CHOLERA is an extremely unpleasant and potentially fatal disease caused by the bacterium *Vibrio cholerae*. The symptoms are hideous: victims are convulsed with pain, and suffer violent vomiting and uncontrollable watery diarrhoea. Many, if their severe dehydration is not treated, turn blue and die within a short time.

In the 19th century, pandemics of cholera spread out from the Ganges Delta in the Indian subcontinent, killing millions of people around the world. In the latter part of that century, scientists were able to show that cholera is spread when food or water becomes contaminated with faecal matter containing cholera bacteria. Improvements in sanitation have made cholera uncommon in the Western world, but it still poses a threat to many people in parts of Asia, Africa and South America.

In October 1831 a local newspaper in the port of Sunderland in northeast England warned its readers of a dangerous new epidemic heading their way: Asiatic cholera. Its early symptoms, according to the *Sunderland Herald*, included:

> *'a sick stomach … vomiting or purging of a liquid like rice-water … the face becomes sharp and shrunken, the eyes sink and look wild, the lips, face and … whole surface of the body a leaden, blue, purple, [or] black.'*

The reporter noted that there was, as yet, no specific treatment for the disease, but reassured readers that:

> *'the greatest confidence may be expressed in the intelligence and enthusiasm of the doctors … who will surely find a method of cure.'*

Sunderland was hit by cholera in the following months. It went on to attack many other towns in the British Isles, killing over 5000 people in London alone in 1832. It was rife in Asia and Europe, and reached New York City, from where it spread across the whole American continent. This was cholera's first visitation to the western hemisphere and, despite the Sunderland newspaper's optimism, there was no cure.

timeline

1st millennium BC *Ancient Sanskrit, Chinese and Greek texts describe a cholera-like diarrhoeal disease.*

AD 1543 *Portuguese explorers report cholera in India.*

***c.*1817–23** *The first cholera pandemic: the disease spreads from its cradle in the Ganges-Brahmaputra Delta through Asia but does not reach Europe or the Americas.*

***c.*1826–37** *The second pandemic: the disease devastates Asia, North Africa and Europe, reaching England in 1831 and the Americas in 1832.*

1842 *In his 'Report of an Inquiry into the Sanitary Conditions of the Labouring Population of Great Britain', Edwin Chadwick (1800–90) recommends improvements in sewerage, water supply and drainage.*

***c.*1846–63** *The third pandemic: the disease again spreads from India across much of the globe. 1854 is one of the worst years on record.*

1849 *John Snow (1813–58) publishes* On the Mode of Communication of Cholera, *after 50,000 people in England die of the disease.*

1851–2 *The first International Sanitary Conference is held in Paris, with its principal focus on cholera. More such conferences follow.*

A depiction of the cholera epidemic of Paris, which reached the capital in the spring of 1832. The outbreak claimed the lives of 18,000 people in Paris and more than 100,000 in France as a whole.

Tracking cholera pandemics in time and space

The word 'cholera' is derived from the Greek *khol* meaning 'bile', and *rhein*, 'to flow'. The word (or the fuller Latin term *cholera morbus*) had been used since ancient times to describe any sporadic diarrhoeal affliction. However, the devastating and unstoppable diarrhoea that characterized the Asiatic cholera was unlike anything that had been experienced before. Indeed, we now know that its watery contents contain bits of the body's gut as well as swarms of cholera bacteria, and it is rapid dehydration that leads to the shrunken features and the blueish tinge, accompanied by shock and, finally, death.

It is hard to say for sure whether the cholera pandemics that erupted and spread over the globe in the 19th century were different from earlier episodes of *cholera*

1854 *John Snow has the handle of the Broad Street pump in London removed to prove that cholera is transmitted through drinking water that is contaminated with raw sewage.*

1854 *The Italian scientist Filippo Pacini (1812–83) is the first to observe the cholera bacillus; in 1879 he proposes intravenous injections of saline solution as a treatment. His ideas are overlooked.*

c.1865–75 *The fourth pandemic: perhaps the most widespread of them all, spreads from India to affect large parts of the world, including Europe, much of Africa, and the Americas.*

1881–96 *The fifth pandemic: the first in which cholera was identified with certainty as the true cause.*

1883–4 *The German bacteriologist Robert Koch (1843–1910) identifies in Egypt and India the cause of cholera – a comma-shaped bacterium known as* Vibrio cholerae.

