

chapter 13

Cholera

Scholars debate whether cholera had long existed on the Indian subcontinent, which encompassed its endemic home—the delta of the Ganges and Brahmaputra Rivers. What matters for our purposes is that by the early nineteenth century cholera was endemic in India but unknown elsewhere until it burst into a major epidemic in 1817. Soon thereafter it moved beyond India, beginning a devastating international career that took it to Europe in 1830. Cholera, then, is the history of seven successive pandemics:

1. 1817–1823: Asia
2. 1830s: Asia, Europe, North America
3. 1846–1862: Asia, Europe, North America
4. 1865–1875: Asia, Europe, North America
5. 1881–1896: Asia, Europe
6. 1899–1923: Asia, Europe
7. 1961–the present: Asia, South America, Africa

At the start of the nineteenth century, the disease was imprisoned in India because the bacterium that causes it—*Vibrio cholerae*—is delicate and does not travel easily (fig. 13.1). During the succeeding decades a number of factors vastly increased the movement of people between India and the West, while revolutionizing the duration of the journey. Three developments were critical: British colonialism, as it set troops and trade in movement; religious pilgrimages and fairs, including the Haj, which took Indian Muslims to

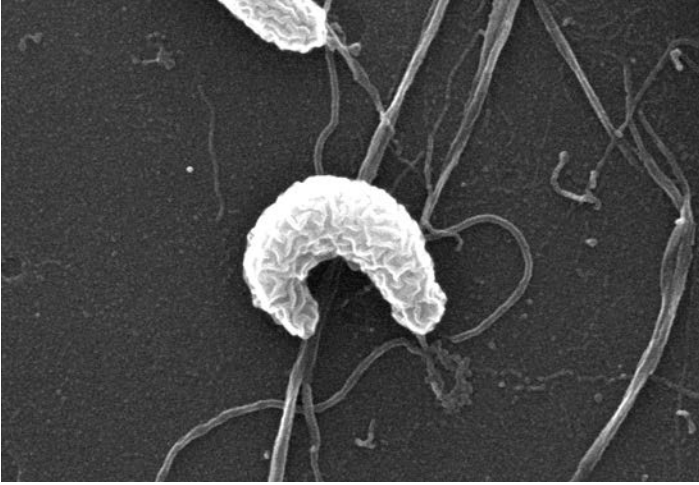


Figure 13.1. Electron microscope image of the comma-shaped *Vibrio cholerae* bacterium, which causes Asiatic cholera.
(Photograph by Louisa Howard, Dartmouth College Electronic Microscope Facility.)

Mecca; and the transport revolution involving railroads, steamships, and the Suez Canal.

These developments enabled the vibrio to gain access to the West, but the bacterium also required welcoming conditions in which to thrive upon its arrival. The epidemic diseases that afflict a community are never purely random. They exploit features of a society that are social, economic, political, and environmental. In the case of cholera—a disease transmitted by the oral-fecal route—the Industrial Revolution and its pathologies created favoring conditions. Cholera thrived on such features of early industrial development as chaotic and unplanned urbanization, rapid demographic growth, crowded slums with inadequate and insecure water supplies, substandard housing, an inadequate diet, ubiquitous filth, and the absence of sewers. When the vibrio disembarked in the port cities of Marseille, Hamburg, Valencia, and Naples, it found ideal conditions awaiting it.

Plague was the most dreaded disease from the fourteenth century through the early eighteenth; smallpox succeeded it in that role during the eighteenth century; and cholera was the most feared disease of the nineteenth century. Indeed, much of the discussion surrounding the early encounters with cholera concerned the question of whether its arrival marked a “return of the plague.” Some of the familiar names given to the disease capture the

horror it inspired—cholera morbus, cholera asphyxia, “the gypsy,” “the monster,” “blue cholera,” and “king cholera.”

Cholera was feared for many reasons. One was its sudden appearance as an unknown invader from the East—indeed, it was called “Asiatic cholera.” It also created alarm because of its gruesome symptoms, its high CFR, its sudden onset, and its predilection for attacking adults in the prime of life. So intense was the terror it inspired that cholera gave rise to a series of societal responses, some of which will be already familiar to readers, that magnified the disruption that it left in its wake—mass flight, riot, social hysteria, scapegoating, and economic disruption.

Since the nineteenth century was an era of acute societal tensions marked by a series of revolutionary outbreaks, it is often dubbed the “rebellious century.” Its passage was punctuated by such drastic social upheavals as the revolutionary wave of 1830, the revolutions of 1848–1849, Italian and German unification, and the Paris Commune. Because of the fact that cholera accompanied these events and indisputably heightened political tensions, it was once common for historians to wonder whether cholera across Europe was a contributory factor in the coming of revolution. It is clear by now, however, that such a view is untenable. The causal chain worked the other way around; that is, the outbreak of revolution, war, and social disorder created ideal conditions for cholera to survive. Cholera moved in the wake of revolution rather than triggering it. Asiatic cholera accompanied the troops who were mobilized to crush revolutions rather than with the crowds that rioted to start them.

Although it is now clear that cholera did not cause the revolutions of nineteenth-century Europe, the pendulum can also swing too far in the opposite direction. Some argue that cholera not only failed to cause revolutions, but even failed to produce a lasting impact of any kind. This assessment holds that cholera was dramatic and led in the short term to considerable sound and fury; but in the long term, its legacy was small and nowhere near the order of magnitude of other epidemics such as plague and smallpox. In order to decide among these conflicting views, we first need to examine the etiology and symptoms of cholera, its treatment, and its epidemiology.

