeared to prove the deadly effects of choleraic discharges upon the animal economy were made upon weakly and fragile animals, such as mice and rabbits. It was found that mice to whom bibulous paper steeped in choleraic fluid had been given had died; but H. Ranke has shown that filtering paper, minus choleraic stuff, causes disease in mice. It is clear the question as to the precise nature of the *materies morbi* of cholera is in a very unsatisfactory condition at present. Dr. Weir, Health Officer for Bombay, had directed attention to the fact that the persons in that city whose business it is to collect ordure are not more liable to cholera than other classes.

#### PROPHYLAXIS.

The most effectual manner in which to exclude cholera from a country would be to prevent the entry of persons and articles from infected districts. In practice it has been found impossible to effect so rigid a quarantine as this. In 1831 a determined attempt was made to keep cholera out of St. Petersburg. A cordon of soldiers and police was drawn round the city, and no one was allowed to enter it unless he could prove that he had not, for however brief a period, been in an infected district. Notwithstanding these precautions St. Petersburg was attacked by cholera at as early a date as many other parts of the North of Russia.

On the other hand, it is asserted that the immunity from cholera

which certain parts of Bavaria, Saxony, and Mecklenburg enjoyed during cholera epidemics was the result of precautionary measures vigorously enforced. In most countries quarantine regulations more or less effective are enforced when an invasion of cholera is apprehended.

Dr. C. Macnamara suggests that quarantine regulations would be more useful at the ports of debarkation than elsewhere. He considers it is improved naval hygiene we should rely upon rather than upon lazarettos. The Indian Government ought to make every effort to prevent the disease from passing into Afghanistan, for whenever cholera reaches Herat it is certain to spread into Persia, Asiatic Turkey, the Khanates, and Asiatic Russia. The roads from India into Afghanistan are not numerous, and quarantine regulations might be carried out at this "scientific" frontier at a moderate cost.

When cholera makes its appearance in a district, very prompt and comprehensive measures may at once cut short the disease. The moment the first case is announced the medical officer of health and a sufficient number of the sanitary staff should proceed to the patient's home. The matter ejected from the patient should be at once disinfected, wherever it may be found. If some of it has already been thrown into the privy or ashpit, the whole contents of those receptacles should be promptly disinfected. Should any choleraic discharge have fallen upon the floor, stairs, &c., it should be treated with a disinfectant *in situ*, and then carefully scraped up and removed for more perfect treatment. Should the patient die or be removed to hospital, his clothes and bed clothes should be burnt, and the house in which he lived should be thoroughly disinfected by both gaseous and liquid applications. If at all possible the patient should be promptly removed to hospital, and the greatest care taken to have the vehicle which conveyed him there purified. Everyone who had been in contact with the patient should take full baths, and no one should partake of food or drink in the sick room, nor should the attendants on the affected be more numerous than are absolutely required. When relieved from duty the nurse should perform the most thorough ablution. No water should be drank that had not been recently boiled for ten minutes, and great care should be taken to preserve water from pollution. The water which has been kept in the house all night should not be used for drinking or cooking purposes.

What is the best disinfectant to apply to the choleraic dis-

charges? Dr. John Dougal says that carbolic acid is not a disinfectant, but merely a preservative agent, whilst Lebert considers it the best material to use in the treatment of choleraic dejecta, &c. Whatever disinfectant may be employed should be used in very large quantity in order to insure a thorough destruction of the zymotic properties of the discharges. Sulphurous acid and carbolic acid conjointly might be used. One pint of hydrochloric acid and one pound of sulphate of iron dissolved in a gallon of water would make a powerful disinfectant for the alkaline dejecta of cholera.

*General Prophylaxis.*—If cholera is expected the best preparation to resist the invader is to have streets, houses, clothes, persons and water as free from filth as possible. The privies should be cleaned and carbolic acid or chloride of lime applied to them. The condition of the house drains and main sewers and their traps should be looked after, and the defects which are sure to be detected, if looked for, remedied. The markets should be inspected, and no unripe or over-ripe fruit or vegetables allowed to be sold. Ample stocks of disinfectants should be laid in, and vehicles for the removal of the sick to hospital should be provided. It is desirable to ascertain whether or not houses could be procured for the purpose of turning them into temporary hospitals, should the epidemic assume large proportions. In the larger towns the temporary hospitals should not be too distant from the localities likely to furnish their inmates. The nature of the supplies of water is a point of primary importance. Every source should be examined, and those of impure or doubtful nature closed. As a rule the local wells and pumps in localities densely inhabited will be found unfit for use.

When cholera is established in a district, printed instructions for the better observance of sanitary precautions should be circulated amongst the people, and they should be instructed how to act in the event of an attack of cholera being apprehended. The importance of the premonitory symptom of diarrhœa should be dwelt upon. House to house visitations by the sanitary staff and by volunteer sanitarians is a useful measure. When cholera reappears frequently in the same house it should be closed as "dangerous to health," and its inmates transferred to one of the houses which the local sanitary authorities ought if possible to provide for such emergencies. For prophylactic purposes every case of diarrhœa should be regarded as one of cholera, so far as the disinfection of the dejecta of the patient is concerned.

Küchenmeister has suggested the mixing of choleraic discharges with sawdust, in order that they may be burned. The Sanitary Commissioner, with the Government of India, considers that this plan is unsafe, because, during the combustion of a portion of the mixture, a volatile infective matter might be distilled out of the other part not yet heated to incandescence. Dr. De Renzy, however, highly approves of the combustion process, and considers Dr. Bryden's objection untenable. The addition of paraffin to the sawdust is desirable, as it causes an immediate combustion of the mass. During an epidemic it might be found practicable on the part of the sanitary authorities to supply sawdust and paraffin mixture to infected houses. In the hospitals this mixture could be readily obtained.

I cannot too strongly insist upon the importance of sparing neither time nor money in the attempt to arrest the spread of cholera when it first appears. A sum of £50 spent in such an effort may be the means of saving hundreds of lives, and of obviating the necessity for a long-continued expenditure of money, and of stamping out an outbreak which otherwise might entail enormous expense upon the ratepayers. It is stated<sup>a</sup> that Bristol escaped almost completely the epidemic of 1866 owing to the vigorous system of disinfection carried out by Dr. Davies, Medical Officer of Health.

It is stated that during the last epidemic of cholera at Leipzig the most extraordinary efforts were made to disinfect the city, and yet never before had so severe an outbreak occurred. Perhaps, however, the disease might have been even more destructive had the disinfecting operations been less energetically carried out. Cleanliness, as a preventive measure, ranks much higher than disinfection.

In the case of a vessel placed in quarantine the following precautions should be adopted:—The vessel should be moored in deep water. If the patient can use the *petit* of the vessel so much the better, as the choleraic matter then passes directly into the sea. If he cannot, then the discharges should be disinfected and thrown overboard as soon as possible. The *petit* should be kept clean, and the vessel at large should be kept as free from filth as possible. Suitable disinfectants might with advantage be used. Should a patient die, the body should be heavily weighted and consigned to the sea, preferably at some distance from the vessel, seawards; the clothing and bedding of the deceased should be burned.

<sup>a</sup> British Medical Journal, April 13th, 1867.