1885 *The Spanish physician Jaime Ferrán (1851–1929) tries out a vaccine against cholera, first testing it on himself and then inoculating 30,000 people.*

1899–1923 *The sixth pandemic: cholera spreads from India across Asia and into eastern and southern Europe. It is especially severe in India – where nearly 1 million die in 1900 alone – and also in Russia during the First World War and the 1917 Revolution.*

(continued ...)

'Sur ... We aint got no priviz, no dust bins, no drains, no water-splies, and no drain or suer in the hole place. The Suer Company, in Greek Street, Soho Square, all great, rich powerfool men take no notice watsomdever of our complaints. The Stenche of a Gulley-hole is disgustin. We all of us suffer, and numbers are ill, and if the Cholera comes Lord help us.'

AN APPEAL PRINTED IN *THE TIMES* OF LONDON IN 1849, AS CHOLERA SPREAD THROUGH ENGLAND

morbus. Contemporaries, and historians since, have generally agreed that the origin of the great pandemics of cholera lay in the populous Ganges-Brahmaputra Delta in India (where the disease had probably been endemic for centuries) – hence, the adoption in the West of the term 'Asiatic cholera'. The first pandemic (and there have been at least six more since) began to spread from its natural heartland in 1817 right across Asia. It did not, however, continue to move any further west, and by 1823 it had petered out: many mysteries still surround the sudden eruption and cessation of these pandemics.

It was the second and subsequent pandemics of the 19th century that engulfed nearly all the populated regions of the world. When in the 1830s the disease struck Moscow in Russia, Hamburg in Germany, Sunderland and London in England, Paris in France, Quebec in Canada and New York City in the USA, Asiatic cholera was well and truly on the world map. Carrying a mortality rate of at least 50 per cent, and conveyed unwittingly over land and sea by traders, soldiers, sailors, pilgrims, refugees and migrants, each pandemic (lasting from five to 30 years) followed a somewhat different trajectory. But all who found themselves in the path of the dreaded disease were terrified that they would be its next victim.

THE STENCH AND SQUALOR OF THE SLUMS

Cholera affected young and old, rich and poor, but its striking epidemiological characteristic in the 19th century was its devastating impact on centres of pilgrimage such as the Ganges and Mecca, and on the stinking slums of the rapidly expanding industrial towns of Europe and North America. The shock of the disease – its sudden onslaught and the haste with which death followed – was matched by its foul symptoms. Vomit and profuse diarrhoea produced a sickening and humiliating stench, and when cholera struck the burgeoning towns of Europe and the USA it added one more intolerable smell to the noxious vapours already

timeline

1905 *The Vibrio El Tor strain of cholera is isolated from the intestines of six Muslim pilgrims returning from Mecca and housed in the El Tor quarantine station on the Sinai Peninsula.*