Etiology, Symptomatology, and Artistic Responses

Cholera is caused by the bacterium *V. cholerae*, which was discovered by Koch in 1883 and is famously gruesome in its pathology. In a majority of people who ingest the vibrio, the gastric juices of the digestive tract are

sufficient to destroy the pathogen without ill effect. If, however, the number of vibrios swallowed is overwhelming, or if the digestive process is undermined by a preexisting gastrointestinal disorder, the consumption of over-ripe fruit, or overindulgence in alcohol, then the invading bacteria pass safely from the stomach into the small intestine. There they establish an infection as the vibrios reproduce and attach themselves to the mucous lining of the bowel.

In response, the body's immune system attacks the bacteria, but as they die they release an enterotoxin that is one of the most powerful poisons in nature. Its effect is to cause the wall of the intestine to function in reverse. Instead of allowing nutrients to pass from the lumen of the bowel into the bloodstream, it now permits the colorless liquid portion, or plasma, of the blood to drain into the digestive tract and to be expelled explosively through the rectum.

This loss of blood plasma is the source of the cholera patient's "rice-water stools"—so named because of their resemblance to the liquid present in a pot in which rice has been boiled. This fluid pours forth copiously—at a rate of up to a liter an hour—and it is normally supplemented by further fluid loss through violent retching during which, it is said, fluid pours forth from the mouth like water from a tap. The result constitutes the functional equivalent of hemorrhaging to death through hypovolemic shock.

Violent expulsion of liquid from the digestive tract marks the sudden onset of illness after a short incubation period that lasts from a few hours to a few days. In the extreme case, known as *cholera sicca*, the draining of fluid is so rapid and devastating that the result is instant death. In all patients, the onset occurs without warning so that people are often overtaken in public spaces—associating cholera particularly with fear because the gruesome and painful ordeal of the victim can be a public spectacle. A characteristic that marks the disease apart from others is the rapidity of its course in the human body. Apparently robust and healthy people can finish lunch and die in agony before dinner, or board a train and perish before reaching their destination.

Such sudden seizure also sets cholera apart as an affliction because it bears more resemblance to poisoning than to a "normal" endemic disease familiar to most people. The entire pathology of the disease even resembles the effects of ratsbane—the white, powdered arsenic used to exterminate rodents that was widely used in the nineteenth century. All the tormenting symptoms of the disease were therefore consistent with the idea that perhaps cholera was a crime rather than a natural event. This conclusion was all the

more frightening because there was no cure and nearly half of nineteenth-century victims of cholera perished.

The appalling symptoms of cholera are a direct result of the loss of bodily fluids and the devastating systemic impact that ensues. Nineteenth-century physicians held that the disease passes through two phases after the incubation period ends: the “algid” (ice-cold) stage, and the “reaction” (countervailing) stage. The first is especially marked by high drama and lasts from eight to twenty-four hours, with a terrifying and sudden transformation of the patient. The longer the algid stage lasts, the more dire the prognosis. While fluid drains away, the pulse becomes progressively feebler, blood pressure plummets, and the body grows cold to the touch as the temperature falls to 95 or 96°F. The face rapidly takes on the livid, shrunken aspect of a death mask or a patient after a prolonged wasting illness. Often, it was said, the still living body of the patient is “cadaverized” and unrecognizable. The lifeless eyes are cavernous and surrounded by dark circles and are blood-shot beneath lids that are permanently half closed. The skin is wrinkled, the cheeks are hollow, the teeth recede from blue lips that no longer close, and the tongue, now dry and thick, resembles shoe leather. Unrelenting waves of dizziness, hiccups, and unquenchable thirst add to the torment.

As doctors discovered when attempting to practice venesection, the blood itself turns into a dark tar so viscous that it barely circulates. Deprived of oxygen, the muscles contract in powerful cramps that sometimes tear both muscles and tendons and cause searing abdominal pain. In the words of the Victorian-era cholera expert A. J. Wall: “In extreme cases, nearly the whole of the muscular system is affected—the calves, the thighs, the arms, the forearms, the muscles of the abdomen and back, the intercostal muscles, and those of the neck. The patient writhes in agony, and can scarcely be confined to his bed, his shrieks from this cause being very distressing to those around him.”¹ Often the cramps themselves lead to death as they cause such severe contractions of the laryngeal muscles that they prevent both swallowing and breathing. Patients therefore experience a desperate sense of impending asphyxiation, and they thrash about wildly in frantic efforts to breathe. To both patient and onlooker the experience is all the more painful because the mind is unimpaired and every moment of pain is fully experienced as death threatens from cardiac arrest and suffocation.

Those who survive the algid stage pass into the reaction period, which is comparatively uneventful although the prognosis is no more favorable. The clinical signs of algid cholera subside or are even reversed. Body temperature

risers or gives way to fever, cramps and evacuations diminish, pulse strengthens, and skin color returns. The overall appearance of sufferers suggests that they are on the path to recovery. Unfortunately, however, a severely weakened patient, now frequently delirious, is highly susceptible to a range of complications—pneumonia, meningitis, uremia, and gangrene of the extremities such as fingers, toes, nose, and penis. Most lethal of all is uremia, which accounted by itself for nearly a quarter of all nineteenth-century mortality from cholera. The condition results from the patient's dense blood, which mechanically obstructs circulation through the kidneys and leads to renal failure, suppression of urination, and toxemia.

