DOCUMENT 11 (Online Companion)

Atmosphere, Thames water, and elevation: General Register Office on predisposing causes of the cholera epidemic of 1848–49[1]

Sometime in 1850, the General Board of Health sent George Graham, the Registrar-General, a request: Would he prepare an account for them, listing all cholera cases, by age and sex, registered in England and Wales during the recent epidemic? Graham and the Statistical Department of the General Register Office decided instead to undertake a more comprehensive analysis, with the ultimate goal of publishing a formal report. William Farr, Examiner and Compiler of Abstracts in the department, agreed to supervise the task.

At the time, Farr was in his mid-forties. Two decades earlier, he had spent several years on the Continent, financed by a bequest from a benefactor, studying the numerical method, He returned to England, qualified as an apothecary, and opened a general practice in North London. Medical statistics was and avocation until his appointment as a department head at the General Register Office. In 1847, New York University awarded Farr an honorary Doctorate in Medicine for his contributions to statistical medicine and public health.

[i] In the calamity to be described, the minister of destruction was a pestilence that spread over the face of the island and found in so many cities quick poisonous matters ready at hand to destroy the inhabitants. In following cholera through its fatal way, however, the inquirer meets with some grounds of consolation. He sees places on every side which the epidemic passed over, leaving the inhabitants in the serene enjoyment of health and complete immunity. And the hope is perhaps not fallacious that an examination of the results of the second may be the means of mitigating, if not preventing, a third invasion. For whatever may be the immediate cause of cholera, it will appear evident that in England it is only seriously fatal under certain known physical conditions, which admit to a great extent of remedy.

It is not necessary to describe here the nature of the disease. [That] task devolves to others . . . [cites General Board of Health's Report, with appendices by Sutherland and Grainger; forthcoming report by a special committee of the College of Physicians; R. D. Thomson's analysis of the chemistry of cholera; descriptions by Dr. Budd and Dr. Watson].

Under the Act for the Registration of Births, Deaths, and Marriages, the name, sex, age, and occupation of every person who dies in England—as well as the time, place, and cause of death—are registered. The whole of this system of observation and record was in operation when cholera broke out. The quarterly abstract of deaths for the whole kingdom, and the London tables which are published weekly—presented notices of its rise, progress, and decline in particular districts. . . .

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[1] GRO [William Farr], *Report on the Mortality of Cholera in England, 1848–49* (London: HMSO, 1852). Pagination of Farr's report is in Roman numerals, whereas maps, diagrams, tables, and extracts from registrars' returns are in Arabic numerals.

Contents of the Tables Published at the End of the Report

[ii] The first of the following series of tables shows that 1057 males and 877 females died from cholera during the year 1848, and of those numbers, 612 males and 493 females, died in the three months of October, November, and December [numbers not limited to Asiatic cholera? (pp. 1–4)]. . . .

The second series of tables shows, of the 53293 deaths from cholera and 18,887 deaths from diarrhoea during the year 1849, how many occurred in each of the 11 divisions, 44 counties (or groups of counties), and 623 districts of England (pp. 5–19). . . . The population of 1841 is set forth in a distinct column and shows the lowest numbers that could have been exposed to the attacks of the disease. In the towns, and in the manufacturing and mining districts, the population was, of course, much greater in 1849 than in 1841.

The third is a remarkable series of tables. It shows the number of deaths from cholera and diarrhoea on each day of the year 1849 in all England, in 11 divisions, and in 44 registration counties (pp. 20–107). Thus, the march of the epidemic through every county can be followed day by day.

In the returns that have previously been made of the mortality of cholera in this and in other countries, only the deaths from that disease in parts known to be severely infected have been inserted. It is evident that under such a system, based on imperfect registration, many deaths must have escaped observation. But the causes of nearly all the deaths in England are registered, and all the deaths of 1848 and 1849 are [ii/iii] recorded in the volumes from which the present return is derived. The reader can now trace the progress in place and time of the great epidemic through 17 millions of people, settled over a wide extent of country, in all the various circumstances of life. And the difference in the time of the invasion, as well as the absence or the inconsiderable mortality of the epidemic in places lying be the side of districts overwhelmed by its effects—is undoubtedly one of the circumstances which most deserve the attention in the study of cholera.

The fourth series of tables shows how many males and females died at *various ages* of cholera and diarrhoea in the divisions and counties of England. Taking 100 years as the limit, the lifetime is divided into twenty equal quinquennial periods. The tables show that the deaths were distributed unequally over the whole of these periods. The deaths in each of the first five years of life are separately given, as in that short interval of age, a remarkable change takes place in the form and fatality of the disease (Tables pp. 108–119).

A swift and precipitate course ending in dissolution is a characteristic of all plagues and fixes attention in cholera. The duration of 39,468 fatal cases of cholera, and of 7,896 fatal cases of diarrhoea, is shown in the fifth series of tables. The duration in hours and days is exhibited at the quinquen-

nial ages that have been already named. Tables are given for all England, for England exclusive of London, and for each division of the country (pp. 120–165). The 623 districts of England are divided into 2,189 sub-districts. The population (1841), the deaths from cholera, and the deaths from diarrhoea in each sub-district are given in the notes (pp. 166–300) which close the volume.

Activity of the London Sub-district Registrars

The London registrars returned every case of death from cholera or diarrhoea weekly and, in the height of the epidemic, daily, accompanied by any information which either the informants or their own observation supplied, respecting the state of the street or houses in which the deaths occurred. This information was necessarily collected in haste. But [it] was found to be substantially correct and had an excellent effect at the time in directing the immediate attention of the authorities to some of the most crying evils that induced and aggravated the disease. A digest of these registrars' local reports is embodied in the notes, which contain many curious and suggestive facts. The gentlemen who abstracted the cases were requested to compile from the transcripts short notices of the first and last deaths, distinguishing the dates of such deaths, as well as the professions of the persons who died and the localities which suffered most in every sub-district. The local inquirer is requested not to accept any opinions expressed in the notes, or the summaries of the fact themselves, as ultimate results. Consider them only as indications of the direction in which investigation may be advantageously employed. Upon the number of deaths returned and the tabular results, full reliance may be placed as they have been derived directly from the returns and have been duly checked. . . .

Health of England Prior to the Recent Cholera Epidemic

Although no regular registers of deaths were kept prior to the Reformation, the chronicles show clearly enough that England has been periodically devastated by famines and plagues from the earliest times. A large proportion of the population of the island has been more than once swept away by these visitations. The great plagues of the sixth and seventh centuries—which destroyed, according to some estimates, half the inhabitants of the Eastern empire—extended to Britain. Besides the Black Death in the fourteenth century, the sweating sickness of the sixteenth century, and the plagues of the seventeenth century, terminating in the plague of 1665 described in detail by the historians—a long catalogue of famines and epidemics may be given which, though briefly and imperfectly noticed in the chronicles, were perhaps not much less fatal.

After the [Glorious] Revolution [of 1688], the great plagues ceased. But the mortality was kept up by [iii/iv] typhus, smallpox, influenza, and other **zymotic** diseases. . . . Sanitary improvements in the navy, the army, and the prisons, as well as the discovery of vaccination by Jenner—all

zymotic: See Glossary.

conduced to the diffusion of sound doctrines of public health and had a practical effect which, with the improved conditions of the poorer classes, led to a greatly reduced mortality [early] in the present century. Since 1816, the returns indicate a retrograde movement. The mortality has apparently increased. Influenza has been several times epidemic. The Asiatic cholera reached England and cut off several thousands of the inhabitants in 1832. It reappeared and prevailed again, as we have seen, with no mitigated violence, in 1849.

Variations in Health Depend on Atmosphere that People Breathe

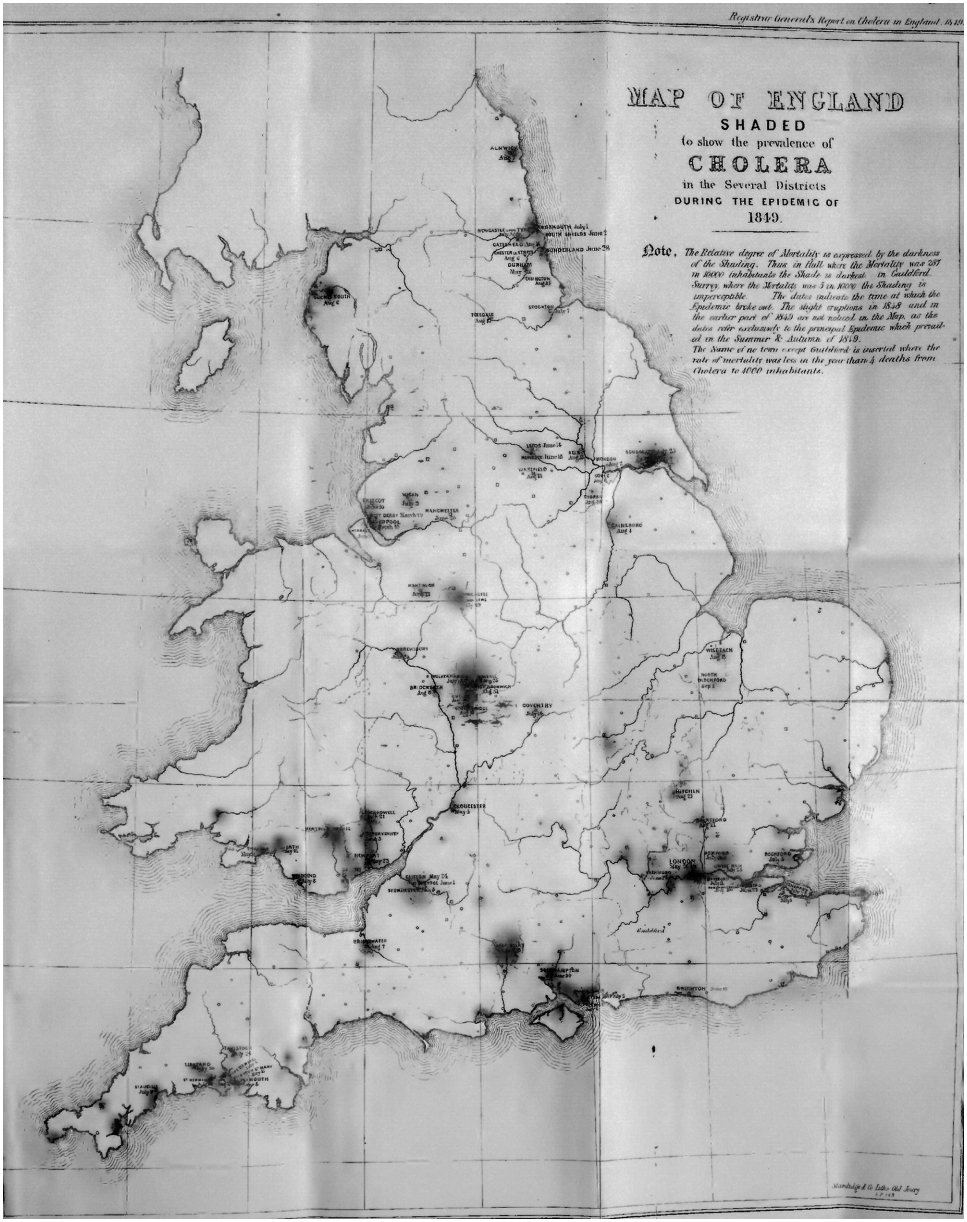
The health of all parts of the kingdom is not equally bad. Some districts are infested by epidemics constantly recurring; the people are immersed in an atmosphere that weakens their powers, troubles their functions, and shortens their lives. Other localities are so favourably circumstanced that great numbers attain old age in the enjoyment of all their faculties and suffer rarely from epidemics. The variations in the mortality are seen in the tables (pp. cvi–cxxvii) which have been extracted and arranged from the *Ninth Annual Report*. The rate of mortality is calculated on 2,436,648 deaths in the 7 years, 1838–44; and the population taken at the census of 1841, in the middle of that period. . . .

Upon looking generally at the health of the population, it will be found that people suffer most in the great town districts. Liverpool and Manchester are the places of highest mortality, then follow some of the districts of London, ... The mortality is not increased equally at every age in these districts. And it varies [iv/v] considerably in the two sexes. The returns for childhood, manhood, and old age, males and females, conspire in proving the general causes of insalubrity operating with different degrees of intensity, but with much greater force than in other parts of the country. . . .

[vii] The light parts of the country in the map represent a population in health and vigour, rarely attacked by zymotic diseases, living in considerable numbers to an advanced age. The dark parts are real "valleys of the shadow of death," where the population is sickly, feeble, short-lived—where thousands of the infants are convulsed, the children's brains inflamed, tuberculous, distended with water—where smallpox, measles, and scarlatina, instead of being light eruptions, destroy the structure of the skin, putrefy the throat, inflame the lungs—where the natural process of teething is often fatal to the child, childbearing to the mother—where typhus, pneumonia, bronchitis, asthma, and consumption destroy thousands of lives, bereaving families, and leaving multitudes of widows and orphans following in the train of untimely death. . . .

Timing of Two Cholera Pandemics

Cholera is more fatal in Asia than in Europe. Several partial epidemics are described in the annals of India before the rise of that great epidemic of 1817, which encircled the world and destroyed men wherever it found



Opposite clxxiv.

them in the circumstances that lend it power. . . . Since 1817, India has experienced several partial epidemics. In 1845, cholera was epidemic in Kabul, which from 1839 to 1842 had been the seat of war and the scene of great triumphs and great disasters. Bombay was attacked in the spring of 1846, and a part of the army at **Kurrachee** was assailed by the disease in its most fatal forms. From Afghanistan, the **Punjab**, and **Sindh**, the epidemic

Kurrachee: Karachi, southeastern Pakistan.
Punjab: State in northern India.
Sindh: State in Pakistan, location of Karachi.

extended over Persia and Syria in 1846, reached Astrakhan at the mouth of the Volga on the Caspian Sea in June 1847, Moscow in September 1847, Petersburg and Berlin in June 1848, Hamburg in September 1848, Edinburgh at the beginning of October 1848. The epidemic [vii/viii] travelled at the same rate as the epidemic of 1830–31. . . .

The first epidemic starting from Bengal in August 1817, reached Bombay on 10 August 1818 and Astrakhan on 16 September 1823, and there it died away. In Persia, several local epidemics appeared at intervals in the 7 years, 1823–30. The great epidemic that traversed Europe is said to have sprung up in June 1830 on the low western shores of the Caspian Sea. The velocity of the two epidemics only differed in Asia; it was the same in Europe.

It is worthy of remark that in the hot season of 1846, when the cholera epidemic acquired great force about the Indus, summer cholera and diarrhoea prevailed with great violence in England. . . . [ix] The deaths in London at the close of June from diarrhoea, dysentery, and **common cholera** rose to 40 weekly. The progress of the epidemic abroad, and the bad sanitary condition of London and many towns, justified the warning in the remarks of this quarter[ly return]—not to wait until cholera reached the country; but to look before and remove the nuisances which give the disease breath, life, and being. The air was 2° above the average temperature and the horizontal movement was less than it was in spring [of 1844] . . . . In the summer quarter (July, August, September) of 1846, an extensive epidemic prevailed. The 5 weeks from 11 July to 15 August were the most fatal in London. Young children were the principal sufferers: it had the usual symptoms of **cholera infantum**. "The disease also proved fatal to many old people; and some adults died of attacks which could not in their symptoms be distinguished from Asiatic cholera. It was, however, quite evident from the first that the epidemic had not the characters of the malady which broke out in the winter of 1832, but was closely allied to the cholera described by Sydenham, which he says lasted a month . . .".[3]

common cholera: Mild gastroenteritis, sometimes referred to as "English" cholera.

cholera infantum: Infant gastroenteritis. "The heat of the weather seems to be the predisposing , if not the exciting, cause. It is a fatal disease in towns" (*DMS*).