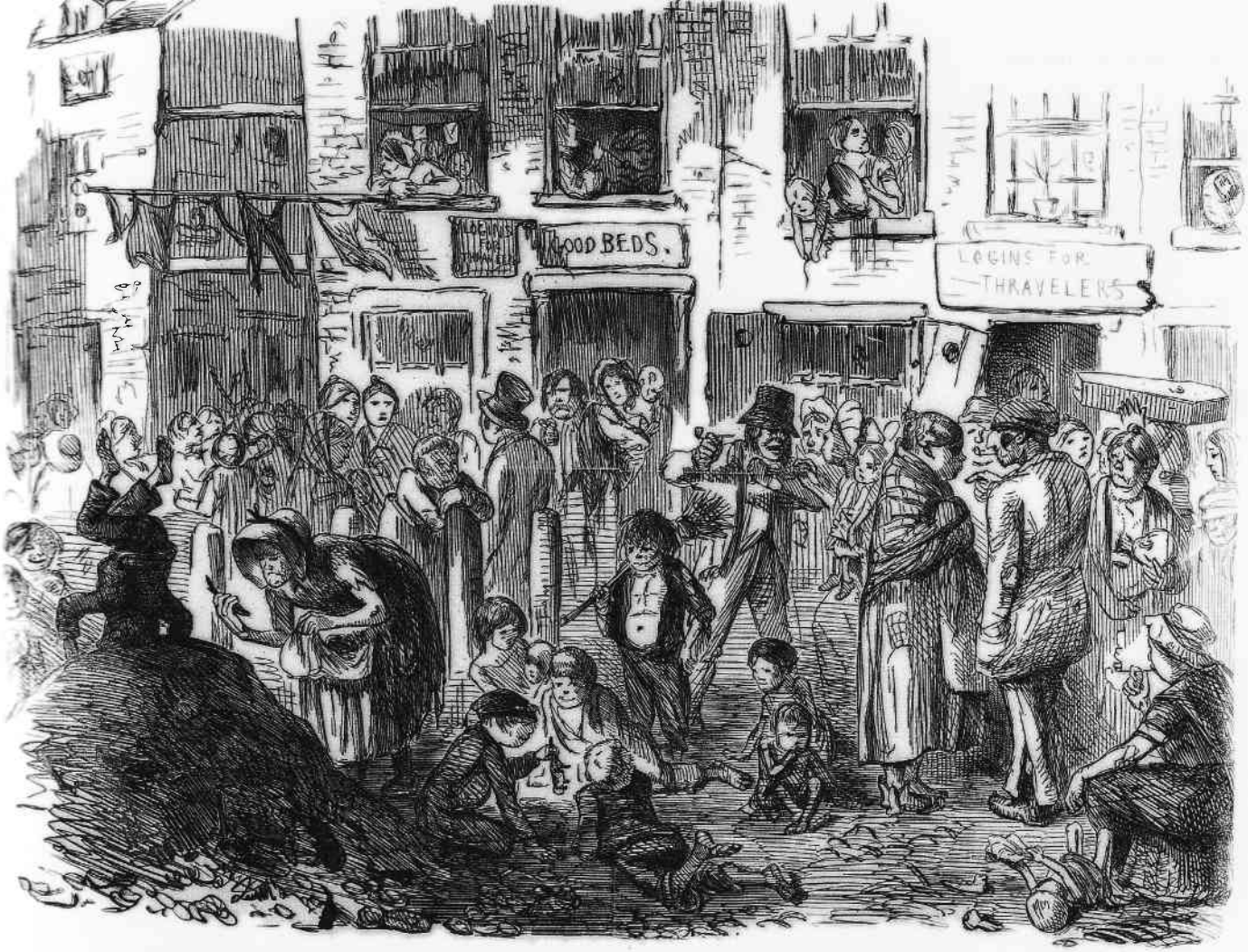
1961–present *The seventh pandemic: the longest ever, and this time originating in Indonesia and largely featuring the El Tor strain. Cholera engulfs most of Asia, the Middle East, Russia and parts of southern Europe. It also spreads to West Africa and South America.*

1970s *Scientists use oral rehydration therapy (ORT) to reduce cholera mortality in the refugee camps during and after the 1971 Indo-Pakistan War.*

1978 *The WHO creates the diarrhoeal disease control programme to popularize the use of ORT.*

1993 *Another new strain of cholera emerges in Asia, called* V. cholerae *1039 Bengal.*

2005 *Fifty-two countries report 131,943 cases and 2272 deaths from cholera. The real figure is likely to be higher, and cholera remains a serious disease in Asia, South America and Africa, and is particularly likely to flare up in times of war, famine and natural disaster. It has also been observed that the cholera organism can live outside the human body in aquatic environments.*



The Court of King Cholera as this 19th century engraving was entitled. The squalid, insanitary conditions that existed in parts of London and other places were a breeding ground for cholera. Words cannot adequately evoke the stenches that assaulted the noses of our 19th-century forebears.

oozing from dung-fouled streets, festering tenements, unwashed bodies, belching factories, stinking slaughterhouses, putrid rivers, overflowing cesspools and open sewers that were so often features of everyday life.

The doctors who sought to understand and deal with cholera were totally confused as to how and why this 'new' disease was spreading. Furious debates ensued. The miasmatists (or anti-contagionists) were convinced that, like other epidemic fevers that afflicted the poor, cholera's root lay in the stench and squalor of the slums. Edwin Chadwick (1800–90), the English social reformer, wrote:

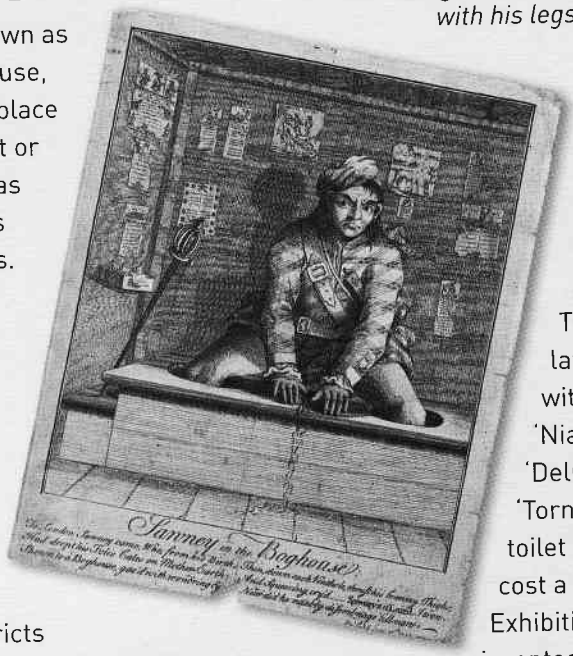
> *'All smell is, if it be intense, immediate, acute disease; and eventually we may say that, by depressing the system and rendering it susceptible to the action of other causes, all smell is disease.'*