Even after a patient dies, cholera continues to horrify. A ghoulish aspect of the disease is that, while the living patient resembles a corpse, the dead body of a victim seems alive. A haunting feature of the disease is that it produces vigorous postmortem muscular contractions that cause limbs to shake and twitch for a prolonged period. As a result, the death carts that collected the bodies of those who died of the disease seemed to be teeming with life, triggering fears of malevolent plots and of premature burial (fig. 13.2).

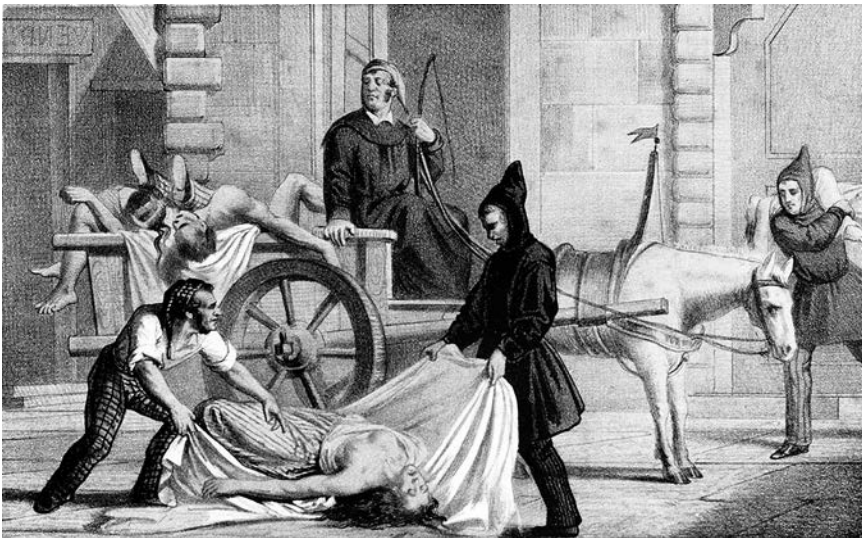


Figure 13.2. Gabriele Castagnola, *Cholera in Palermo* (1835). The dead were loaded onto carts, sometimes with their muscles still eerily twitching. Twenty-four thousand people are said to have died in Palermo during the second world cholera pandemic in the 1830s. (Wellcome Collection, London. CC BY 40.)

In a variety of ways, therefore, the nature of the pathology of cholera powerfully shaped the cultural response to it. This exotic invader from the East was too foul and degrading to give rise to extensive treatment in operas, novels, and paintings in the manner of some other infectious diseases. As we shall see in Chapter 14, tuberculosis generated an extensive literary and artistic production and was perceived as an appropriate starting point for reflections about the nature of beauty, genius, and spirituality. Whatever the reality of the misery tuberculosis caused, it was an affliction of the lungs that wasted the body away in “obedience” to Christian theology and the prevailing “norms” of bourgeois sensibility.

Syphilis also had its romantic devotees. This was paradoxical because the disease was disfiguring, morally troubling, and often lethal. But it struck all strata of society without distinction, and even its dissolute connotations enabled it to provoke levity. Libertines could regard “the clap” as an iconoclastic badge of honor, of free thinking in defiance of hypocritical conventions, and of sexual conquest. The nineteenth-century writers Gustave Flaubert and Charles Baudelaire, for instance, treated the disease with bravado.

Even plague, the most cataclysmic of all afflictions, had its redeeming artistic features. The great mortality it caused was universal in the sense that, unlike cholera, it afflicted all echelons of society from top to bottom, and its symptoms, however agonizing, were not directly scatological. As we have seen, it prompted outpourings of works in all media contemplating the relationship of God to Man, and the meaning of life.

But cholera was an irredeemably filthy, foreign, and lower-class disease. A cholera epidemic was degrading, vulgar, and stigmatizing, both for the victims and for the society that tolerated such squalor and poverty in its midst. In the later pandemics, when the mechanisms of cholera and its oral/fecal mode of transmission were largely understood, the necessary societal remedies were both readily apparent and far from lofty. Sewers, safe water, and flushing toilets were required—not repentance or divine intercession. Similarly, it is impossible to imagine a choleraic opera heroine reaching her denouement while pouring forth her insides onto the stage as a counterpart to the beautiful death of consumptive Mimì in Giacomo Puccini’s *La Bohème*, which premiered in 1896.

Cholera did attract artistic treatment, but in ways that are distinctive and revealing. One narrative strategy was to concentrate on the social impact of the disease while omitting its medical aspects. Thus, in his naturalistic novel *Mastro-don Gesualdo* (1889), which traces the course of cholera

across the island of Sicily, the Italian author Giovanni Verga chose not to enter the sickroom or to explore the suffering of individual patients. In the same spirit the Colombian writer Gabriel García Márquez opted, in his work *Love in the Time of Cholera* (1985), to keep the disease as a looming background presence rather than as a central feature requiring vile description.