Different Terms for Cholera Used in Britain

[x] [In England in 1848,] 1934 deaths were referred to cholera: 829 in the first nine months, and 1105 in the last three months of the year 1848. The former were generally considered cases of common "English" cholera; many of the latter were universally held to be "Asiatic" cholera. The two forms are often not distinguished in the returns. The cases, sepa- [x/xi] rately considered, run so insensibly into each other that the attempt at distinction would have been fruitless. . . .

In abstracting the cases of 1849 for the series of tables in this vol-

[2] "Sydenham, *Opera. Obs. Med. Anni 1669*. He also describes the severer epidemic of 1676 [in another volume]."

ume, all cases returned as "cholera," whether English or Asiatic, **cholerine**, "bowel complaint," and diarrhoea, simply or as a complication of other diseases, were transcribed. All the cases in which the term "cholera" or "choleraic diarrhoea" occurred, were referred to cholera. About 300 cases in which diarrhoea was evidently a symptom of consumption or some other disease were struck out. The residue of the cases was classed under diarrhoea.

cholerine: Active principle that zymotic theorists considered the cause of cholera.

Diarrhea As a Distinct Disease

Excluding the symptomatic affection such as is observed in fever, consumption, and enteritis, there is evidently an **idiopathic** disease which may properly be called diarrhoea. [It] is as constantly observed in English towns when the temperature rises above 60° as bronchitis, and as catarrh when the temperature falls below 32°.

idiopathic: Primary; not dependent on another disease; unknown cause.

Diarrhea As a Stage in Dysentery & Cholera

Wherever dysentery is epidemic, a great number of cases occur which exhibit all the intermediate symptoms between simple purging without fever and the characteristic fever, pain, and bloody mucous discharges of dysentery. The dysentery often begins as simple diarrhoea. In such circumstances, the diarrhoea is really a constituent part of epidemic dysentery, modified by the condition, place, and age of the patients. In like manner, the diarrhoea which is generally prevalent at the same time as cholera, often painless with rice-water evacuations,[2] vomiting, and slight spasms, is to be held, in its various shades, a constituent part of the cholera epidemic. Many of the cases of diarrhoea in 1849, . . . however, were of a simple character and of the same nature as the diarrhoeas of other years.

Summer Cholera and Asiatic Cholera in London, 1848

We shall now give a more particular account of the progress of cholera in 1848 and of the first appearance of the new epidemic form. In London, deaths [registered in *Weekly Returns*] were referred to cholera in every month of 1848. . . . The disease was epidemic [during the summer and] subsided in September; it presented little that was extraordinary in its course or the number of cases. The deaths registered from cholera in the first week of October were 13 . . . . The temperature was [xi/xii] declining, yet the mortality increased rapidly in October and 65 persons died from cholera in the first week of November. The cases were severe and rapidly fatal. It was evidently the epidemic cholera—the Asiatic cholera. To everyone accustomed to observe popular disease, the difference in the two forms was striking. . . .

[Twenty-seven cholera cases extracted from the *Weekly Return* ending 29 July in which medical attendants certified causes of death as Asiatic cholera, cholera infantum, dysentery, diarrhoea, **English cholera**, etc.]

English cholera: See Farr's comment, xvi, and "cholera" in Glossary.

Cases approaching the Asiatic form occurred early in the year. In the week

[3] "Dr. R. D. Thomson has shown that this fluid is not the serum of the blood . . . . The light flakes are the epithelial scales of the intestine (On Cholera, *Trans. Royal Med. Chir. Soc., London*, vol. xxxiii)."

ending . . . 13 May, a woman aged 40 died in Aldgate, Whitechapel. A note [from the medical attendant] stated that "the case presented the appearance of Asiatic cholera, viz., purging constant, no bile in the stool, cholera voice, suppression of urine; died in four days, in a state of collapse.". . . On 12 September, a pilot aged 55 died of Asiatic cholera (36 hours duration) . . . . On 22 September, a mariner aged 52, died after 11 1/2 hours illness of "Asiatic cholera" at 8 New Lane, St. John, Horsleydown, in the district of St. Olave. These were probably two real cases of the new epidemic form. . . .

[xiii] The great change now takes place. . . .

[xiii–xvi. Four pages of entries from October 1848 returns in which medical attendants primarily listed cause of death as Asiatic cholera, plus a few listed as English cholera.]

Summer Cholera Is Ancient and Not Peculiar to England

[xvi] The term, "English" cholera, is objectionable as it implies that the disease is peculiar to England, whereas it prevails, in nearly the same form, all over the world and is described by Celsus and the ancient writers, as well as by Sydenham. For the sake of distinction, as it is so much under the control of temperature and season, it may be called "Summer cholera." About half the fatal cases of Asiatic cholera terminate within 24 hours of appearance of it characteristics symptoms. . . . Half the cases of summer cholera did not terminate in three days; and half the cases of diarrhoea lasted more than six days. This is a new and important element in the diagnosis. . . .

Duration As a Possible Diagnostic Distinction

[xvii–xx. Cholera in eleven divisions of England and Wales, other than London, in 1848.]

[xx] The tables, pp. 20–107, and the notes, pp. 166–300, show the progress of cholera through the year 1849. The state of the public health was described in the quarterly and weekly returns. It is now possible, from all these sources comprising facts recorded and observations written at the time, to trace the effects of the epidemic and the extent of its ravages through the year. . . .

Cholera and Diarrhoea in England, 1849

[xxii] Many of the cases of diarrhoea were such ordinary cases as every year occur. But diarrhoea is one of the earliest and most common symptoms of cholera, and many cases differed only from cholera in the ab-

Deaths from Cholera and Diarrhœa in England, in each Month of the Year 1849.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Cholera .	658	371	302	107	327	2046	7570	15872	20379	4654	844	163
Diarrhœa .	810	698	708	666	721	926	2124	3599	4928	2244	871	592
Cholera & Diarrhœa	1468	1069	1010	773	1048	2972	9694	19471	25307	6898	1715	755

sence of "spasms" or of some of the striking, rather than the essential, symptoms. 12,045 of the 18,887 deaths referred to diarrhoea were in children under 5 years of age. The symptoms of cholera, as well as of other diseases at that early age, undergo considerable modification.

1849 London Cholera Field: Extracts from Weekly Returns of Births and Deaths

[xxiii] The distribution of the epidemic over the country may now be shown. London was the centre of a great system of attack . . . . The disease, like a smouldering fire, broke out as the temperature advanced in London. The return for the week ending 12 May "indicated a continued tendency in the public health to improve. . . . The wind was southwest, rain fell to the extent of 0.67 inches, and the mean temperature of the air was 54.9°, or 2.6° above the mean temperature of the week. In all London, only one little girl, aged 5 years, died of cholera in 6 hours."

In the week ending 26 May, . . . three women, however, died of cholera . . . [and] two children died of choleraic diarrhoea. The temperature was 56.9°, or 1.6° above the average; the fall of rain was 1.37 inches.

In the week ending 2 June, 895 deaths were registered; 9 from cholera. The mean temperature of the air was now 60.3°, of the Thames water 63.5°. The fall of rain was 1.6 inches; the wind sluggish N. and S.W. Negative electricity was exhibited during heavy rain on Monday; positive on Friday and Saturday. The deaths from all causes were 971; and 22 were by cholera in the week ending 9 June. The mean temperature of the air was 59.7°; the temperature of the Thames was 65.7°.

The deaths in the week ending 16 June were 912; . . . cholera was fatal to 42 persons. . . . The deaths in the next week were 985; . . . 49 were from cholera. . . .

In the week ending 30 June, 1,217 deaths were registered; 124 by cholera. The cholera was by far the most prevalent on the south side of the Thames. The temperature of the air in the beginning of the week was much above the average; the temperature of the Thames was 66.6° during the week.

The deaths in the week ending 7 July were only 1,070, but cholera increased and the deaths which it caused were 152. The mean temperature of the air was 62.7°; on Saturday, the thermometer reached 82° in the shade, 103.5° in the sun.

In the second week of July, the . . . deaths were 1,369. The increase was referable to cholera, which was the cause of 339 deaths. . . . [xxiv] The northern districts suffered least, the southern most. The air was stagnant and the wind in the N.N.E. The sky was cloudless, and no rain fell. The mean

[4] "The number of *deaths* cited in the weekly tables of London invariably refer to the deaths *registered* in the *week*. The deaths are *registered* at a certain interval after their occurrence; consequently, the deaths registered in a week are not all the deaths that occur in the week. The deaths *occurring* on every day are given in the subsequent tables."

temperature of he air was 66.8°; of the Thames, 68.7°.

The mortality increased . . . in the third week of July; 678 of the deaths were by cholera, 131 by diarrhoea. The high [elevation above the Thames] north districts still enjoyed comparative immunity (7 deaths from cholera). The hottest attack was directed to t he south side of the Thames, where 443 of the deaths occurred. Poplar in the east suffered severely; 37 deaths from cholera were returned. The mean temperature of the week fell to 60.5°; the winds were stirring, the sky was overcast, lightning flashes were seen on the 19th and 20th. The thunder was followed by showers and heavy rain.

22 July to 28 July. . . . The deaths from cholera are 783, from diarrhoea 224. The districts on the south side of the river still form the field on which the disease is most active. There is a slight decrease in the eastern districts." . . . The mean temperature is 58.9°; the fall of rain in the week is 2.15 inches. The wind is S.W., and moves at a rate of about 100 miles a day. On the afternoon of the 26th, a violent thunder storm occurred, the flashes of lightning were vivid and in quick succession, followed by loud thunder at intervals of 15 to 20 seconds generally. Rail was falling heavily during the storm.

July 29 to 4 August. The deaths registered . . . from cholera, 926. Diarrhoea has decreased; it is the cause of 179 deaths. . . . The epidemic is still chiefly on the south side of the Thames, where 621 of the 926 deaths occurred. The temperature of the air (59.5°) still remains below the average. . . .

In the week following, the mortality from cholera declined. The people generally were ready to believe that the epidemic was giving way, and the efforts which had been commenced without much vigour, and with little confidence in their efficacy, by the local authorities were suspended. Looking at the course of the epidemic in 1832, at the preceding low and now high temperature, at the field of operations which had hitherto been very much confined to the south side of the river and were now extending to the north, it was evident that the danger was increasing and that more active exertions were required. The following extracts from the weekly tables exhibit the progress and the effects of the epidemic at its height:—

5–11 August. The deaths in London . . . are 1909. . . . Diarrhoea and cholera were fatal to 173 and 823 persons. The deaths from cholera during the last six weeks were 152, 339, 678, 783, 926, and 823. The decrease is gratifying . . . . [However,] the parishes which have not yet been visited must be on their guard. Those in which the epidemic has partially subsided should redouble their precautions. The epidemic of 1832 broke out in three successive eruptions, the first commencing in February was at its maximum

in [xxv] in April. The second rose rapidly from June to July, and sank again down to the second week of August. . . . A third eruption in 1832 broke out at the end of August and extended to the first weeks of September; a fourth in 1833.

It is satisfactory to find that the deaths of 819 out of the 823 persons who died last week of cholera are certified. They were seen by qualified medical attendants. But it is to be feared that the advice was not obtained in time. The accounts of the sudden stoppage of the epidemic by prompt medical treatment and house-to-house visitation are perhaps over-coloured. . . . Medical men are called when the people are dying, but it is then too late. . . .

12–18 August. It is one of the characters of epidemic diseases that in some years their fatality is inconsiderable, in other years excessive. Since 1832 and 1833, cases of cholera have appeared in the tables; but deaths in the second week of August during the past five years have fluctuated from 1 to 23. In the week ending Saturday, 18 August, the deaths in London were 2230, of which 1230 were by cholera, 188 by diarrhoea. . . . The population [of London] is about 2,206,000, so that nearly 1 in 1000 of the inhabitants now die weekly. The deaths from all diseases, except cholera, are 1000, which is the average number of the season. . . . Of the 6194 persons who have died of cholera in London since 1848, 3524 have died on the south side of the Thames. It has now crossed the river. . . .

This excessive mortality must be viewed with great regret. Looking t the authentic reports of the effects of general sanitary measures and of efficient medical relief placed within the reach, or carried to the homes, of the people, it is quite evident that the measures now in operation are unequal to the emergency. The classes which have the greatest claim for public succour are not idle, habitual paupers but the hard-working artisan. Yet it is stated that in some particular parishes the arrangements are such that medical relief is not procurable directly from the district medical officers who are, to the utmost extent of their powers, discharging their painful duties with praiseworthy diligence and humanity. In a disease which so often attacks in the night and is fatal in twenty-four hours, the poor have to procure orders before they can be treated. Unless some change be made in these simple administrative arrangements, the mortality from cholera may be higher than it has yet been in London.

To render all the assistance which the registration system can afford for the discovery and removal of the causes of cholera, the registrars were last week requested to state in each case—"whether the house or street in which the death occurred was close, ill-cleansed, overcrowded, or otherwise unfavourable to health." The results will be found in the Notes [to the weekly tables, some of which are excerpted at the end of this report], whic

show, besides the sex, age, profession, duration of disease, date and place of death—in every fatal case of cholera and diarrhoea registered during the week.

19–25 August. . . .The deaths registered in London were [xxv/xxvi] 2456, of which 1272 were by cholera, 240 by diarrhoea. . . . Although the number of deaths last week is greater than any number yet recorded, it is gratifying to learn that active measures are now in actual operation, or commencing, in every district to combat the great epidemic which has already destroyed 7466 lives in London.

Albion Terrace Outbreak

[At Albion Terrace, on Wandsworth Road] "it appears," says the registrar, Mr. Frost, "that at No. 13, where the first death occurred, the refuse of the house had been allowed to accumulate in one of the vaults (which is a very large one) for about two years, and when removed last week, the stench was almost intolerable, there being about two feet of wet soil covered with maggots. The drains also had burst, overflowed into the tank and impregnated the water with which the houses were supplied. On the back ground, in the distance, was an open ditch into which nearly the whole of the soil [sewage] of Clapham runs." As turpentine to flames, so is the exhalation of such cellars, tanks, and sewers to cholera. It broke out. It diffused itself rapidly. It attacked many. And 19 inhabitants—after some hours of suffering, sickness, and spasms—expired. The effects of decomposing refuse and water on health are well known. These fatal subsidies to cholera had been heard of every day, yet no steps had been taken for their removal from Albion Terrace in July. . . .

The revelations of the state of their districts in the registrars' notes, this and last week, prove that it will be no easy task—not to stay the plague of cholera, for it will subside—but to remove the evils which make cholera and all epidemics fatal. . . . Will not all the national strength and resources be put forth to improve the hygienic condition of the people and to rid England of the causes of the fatality of epidemics? This may yet be done by the government, if aided by the force of facts and enlightened public opinion.