William Farr (1807–83), the English medical statistician, said that lethal miasmas were like a mad dog prowling forth from the city's cesspools and sewers. Chadwick, Farr and others in Europe and the USA, including Lemuel Shattuck (1793–1859) in Boston, amplified their arguments with 'sanitary' or 'effluvia' maps and vital statistics that showed a direct correlation between the filthiest, most overcrowded or poorest parts of the cities and the highest mortality rates. In Bethnal Green in London, the average age of death was 16 years in the mid-19th century. In the more 'salubrious' areas, it was 45 years. Infant mortality rates in the worst parts of London, Liverpool, Manchester, Paris, New York and elsewhere were

THE GONG HOUSE

A single privy – variously known as the gong house, bog house, place of easement or temple of convenience – was often shared by as many as 40 people in Victorian cities. Night-soil men (known in Medieval times as gong-fermors) collected the contents of privies from some houses and dung heaps – usually at night. Human excrement was sold and recycled as fertilizer for farmers' fields. Privies in poor districts were rarely emptied, however, and invariably seeped into underground pits or cesspools, from where they eventually contaminated water supplies.

In the early 19th century in London, water closets began to be installed in the houses of the rich. Unfortunately, without a functioning sewerage system to connect to the WCs, their contents often made their way back into the drinking water supplies, making matters even worse.



A man in Highland dress, *seated on a latrine with his legs thrust down the holes in the board, relieves himself in a 'bog house' in this engraving from 1745.*

Thomas Crapper and others later designed new toilets with fancy names such as 'Niagara Falls', 'Waterloo', 'Deluge', 'Rapido' and 'Tornado'. The first paying public toilet in Victorian London – which cost a penny – was at the Great Exhibition in 1851. Toilet paper was invented in the 1860s.

The pure gatherers

One of the worst jobs in Victorian England was that of 'pure-finder'. 'Pure', or decomposing dog dung, was used in 'purifying' or softening leather, and men and women gathered it as a final resort rather than going into the workhouse. A bucketful of 'pure' bought a day's lodging and food.

shocking – as many as one in three or four babies dying before their first birthday. Life expectancy was very low – little more than 20 to 30 years among the working classes. Cleaning up the poverty and squalor, washing the 'Great Unwashed' and sorting out the stenches and foul sanitation of urban and industrial areas were high on the agenda of the 19th-century miasmatists and social reformers.

Their opponents – the contagionists – observed the path of Asiatic cholera as it tracked its way from east to west, from ports to inland towns, via ships, river boats, canals, wagon trains and (later) railways. The contagionists believed that the disease must be transmitted by some poison passed from person to person. The only way to prevent the disease spreading, they argued, was through strict quarantine measures. However, this posed a threat to the commercial activities of the industrializing nations, and international sanitary conferences were set up to debate the question.

There were others who saw cholera as just one aspect of the moral and physical degradation of the working classes. Wherever there was rottenness, drunkenness and uncleanliness, there poverty and disease struck most viciously and – they argued – deservedly. Countering such arguments, humanitarians tried to convince their contemporaries that the poor were diseased not because of their immoral state of mind or body but because they were living and working in conditions of appalling filth, hunger and wretchedness. Cholera, with its spectacularly ghastly effects, was evidence not of moral justice but of human injustice.

In his 1845 book, *The Condition of the Working Classes in England*, Friedrich Engels (1820–95), the German political theorist, described a typical urban scene in Manchester. Everywhere he went he met '*pale, lank, narrow-chested, hollow-eyed ghosts*' cooped up in houses that were mere '*kennels to sleep and die in*':

> *'Passing along a rough bank, among stakes and washing lines, one penetrates into the chaos of small one-storied, one-roomed huts, in most of which there is no artificial floor; kitchen, living and sleeping-room all in one … '*

Engels went on to note the piles of residue and offal, and the constant disgusting stench. Others depicted the miserable conditions of the hordes of people who were crammed into basement rooms through which the effluent from outside privies oozed. Such conditions aroused horror and indignation in Engels and other sympathetic observers.