Perhaps the clearest indication of the differences that set cholera apart from other epidemic diseases is to contrast two works by the same author—Thomas Mann, who dealt with tuberculosis in *The Magic Mountain* (1924) and cholera in *Death in Venice* (1912). In *The Magic Mountain*, the German author examined every nuance of life in an elegant sanatorium and carefully traced the medical career and intellectual enlightenment of the protagonist, Hans Castorp. When dealing with cholera in the outbreak of 1910–1911, however, Mann presented the disease as emblematic of the final “bestial degradation” of the sexually transgressive writer Gustav von Aschenbach. Revealingly, however, Mann spared von Aschenbach the final indignity of revealing his symptoms, allowing him instead to make medical history by becoming the first cholera patient ever to die peacefully asleep in a deck chair. Similarly, the film director Luchino Visconti did not allow cholera’s gross pathology to intrude upon his cinematically beautiful portrait of Venice in his 1971 movie version of the novella. Cholera is just too disgusting to depict.

Treatments

Throughout the nineteenth century physicians were overwhelmed by the sudden onset, severity, and rapid course of cholera. Nothing in their armamentarium made any significant difference in relieving suffering or prolonging life. In desperate attempts to save their patients, doctors often had to rely on the most experimental and invasive interventions—all to no avail.

Treatment was initially based on humoral principles, especially the concept of the healing power of nature (*vis medicatrix naturae*) and its companion doctrine that the symptoms of a disease were nature’s therapeutics. Hippocratic and Galenic teachings suggested that the violent retching and diarrhea that characterized cholera were the body’s strategy to rid itself of a systemic poison. To assist nature in this effort, physicians administered the most powerful emetics and cathartics known, including ipecac among the former and aloe, senna, cascara, and castor oil among the latter.

Pursuing this medical philosophy, doctors deployed the signature procedure of all orthodox physicians—venesection. Bloodletting then had

numerous advantages. It was systemic, the strategy behind it was clear, it allowed the physician powerful control, and it had the sanction of two millennia of medical practice. A problem with it in treating cholera patients, however, was that they were already losing blood plasma at such a high rate that blood barely flowed and veins were difficult to locate. It therefore became necessary to open major blood vessels, arteries as well as veins.

Since bloodletting in such circumstances proved unproductive, doctors resorted to an array of desperate and experimental procedures. One of these, developed in the 1830s, was promising and, ironically, ultimately provided the basis for modern cholera therapy. This was rehydration. Since it was obvious that cholera patients were losing fluids at a lethal rate, many doctors reversed orthodoxy by replacing fluids rather than augmenting their flow. But simply giving copious drinking water to already exhausted patients caused them to wretch even more violently. Thus its main effect was to hasten death.

A more invasive alternative was what one might conceptualize as reverse phlebotomy—not the draining of fluid from the veins but the administration of water through them. This early form of rehydration, however, did nothing to alter patients' prognoses. Not knowing how much fluid to administer, physicians often overdosed, causing heart failure. Furthermore, since they were unaware of germs and of the need for the water to be sterile, they also induced septicemia.

An additional problem was that of salinity. The natural impulse was to replace like with like by administering fluid that was isotonic—that is, of the same saline level as blood. Unfortunately, however, body tissues absorb fluid only if it is hypertonic—of a much higher salt concentration. The often repeated result throughout the century was that the fluid injected into the veins simply drained into the bowel, enhancing the already profuse rice-water flow.

It was only in 1908 that the British physician Leonard Rogers initiated two additional procedures. The first was constructing a “cholera bed,” which had a large hole in the center and a bucket beneath it to catch the rice-water evacuations in order to measure the loss. He was then able to administer the proper amount of fluid in a gradual drip that avoided sudden cardiac arrest. Equally important was Rogers's second innovation—to use a hypertonic saline solution in distilled water. The body retained this solution, and it did not cause septicemia. These developments halved the CFR of cholera—to 25 percent. A later refinement was the development of oral rehydration by means of packets of salt, sugar, and electrolytes that can be dissolved in a

bucket of clean water. Oral hydration is effective because the glucose in the solution increases the capacity of the intestines to absorb salt and, with it, water. This strategy, which is simple, inexpensive, and easy to administer, lowers mortality still further and has been the sheet anchor of cholera therapeutics since it was widely adopted in the 1970s.

A puzzling question is why rehydration experiments persisted throughout a century of unalloyed failure. The reason is that often unsuccessful rehydration produced seemingly miraculous and tantalizing short-term effects. Even critically ill patients seemed to recover. The agonizing cramps, the sense of impending suffocation, and the loss of body heat all suddenly receded. They sat up in their beds, chatted, and had time to rewrite their wills before the inevitable relapse occurred and the disease resumed its course.

Of all nineteenth-century treatments for epidemic cholera, however, perhaps the most painful was the acid enema, which physicians administered in the 1880s in a burst of excessive optimism after Robert Koch's discovery of *V. cholerae*. Optimistic doctors reasoned that since they at last knew what the enemy was and where it was lodged in the body, and since they also understood that bacteria are vulnerable to acid, as Lister had demonstrated, all they needed to destroy the invader and restore patients' health was to suffuse their bowels with carbolic acid. Even though neither Koch nor Lister ever sanctioned such a procedure, some of their Italian followers nevertheless attempted this treatment during the epidemic of 1884–1885. The acid enema was an experimental intervention that, in their view, followed the logic of Koch's discoveries and Lister's practice. The results, however, were maximally discouraging, and they demonstrate that scientific advancements like the germ theory of disease can have lethal consequences if they are hastily and incautiously translated from the laboratory to the clinic.