26 August to 1 September. The deaths registered in London . . . were 2796, of which 1663 were by cholera, 234 by diarrhoea. The mortality exceeds that of any previous week. The greatest number ever registered here in any week since 1840 was 2454 deaths, . . . when the last epidemic of influenza prevailed. In the cholera epidemic of 1832, the parish clerks (in the old bills of mortality) returned 1021 burials for the week ending 28 August which, allowing for the defects in the returns and for increase of population, are equivalent to 2450 deaths at the present time. The burials after that week in

1832 declined. The mortality is nearly three times the average of the season and is sensibly felt all over the metropolis. . . . [In Bethnal Green,] "the hurried passing and repassing of messengers, and the wailing of relatives filled the streets with confusion and woe, impressed on all a deep sense of an awful calamity." . . .

[xxvii] On the day the above remarks were written, Tuesday 4 September, the mortality in London was highest; 336 persons died of cholera during the day, 314 died on Wednesday, 297 on Thursday, 284 on Friday, and 311 on Saturday. As the decline of the epidemic was slow and registration takes place 3 or 4 days after death, the return for the week ending 8 September was heavier than the return of the week preceding. . . . Under these circumstances, it was deemed right to advert to the epidemic's decline, which its previous course, the law which govern its progress, its actual operations, and the season of the year—all rendered probable and next to certain. . . .

2–8 September. The bills of mortality were commenced in the reign of Queen Elizabeth, and ever since the year 1603 have been published by authority in London. . . . The parish clerks of London in the seventeenth century, when the plague was at its height, counted the deaths and recorded their supposed causes. And the citizen, when the death cart traversed the streets, anxiously studied the bill, surrounded by its gloomy symbolical border, announcing 8297 deaths in a week out of a population of 600,000. . . . One of their immediate advantages, however, is the evidence [the bills of mortality] furnish that the most fatal and threatening plagues go through, with some perturbations, certain prescribed orbits. After raging for a given number of weeks, [they] disappear. Plague, influenza, and cholera have been vanquished before. To despair now would be as unreasonable as it was in the beginning of the year to deny that the cholera epidemic was impending. . . .

People are so much accustomed to associate danger exclusively with pain that the most fatal symptom unaccompanied by pain is neglected. They must, however, be taught to look upon painless diarrhoea with the anxiety that people in the plague looked upon swellings, called tokens—which were also painless—but with less fear. For the premonitory symptom now seems to be sent not so much to announce death as to give timely warning, and to call attention to that stage of the malady in which medicine can heal. . . .

[xxviii] 9–15 September. A *daily return* of the fatal cases of cholera and diarrhoea was now made to the Registrar-General. The particulars of all the deaths from these causes on Monday 10 September were printed on Tuesday 11 September and thus facilitated the house-to-house visitation which had been set on foot by the Board of Health, and was efficiently carried out in several districts. The mean temperature, which in the two previous weeks

had been 64.0° and 64.1°, fell to 56.5°. The wind, which had been north, blew from the southwest. Electricity was, as it had been for the previous weeks, positive and stirring; frequent flashes of lightning were seen during Monday, Tuesday, and Wednesday evenings. The sky was often overcast and showers fell.

The deaths in the week fell to 2865, of which 1682 were from cholera, 280 by diarrhoea. From this date, the epidemic rapidly declined. The deaths . . . from cholera [in the following eight weeks] were 839, 434, 288, 110, 41, 25, 11, and 6. . . .

London Cholera and Diarrhoea Deaths Summarized

In the last three months of the year 1848, 478 persons died of cholera, which in the year 1849, destroyed 14,137 lives in London. In the year 1849, not less than 3899 deaths were referred to diarrhoea. The deaths from the two causes [in 1849] were 18,036. One in 161 of the inhabitants was cut off by the epidemic in its severest form. Of every 10,000 persons living, 62 were killed by cholera, 17 by diarrhoea.

While London was suffering, all the region round was assailed. All the country in the basin of the Thames, Suffolk, Norfolk, the south midland counties, and Sussex were involved in the attack. . . . [xxx] On this wide field, . . . the epidemic committed great ravages; 18,502 lives were destroyed by cholera alone. . . . The poison, or whatever it was, pervaded the whole field. For in almost every district, it caused one or more deaths, either in the aggravated form or in the masked shape of diarrhoea.

[xxx–xxxix] Cholera fields in Portsmouth, Plymouth, Bristol, Wolverhampton, Liverpool and Manchester, Hull, and Tynemouth.

[xxxix–xli] Influence of sex on the mortality from cholera.

[xli–xlii] Mortality at different ages.

[xliii–xliv] Duration of cases of cholera.

Epidemics of 1831–32 and 1848–49 Compared

[xliv] The Board of Health in 1831–32 collected much information respecting the epidemic which it was their office to combat. . . . [xlv] The deaths of the year 1832 in England and Wales amounted to less than half the number who were registered in 1849. But the returns which the Board of Health in 1832 procured were voluntary, partial, and evidently defective. . . . Notwithstanding the defects of the returns of 1832, they furnish us with the means of satisfactorily showing that the epidemic generally followed the same track in 1848–49 as it did in 1831–32. But it was much more fatal in some places, and less fatal in others, in the two periods. . . .

[xlvi] The two epidemics in England [each] continued fifteen months. They began in October, spread gradually, increased, and then as spring advanced, partially subsided. . . . The first epidemic descended to the lowest point in May 1832 and rose to the highest pitch in August, when it caused 29 percent of the total deaths. The second epidemic descended to the lowest point in April 1849 and was most fatal in September, when it caused 37 percent of the total deaths. It is worthy of remark that the cholera in both epidemics entered England after the wheat harvest was over, at the close of the hot season, and that it was most fatal in and after the wheat harvest of the year following. . . .

Seasonal Influences

Two diagrams, illustrative of the progress of cholera and of the meteorological phenomena on every day of the year 1849, are appended to the report. The second plate shows the temperature, the fall of rain, the direction of the wind, and the height of the barometer on every day at Greenwich. The meteorological phenomena admit therefore of strict comparison only with the line of cholera in London, plate III. . . . Thus, the weather was cold in the first half of January. The line [xlvi/xlviii] temperature remained high, then cholera rose much higher. In September, the temperature begins to descend and the cholera line shoots up its highest points, attaining the greatest elevation when the curve of temperature is descending. . . .

Meteorological Influences

[Plate iv] The radiating power of the sun depends on the time it is above the horizon and on its angular elevation. As both these elements attain their maximum in the summer solstice, the greatest power of the sun is then exerted. But its effect on the atmosphere goes on accumulating, and the temperature of the air is highest later in the year. . . . As the greatest effect on the air appears some weeks after the sun has exerted its utmost power, so the diseases which excessive heat favours appear some time after the temperature of the air has been highest. . . .

London has two healthy and two unhealthy seasons. The first healthy season extends from the 14th to the 29th week—through April, May, June, and the greater part of July. The second healthy season extends from the 40th to the 47th week—through October and November. The first unhealthy season extends over December, January, and February. The second, over August and September.

The fifth plate, in a series of eight circular diagrams, presents a view of the mortality of London in the seasons and weeks of ordinary and plague years. . . . How much London in the nineteenth century is less fatal to its inhabitants than London in the seventeenth century [when five plagues occurred between 1593 and 1665] is evident . . . .

Plague vs. Cholera Years

Influence of Days of the Week

[xlix] On Saturday, Monday, Tuesday, and Wednesday, the deaths from chol-

era were above [average], and on Thursday, Friday, and Sunday below the average. In the whole country, Tuesday was the most, Friday the least, fatal day of the week. The disparity in the deaths was greatest in London . . . . The weekly wages are generally paid on Saturdays. Mondays in London and other cities are days on which a certain proportion of the population indulge in intoxicating drinks. Fridays are days of comparative abstinence.

Striking Influence of Locality

Many instances have been given of the partial ravages of cholera. . . . By collecting the districts together in which the mortality was high, we find this striking result: that [xlix/l] 46,592 of the 53,293 deaths from cholera in the year 1849 occurred in 134 of 623 districts; or, in less than a seventh of the area of England and Wales, among four parts in ten of the population. . . .

In 85 districts of England and Wales, no death from cholera was registered in 1849. Not a single death from either cholera or diarrhoea was registered in 12 of those districts. . . . The only town of any magnitude in the 85 districts is Hereford. The other districts are made up of villages or small towns. . . . [li] In the county of Hereford, only one death from cholera was registered in 1849. . . . This county lies high. The population is scattered over the county and engaged in agriculture. It is out of the line of railways. The common drink of the people is cider. . . . The 85 districts which escaped the epidemic cholera in 1849 lay in general high, round the sources of rivers, and were thinly peopled. . . .

Coastal Ports & Districts Had Most Cholera Deaths

[lii] The cholera was three times more fatal on the coast than in the interior of the country. . . . 36, 241 of the deaths from cholera occurred in the districts lying against low, navigable rivers and the seas. . . . The character of the coast varies. By a further analysis, it is found that the fatality of cholera on the coast was greatest in the chief seaport districts. Thus 26,773, or more than half the deaths in the country from cholera happened in the districts of or about London, Liverpool, Hull, Bristol, Plymouth, Portsmouth, Southampton, and Tynemouth. . . . Cholera reigned wherever it found a dense population on the low alluvial soils of rivers, round the estuaries of the Thames, the Humber, the Mersey, the Severn, the Tamar, and their tributary waters. Certain cities and towns lie on the same rivers at different elevations and are intimately connected. The one is the port and entrepôt, the other the manufacturing seat and centre of the surrounding country. Liverpool, Manchester, and other districts are thus related. It will be found that cholera prevailed at both extremities of the connecting line, but that it was almost invariably most fatal in the port or district lying lowest down the river. . . . [liii] Cholera in the low seaside districts destroyed 85 in 10,000 of the inhabitants, while in the inland towns it was fatal to 38 in 10,000 of the inhabitants. . . . The [London] metropolis, with its mixed [part seaport, part inland] population, experienced an intermediate mortality; 62 in 10,000 of

Low Elevation Associated with High Cholera Mortality

(p) Mortality from Cholera in Seaport, Inland Town, London, and Country Districts.

—	Area in Acres.	Population Enumerated. Persons. June 7th, 1841.	Population Enumerated. Persons. March 31st, 1851.	Deaths of Persons in 1849 from Cholera.	Deaths of Persons in 1849 from Diarrhœa.
47 Districts, including the principal Seaport Towns (except London)	2,333,290	1,778,814	2,153,319	17,703	3,499
41 Districts, comprising the principal Inland Towns	1,663,288	1,930,371	2,243,183	8,193	3,840
London (comprising 36 Districts)	77,964	1,948,369	2,361,640	14,137	3,899
The remaining 499 Districts of the Country	32,448,338	10,256,594	11,164,626	13,260	7,649

the inhabitants died of cholera. The mortality from cholera in the rest of the kingdom on smaller streams and higher ground, was at the rate of only 12 in every 10,000 of the 11 millions of people. . . .

Noxious Exhalations from Filth Can Trump Elevation As a Factor

[liv] Cardiff is the port of the Merthyr Tydfil district. . . . Cardiff and Merthyr Tydfil are [liv/lv] therefore connected with each other in the same was as the towns previously mentioned; but in this respect they differ, that the mortality is greater in the high district than in the low port town. . . . The epidemic, however, began first at Cardiff. The canal at Cardiff was emptied and the mud lay exposed to the sun in the spring. . . . The epidemic broke out . . . and subsided sooner in the port than in the inland mining district. The canal mud lay exposed and the houses were crowded and dirty in the poor streets of Cardiff, but the insalubrious condition of Merthyr Tydfil exceeds that of the old settled town. . . . "From the poorer class of the inhabitants, who constitute the mass of the population, throwing all slops and refuse into the nearest open gutter before their houses, from the impeded courses of such channels and the scarcity of privies, some parts of the town *are complete networks of filth emitting noxious exhalations*."[5] " . . . There are no regulations for draining the town. The surface water is retained. There are stagnant pools and ditches contiguous to the dwellings. . . . After a long drought, the stench is almost intolerable in many places."[6] The houses of small but respectable trades people are unprovided with privies. The interior of many of the houses is cleanly and well kept. . . . The houses are chiefly supplied [lv/lvi] with water by pumps and wells. The supply is scanty and, as most of the wells are fed by surface waters, it may be doubted if they can be free from a mixture with impurities derived from the house refuse soaking the ground in all directions. . . .

Suggestion
Consult Appendix A to the GBoH *Report* for an illustration and additional description of cholera mortality near the exposed mud of the Cardiff canal (Document 10–II <CWS>, 30).

Epidemic cholera was raging in Hamburg when the first cases were noticed in the ports of London, Hull, Sunderland, on the east coast of England, opposite [Hamburg] and in constant commercial relation with

[5] GRO, *Quarterly Report* 3 (1849), 15.
[6] HoT Commissioners, *Report* 1 (1844), 316–24.

that continental port. The epidemic appeared in an unequivocal form at the commencement of October 1848. Yet it made little progress until the spring of 1849, when it gradually spread from the coast and river mouths to the interior of the country. . . .

Influence of Geological Formations

[lvii] Cholera attacked the greater part of the districts on the coal fields of England and was most fatal in the denser masses of the mining population. Mining operations have, in all times and in all places, been fatal to man, chiefly in consequence of the negligent habits of the people and the absence of the health regulations which exist in towns possessing a municipal organization. The ground on the coal formation may have lent the epidemic fatality. . . . The epidemic was not generally fatal on the primary ground formations—on the granite, the Silurian, or the Devonian systems. While Herefordshire, however, on the old red sandstone escaped, Cornwall and the south of Devon on the same formation, suffered severely. . . . A few scattered cases occurred in the marshy districts, . . . but the mortality was inconsiderable and below the average. . . .

Causes of Mortality in London

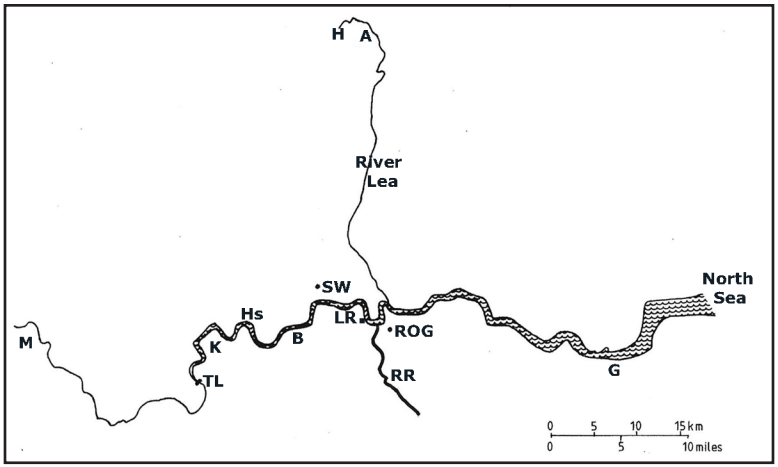
[lviii] The first cases of the epidemic appeared in the heart of the port. And it was noticed at an early period that the mortality was much higher on the south side than on the north side of the Thames. The south side of the river is low and badly drained. It was deemed desirable to ascertain, if possible, the state of the sewers and drainage of every district in order to determine the effects of emanations from the soil.