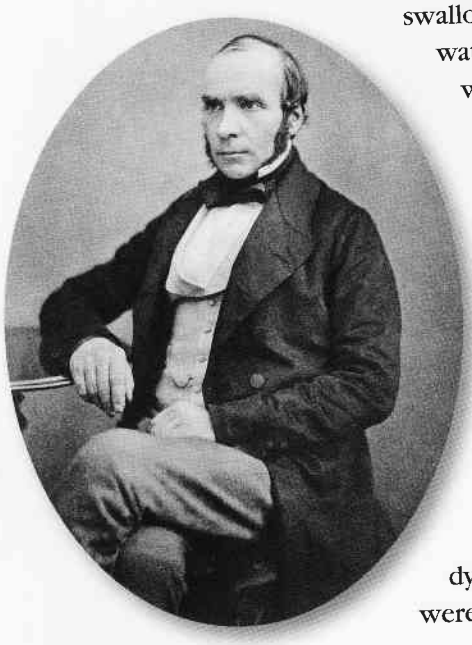
The diseases that afflicted the poor in such slums were numerous – typhus, typhoid, smallpox, tuberculosis, measles, dysentery, infantile diarrhoea, diphtheria, scarlet fever, rickets, whooping cough, bronchitis and pneumonia, to name a few. Many people also met their end in accidents, especially in factories and mines. Some were poisoned by industrial toxins and adulterated food, or exhausted by hard labour and hunger. But it was cholera, with its sudden and dramatic impact, that prompted the greatest concern and confusion. What was its cause and how was it transmitted? As the debates rumbled on, one man found the answer – or thought he had.

A satirical cartoon entitled 'Mistaking cause for effect', from an 1849 edition of *Punch*. The original caption below the illustration read: 'I say, Tommy, I'm blow'd if there isn't a man turning on the cholera'. Many towns in England at the time did not provide piped water to houses. People queued, drew and paid for their water from street stand-pipes, and cholera-contaminated water from such pipes killed many.

Turning off the cholera

In 1849 the satirical magazine *Punch* published a cartoon entitled 'Mistaking cause for effect', in which a young boy turns to his little friend and comments: 'I say, Tommy, I'm blow'd if there isn't a man a turning on the cholera'. In 1854 a British doctor, John Snow (1813–58), attempted to 'turn off the cholera' by requesting the removal of the handle of the Broad Street pump in Soho, London.

Snow had witnessed the horrors of the second cholera pandemic in a village near Newcastle-upon-Tyne in northeast England late in 1831, shortly after its initial outbreak in Sunderland. He later practised in the bustling but squalid Golden Square area of Soho, where he became convinced that cholera might be caused by



John Snow, photographed in 1856. This young, teetotal and vegetarian doctor played a major role in the discovery of the waterborne nature of cholera after observing fatalities around the Broad Street pump in Soho, London, in 1854.

swallowing '*some as-yet-unidentified*' infective particle in sewage-contaminated water. The River Thames was, as Snow observed, in effect an open sewer into which excrement was discharged. In 1849, with cholera once more raging, Snow published the first account of his 'waterborne' theory. Cholera continued to strike, killing perhaps some 50,000 in Britain between 1848 and 1850, and recurring with a vengeance in the following decade. The year 1854 was one of the worst years in the global history of cholera.