Epidemiology and the Example of Naples

Vibrio cholerae, which did not live freely in the environment and had no natural reservoirs other than human beings, depended on the steamship and large-scale movements of people to arrive in the West. It was transported in the guts of crew members and passengers; on their bed linens, clothing, and personal effects; and in their waste. Arriving at a European or North American port city, the microbe was carried ashore or discharged into the waters of the harbor. The first cases broke out typically among people who were exposed to the harbor and those who frequented it, especially during warm weather. These first victims were consumers of raw shellfish that had

feasted on untreated sewage, laundrywomen who washed the clothes of sailors and passengers, and the keepers of inns and restaurants in the city districts near the port. Their misfortune marked the onset of what was termed “sporadic cholera,” which did not denote an epidemic but rather a trickle of individual cases in a neighborhood, family, or house in which the disease was spread directly from person to person. Venice in 1885 provides an illustration of the manner in which such an outbreak could emerge and persist. There it occurred in a single street, where an innkeeper prepared and served food on the ground floor but tended her son upstairs, who had fallen ill with a severe bout of diarrhea and vomiting. Afterwards she returned downstairs, without washing her hands, and filled orders from her customers. In fortunate cases, and Venice in 1885 was just such a place, the outbreak gradually faded away and the city as a whole escaped a large-scale disaster.

Less happily, the disease could move farther afield in spreading chains of transmission when sanitary conditions permitted. Squalid and congested slums provided a welcoming environment. Here the example of nineteenth-century Naples is especially illuminating because the great Italian port was the European city most frequently and heavily scourged by the unwelcome invader from Bengal. Naples, Italy’s largest city, had a population approaching half a million by 1880. Crucially, by that date the city had not yet accomplished its own sanitary reform, and in 1884 it was on the verge of experiencing the most famous of the eight cholera epidemics that devastated it during the “long nineteenth century.”

Occupying a site that resembled an amphitheater fronting the Bay of Naples, the city was divided in two: the Lower City built on the sea-level plain that formed the “stage” of the amphitheater, and the Upper City constructed on the semicircular hills that rose behind it. The Upper City housed the prosperous strata of Neapolitan society in salubrious quarters that were perennially free from the ravages of epidemic disease. Local doctors regarded it as a city apart.

Infectious diseases overwhelmingly afflicted the Lower City, which encompassed four of the twelve administrative boroughs, or *sezioni*, of the city that were notorious for poverty and unsanitary conditions—Mercato, Pendino, Porto, and Vicaria. There, 4,567 buildings housed 300,000 people in a dense maze of 598 streets. Not without reason, the local member of parliament Renzo De Zerbi termed this the “death zone,” where cholera concentrated its fury during every visitation, with a striking overrepresentation of the population of the four boroughs among the dead. In 1837, for example, the death rate from cholera per thousand inhabitants was 8 for Naples

as a whole but 30.6 in the borough of Porto. Identical patterns reappeared in 1854, 1865–1866, 1873, 1884, and 1910–1911.

Cholera, in other words, was unlike diseases such as tuberculosis, syphilis, influenza, and plague, which afflict all classes of society. Cholera's mode of transmission via the oral-fecal route marked it as a classic example of a "social disease," with a preference for inflicting the poor in environments with substandard housing, insecure water supplies, congestion, unwashed hands, malnutrition, and societal neglect.

Of these urban maladies, overcrowding was the most evident in Naples. Part of an ancient city tightly bounded by hills, marsh, and sea, Lower Naples by the nineteenth century had no further room for expansion. Furthermore, the impact of the sheer press of population numbers was greatly augmented by a politics of *laissez-faire*. The city had no growth plan, housing code, or sanitary regulations. Thus, caught in a building mania, the Lower City witnessed its gardens, parks, and open spaces disappear beneath an avalanche of stone. Towering tenements pressed so tightly together on both sides of narrow streets that three people could barely walk abreast and the sun never reached ground level. Hastily constructed, many buildings were in such advanced disrepair that they resembled heaps of broken masonry: "A typical example was the Vico Fico in the borough of Mercato. Permanently festooned with drying linen that dripped on pedestrians below, it measured fifty meters in length and three in breadth, with buildings thirty meters tall. Even in mid-summer, mud and moisture were omnipresent, and an evil black stream wound its way slowly down the center of a lane that no official of the city ever visited."² Unsurprisingly, visitors described Naples as the most shocking city in Europe—a place of such height, Mark Twain wrote, that it resembled three American cities superimposed one on top of another. Everywhere there were "swarms," "thongs," "masses," and "multitudes," such that every alley resembled Broadway in New York.³

But more striking still than the outdoors were the building interiors. In the words of an article published in the *British Medical Journal* in 1884, these "squalid" and "obscene" slums were the worst in Europe—bearing comparison only with the foulest habitations of Cairo. So savage was the overcrowding that in the Vico Fico the average size of a room occupied by seven people was only five square meters, and the ceilings were so low that a tall person was barely able to stand erect. Two straw mattresses covered the floor in such apartments, each providing sleeping accommodation for several occupants. Frequently in such a rookery, the inhabitants shared their space with chickens that helped maintain their subsistence-level lives.

Clearly a space of this kind was fatal to health because the sickroom served simultaneously as bedroom, kitchen, pantry, and living space. Bacteria had ample opportunity to spread directly from person to person on unwashed hands, linens, and utensils. Furthermore, food was stored in the same cramped room and was readily contaminated by a patient's evacuations. Rice-water stools were not easily detectable on a surface, especially in the semidarkness of a Neapolitan tenement.