The principal elements which are likely to influence the mortality of an epidemic, and which we have the means of investigating, are the water supply, the drainage and elevation of soil, the density of population, and the poverty of the inhabitants. London consists of 36 registration districts—which are here made 38—as for the purpose of this inquiry, we separate the low Belgrave sub-district from the rest of St. George, Hanover Square {3c}[7], and detach [two] Paddington [sub-districts] from the Kensington {1a,b} district [cut off by the left border of the map]. . . .

London's Water Supply and the Thames

Before proceeding further in this branch of the inquiry, the effect of the River Thames and of the water supply on the health of London must be noticed. The Thames collects the waters of 6,160 square miles of country, extending from the Cotswold Hills in Gloucestershire to the eastern coast. The great body of this water flows and re-flows through London in tides, which carry [any] matter [deposited] below London Bridge a mile and a half above Battersea Bridge twice a day, and ascend as high as Teddington. The contents of the greater part of the drains, sinks, and water-closets of this

[7] The {*} brackets designate the number of the registration district as it appears in a PDF of Grainger, *Cholera Map of the Metropolis, 1849* <CWS>; a letter after the number indicates a sub-district within the numbered district.



River Thames & London Water Supply

River length is 215 miles, from headwaters in the Cotswolds hills (35 miles west of Oxford) to the North Sea.

A Amwell
B Battersea
G Gravesend
H Hertford
Hs Hammersmith
K Kew
LR Limehouse Reach
M Maidenhead
ROG Royal Observatory, Greenwich
RR Ravensbourne River
SW Sadler's Wells
TL Teddington Locks

(Adapted from Luckin, frontispiece.)

vast city and of the 2,360,000 people on its sides, are discharged through the sewers into its waters—which, scarcely sullied by the primitive inhabitants, have now lost all their clearness and purity. The dark, turbid, dirty waters from half-stagnant sewers are agitated by the tides, but are not purified until they reach the sea. [lviii/lix]

The Thames presents a large evaporating surface which must be taken into account [because] it gives off vapours day and night in quantities which the phenomena of a "London fog" reveal. The still air then condenses the matter which at other times enters the atmosphere invisibly and escapes observation. The mean lowest night temperature of the Thames from 27 May to 15 September 1849 was 64°. The lowest night temperature of the air was 52°. So, the wide simmering waters were breathing incessantly into the vast sleeping city tainted vapours, which the temperature of the air at night would not sustain.

It is a fact, well worthy of attention, that after the temperature of the Thames has risen above 60°, diarrhoea, summer cholera, and dysentery become prevalent, and disappear as the temperature subsides. The cholera reached London in the new epidemic form about October 1848. It prevailed through the winter . . . when the temperature of the Thames was 37°, [then] declined rapidly through April and May. The night temperature of the Thames then rose to 62° in the week ending 2 June. With some fluctuations, it went up to 68° in July and remained above 60° until the middle of September. The deaths from cholera during each of [these warm] 16 weeks were 9, 22, 42, 49, 124, 152, 339, 678, 783, 926, 823, 1230, 1272, 1663, 2026, 1682. The mean night temperature of the Thames fell to 56°, the deaths from cholera [fell] to 839 in the week of 16–22 September. The temperature gradually fell to 38° on the last week of November, when there was only *one* death from cholera registered.

The mortality from cholera increases generally in descending the river on the south side. In Wandsworth {32}, it was at the rate of 100 in 10,000 inhabitants; in Lambeth {31}, 120; St. Saviour {26}, 153; St. Olave {27}, 181; Bermondsey {28}, 161; Rotherhithe {34}, 205, where the water was perhaps most impure; Greenwich {35}, 75, where it had lost some of its impurities. . . . No good analysis has been made of the Thames water at different points of its course, but the matter in suspension is perhaps greatest between London Bridge and Limehouse Reach, against Rotherhithe. . . . The seven districts of London in which the mortality is highest from ordinary causes . . . all adjoin the Thames.

Mr. Glaisher of the Royal Observatory, Greenwich, was requested to make an estimate of the amount of vapour raised by evaporation from the Thames in London . . . . [lx] Upon Mr. Glaisher's estimate, 678, 505 gallons evaporate from an acre of water in a year,which is at the rate of 1,857.6 gallons daily. The bed of the Thames in London is estimated approximately at 2,245 acres. Consequently, 4,170,000 gallons are raised from the Thames, on average, daily though the year. . . . It is probable that in summer, 4 million gallons, or about 18,000 tons of water, are raised from the polluted Thames daily and discharged into the atmosphere which is breathed by the inhabitants of London. It remains to determine how much of the organic matter in the water is raised with the vapour at different temperatures.

London derives its supply of waster for washing, cleansing, cooking, and drinking to a small extent from wells. Eighteen districts have supplies from the **river Amwell**, and from the Lea, a tidal tributary of the Thames; two districts from the Ravensbourne; and eighteen districts from the Thames, at five points of its course. The water is generally pumped by steam power into water butts or reservoirs in the houses, at intervals of one, two, or three days. As the water is of very different degrees of impurity, it will now be right to state the fatality of cholera in the several water districts of London, arranged under the companies by which the water is furnished.

river Amwell: A canal constructed in the seventeenth century. Called New River, it commenced at Amwell springs, near the source of the Lea, ran parallel to that river for 38 miles to waterworks at Sadler's Wells, just north of St. Paul's cathedral.

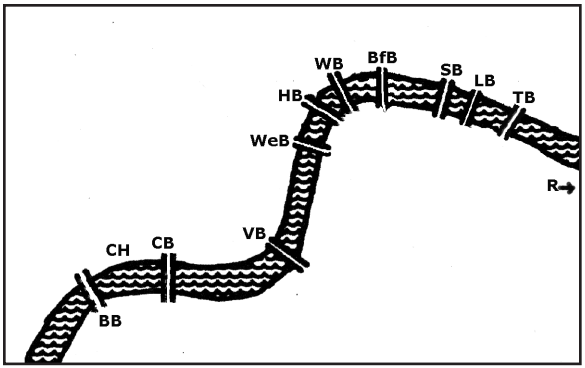
Grand Junction Company.—The waters of the Thames at Kew chiefly supply the sub-districts of Paddington {1a,b}, Hanover Square {3a}, May Fair {3b}, and the greater part of the district of St. James, Westminster {6}. The mortality from cholera was at the rate of 8 in 10,000 inhabitants.

West Middlesex Company.—The waters of the Thames at Hammersmith supply Marylebone {7} and a small part of Hampstead {8}. The mortality from cholera was at the rate of 17 in 10,000 inhabitants in Marylebone. In Hampstead, the mortality was 8 in 10,000.

Chelsea Water Company.— The waters of the Thames at Battersea, much below Battersea Bridge and below the Chelsea Hospital, supply the Belgrave sub-district of St. George, Hanover Square {3c}, and the districts of Chelsea {2} and Westminster {4}. The mortality from cholera was at the

mean rate of 47 per 10,000 inhabitants; in the Belgrave sub-district, the deaths from cholera were 28, in Chelsea 46, in Westminster 68 in 10,000 inhabitants.

Southwark Water Company.—The waters of the Thames at Battersea, still lower down the river, supply the districts of Wandsworth {32}, St. Olave {27}, and Bermondsey {28}. The mortality from cholera was at the rate of 147 in 10,000. In Wandsworth, the mortality was 100, in St. Olave 181, in Bermondsey 161, in 10,000.



Bridges over the River Thames in London

BB Battersea Bridge
BfB Blackfriars Bridge
CB Chelsea Bridge
CH Chelsea Hospital
HB Hungerford Suspension Bridge
LB London Bridge
LR Limehouse Reach
SB Southwark Bridge
R Rotherhithe
TB Tower Bridge
VB Vauxhall Bridge
WB Waterloo Bridge
WeB Westminster Bridge

Lambeth Water Company and Southwark Water Company.—The waters of the Thames between Waterloo Bridge and the Hungerford Suspension Bridge supply parts of the districts of Lambeth {31}, St. Saviour {26}, St. George Southwark {29}, Newington {30}, and Camberwell {33}; the other parts of these districts being supplied from Battersea by the Southwark Company. The mortality from cholera was at the rate of 136 in 10,000. In the district of Lambeth, the mortality was 120, in St. Saviour 153, St. George Southwark 164, Newington 144, Camberwell 97 in 10,000.

Southwark and East Kent Water Companies.—Rotherhithe {34} is supplied with water partly by the Thames at Battersea and by the Ravensbourne, and partly from ditches and wells, into some of which the drains and cesspools soak. The mortality from cholera was at the rate of 205 in 10,000 inhabitants.

East London Water Company.—The Lea supplies the districts of Poplar {25}, Stepney {24}, Bethnal Green {21}, St. George-in-the-East {23}, and Whitechapel {22} with water. The mortality from cholera was at the rate of 63 in 10,000 inhabitants.; and 71, 47, 90, 42, and 64 in each of the five districts.

New River Water Company.—The Amwell and the Lea supply Islington {10}, St. Luke {16}, Clerkenwell {15}, London City {19}, West London {18}, East London {17}, Holborn {14}, St. Giles {12}, the Strand {13}, St. Martin-in-the-Fields {5}. The mean mortality from cholera was at the rate of 41 in [lx/lxi] 10,000 inhabitants. The mortality was least in Clerkenwell (19), near the head of the reservoir; greatest (96) in West London, on the edge of the Thames.

Kent Water Company.—The waters of the Ravensbourne supply Greenwich, where the mortality from cholera was 75 in 10,000 inhabitants, and parts of Lewisham {36}, where the cholera was at the rate of 30 in 10,000 inhabitants.

Two or more companies supply some districts. The district of St.

James, Westminster {6} is supplied by the Kew [Grand Junction Company] and the New River waters; the mortality from cholera was 16 in 10,000 inhabitants. Kensington {1} is supplied by the West Middlesex, the Chelsea, and the Grand Junction Companies; the mortality from cholera was 33 in 10,000. St. Pancras {9} is supplied by the New River . . . and the West Middlesex Companies; the mortality from cholera was 22 in 10,000. Shoreditch {20} and Hackney {11} are supplied by the New River and the East London Companies; the mortality in the two districts from cholera was 75 and 25 in 10,000.

Cholera Mortality Varied, Depending on Where Drinking Water Was Drawn from the Thames

Arranging the groups of districts in the order of mortality, it appears that the mortality from cholera was lowest in districts which have their water chiefly from the Thames so high in its course as Hammersmith and Kew. Upon the other hand, the mortality was greatest in the districts which derive their water from the Thames so low down as Battersea and the Hungerford Bridge. The districts of the New River occupy an intermediate station. In the 6 districts which are supplied with water taken from the Thames at Kew and Hammersmith, 15 in 10,000 individuals died from cholera; the mortality ranged from 8 to 33. In the 20 districts which are supplied with water from the Amwell, the Lea, and the Ravensbourne, 48 in 10,000 inhabitants died of cholera; the mortality ranged from 19 to 96. In the 12 districts which are supplied with water taken from the Thames between the Battersea and the Waterloo Bridge, 123 in 10,000 inhabitants died of cholera; the mortality ranged from 28 to 205. In the second group of districts, cholera was three times as fatal [as in the first]; in the third, eight times as fatal as in the first. The density of the population was greatest in the central group, and nearly the same in the first and third group.

LONDON. GROUP OF DISTRICTS.	Deaths from Cholera to 10000 Persons Living.	Density of Population (Persons to an Acre).	Elevation in Feet above High Water Mark, (Trinity).	Annual Value of Houses (Year ending April 5th, 1843).
6 Districts supplied with Water taken from the THAMES *above* BATTERSEA	15	72	105	£. 82
20 Districts supplied with Water from the NEW RIVER, the LEA, and the RAVENSBOURNE	48	137	42	44
12 Districts supplied with Water taken from the THAMES, between BATTERSEA and WATERLOO BRIDGES . .	123	73	5	31

Inverse Correlation between Cholera Mortality and Elevation in London

The elevation of the soil in London has a more constant relation with the mortality from cholera than any other known element. The mortality from cholera is in the inverse ratio of the elevation. The mortality of the 19 highest districts was at the rate of 33 in 10,000, and of the 19 lowest districts, 100 in 10,000. . . [lxi/lxii].

Cholera was excessively fatal in all the four [registration] districts

which lie on a level with, or below, the **Trinity high-water mark**; it destroyed 144, 161, 164, and 205 in 10,000 inhabitants. In the five districts which lie 2 to 4 feet higher, on average, the mortality from cholera was at the rate of 68, 97, 120, 153, and 181 in 10,000. Westminster experienced the lowest mortality (68) in the 9 low districts, and it is supplied by the Chelsea Company; while all the other districts are supplied by the Lambeth and Southwark Companies. In 10 districts of an elevation of 50 feet and upwards, the mortality from cholera was at the rate of 8, 8, 17, 19, 22, 22, 25, 35, 35, and 53. . . .

Trinity high-water mark: See Glossary.

Notwithstanding the disturbance produced by the operation of other causes, the mortality from cholera in London bore a certain, constant relation to the elevation of the soil, as is evident when the districts are arranged by groups in the order of their altitude. We place districts together which are not on an average 20 feet above the Thames [high-water mark], and find that on this bottom [terrace] of the London basin, the mortality was at the average rate of 102 in 10,000 . . . [etc.; see table to the right].

Elevation of Districts, in feet.	Number of Terrace from bottom.	Deaths from Cholera in 10000 Inhabitants.	Calculated Series (I.)
Feet.			
20—	1	102	$\frac{102}{1} = 102$
20—40	2	65	$\frac{102}{2} = 51$
40—60	3	34	$\frac{102}{3} = 34$
60—80	4	27	$\frac{102}{4} = 26$
80—100	5	22	$\frac{102}{5} = 20$
100—120	6	17	$\frac{102}{6} = 17$
340—360	18	7	$\frac{102}{18} = 6$

By ascending from the bottom to the third terrace, the mortality is reduced from 102 to 34. By ascending to the sixth terrace, it is reduced to 17. It will be observed that the number representing the mortality on the third terrace is one-third of the number 102, representing the mortality on the first, and that the mortality on the sixth terrace is one-sixth part of the mortality on the first. A [calculated] series of approximating nearly to the [lxii/lxiii] numbers representing the mortality from cholera is obtained by dividing 102 successively by 2, 3, 4, 5, 6. A comparison of the numbers of this series with the actual mortality experienced in each district will serve to indicate roughly as much of the effect as is due to elevation. Deviations from the scale are generally explained by the **other elements** of the problem. . . .

other elements: Predisposing causes of cholera besides elevation.

The elevation of the five terraces may be represented by 10, 30, 50, 70, 90 feet; the elevations of the two higher districts are 100 and 350 feet. It will be observed that the mortality at 100 feet is 17, at 50 feet, 34 in 10,000. Consequently, *at half the elevation the mortality is doubled*. . . . It is evident [from the table] that the mortality is not strictly in the inverse ratio of the heights of the soil.

[Non-uniform values are explained by the following formula:]

Let e be any elevation within the observed limits 0 and 350, and c be the average rate of mortality from cholera at that elevation. Also let e' be any higher elevation, and c' the mortality at that higher elevation. Then if the mortality from cholera is inversely as the elevation, we shall have the

proportion:

$$e : e' :: c' : c = \frac{e'}{e} \cdot c'.$$

By adding a constant element, a, the velocity at which the mortality increases, particularly at the lower elevations, can be retarded to any extent. The equation then assumes the form (1) $\frac{e' + a}{e + a} \cdot c' = c$. The value of a can be most readily obtained by taking $e' = 90$, where the mortality was 22; and $e = 0$, where in three districts on a level with the Thames at high water the mortality was 177 in 10000 on an average.