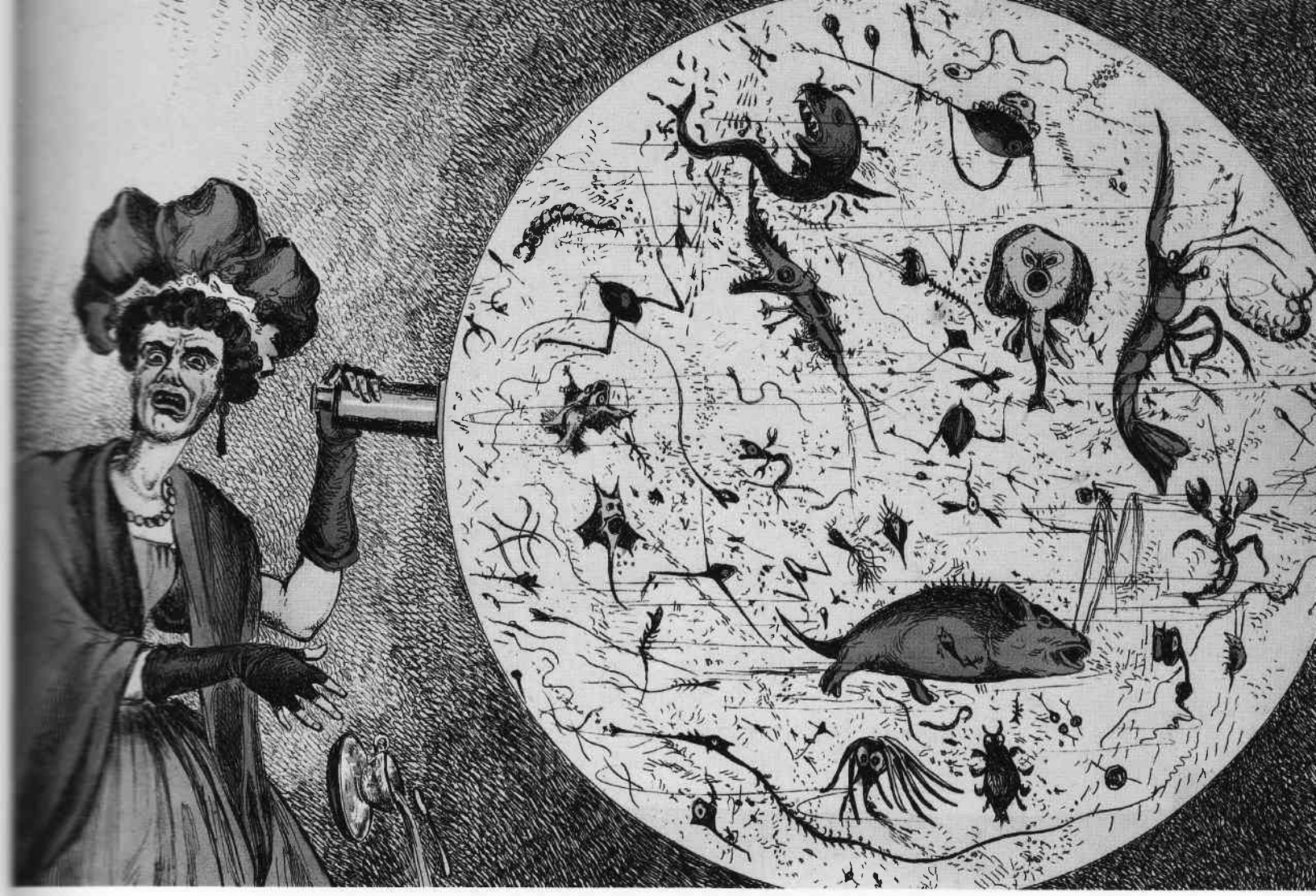
In the oppressively hot August of that year, the baby daughter of Thomas and Sarah Lewis of 40 Broad Street, Soho, London, fell ill with vomiting and green watery stools that emitted 'a pungent smell'. Sarah, desperately trying to cope with her baby's soiled nappies, washed them in a bucket and threw some of the water into a cesspool in the basement at the front of their house. The following day their upstairs neighbours fell ill, and a few days later whole families in the surrounding area began to sicken – often dying together in their dark, squalid rooms. Within ten days, 500 local residents were dead – 10 per cent of the area's population.

John Snow inspected with meticulous detail the drinking habits of the victims of this outbreak. He noted that most of those who caught cholera were drawing their drinking water from the Broad Street pump – which was right outside No. 40 Broad Street. In a nearby workhouse and brewery, both of which had their own private water supplies, there were almost no casualties. On 7 September 1854, two weeks after the local outbreak began, Snow persuaded the authorities to remove the Broad Street pump's handle. Cholera abated.

Where the miasmatists had been convinced that all smell was disease, Snow was now able to pinpoint, in the case of cholera, one particularly noxious source of disease – foul water, not foul air. And while the contagionists had provided a strong case for the infectious nature of the disease, Snow showed that cholera (which affected the intestines rather than the lungs) was not directly transmitted through airborne particles, but by drinking contaminated water. The cycle of cholera was clear, but more subtle than hitherto suspected: what came out one end was flushed into the cesspools or rivers, and the infective particles then made their way back into the pumped drinking water and the gastro-intestinal tracts of its victims.