John Snow, who first deciphered the epidemiology of cholera in London in the 1850s (see Chapter 12), stressed the danger posed to the working classes who lived in cramped and unsanitary accommodations. Since cholera evacuations have no color or smell, and since light in tenements is dim, soiled linens inevitably lead to soiled hands that are seldom washed. Therefore, those who tend a cholera patient unknowingly swallow a portion of the dried stools, and they then pass the material to everything they touch and to those with whom they share food or utensils. Thus, Snow argued, a first case of cholera in such an impoverished family leads rapidly to other cases.

The lack of facilities for cleaning enhanced the danger. Living quarters in the Lower City lacked running water and connections to the sewer system, so that personal hygiene was much neglected and the rooms were covered in a patina of human and animal filth. And, in defiance of contemporary doctrines of miasma, slops were simply dumped into the alleyway outside, giving rise to a pervasive stench and clouds of flies that also conveyed bacteria from space to space. Inevitably, such dwellings were infested with rats and every species of vermin.

Most notorious of all were the tenements known as *fondachi* that were interspersed through the slums of the Lower City and housed some one hundred thousand people. To contemporary visitors, these represented the depths of human misery. The Swedish doctor Axel Munthe, who served as a volunteer in the epidemic of 1884 and possessed a thorough knowledge of the Lower City, described the *fondachi* as "the most ghastly human habitations on the face of the earth."⁴ As if to confirm Munthe's assessment, the *Times* of London described a representative tenement thus:

Imagine the doorway of a cave where on entering you must descend. Not a ray of light penetrates into it. . . . There, between four black, battered walls and upon a layer of filth mixed with putrid straw, two, three and four families vegetate together. The best side of the cave, namely that through which humidity filtrates the least, is occupied by a rack and manger to which animals of

various kinds are tied. . . . On the opposite, a heap of boards and rags represents the beds. In one corner is the fireplace and the household utensils lie about the floor. This atrocious scene is animated by a swarm of half-naked, dishevelled women, of children entirely naked rolling about in the dirt, and of men stretched on the ground in the sleep of idiocy.⁵

Thus a variety of household factors enabled the vibrio to spread in the tenements. Additionally, the southern Italian port was vulnerable through the practice of sewage farming that made market produce a risk to life and health. As in many nineteenth-century European cities, gardeners in the Neapolitan hinterland made trips to the city in the early morning hours to collect human and animal waste from the streets to use as fertilizer. As a result, the vegetables later sold at market stalls grew in untreated human waste and conveyed *V. cholerae* on their return trip to the city in the gardeners' carts. A further grower's artifice increased the danger. A common technique was to dip lettuce and other leafy produce in open sewers on the way to market as the ammonia in urine freshened the leaves for market. Those who consumed such produce were highly vulnerable to infectious diseases.

The notorious overpopulation of the city relative to resources had the additional result of severely depressing wages and destroying the bargaining power necessary for workers to establish trade unions. The poverty of southern Italian agriculture yielded a continuous stream of immigrants to the city, and every poor harvest or fall in the price of wheat quickened the flow. Thus, despite the near absence of an industrial base or secure prospects for employment, Naples was a never failing magnet for the destitute of the countryside. In the words of Girolamo Giusso, director of the Bank of Naples and later minister of public works: "Although Naples is the largest city in Italy, its productive capacity bears no direct relation to the number of its inhabitants. Naples is a center for consumption rather than for production. This is the principal reason for the misery of the populace, and for the slow, almost insensible, increase of that misery over time."⁶

According to assessments by the US Department of State, average Italian wages were the most meager in Europe, and Neapolitan wages were the lowest among major Italian cities. An average industrial worker's earnings were not sufficient, according to the American Consul, to permit the annual purchase of a change of clothing. During the normal ten- to twelve-hour workday, an unskilled male worker earned no more than the cost of four kilograms of macaroni. Four days of work were needed to purchase a pair

of shoes. But such workers held relatively privileged positions—as dockers, engineering workers, metallurgical workers, and employees of the railroads and trams. They were fortunate in having stable employment.

Descending farther down in the social pyramid, one encountered a multitude of men and women occupied in an array of tiny, undercapitalized workshops that were caught in a downward spiral of decline as a result of competition from machinery and from the influx of migrants. In their ranks were cobblers, seamstresses, blacksmiths, bakers, porters, tanners, and hatters who lived from hand to mouth. There were also domestic servants, porters, and fishermen—too numerous for a polluted bay that had been overfished for generations by means of nets with a fine mesh.

More straitened still were the circumstances of those who earned their livings directly in the streets—hawkers of newspapers; peddlers of chestnuts, candy, matches, and shoelaces; messengers; washerwomen; water carriers; and private trashmen who emptied cesspits and removed domestic waste for a fee. They eked out a subsistence by peddling wares and their labor in a bewildering variety of roles that baffled specification. They were termed “micro-entrepreneurs” by some economists, and they formed a large floating population that was a distinctive feature of the city. It was they who provided Naples with its appearance of being a vast emporium. Frequently they lived seminomadic lives, roaming the city in a constant process of reinventing themselves and their jobs.

Most indicative of the degree of Neapolitan poverty, however, was the largest and most abject social stratum of all: the permanently unemployed. Members of the city council noted that of a population of half a million people, two hundred thousand (40 percent) were out of work. They woke in the morning not knowing when they would next eat. It was their misfortune to furnish Naples disproportionately with its beggars, prostitutes, and criminals—and victims of disease. Their poverty was directly linked with a vulnerability to cholera because malnutrition and undernutrition contribute to infectious disease by lowering resistance and undermining the immune system.