From Eq. 1 the value of a in general terms is found to be $a = \frac{e' c' - e c}{c - c'}$.

Inserting the above numbers, we have

$$a = \frac{90 \times 22 - 0 \times 177}{177 - 22} = \frac{1980}{155} = 12 \cdot 8$$

As the series is not perfectly uniform, different values of a are obtained from the formula; and 13 is an intermediate value of a, which has been employed in the construction of the annexed Table, by making e successively 0, 5, 10, 15, . . . 110, 150, 200, 250, 300, 350, in the equation—

$$c = \frac{90 + 13}{e + 13} \cdot 22 = \frac{103 \times 22}{e + 13} = \frac{2266}{e + 13}$$

Mean Elevation of the ground above the High-water Mark.	Mean Mortality from Cholera.	Calculated Series.
0	177	174
10	102	99
30	65	53
50	34	34
70	27	27
90	22	22
100	17	20
350	7	6

Upon comparing the numbers of this series with the mean mortality observed in the districts at eight different elevations, it will be observed that the only considerable discrepancy is at the mean elevation (20–40) assumed to be 30 feet. The excess of mortality is in Wandsworth, West London, and Bethnal Green.

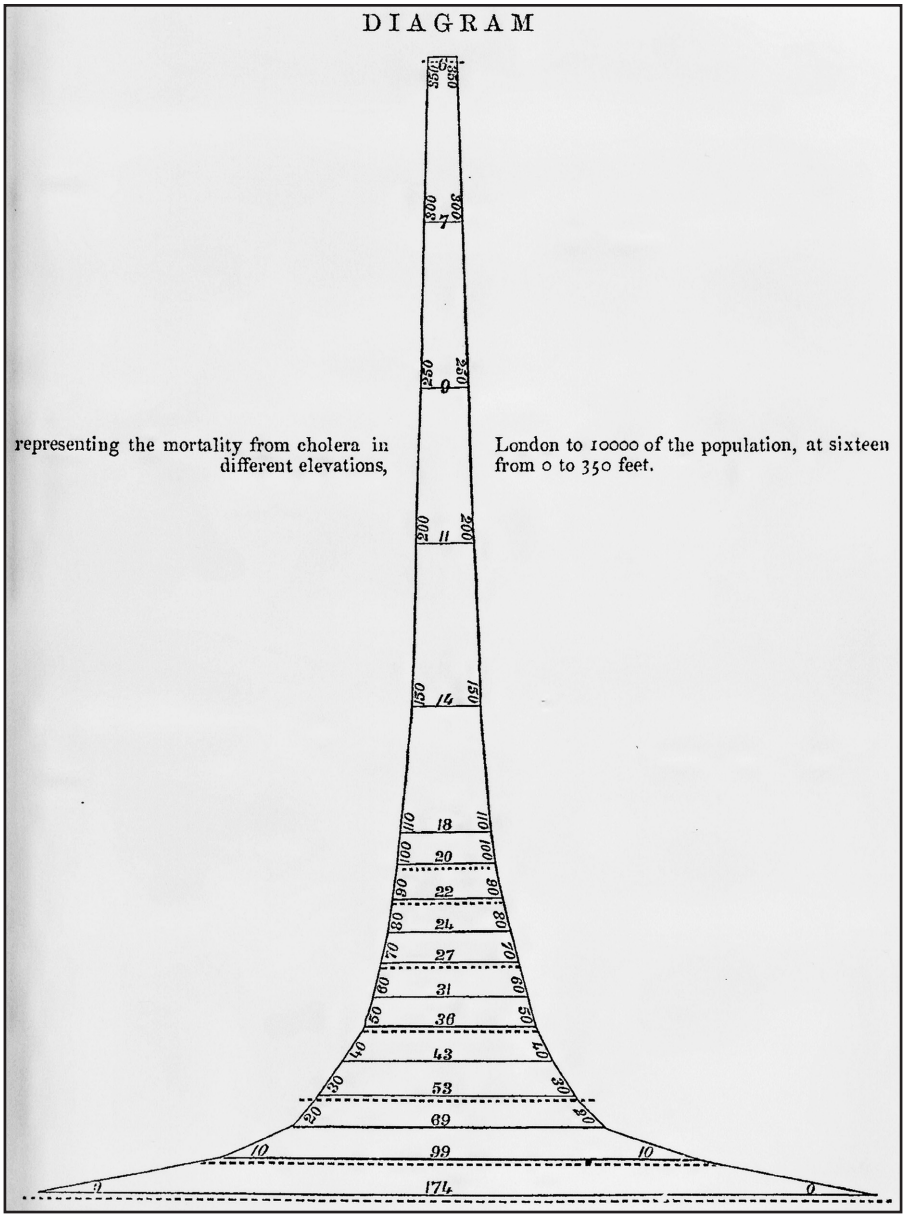
[lxiv] The houses necessarily raise the people of London above the ground. If their *habitat*, day and night, is on an average 13 feet above the ground level, it is evident that the mortality *within the limits observed, is in the inverse ratio of the elevations at which the people live*. The causes of the discrepancies in particular districts are partly explained by differences in the wealth of the people and other causes . . . [as shown in two additional tables].

Law of Inverse Correlation between Cholera Mortality and Elevation

[lxv] The relation discovered between the elevation of the soil and the mortality from cholera [shown in these tables, as well as the diagram on the next page] is so important that it was thought right, after the above calculations were made, to submit the principle to another test—comparing the elevation and the mor-[lxv/lxvi]tality from cholera of each sub-district. The population of the sub-districts in 1851 having been enumerated, it became possible to construct the tables [on] pp. clxvi–clxix, which, although it makes the mortality on the lowest levels less and is deranged [distorted] by the deaths in hospitals and workhouses, entirely confirms the announced law.

Population Density Affects Cholera Mortality Less than Elevation

Density of population within the limits of the London districts is a less important element than elevation of soil. . . [discussion of tables where districts are arranged in order of cholera mortality, rental and/or property value of houses, and density].



[lxv] The figures in the centre express the number of deaths from cholera to 10,000 inhabitants living at the elevations expressed in feet on the sides of the diagram.

The length of the *black horizontal lines* shows the *calculated* relative fatality of cholera in districts at relative elevations indicated by the height of the diagram. The *dotted lines* indicate the mean mortality *observed* in the elevations given. . . .

Elevation Skews Influence of Wealth on Cholera Mortality

Wealth appears to influence the mortality of cholera. Under the income tax, a return was made of the annual value of houses which serve indirectly to indicate the wealth of the inhabitants. Shops and some public buildings, returned under this head, disturb the results. But the division of the value of the houses of a district by their number, or by the number of inhabitants, shows the relative wealth of the districts better than any other indirect tests at our disposal. Wealth represents food, lodging, clothing, cleanliness, medical advice in sickness to a certain extent, as large masses of people supply themselves with these necessaries in proportion to their means. [lxvi/lxvii]

If the 19 wealthiest districts are compared with the 19 poorest districts, the mortality from cholera is found to be inversely as the wealth, measured by the value of the **house-room**. . . . Elevation, however, interferes considerably with these results. . . . Under these circumstances, I find it impossible at present to establish any definite relation between the various degrees of wealth and the mortality of cholera, further than that in districts of some elevation, wealth does exert a certain [inverse] influence on the mortality both of cholera and of ordinary causes. . . .

house-room: Average value of houses divided by the population density.

Mortality from Ordinary Causes

[lxviii] There is a certain relation between the degrees of mortality from ordinary causes and the mortality from cholera [in London]. . . .

[lxix] It has been shown in the general analysis of the returns from the whole kingdom that cholera has not only been most fatal in the low, and least fatal in the high, parts of the country; but that the fatality has diminished proportionally as the dwellings of the population have been raised above sea level. The epidemic began and was most fatal in the ports on the coast. In ascending the rivers, step by step, we saw it grow less and less fatal. It became probable that a certain relation existed between elevation and the power of cholera to destroy life. The more exact information which we possess respecting the London districts establishes this connexion beyond doubt. The relation may not be expressed by the same figures of other places, or in London at other times. But it will always be the general rule that the *mortality of cholera is inversely as the elevation of the people assailed above the sea level*.

Mere density of population had not the same direct effect of increasing the mortality in this disease as in others. In many inland towns and in high, dense parts of London, the mortality was slight or inconsiderable. . . .

The differences in wealth and poverty probably have an effect on the mortality. But abstracting the indirect effect through the selection of sites and the supply of water, the great differences in the wealth of the Lon-

don districts do not enable us to detect a very marked or constant influence of this element on the mortality from cholera. . . .

Elevation of the land involves several conditions which have an important effect on life and health. As we ascend, the pressure of the atmosphere diminishes, the temperature decreases, the fall of water increases, the vegetation varies, and successive families of plants and animals appear in different zones of elevation. The waters roll along the surface of the rocks, or filter through them and the porous strata of the earth to burst out below—the sources of rivers, or of tributaries which carry disintegrated rocks, with the remains and excretions of vegetables, animals, or men in every stage of decomposition. The deposits in stagnant places, and at the estuaries, show the kind and quantity of mixed matter which the laden rivers carry down and deposit on the low margins of the sea at the tidal confluences of the fresh and salt waters.

If we take a series of towns on a river, it is evident that the refuse matter of the first town will pass through the second; . . . and so on to the lowest town, which will be traversed by all the un-evaporated and un-wasted organic matter that has found its way into the waters on their way to the ocean. As the transforming of decaying organic matter into inorganic and innocuous elements is constantly going on, it will be in many cases completely decomposed in its course. What has been said of the refuse of towns will apply to the leaves of the forests, and to vegetable remains of all kinds.

As the rivers descend, the fall of their beds often grows less and the water creeps sluggishly along, or oozes and meanders through the alluvial soil. The drainage of the towns is difficult on the low ground, and the impurities lie on the surface or filter into the earth. The wells and all the waters are infected. Where the houses are built on hillsides and elevations, as in London, the sewage of each successive terrace flows through the terrace below it. The stream widens, the ground becomes more charged, every successive step of the descent, until it is completely saturated in the parts lying below the high-water mark.

The river, the canals, the docks, and the soil of a port may be viewed as a large basin full of an almost infinite variety of organic matters, undergoing infusion and distillation [lxix/lxx] at varying temperatures. As the aqueous vapour which is given off ascends, it will be impregnated with a quantity of the products of the chemical action going on below, variable in amount, but necessarily greatest in the lowest and foulest parts. The emanations, mixing with the superincumbent atmosphere, ascend like smoke. But at the same time, [they] become less and less dense by dilution and by the gradual destructive decomposition. . . .

From an eminence on summer evenings, when the sun has set, exhalations are often seen rising at the bottoms of valleys, over rivers, wet

meadows, or low streets, the thickness of the fog diminishing and disappearing in upper air. The evaporation is most abundant in the day. But so long as the temperature of the air is high, it sustains the vapour in an invisible body which is, according to common observation, less noxious while penetrated by sunlight and heat than when the watery vapour has lost its elasticity and floats about supercharged with organic compounds in the chill and darkness of night.

Law Governing Organic Matter in Atmosphere Parallels Cholera Mortality at Various Elevations

The amount of organic matter, then, in the atmosphere we breathe, and in the waters, will differ at different elevations. And the law which regulates its distribution will bear some resemblance to the law regulating the mortality from cholera at various elevations. It has been seen how rapidly in London the mortality from cholera diminishes a few feet above the low ground on a level with the Thames, while several feet of elevation in higher regions produces no sensible effect. The same thing holds in drainage. The ground on a level with the outlet cannot be drained at all, while a few feet of elevation make a drainage practicable, efficient, and easy. And the law holds that while a few feet of elevation are so important near the outlet, they are of little or no importance on the higher lands of the country. The diagram at page lxv represents roughly the facilities of drainage, as well as the mortality from cholera at the several elevations.

Cholera Linked to Organic Matter Undergoing Chemical Change

It is established by observation that cholera is most fatal in the low towns and in the low parts of London, where, from various causes, the greatest quantity of organic matter is in a state of chemical action. And it may be admitted that cholera, varying in intensity with the quantity, is the result of some *change* in the *chemical action* of this matter—leaving it open for further inquiry to determine whether, in England, that change is spontaneous or the result of the introduction of a zymotic matter from beyond the seas; whether the poison enters the human frame in air or water, through the skin, the mucous membranes, or the air-cells of the lungs. If the facts are so, it follows that cholera will not only be fatal on low ground, but on high ground if, from any concurrence of circumstances, the conditions exist there which are so constantly found in alluvial soils lying on a level with or below the tidal waters. . . .

Cholera Mortality Not Influenced by Atmospheric Pressure or Temperature

The atmospheric pressure and the temperature diminish with the elevation. It is easy to conceive that either may exercise considerable influence when the elevation is considerable. The rarity of the atmosphere, or the perpetual snow on the Himalaya and the Alps, may be alleged as the causes why the epidemic never [lxx/lxxi] crossed their passes. . . . {However,] the variations in temperature and of pressure follow laws entirely different, and are too slight at elevations differing only ten feet to be the direct cause of the great differences in the mortality of cholera.

Certain diseases arises when men are crowded together in close,

dirty gaols, camps, or hospitals; when they inhale morbid exhalations or are placed in contact with others labouring under such zymotic diseases as smallpox; and when they reside in marshy countries. The explanation of the diffusion of cholera by an organic matter is therefore consonant with what is known of the etiology of other diseases.

It has been shown already that when the cholera invades a place, it generally advances slowly at first. Great numbers are attacked. Many have all the symptoms of Asiatic cholera, others have cholera of a milder type, a class still more numerous have choleraic diarrhoea, and great numbers have disorder of the bowels, sickness, indigestion, and slight cramps. The stated proportion of deaths from cholera, out of a given number of cases, varies not only with the malignity of the form and with the medical treatment, but with the definition of the disease. Some take as cholera only cases in collapse. Others include the mildest forms. The lightest forms of diarrhoea are seldom noticed in medical registers and rarely come under medical observation.

Most People Resist the Choleraic Influence

Cholera has rarely been fatal in England to more than 1 in 2 attacked. And it may be laid down, that for 1 death, not more than 3 persons were attacked in the severer way.*. . . Less than 1 in 10 of the population were attacked by cholera or diarrhoea [in 1849]. . . . In all England, 30 died of cholera, 11 of diarrhoea, to 10,000 living, of whom [it may be estimated that] 90 must have sustained an attack of cholera, 1,100 an attack of diarrhoea. In London, . . . it may be estimated that 1,886 in 10,000 inhabitants had an attack either of diarrhoea or cholera. . . .

Higher Elevations Decrease Potency of Choleraic Influence

[lxxii] It is certain that in this, as in other zymotic diseases, great multitudes of the people who in one way or other take an average dose of the poison resist its influence. And it may be admitted that the numbers attacked bear some proportion to the quantity of the specific matter in the air, water, or earth of the place where they dwell. This specific matter is known only by its effects. But it has been shown that the deaths from cholera vary in some proportion to the quantity of organic matter in the state so commonly observed in the low parts of low towns. Our generalization then goes to this extent, that the cause of cholera is some chemical modification of organic matter. And here is the great practical fact—*although elevation of habitation, with purity of air and purity of water, does not shut out the cause of cholera, it reduces its effects to insignificance*.