When John Snow showed Reverend Henry Whitehead (1826–96) his now famous 'ghost' map of the cholera deaths and the location of the water pumps in the Golden Square area, drawn up in the autumn of 1854, he too became convinced by Snow's theory. Whitehead, a young curate who had tirelessly worked to mitigate the worst effects of the outbreak, conducted his own bit of detective work and discovered in the death registers the tragic record of the little baby, who, he subsequently concluded, was the first case and 'cause' of the transmission of cholera. The cause of her death was given as follows:

> *'At 40 Broad Street, 2 September, a daughter, aged five months, exhaustion after an attack of diarrhoea four days previous to death.'*



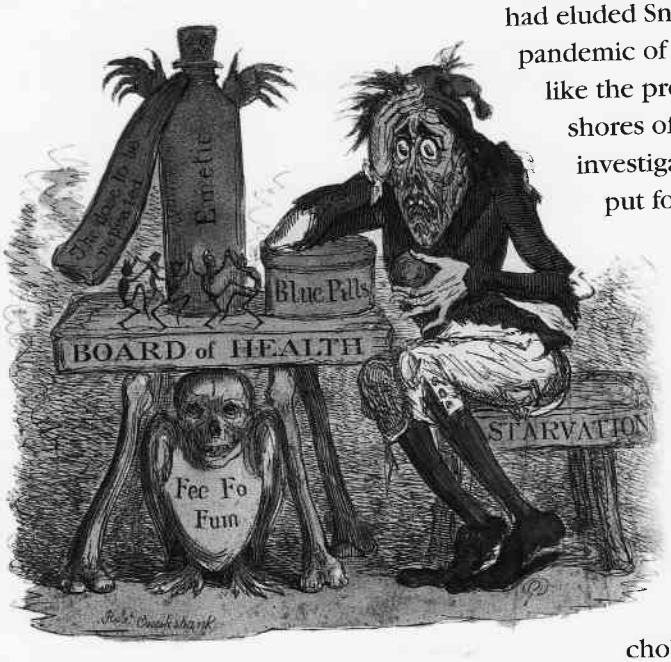
Sarah Lewis, her mother, survived, but the father, Thomas, contracted cholera and died two weeks later. Sarah continued to throw contaminated excreta – this time her husband's – into the cesspool but, fortunately for others, the Broad Street pump had been temporarily turned off.

Today, next to the site of the pump in Broad Street (now Broadwick Street), is the John Snow Pub, which commemorates the significance of Snow's discovery.

Dying for a drink

What in retrospect could have been a 'magic' medical breakthrough was not immediately appreciated, however. Indeed, some (including Snow) thought that by the time the Broad Street pump had been removed, cholera in Soho was already on the wane. Many others expressed scepticism – wasn't this just a coincidence? But, although Snow's clever medical detective work did not in itself lead to a widespread acceptance of his waterborne theory, there were other forces at work that continued to convince 'sanitarians' in many parts of the Western world that the populous towns, as well as the countryside, needed a big clean-up. The 'Great Stink' of London in the summer of 1858, when the House of Commons had to break off its proceedings and soak the curtains in chloride of lime to cover up the stench, showed that the time was ripe for drastic sanitary reform.

Although darkly humorous, this satirical engraving left no one in doubt about what was generally thought to be present in the foul, sewage-laden water of the 19th-century River Thames. The original caption read: 'Microcosm dedicated to the London Water Companies; brought forth all monstrous, all prodigious things, hydras and gorgons, and chimeras dire. A Monster Soup, commonly called Thames Water, being a correct representation of that precious stuff doled out to us!'



Entitled 'A cholera patient', this early 19th-century etching shows a cholera victim experimenting with remedies. Cholera became one of the most feared and terrible scourges to emerge in western Europe after bubonic plague.

It was not until the 1880s that the critical piece of the cholera puzzle, which had eluded Snow and others, was finally fitted into place. The fifth cholera pandemic of 1881–96 spread westward from the Indian subcontinent just like the previous ones had done and, although it did not reach the shores of Great Britain, its severity elsewhere prompted scientists to investigate its cause. German and French bacteriologists had already put forward the so-called 'germ theory' of disease in the 1860s and 1870s, but the 'germ' causing cholera still remained a mystery. This was despite the fact that in 1854 an Italian, Filippo Pacini (1812–83), had observed the microbes that cause cholera in the excreta and intestinal contents of victims. Unfortunately, his valuable work had been overlooked by other scientists.

In 1883, unaware of Pacini's observations, two rival teams – one French, one German – were dispatched to Alexandria in Egypt, where cholera had been introduced by pilgrims returning from Mecca. The French 'Pasteurians' took cholera-contaminated waste and attempted to reproduce the disease in animals. As cholera has no mammalian host outside the human body, their efforts failed, and when one of their team succumbed to cholera they returned to France. The German team, headed by the famous bacteriologist Robert Koch (1843–1910), proceeded down a different route. They performed autopsies on ten cholera victims and there, in the intestines, they identified under the microscope a short, curved, 'comma-shaped' bacillus.