With specific regard to cholera, an important factor was that the poor lived in good part on a diet of overripe fruit and rotting vegetables as the cheapest produce available. But such a diet also caused gastric disturbances and diarrhea, which predisposed their sufferers to cholera by reducing the time of digestion. This was critical because the acidic environment of the stomach destroys bacteria and is the body's first line of defense against *V. cholerae*. As we have seen, preexisting digestive problems allowed the vibrio

to survive passage through the stomach and to enter the small intestine still alive.

Clearly, once having gained access to the impoverished boroughs of the Lower City, cholera had ample means to spread from person to person and from tenement to tenement in clusters of “sporadic cholera” cases. What transformed such sporadic appearances of the disease into an explosive, generalized epidemic was the contamination of water supplies. Here too there was a major difference between the Upper City and the Lower City, as residents from the two areas drank from different sources. In the Upper City, the population relied on rainwater collected and stored in well-maintained private tanks. In the Lower City, people turned to more hazardous supplies. Most important were three aqueducts that delivered forty-five thousand cubic meters a day of severely polluted water. The Carmignano aqueduct illustrates the perils. It conveyed its supply of water forty-three kilometers from springs at Montesarchio. This water flowed across the countryside in an open canal, traversed the town of Acerra, and then flowed again across the fields to the gates of Naples. There it divided into branches that fed the two thousand cisterns of the Lower City. By lowering buckets into the tanks, which were usually located in courtyards, the inhabitants quenched their thirst and met domestic needs.

But every point from source to storage tank provided opportunities for contamination. Leaves, insects, and debris were blown into the uncovered canal. Peasants retted hemp in the stream, laundered garments, and disposed of household waste and the carcasses of farm animals. Meanwhile, mud and manure from the fields seeped through the porous stone or drained directly into the canal after a rain. Worse still, the aqueduct branch lines and the sewer mains ran parallel beneath the city. Since both were made of porous limestone, their contents slowly intermingled. Often the water arrived brown and thick with sludge that finally settled at the bottom of courtyard cisterns.

There, the contamination continued. Built of limestone like the aqueduct, the water tanks allowed surface water to percolate through the soil and into them. In the many buildings where cesspits were placed adjacent to the tanks, the bacterial exchange was immediate and overwhelming. Tenants, in addition, were not always careful when emptying their slops. Always poorly maintained, the cesspits frequently overflowed, allowing their contents to join the water already in the tanks. Even the final collection of water in household buckets had medical relevance. Rarely washed, they lowered their cargo of germs into the supply even more readily than they raised the waiting water, which was brown, malodorous, and teeming with surprises.

For all of these reasons, water from the cisterns of the Lower City had an evil reputation, which was augmented by its discouraging smell and visible contents. Ground-floor residents, for whom it was easiest to transport water, often reserved the cisterns for household purposes and fetched drinking water from more distant and less suspect public fountains. Residents of the upper stories, for whom carrying buckets of water was an onerous chore, made more extensive use of the cisterns and paid a heavier tribute in death and disease.

In the Neapolitan urban environment, which differed only in degree from the norm of major European cities in the nineteenth century before the sanitary revolution, cholera followed a typical pattern. After arriving in the warm spring or summer, it first broke out in scattered clusters of sporadic cholera that were often unnoticed by the authorities of a city where few inhabitants ever saw a doctor or a municipal health official. Thus the disease spread, perhaps for days, in neighborhood chains of transmission, until the vibrio gained access to the water supply. Then, as John Snow demonstrated in London, a major epidemic could erupt violently, claiming its victims preferentially among the impoverished and unsanitary boroughs of the Lower City. At the height of the most savage epidemics, such as those of 1837 and 1884, as many as five hundred people died of this one cause in a single day, invariably in the heat of summer when people drank most plentifully to quench their thirst.

Why the disease then slowly declined after a period of weeks and finally faded away is not fully understood and remains what Robert Koch termed one of the many “cholera mysteries.” Certain factors are likely to have played a significant role, however. One is seasonality. Like other gastrointestinal pathogens, *V. cholerae* is not hardy in cool temperatures, and people drink less copiously in autumn than in summer. In addition, the vibrio can survive for an extended period in perspiration, so a change in the weather can make an appreciable difference in the number of cases. In the autumn people also consume less overripe fruit. And as we have stressed, the whole of the population is not equally vulnerable. The peak of an epidemic coincides with the affliction of those who—by reason of occupation, housing conditions, the presence of prior medical conditions, dietary habits, and physical constitution—are most at risk. Those who remain unaffected possess some degree of resistance. Having attacked people who are most vulnerable and most exposed to danger, cholera then behaves like a fire that has run short of fuel.

In addition to such “spontaneous” reasons for the decline of a cholera epidemic in a community, the health policies adopted by municipal and

national authorities during the nineteenth century probably also played an appreciable role, sometimes positive but often not. In the first pandemic to reach the West in the 1830s, the first reaction of states was to impose coercive plague measures of self-defense by means of sanitary cordons and quarantine. The Italian government even resorted to such policies in 1884 in a desperate bid to seal its borders against microbes. Both in the 1830s and the 1880s, such a strategy proved counterproductive as it served only to spread both cholera and social disorder by inducing large-scale flight and devastating the economy. Antiplague measures were therefore abandoned in the face of cholera.