Cholera has prevailed in many parts of the civilized world, and has probably not spared unexplored regions of whose barbarous inhabitants little or nothing is known. . . . The Indian epidemic began in the Delta of the Ganges. . . . "Jessore, the place in which the disorder first put on a very malignant form, is," says [James] Jameson [an army medical surgeon in the Bengal

Presidency], "a crowded, dirty, ill-ventilated town, surrounded by a thick jungle, and in the rains by an immense quantity of stagnant water. . . . [lxxiii] From this plentiful source of corruption, foul air is constantly given forth. As all ventilation is obstructed by large groves of trees and vegetation of every description, it is there concentrated until it becomes entirely unfit for the purposes of respiration. The miserable condition of the generality of the inhabitants of these villages is hardly to be imagined. . . . The higher classes of natives, and Europeans generally, inhabiting the better raised and more airy parts of the town, suffered proportionally less than the lower ranks. . . . There is abundant proof that in *high, dry, and generally salubrious spots, it was both less frequent in its appearance and less general and fatal in its attacks than in those that were low and manifestly unwholesome*."

Mortality in 1817 Bengal Outbreak and Law of Elevation

A cholera which, in all its leading symptoms, is the same as the epidemic disease, has existed from time immemorial in Europe and Asia. Cases are related in the earliest medical writings and occur sporadically every year in England. The disease in the epidemic is a variety, well characterized by the duration of the fatal cases. We call the one variety Summer cholera, the other Asiatic cholera, merely to give them distinctive names. With the facts before us, will any theory account for the phenomena? What is the cause of Summer cholera? What is the cause of Asiatic cholera? Why does cholera in one year destroy only a few lives and occur sporadically, in other years spread successively over the whole world and destroy a million or more of the inhabitant in a short space of time? In what way is the malady propagated? . . .

Theories & Analogies

1. Volcanic Activity

[lxxiv] The theory of volcanic agency has been ingeniously advocated by a recent writer who has closely studied cholera and other epidemics. [John Parkin] discovers five points in which the phenomena of volcanoes and pestilences agree, and thus summarily lays them down as laws. . . . The theory assumes that the pestilence is caused by "poisonous elements generated in subterraneous reservoirs and diffused in the surrounding atmosphere." The gases and ashes which escape from volcanoes have been analyzed, but the "poisonous element" has not been identified or detected in places suffering from cholera. . . .

Atmospheric and Other Analogies

Tempests, thunder storms, showers of rain, the formation of clouds, evaporation, and combustion present many analogies with the pestilential outbreak. The gentle wind quickens into a violent tornado, traverses lines of country, prostrates everything in it course, and then quietly dies away like cholera, to appear again at intervals and in other places. The cloud,, no bigger than a man's hand, lies quietly on the sky, spreads, covers the heavens; a few drops of rain fall, the lightning flashes, the thunders roll, the water descend in sheets on the earth. Then the tempest subsides and the atmo-

sphere is more tranquil than it was before, just as the phenomena succeed each other in an epidemic. In combustion, the fire smoulders for a time until the whole mass is heated. Then chemical action is accelerated. The flame bursts out, intense heat is evolved, and the fire subsides when the combustible material is consumed. Blights and the sudden development of infusorial and cryptogamic life present so many analogies with epidemics in their effects on the vegetable kingdom, their diffusion, and their course, that they have been by some regarded as the cause of pestilence. The growth of grasses also presents a parallel. . . . Many striking processes of the inorganic as well as the organic kingdom present series of developments which have analogies with, but are not causes of, pestilential phenomena. The theorist, however speculative [lxxiv/lxxv] he is, may, by tracing these analogies, often open the way to a happy generalization . . . .

2. Electrical Theory

The hypothesis that electricity is the cause of cholera has been advanced by recent writers of ability. Mr. Orton has summed up all the facts and arguments in its favour. He suggests rather than asserts that a "deficiency of electricity," or a negative instead of the more common positive electricity of the atmosphere, is the "primary remote cause" of the epidemic. . . . Many examples of thunderstorms and great electrical disturbances have been noted in epidemic years. Similar disturbances happen in other years, and neither Mr. Orton nor any other writer has succeeded in showing, from observation with the electrometer, that there is any invariable relation between the progress of electrical phenomena and epidemic outbreaks of cholera. . . .

[C. F.] Schönbein, the Professor of Chemistry at Basle, has given a new turn to the electrical theory. His experiments and investigations . . . prove that pure or atmospheric oxygen, on being exposed to the action of electrical sparks, is transformed into an odoriferous matter, which he calls ozone. . . . [It] instantly decomposes sulphuretted or phosphoretted hydrogen and acts upon almost all organic substances. . . . Ozone, in variable quantities, is incessantly formed by electrical discharges continually going on in the atmosphere . . . . The miasmatic matters thrown into the atmosphere by the infinite number of plants and animals hourly dying in the earth, water, and air are, he is disposed to believe, decomposed by ozone, which is simultaneously destroyed.

Ozone, like chlorine, irritates the lungs . . . . Schönbein does not think the question of [cholera] causation decided, but strongly recommends ozonometric observations. Instead of adopting this suggestion, and in the absence of observation, it was argued by some, when cholera was epidemic in 1849, that an excess of ozone was the cause of influenza and that a deficiency of ozone was the cause of cholera! [lxxvi] That ozone exists in the atmosphere and dsetroys miasms is probable. But the hypothesis assumes that

a cholera matter exists independently of ozone, by which it is supposed to be destroyed. Schönbein, by experiments on the Jura Mountains, ascertained that at 1200–1800 feet above the level in Basle, his ozonmeters exhibited higher degrees than they did at the same time in Basle. Whence he infers that the higher contain less miasmatic matter than the lower regions of the atmosphere.

3. Bad Water

Jameson, in the last page of the supplement to his admirable *Report on the cholera in Bengal*, after noticing that some of the natives placed "great faith in boiled water as a preventive," and that one of the principal native gentlemen of Calcutta ascribed the "singular healthiness of his numerous household to his having taken the simple precaution of allowing no water to be drank by them until it had been previously boiled," adds: Bad water no doubt sometimes immediately induces the disorder, but we must not suppose it is the sole cause of it." This is borne out by some observations in the Indian Reports, where, however, the sources of the water supply are too seldom referred to . . . .

4. The Fungus Theory

"In the summer of 1849, Dr. Brittain and Dr. Swayne of Bristol considered that they had discovered the cause of cholera in a minute fungus. And Dr. W. Budd, of the same city, met with the supposed fungus in various specimens of water used as drink in places where the cholera was very prevalent."[2] Upon further investigation, the supposed fungi were, by experienced microscopists, pronounced to be other matters. And after the able report of the Committee of the London College of Physicians, the hypothesis was generally abandoned.

5. Local Affection of the Alimentary Canal—Dr. Snow's Theory

a paper: *MCC*, Document 3.

a subsequent paper: P*MCC;* see Document 9–II.

Dr. Snow, in **a paper** dated Aug. 29, 1849, advanced a theory of the pathology of cholera; and it is in many respects the most important theory that has yet been propounded. Dr. Snow, after endeavouring in **a subsequent paper** to show that the disease is propagated by human intercourse, thus states his doctrine: "The induction from these data is that the disease must be caused by something [lxxvi/lxxvii] 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 cause 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

[2] Dr. Snow on cholera, paper read at the Epidemiological Society, [3 June] 1851 ["On the mode of propagation of cholera," *MT* (13 December 1851): 612 <http://johnsnow.matrix.msu.edu/work.php?id=15-78-C6>].

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 arrive to take their meals in the sick [746/747] 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. . . . 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 in to the rivers."[3]

Dr. Lloyd, on August 30, 1849, at a meeting of the South London Medical Society, adduced instances of the great mortality from cholera of people in Silver Street and Charlotte Place, Rotherhithe, who got their water from a well and a ditch into which the privies discharged their contents. The disease was much more fatal in the parts of Rotherhithe where ditch-water was used than it was in places which had their supply from the water works. Dr. Snow has collected examples in the South London districts; where the water being derived from deep wells, few cases of cholera occurred. [He also found] other instances of a great fatality among people living in houses, such as those in {Albion Terrace,] Wandsworth Road, where the contents of the water closets found their way into the water.

He shows, from a communication with Dr. Shapter, that in 1832, Exeter was supplied with water taken from the streams of the Exe into which sewers emptied themselves. Subsequently, water works were established on the river two miles above town, and more than two miles above the tidal range. In three months of 1832, cholera destroyed 347 lives in Exeter. In 1849, it was only fatal to 44 persons, many of them strangers who died within three days of their arrival. An opposite instance is afforded

[3] "On the pathology and mode of communication of cholera," by John Snow, M.D. . . [*LMG* (2 November 1849): 746–47 <http://johnsnow.matrix.msu.edu/work.php?id=15-78-2A>].

by Hull, which in 1832 was scantily supplied with water from springs in Aulaby, three miles distant. About seven years since, water works were established on the river Hull, two miles and three-quarters above its confluence with the Humber, and afford the town a plentiful supply. But half the sewage of the town is delivered into the waters of the river Hull, half into the Humber. The tide flows up the river many miles past the water works, and carries with it the contaminated liquids of the sewers. In 1832, the cholera was confined almost exclusively to the poor and the deaths amounted to about 300. In 1849, the deaths were 1,178 and occurred among all classes of persons.[4] Negative and positive instances in other towns are cited by Dr. [lxxvii/lxxviii] Snow, and in their ***Reports*** to the [General] Board of Health by Dr. Sutherland and Mr. Grainger.

Dr. Snow's theory of the propagation of Asiatic cholera in London is very simple. The cholera matter was brought to London [in 1848] by patients from Hamburg; it was multiplied in the intestines of infected people until the disease spread in this way all over the metropolis. It necessarily implies that the rice-water discharges of the cholera patients may, under the present system of water supply, be distributed unchanged to nearly every house in London where water is used for drink, ablution, and washing. Dr. Snow is unfortunately able to show that this excremental distribution—almost too revolting and disgusting to write or read—is possible to a very considerable extent [Farr footnotes *MCC*, 23-26]. The sewers of London run into the Thames and the Lea, from which a part of the water supply is derived. The water . . . [is] baled from the ditches only by the wretched inhabitants of such parts as Jacob's Island. It is in one case before distribution pumped up to a distant reservoir at Brixton. In other cases, it is taken higher up the rivers, largely diluted, or beyond the reach of any but casual contamination. Filtration is employed. Chemical action, as the chemists on behalf of their wealthy clients tell us, is incessantly going on, and converting impurities into simple elements. So that it is only in some places, or in rare circumstances, that the organic waste can reach and injure people. Still, in this mitigated form, the risk is too tremendous to be incurred by two millions and a half of people, who require and can obtain an abundance of sweet water. . . . The experience of Paris . . . as well as of many of our own towns, lends some countenance to Dr. Snow's theory.

6. Theory of Contagious Infection at a Distance

The general argument in favour of the propagation of cholera by infection has been forcibly stated by Dr. Bryson. [He] brings facts from the experience of the navy to show that the existing virus may take effect at the distance of one or two miles, if not further. In contact with inanimate substances, [it] may be conveyed to the distance of many hundred miles, provided the transit be accomplished within the space of about ten

[4] The numbers of deaths in 1849 are from the present returns.

days. Dr. Bryson admits that the question of quarantine is surrounded with practical difficulties, as instances of cholera occurred in several ships of the Mediterranean squadron *before they had any communication with the shore* where the disease was prevailing. Indeed, on the hypothesis of infection, which assumes that an "atmosphere charged with the specific virus emanating from a population labouring under cholera and choleraic diarrhoea may prove effective at the distance of several miles from an infected locality." Or, on the hypothesis of diffusion by water up the tidal streams, it is difficult to understand how the ordinary quarantine can at all exclude the epidemic. [lxxviii/lxxix] Nothing but the absolute cessation of all intercourse between this island and the rest of the world would be effectual.

Instances are cited by writers on contagion of medical officers in attendance on cholera patients suffering or escaping attacks of the disease. But they are seldom conclusive. In London, for example, one hospital physician and one hospital surgeon died of the disease. The mortality was consequently higher in this class than it was in the rest of the inhabitants of London. But the two hospitals, Guy's and St. Thomas's, are in two of the lowest and most fatal districts on the south side of the river, and cholera patients were not apparently admitted at Guy's Hospital, although they were treated at St. Thomas's. The disease was not fatal on the higher ground, north of the Thames, to any of the medical officers of the hospitals where cholera patients were freely admitted. Whether any of them suffered from premonitory symptoms is unknown. Yet, this is an element to be taken into account. For it may be assumed that in medical men, the disease is more frequently checked in the early stage, when it is amenable to treatment, than it is in the rest of the community.

The fact that the first cases of the epidemic appear in the sea ports is not, in itself, a decisive proof of the importation of the disease. For if it is ever indigenous, as it was on the delta of the Ganges, it will almost certainly break out in such low places and circumstances ass are found in the neighbourhood of nearly all sea ports.

7. Spontaneous Development

The hypothesis of spontaneous development in England has been advanced, and may be supported by arguments of some weight. Thus, there can be no doubt that the epidemic cholera is closely allied in all its essential symptoms to sporadic cholera, and the conversion of the one variety into the other in England is not a priori impossible. The march of cholera and diarrhoea since 1838 presents the appearance of a progressive development. . . . The seasons of the year and the circumstances of the people presented great variations in the twelve years, but on the whole, they favoured epidemic development. The price of wheat rose rapidly . . . . The potato crop failed partially in 1845, and in 1846 the failure was general. The country in 1847, besides commercial distress, suffered some of the consequences of famine.

The potato is antiscorbutic and could not be replaced by other food of a different quality. Scurvy prevailed in many ports of the kingdom. Influenza broke out as an epidemic at the close of 1847. The cholera eruption followed at an interval of a year. The spontaneous eruption of cholera has its analogue in the other zymotic diseases: thus smallpox, scarlatina, and typhus are five or ten times as fatal at some times as they are at others in districts of London. An isolated, local epidemic of cholera which broke out in the Coventry workhouse [in 1838] appears to show that the spontaneous evolution of epidemic cholera is possible in England. . . . Fortunately, the disease was confined to the house, and did not extend its visit to the town.

[lxxx] While the facts prove that the population was undergoing a morbid change, which may have issued in a great epidemic, it seems more consonant with the whole history of the disease to admit that, while the materials were smouldering in England, the flame which threw the mass into combustion was of Asiatic origin.

8. Zymotic Theory

a note: Extracts appear in smaller font within the text below.

It is not necessary to discuss the zymotic theory here, but I give in **a note** the substance of a paper on the subject which appeared in the Appendix to the Registrar-General's Fourth Report. . . . It may, I think, be admitted that the disease, Asiatic cholera, is induced in man by a certain specific matter. As it has been proposed to call the matter *varioline* which causes smallpox, so *cholerine* may designate the zymotic principle of cholera. A variety of that matter was produced in India in certain unfavourable circumstances. It had the property of propagating and multiplying itself in air, or water, or food and of destroying men by producing in successive attacks the series of phenomena which constitute Asiatic cholera.