Koch confirmed his findings the following year in the teeming, cholera-infested suburbs of Calcutta, India, where he found the same cholera bacillus (*Vibrio cholerae*) in both the local drinking water and the stools of victims. John Snow had been right – although it is claimed that Koch did not know of his work any more than he was aware of Pacini's. Cholera was, indeed, a waterborne disease, communicated mainly by polluted water and transmitted through the faecal-oral route. But now scientists could 'see' the swarms of bacteria that invaded and multiplied in the guts and gushed out with the watery diarrhoea of its victims. A vaccine, albeit only partially effective against cholera, was developed in the late 19th century. More significantly, Koch's confirmation of the mode of communication of cholera gave a belated and much needed impetus to the authorities to put in place measures for disease prevention and control.

'We prefer to take our chances with cholera and the rest than to be bullied into health.'

THE TIMES OF LONDON (1854), IN RESPONSE TO EDWIN CHADWICK'S PROPOSAL TO PUMP CLEAN WATER FROM SURREY INTO CENTRAL LONDON

Effluence and affluence

Many people, when asked to name the greatest medical breakthroughs of the past, think of such discoveries as the germ theory, anaesthesia, penicillin or vaccination. But in a recent UK poll of doctors and the public, it was in fact sanitation that topped the list of the greatest 15 medical milestones since the

1840s. Turning on the cholera had been easy. Turning it off was more problematic, but improvements in sanitation over the course of the second half of the 19th century and the 20th century in the industrialized world eventually achieved radical gains for the lot of the poor, as well as the rich. In other parts of the globe, the story has been very different. Beginning in the 1960s, a seventh pandemic of cholera (of a new strain known as El Tor) erupted, this time in Indonesia, and spread to many parts of Asia, Africa and South America. Easily and rapidly conveyed by air, land and sea, cholera has taken a huge toll on people living in squalid slums with little access to safe water, and on those forced into overcrowded and foetid refugee camps during natural or man-made crises.

A SIMPLE SOLUTION?

Improvements in sanitation and the provision of safe water are still desperately needed in much of the developing world. There is now, however, one cheap and simple method of treating those who are infected with cholera: oral rehydration therapy (ORT). Originally suggested in the early 19th century and used intravenously from the early 20th century, a simple solution of clean water, salt and sugar – promoted in the 1970s as an oral therapy – can drastically reduce the mortality rate of cholera, from 50–60 per cent in untreated cases to as little as 1 per cent for those given ORT. The cholera bacteria produce and secrete toxins that trick the cells of the intestines into expelling prodigious quantities of water. Dehydration and the resulting loss of essential water and salts lead to rapid death. Antibiotics can help reduce the numbers of *Vibrio cholerae* in the intestines and shorten the period of communicability, but ORT, by replacing the lost fluid and salts, can change cholera from a life-threatening condition to a disease that can be quickly treated at home.

ORT is also invaluable for those dehydrated by other diarrhoeal diseases that afflict many parts of the world. Diarrhoeal and faecal-orally transmitted diseases together account for millions of deaths in the world today. In the 1980s nearly 5 million children under the age of five died each year from diarrhoea. By the 21st century diarrhoea as a cause of death in young children had fallen from 33 per cent of deaths to 18 per cent, and it is estimated that some 50 million lives have been saved over the past 25 years thanks to ORT.

Today, the greatest challenge is how to reach the poorest sections of the population with this life-saving intervention and avoid the 2 million or so preventable deaths from cholera and diarrhoeal diseases every year. 'Sanitation [illegible] ultimate goal for the 21st century.

A COCKTAIL OF CHOLERA

One of Robert Koch's sceptical colleagues, the Munich hygienist Dr Max von Pettenkofer (1818–1901), decided to test Koch's theory that cholera was caused by a germ. He asked Koch to send him his cholera vibrios and put them to the test:

'Herr Doctor Pettenkofer presents his compliments to Herr Doctor Professor Koch and thanks him for the flask containing the so-called cholera vibrios ... Herr Doctor Pettenkofer has now drunk the entire contents and is happy to inform Herr Doctor Professor Koch that he remains in his usual good health.'

Remarkably, Pettenkofer survived his cocktail, which contained billions of cholera germs – enough to infect a whole army. He may have been one of the lucky ones to survive this deadly disease, perhaps he had an excess of 'bile' (stomach acid) which can kill the germs before they do their damage.