That *cholerine* is an organic matter cannot, I think, be doubted by those who have studied the whole of its phenomena and the general laws of zymotic disease. The great questions remain—Is *cholerine* produced in the human organization alone and propagated by excreted matter? Is it produced and propagated in dead animal or vegetable matter or mixed infusions of excreta and other matter out of the body? Is it propagated through water? through contact? or through all these channels? Observations sufficiently exact to decide these questions definitively have yet to be made and discussed on the principles of probability. The decisive facts cannot be investigated by **experiments** in which human life may be exposed to risk. They must be carefully looked for and **noted by good observers**. Conflicting theories serve, among other purposes, to direct the attention of observers to important points which they may otherwise neglect.

experiments . . . noted by good observers: Natural experiments such as what Grant and Snow believed had occurred in the Surrey Buildings cholera outbreak should be investigated.

Note.—The zymotic hypothesis, which is strictly applied to all the known phenomena of cholera, is thus stated: "Miasm, properly so called, causes disease without being itself reproduced. . . . Carbonic acid and sulphuretted hydrogen, which are frequently evolved from the earth in cellars, mines, wells, sewers, and other places, are amongst the most pernicious miasms" (Liebig). Miasms produce diseases like ague, without

Definition of Miasm

being impregnated by contagion. And the poisons—carbonic acid, sulphuretted hydrogen, and other gases which are given off by organic matter in putrefaction—afford an illustration of their action. . . .

Certain matters which have not yet been analyzed produce smallpox, glanders, hydrophobia, syphilis, measles, scarlatina, and other diseases. As it was before proposed to give names to the well-defined diseases produced by poisons, . . . it will be equally useful to name these specific matters or transformations of matter by which diseases are propagated either by inoculation and contact (contagion), or by inhalation (infection). The list [to the right] exhibits the popular and scientific names of diseases in juxtaposition with the proposed name of their exciters. It may be assumed, hypothetically, that in the blood corresponding bodies exist which are destroyed, and by the transformation of which the exciters are generated or reproduced: . . . [lxxx/lxxxi]

Contagion and Infection Defined

Disease (Popular Name)	Disease (Scientific Name)	Zymotic Principle (Exciter)
Smallpox	variola	*varioline*
Cowpox	vaccinia	*vaccinine*
Glanders	equinia	*equinine*
Hydrophobia	lyssa	*lyssine*
Syphilis	syphilis	*syphiline*
Infection in Dissecting	necusia	*necusine*
Erysipelas	erysipelas	*erysipeline*
Puerperal Fever	metria	*metrine*
Measles	rubeola	*rubeoline*
Scarlet Fever	scarlatina	*scarlatinine*
Hooping Cough	pertussis	*pertussine*
Dysentery	dysenteria	*enterine*
Diarrhoea	diarrhoea	*enterine* or *cholerine*
Cholera	cholera	*cholerine*
Influenza	influenza	*influenzine*
Typhus	typhus	*typhine*
Plague	pestis	*pestine*

The chemical composition of these principles is at present unknown. But salts are distinguished from each other by their relations to other bodies, and though they may have the same appearance in solution, are found to differ by the compounds which they form with other bodies in the solution. So, the existence is demonstrated by the effect of the matter here called *lyssine* on animals, although it cannot be detected by the rough analysis of artificial chemistry. The smallest quantity imaginable of *lyssine* inserted under the skin of a dog produces hydrophobia. And the bites of the infected dog will throw other dogs, and even human beings, into a state similar to that of the dog from which the charge of *lyssine* originally came. *Varioline* in the same manner produces smallpox if the patient has not previously undergone its influence or the influence of *vaccinine*—a modification of *varioline*.

The diseases of this class have been frequently spoken of as fermentations. Liebig has now opened the way to the explanation of their nature by a reference to the phenomena attending the transformations of organic compounds, excited by the action of other compounds simultaneously undergoing analogous transformations. Thus yeast (which is gluten in a state of transformation) added to wort (which contains gluten and sugar) converts the gluten of the wort into yeast, and at the same time the sugar into alcohol and carbonic acid, the two transformations going on together and the latter ceasing when the former ends. The yeast reproduces yeast, if gluten from which it was originally derived, be present. And if the temperature and circumstances be favourable, fermentation may be spontaneous.[5]. . .

It must be admitted, with respect to all forms of these diseases, . . . [that] it is impossible to account for their existence in the world upon any other principle than that of spontaneous origin. Still, the property of communicating their action and affecting analogous transformations in other bodies is as important as it is characteristic of these diseases, which it is proposed therefore to call in this sense **zymotic**. A single word . . . is required to replace in composition the long periphrasis, "epidemic, endemic, and contagious diseases." With a new name and a definition of the kind of pathological process which the name is intended to indicate, persons who have not made themselves acquainted with the researches of modern chemistry can scarcely fall into the gross error of considering this peculiar kind of diseased action and vinous fermentation absolutely identical, . . . while it is admitted that they are of a chemical nature and analogous to fermentation. . . . Little is known of the series

zymotic: See Glossary for Farr's definition.

[5] See Liebig's voluminous exposition of the doctrines of fermentation, in *Chemistry of Agriculture, Physiology, and Pathology,* 2 vol. [date?].

of chemical changes and products in any single zymotic malady, or of the chemical reactions of the living forces and organs. Smallpox is, by hypothesis, the transformation of *varioline* and certain unknown, concomitant chemical changes in the blood and the skin, manifesting the important symptoms which fall under direct observation. . . .[lxxxii] [It appears that] the blood which pervades the whole system is the primary seat of zymotic diseases. But this does not diminish the importance of the local phenomena with which they commence, proceed, or terminate. For they affect (as poisons do) particular organs more extensively and frequently than others, give rise to specific pathological formations or secretions, and derive their character from the lesions and affected organs. The heat disengaged in these diseases suggest the term, fever . . . .

Some zymotic diseases recur, others happen only once in life. If they happen twice, it is the exception. . . . The tendency of zymotic diseases to increase and decline in activity is one of their most remarkable properties. The suddenness of their outbreaks, with the great mortality of which they were the cause, excited at an early period the attention and solicitude of mankind. The tendency is indicated by the terms epidemic and endemic. The latter serves to designate diseases which are excited by miasmata and prevail in proportion to the quantity of miasm developed. The former, epidemic, denote the diseases transmitted from man to man, independently of locality, or only dependent on locality, temperature, and moisture as adventitious circumstances. For statistical purposes, the epidemic, endemic, and contagious diseases have been classed under one head, as they may all be excited by organic matter in a state of pathological transformation. Ague is not contagious and is apt to recur. . . . I feel inclined to consider it a zymotic disease in which, to use the language of Liebig, the exciter is destroyed as soon as it is reproduced. . . .

Sydenham referred in the following passage to zymotic diseases, which were so rife in London formerly: . . . "If the humours are retained in the body beyond the due time, either (1) because nature cannot digest and afterwards expel them, or (2) from their having contracted a morbific taint from a particular constitution of the air, or (3) lastly, from their being infected with some poison—by these, I say, and the like causes, these humours are worked up into a substantial form or species that discovers itself by particular symptoms, agreeable to its peculiar essence. These symptoms, notwithstanding they may, for want of attention, seem to arise either from the nature of the art in which the humour is lodged, or from the humour itself before it assumed this species, are in reality disorders that proceed from the essence of the species newly raised to this pitch [zym*ine*]. So that every specific disease arises from some specific exaltation, or peculiar quality, of some humour [zym*in*] contained in a living body.". . .

[lxxxiii] The early medical observers have directed attention to the analogies [that] zymotic diseases have with combustion, fermentation, putrefaction, and poisoning. These analogies have been, to a certain extent, confirmed by the researches of modern chemistry. Liebig has been led by the study of organic transformations—fermentation, putrefaction, decay—to develop a theory, invented by the greatest practical physicians, to explain the phenomena of zymotic diseases. . . . [Farr extracts passages from Morton and Willis that, like Sydenham's, he considered anticipations of the zymotic hypothesis.]

Present-Day Zymotic Diseases Are Most Fatal in Low Places

[lxxxiv] The influence of elevation, if not as obvious in other zymotic diseases as it is in cholera, is equally important, for they are all governed by similar laws.

[lxxxiv–lxxxv] Ague and remittent fever.

[lxxxv–lxxxvii] Yellow fever.

[lxxxvii–xc] Plague.

[xc] The human race is now destroyed periodically by five pestilences: cholera, remittent fever, yellow fever, glandular plague, and influenza. The origin, or chief seat, of the first is in the delta of the Ganges; of the second, the African and other tropical coasts; of the third, the low west coast round the Gulf of Mexico or the delta of the Mississippi, and the West Indies; of the fourth, the delta of the Nile and the low seaside cities of the Mediterranean. Of the generating of influenza, nothing certain is known. But from the course of its epidemics, one might be disposed to look for it in Russia. . . .

Five Pestilences, Salubrity of High Places, and the Influence of Locality on Human Races

The [first] four great pestilential diseases—cholera, yellow fever, remittent fever, and plague—have one property in common. They begin and are most fatal on low ground. Their fatality diminishes in ascending the rivers and is inconsiderable around river sources, except under peculiar circumstances . . . . Safety is found in flight to the hills and to the desert, or in the removal of ships from infected ports to the open sea. Large masses [xc/xci] of men—armies, pilgrims, or sailors in foul ships—often carry the epidemic with them to unhealthy places.

The people living on land of a certain elevation above the plains are not only safe from the attacks of cholera, remittent fever, yellow fever, and plague. They are in a remarkable degree exempt from other maladies. Their functions are healthy and their faculties are energetically developed. They present the finest types of the human race. . . . The people bred on marshy coasts and low river margins, where pestilence is generated, live sordidly, without liberty, without poetry, without virtue, without science. They neither invent nor practise the arts. They possess neither hospitals nor castles, nor habitations fit to dwell in; neither farms, freeholds, nor workshops. They are conquered and oppressed by successive tribes of the stronger races and appear incapable of any form of society except that in which they are slaves. Strangers no sooner set foot or attempts to settle on the soil than the endemic terror attacks them as if to bid them begone. If they remain, their institutions, palaces, and monuments fall into ruins as the generations degenerate. . . .

[xcv] The extensive observations which have been collected under the Registration Act, and the calculations in this *Report*, show indisputably that the elevation of the soil exercises as decided influence on the English race as it does on the native races of other climes. The great, striking, practical fact which this inquiry into the mortality of cholera in England has elicited is the influence of slight degrees of elevation. In the vast population of London it is rendered evident. In the part of the parish of Lambeth near the level of the Thames, the cholera destroyed 163 per 10,000 inhabitants; at Kennington, 8 feet high, 90; at Brixton, 56 feet high, 55; and, finally, at Norwood, the highest sub-district of the parish where the inhabitants are

at least 128 feet above the river, only 5 in 10,000. This was not accidental. Elevation within these moderate limits operated with the regularity of a general law. The influence of elevation has been felt all over the kingdom. Everywhere, the low cities have suffered.

[xcvii] All analogy proves that no extensive or permanent degeneration of race can be accomplished in less than two or three generations. The great change is as slow and insidious as it is certain. It is rarely perceived by its victims, who remain rooted and benumbed on the spot unless they and the community are aroused by sudden and terrible catastrophes. That angel which, it would seem, it has pleased the Almighty Creator and Preserver of Mankind to charge with this dread mission is the pestilence. Wherever the human race, yielding to ignorance, indolence, or accident, is in such a situation as to be liable to lose its strength, courage, liberty, wisdom, lofty emotions—the plague, the fever, or the cholera comes; not committing havoc perpetually, but turning men to destruction and then suddenly ceasing, that they may consider. As the lost father speaks to the family, and the slight epidemic to the city, so the pestilence speaks to nations in order that greater calamities than the untimely death of the population may be averted. For to a nation of good and noble men, death is a less evil than degradation of race.

The acknowledged greatness of England has been variously accounted for. It would be illogical to refer it to any single circumstance. Among its primary causes are, however, unquestionably to be classes the character and quality of the race of men—derived in happy proportions from a Scandinavian, Celtic, and Saxon stock—and bred mostly in pure air on the hills and grounds of moderate height, supplied with running water, or on the fertile plains and valleys of an island, pregnant with mineral wealth and well placed for commerce . . . . It is probable that more than one-fourth of the next generation of the English race will be born and bred in insalubrious places, which must in the long run induce degeneracy. The proportion os such births is rapidly increasing. Is it not time, then, to take heed? Are we not on the verge of a great calamity? This question is more than a question of life and death for the people. If degeneration should extend, and large numbers of the English race be divested of its noblest characteristics, their reclamation would be an arduous if not impracticable undertaking. . . .

[xcix] The history of cholera, and the knowledge which we have acquired of the circumstances in which pestilences are fatal, suggest some useful practical rules and works.

Practical Suggestions and Conclusions

1. Persons who have the means may, by an early removal from an *infected district*, always *find safety* in such salubrious districts as . . . had deaths neither from diarrhoea nor cholera in the year, 1849. . . .

2. *Strangers* who can avoid it should not visit a town in an epi-

demic. They appear to be peculiarly liable to an attack. Persons whose duties confine them to an infected town will find that removal from districts in which the epidemic is raging, to high, clean districts of the same town insures a great degree of immunity.

3. In outbreaks where it may be necessary to move large numbers of people, they should be sent to high, dry ground, where good water can be procured. Clean *ships* generally find safety by going out to sea, *armies* by removing from the camp in which they are attacked and encamping on high ground.

4. High places are also generally safe asylums from plague, yellow fever, remittent fever, and ague. It is necessary in the **epidemies**, as it is in cholera, to keep away from marshes and rivers in the lower parts of their course, and to obtain water, if possible, from unpolluted springs.

5. Armies suffer more from cholera on the march, or immediately afterwards, than they do in station. Many instances are adduced from Indian experience . . . .

[c] 6. *Travellers* in unexplored countries should not rest on low, swampy spots. . . .

7. *Intercommunication*. It does not appear that the quarantine has been of any avail in cholera. . . . The circulation of dirty, pestilential ships . . . is not unattended with danger to the health of the community. . . . The futile, superstitious practices of the lazarettos are as contemptible in the eyes of science as they are injurious to commerce. Vagrants are the pestilential ships of the land. They carry diseases and zymotic venoms, as well as vermin and vice, to lodging houses, workhouses, and gaols over the country. This peculiar and degraded race can only be dealt with by special measures.

8. *Food*. The temperate use of sound meat, bread, rice, potatoes, grapes, apples, and other fruit for food—with exercise—and sweet water, beer, cider, wine for beverage, are excellent preservatives in times of pestilence. . . .

9. *Water*. The precautions to take against cholera, in regard to water, are well stated by Dr. Snow. They are of so simple a nature that, considering all the facts, no person can prudently neglect them.

(a.) Water into which sewers flow, or which is navigated by persons living in boats, or which is any other way contaminated by the contents of drains or cesspools, should be entirely disused. (To warn any class of men against the use of unclean, excremental water, even filtered, may appear useless. But it is now known that it enters into the supply of some of the principal cities of Europe and contaminates the eau sucree of Paris as well as the house water of London. The disagreeable, revolting nature of this truth has probably been a cause of its suppression, and the consequent perpetuation of an insufferable nuisance.)

(b.) Hand-basins and towels, with sufficient water, should always be in readiness in the sick person's room, where everyone should observe strict cleanliness. Nurses and other people should invariably wash their hands before touching food.

(c.) The healthy should be separated from the sick, and be removed to another abode when they have no place but the sick-room in which to prepare and take their meals.

(d.) Soiled linen should be immersed in water until it can be scalded and washed. If it should become dry, the matter might be wafted about in the form of dust. (The washing of the linen of cholera patients in the ordinary way is apparently not unattended with danger.)[6]

The sanatory value of pure water, as well as the danger of habitually using water holding organic matter of any sort in solution, has been known from the earliest period. . . . If is a difficult engineering task to place an adequate supply of fresh water within the reach of every householder in the large towns. But the task is of such vital importance that it cannot be neglected. . . .

[cii] 10. *Refuse*. Water, vegetables, hay, grain, cattle, food of every kind, worth many thousands of pounds sterling, are brought from the country every week into the towns of the kingdom. . . . The practice has been to throw the refuse into the streets, to deposit it in cesspools, or to wash it down the sewers into the rivers. The third is the modern practice in England; where the river water is not used [for drinking water, this] is . . . the least evil. But it has these intolerable disadvantages—the sewers invariably emit poisonous vapours, the rivers are polluted, and the organic matter is thrown away. It becomes, then, a great question whether, by the use of ashes, peat charcoal, or some other stuff, a modification of the old system of night men, mechanical arrangements, and the use of the railways and canals, the manure of the towns may not be returned to fertilize the fields of the country in place of guano, for which it is found to be an adequate substitute.

11. *Air*, not stagnant—sweet, pure, and dry, rather than moist—is the healthiest, and is sometimes a preservative against pestilence on ground otherwise unfavourably placed and watered. But pure air and water are almost inseparable, and conversely so are impure air and impure water. . . . The air of London and of many of the large towns if the island is moist and foggy. The low situation of parts of the ground, and the vast extent of the evaporating surface of the rivers, often warmer than the air, are the causes of the excess of fog. . . .

12. *Earth*. If it is important that travellers, armies, and all moving bodies of men should avoid damp, low grounds, it is evidently of still greater

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[6] Slightly altered from Paper on Cholera [*MPC*] by J Snow, . . . [*MT* (13 December 1851): 612].

importance that the habitations of a people should be raised on dry, drained land of a certain elevation, washed by rains, and ventilated by the breezes of heaven. . . .

13. In the *Colonies*, the choice of sites for new towns is a matter of primary importance. The sites lying most conveniently for commerce are often low and insalubrious. As Low shores are more subject to inundations, earthquakes, pestilences, and the influences that deteriorate the English race, the tempting facilities they offer should not weigh against the enduring advantages of high healthy lands. . . .

14. *Climate*. . . . Near the spot which has for many years been the centre and capital of the imperial power of India, the devastating epidemic cholera was generated which has twice ravaged these islands and twice encircled the world. The average mortality of the English troops in India has hitherto exceeded 5 percent annually. The removal of the European population from the low to the high land, railways, vast systems of drainage, and the steady prosecution of the sanatory measures which have been commenced, are required to justify the credit which the Government of India has latterly obtained from enlightenment and beneficence.

15. *The Medical Profession*. . . "No city, perhaps, ever possessed such an efficient body of medical men as are now practising in London. During this epidemic they have performed services which in any other field must have won the highest honors. . . . Nearly all the sick have been seen by these practitioners, yet 12,837 persons have already died of cholera in London. How is this? The medical force will be found to have been employed at an immense disadvantage. It is called into action at the wrong end of the malady. Inquiries prove that while medical advice is generally sought in the characteristic stage, it is seldom obtained in the premonitory stage when the power of medicine is decisive. And to that earlier and still more important period preceding the premonitory stage, which is prevented as easily as cured, medical practice has had little or nothing to say. Cholera here also only shows in high relief what exists in ordinary circumstances. Medical men rarely, if ever, treat the beginnings of diseases and are scarcely ever consulted professionally on the preservation of the health of cities or families."[7]

[cvi–clxxiv] Tables referred to in the foregoing report.

Maps and Diagrams [4 plates]

Part II.—Tables

[1–165. Ten tables showing deaths from cholera, or cholera and diarrhoea,

[7] *Weekly Return of Births and Deaths in London* (15 September 1849).

in various counties and districts of England.]

[166] Notes on Cholera [selections from *Weekly Returns* for London and annual returns from counties in England and Wales]. . . .

St. James, Westminster

[171] 6; 1. St. James, Westminster; *Berwick Street*. Population 10,449—[Deaths from] Chol. 19; Diarr. 23.—This [sub-]district extends from Oxford Street on the north to Coventry. Street on the south. On 18 July, a case of cholera proved fatal at 1 Arches Court; 2 other deaths occurred in this month; in August, 6. An increase took place in September, viz., 10 deaths; the last death on the 23rd of this month, at Pulteney Street. Diarrhoea proved most fatal in the month of July. Peter Street, Queen's Head Court, Pulteney Place, Peter Street, Rupert Street, Noel Street, Richmond Street, etc., are some of the neighbourhoods in which cholera proved fatal. The following notes are extracted from the registrar's reports:

On 20 July at 4 Hopkins Street, a cabman, aged 56 years, died of cholera, 44 hours. This death took place at a common lodging house, consisting of 5 sleeping rooms and containing 24 beds; there are 7 beds in one room, and 6 in another. The deceased . . . was of intemperate habits.

On 20 August at 5 Queens Head Court, umbrella maker, aged 26, cholera 14 hours. A very temperate [171/172] man of weak constitution. In a coal vault and at the back of the house was a large accumulation of oyster-shells and refuse of the same kind, the smell of which was very offensive; they were removed some days before the attack.

On 4 September at 26 Peter Street, son of a labourer (deceased), cholera 24 hours. This child was interred on the same day with its father, who died of cholera a few days before in the hospital. Peter Street is considered very unfavourable to health; mostly inhabited by the lowest description of Irish.

On 21 September at 5 Queen's Head Court, coach-maker, aged 58 years, cholera 15 hours. The deceased was a very temperate man. He moved from 7 Archer street, in good health, the day before his death. The house, 5 Queen's Head Court, not only abuts on the back yards of 2 or 3 of the houses in Little Pulteney Street, but has the wall of an old cesspool projecting several feet into the back kitchen. The brickwork is not only damp, but very often quite wet, and frequently emits a most intolerable stench to the lower parts of the house.

On 23 September at 2 Pulteney Court, son of a house-painter, cholera 3 days. Pulteney Court is most unfavourable to health, the sewers passing under the houses. . . .

6; 3. St. James, Westminster; *Golden Square*. Population 13,612.—Chol. 23;

Diarr. 12.—This [sub-]district is bounded on the north by Oxford Street, on the west by part of Regent Street, Conduit Street, and New Bond Street, on the east by Poland Street, etc., and on the south by Vigo and Brewer Streets.

On 18 May, cholera fatally attacked a milliner residing in Regent Street; the next case occurred 5 July; by the end of the month, 3 deaths were recorded; in August 6; in September 12; after a lapse of 2 months, a solitary case occurred which proved fatal at Great Pulteney Street, on 13 December, to a fringe-maker's wife, aged 70 years; 10 deaths from cholera occurred in the Workhouse, situated in Poland Street, several of whom belonged to other parts of the parish; the number of pauper inmates is about 600. Marshall Street, South Row, Carnaby Street, Little Windmill Street, Little Marlborough Street are amongst the infected localities of this district.

On 5 July at 10 Cross Street, Carnaby Street, a female, aged 38 years, "cholera accelerated by bad drainage, 14 hours" (*inquest*). The registrar states that "deceased was in good health previous to the attack. A full cesspool, which communicates with the drain, became overcharged and was opened for the purpose of being cleansed at the time deceased was attacked, which circumstance is supposed to have accelerated her death. Her husband was likewise attacked."

On 10 August, in Saint James's Workhouse, a servant, aged 30 years, cholera 26 hours. The registrar states that "she left the Workhouse well on the previous Monday to nurse a cholera patient who died the following morning, in Archer Street. Next day, she washed the linen used by the deceased and returned to Workhouse the same evening; attacked the following morning with cholera."

On 31 August at 33 Little Windmill Street, widow of a porter, aged 53 years, cholera 14 hours, suffering many years from diarrhoea. Informant and medical attendant says the stench from a cesspool, drain, and **dust-hole** is most offensive, and was a powerful incentive to this death. . . .

[173] 8; 1. Hampstead; *Hampstead*. Population 10,093.—Chol. 9; Diarr. 11. Includes the entire parish of St. John Hampstead, situated north of Regent's Park.

Hampstead

On 30 July, a female aged 35 years died of cholera. Between this date and 4 September, 9 persons fell victim to the epidemic. The registrar refers to the following cases:

"On 9 August at the Heath, Wesleyan preacher aged 61 years, cholera 8 hours; came to Hampstead with a friend in the morning preceding for a change of air. It appears that the deceased had left his home, Albion Terrace, Wandsworth Road, having lost his wife the day before, his mother and 2 servants within 2 or 3 days in the same house, all from cholera."

"On 27 August at Flask Walk, wife of labourer, aged 46 years, chol-

era 16 hours. Had been attending a youth who was attacked with cholera some days ago."

"On 22 August at Church Lane, wife of wheelwright, aged 48 years, of cholera.Had been attending a family attacked by cholera (*inquest p.m.*)."

[206] 27; 2. St. Olave; *St. John, Horsleydown*. Population 10,665.—Chol. 192; Diarr. 33. Includes the entire parish of St. John, Horsleydown.

St. John, Horsleydown

Cholera prevailed in this [sub-]district, commencing on 12 June at Susanna Place, and gradually increased to 4 and 5 September, on which days the epidemic attained it greatest severity. After 13 September, a perceptible decline continued to 1 October. From this date the locality was free of the disease. The number of fatal cases returned in 3 months were in July, 48; in August, 79; and September, 56. In these three months, the deaths from all causes exceeded the births by 181; 183 deaths were from cholera, and 79 from all other causes.

In the Union Workhouse, 28 deaths from cholera and 13 from diarrhoea were registered during the year, including those removed from the registrar's district of St. Olave, the number of inmates about 340. The epidemic was prevalent in Fair Street, Surrey Buildings, Tooley Street, Freeman's Lane, Gainsford Street, Thomas Street, Vine Yard, etc. In vessels lying off Horsleydown in the river Thames, 3 deaths from cholera occurred, situated nearly opposite the Tower of London. The following notes are selected from the registrar's reports:

"On 13 January at 2 Griffith's-rents, a dressmaker, aged 25 years, cholera 14 hours. The above case occurred in a filthy place, exposed to an open sewer."

"On 13 July at 30 College Street, son of a toy-maker, aged 4 years, cholera 10 hours, convulsions 4 hours. Two street gratings in front of this house, in which 2 cases had previously occurred."

In his return for the week ending 4 August, the registrar states that "no less than 9 deaths have taken place this week in Surrey Buildings from cholera, and other persons are lying dangerously ill. The court contains about 14 houses, which are constantly exposed to the effluvia of an open sewer. The water they drink is from a well, which is not protected from the drainage of the sewers."

"On 15 August at 3 Freeman's Lane, widow aged 64 years, cholera 24 hours. Four persons have died of cholera in this house."

"On 22 August at 22 Fair Street, wife of a currier, neglected diarrhoea one week, cholera 13 hours. Bad sewerage. In the same house on 23 August, a single woman, cholera 26 hours. The complaints of the inhabitants have been numerous for many years past, but especially during the preva-

lence of cholera. More deaths from cholera have taken place in this street than any other place in the parish (Surrey Buildings excepted). Sewers run under every third or fourth house, and the inhabitants are not sufficiently protected from the effluvia thereof."

"On 10 September at 18 Butler's Place, currier aged 37 years, diarrhoea, cholera 3 days. The house is situated close to a burial ground."

"On 14 September at 13 John Street, son of lighter-man, aged 11 years, cholera 18 hours, congestive fever 2 days. Two persons have died in this house, and several in the street. . . .

[216] 32; 1. Wandsworth; *Clapham*. Population 12,106. Includes the entire parish of Clapham, lying between the Battersea and Brixton districts.

On 10 July at 5 Union Street, Larkhall Lane, the first fatal case of cholera terminated in 11 hours. By the end of the month there were 22 deaths; in August, 57; in September, 33; in October, 2, the last case at Park Road on 7 October. The epidemic attained its maximum on 4 August.

Wandsworth, Clapham: Albion Terrace

On this day, 4 deaths occurred in Albion Terrace, Wandsworth Road; 19 deaths from cholera in this terrace are recorded in 17 days, between 28 July and 13 August, both inclusive. The epidemic first commenced at No. 13 on 28 July; in the same house, 4 August, another death occurred. At No. 14, 2 deaths; at No. 6, 5; at No. 12, 2; at No. 2, 3; etc. . . . [In] 13 cases of the above 19 in Albion Terrace, life was extinct in 15 hours after the attack.

The following cases are selected from the registrar's reports:

"On 4 August at Northumberland Place, daughter of a labourer, aged 15 months, cholera 7 hours. The father of the above was at this time suffering from typhus after an attack of cholera. There is a very offensive ditch in front of the house."

"On 11 August at 7 Howard Street, Wandsworth Road, widow of a gardener, aged 55 years, cholera 15 hours. The same offensive ditch runs at the bottom of Howard Street that runs along the back of Albion Terrace. The woman had been nursing in Albion Terrace."

"On 13 August at 2 Albion Terrace, Wandsworth Road, commercial clerk, aged 24 years, cholera 6 days. He was taken ill the same day that his brother died of cholera."

"On 16 August at Northumberland Place, son of labourer, cholera 24 hours. This is the third death that has occurred opposite the ditch, which still remains open and flowing over the road."

On 18 August at 2 Pensbury, Wandsworth Road, stationer aged 28 years, cholera 10 days, hemorrhage from bowels 8 hours. Was first attacked at 7 Albion Terrace, Wandsworth Road, and removed to 2 Pensbury, nearly opposite."

In the house [at] 6 Albion Terrace, Wandsworth Road, 5 deaths were registered from cholera between 4 and 9 August, inclusive—a Wesleyan minister's wife, aged 59; his mother, 80; a widow, 49; and two old servants. The registrar of Hampstead adds that on 8 August, an aged man came with a friend to **Hampstead** for change of air; at 6 o'clock the next morning, he fell ill and had medical advice, but died in eight hours. This old minister [**widower**], aged 61 years, was apparently the last of his family, for he had seen his mother, wife, and servants die before him in Albion Terrace.

A stockbroker died of cholera at 12 Albion Terrace; the daughter of a grocer, a child of 5 years of age, at No. 1; the widow of a coach proprietor and two commercial clerks at No. 2; a gentleman's widow at No. 3; a surgeon's daughter at No. 4; a spinster aged 41 at No. 5; a your woman aged 21 at No. 10; a gentleman at No. 12, where the stockbroker died; a young woman aged 19 at No. 13, where a young woman also died on 28 July; and a gentleman's wife at No. 14, who had sen here daughter die there the day before. Nineteen persons died of cholera; many of the inhabitants of the terrace were dispersed and the deaths of several registered elsewhere. . . . Fourteen deaths by cholera occurred in 5 houses of the above terrace in about a fortnight.