Other policies adopted during the course of cholera epidemics were more positive in their effect. Voluntary and municipal services, for instance, were instituted in some places to distribute assistance in the form of blankets, food, and medication. In addition, municipalities banned mass assemblages of people, regulated burials, organized campaigns to clean up streets and empty cesspits, lit sulfur bonfires, closed workshops that produced noxious odors, and opened isolation facilities for the stricken.

Which factors were decisive, and to what degree, is unknowable. Cholera epidemics, however, proved self-limiting, and after weeks of high drama and suffering, they ebbed and faded away. In Naples, the first cases of the epidemic of 1884 probably occurred in the second half of August; the disease flared up in full force at the beginning of September; and the last victim was interred on November 15. Besieging the city for two and a half months, the disease claimed approximately seven thousand lives and sickened fourteen thousand people.

The Terror of Cholera: Social and Class Tensions

The passage of cholera through a city heightened social tensions and frequently triggered violence and revolt. One reason was the striking inequality of the burden of suffering and death, which, as we have seen, fell overwhelmingly on the poor. To many, however, this apparent immunity of the prosperous seemed mysterious and suspect. Why were doctors, priests, and municipal authorities able to move with impunity while visiting patients and enforcing protective health regulations in neighborhoods where so many around them suffered and died?

Sound epidemiological reasons explain such invulnerability. Those who intervened from outside in the midst of the emergency did not in fact share the conditions of those who lived in the area. Cholera is not transmis-

sible except in a very specific manner that rarely exposed visiting members of the municipal government, the medical profession, and the church to serious risk. Those officials did not live in the tenements they visited. They did not take meals or sleep in the sickroom, or drink from cisterns in the courtyards. In addition, they ate a diet that did not include fruit, vegetables, or seafood from local markets; and they washed their hands.

To already frightened residents, however, much seemed suspect, and rumors easily spread that the visitors were the agents of a diabolical plot to destroy the poor in a literal class war. The symptoms of cholera and its sudden onset, after all, suggested poisoning, as did strict burial regulations that excluded the community and caused the bodies of family members to be taken unceremoniously away while their limbs still stirred with apparent signs of life. Why, in any case, were outsiders suddenly interested in the health and habits of the poor when they had never been seen before? The concept was baffling. Furthermore, as the disease suddenly surged in a community, it seemed that the more frequently outsiders intervened, the more intense the epidemic became. Causation and correlation were conflated in the minds of those who suffered the most.

But in Naples in 1884, perhaps the most important lesson in the plausibility of popular conspiracy theories was the behavior of the municipal officials during the early weeks of the outbreak. The city sent teams of people who would now be termed health-care workers and disinfection squads, but they conducted themselves almost like an army in enemy territory. Making a great show of force, they arrived at tenements with weapons drawn, sometimes at night, and ordered distraught tenants to surrender critically ill relatives to undergo isolation and treatment at a distant hospital that was rumored to be a death house. The teams also compelled families to surrender precious linens and clothing to be burned and to allow disinfectors to fumigate and cleanse the premises. The behavior of city personnel was so unnecessarily high-handed that it was universally condemned by the press, which admired their zeal but criticized their methods. As the mayor later admitted, the procedures he had approved served above all to spread distrust and resistance.

It seemed implausible to residents that the city was acting for their benefit. The population drew its own conclusions, and it is hardly surprising that the press reported that the Lower City seethed with “class hatred” and that officials complained about what they saw as “the indescribable resistance opposed by the lower classes to the measures intended for their salvation.”⁷ An important and recurrent expression of popular resistance was ritualized

public defiance, which took a variety of forms. One was dietary. The city had posted notices giving advice to avoid unripe or overripe fruit. It then attempted to enforce this admonition by a rigorous inspection of market stalls and the confiscation and destruction of suspect produce. Neapolitans responded by holding a series of public dietary demonstrations. Crowds gathered in front of city hall, where they set baskets of figs, melons, and assorted fruit on the ground. Demonstrators then proceeded to consume the forbidden fruit in enormous quantities while those who watched applauded and bet on which binger would eat the most. All the while they shouted defiant epithets at officialdom.

Alternatively, people obstructed municipal workers as they attempted to combat the epidemic by means of purifying sulfur bonfires. To the population the fires were abhorrent because the pungent fumes were irritating and they drove armies of sewer rats into the streets. A French volunteer during the emergency wrote:

I shall never forget . . . the famous sulphur bonfires. In ordinary times fresh air is in short supply in the Lower City; with the arrival of cholera, it became impossible to breathe even on the highest point of Upper Naples. As soon as evening fell, sulphur was burned everywhere—in all the streets, lanes, and passages, in the middle of the public squares. How I hated those sulphur fumes! The sulphuric acid cauterized your nose and throat, burned your eyes, and desiccated your lungs.⁸

Citizens therefore gathered to prevent the workers from carrying out their assignments and to extinguish the flames as soon as they were lit.

Similarly, the residents of the Lower City flouted municipal regulations banning public assemblies. Processions of hundreds of penitents wearing crowns of thorns and bearing images of saints marched through the borough streets and refused police orders to disband. When traditional festival days of local saints arrived in September, the people observed the occasions in the usual manner marked by crowds and excesses of fruit and wine.

More conflictual was the opposition to the public health regulation that all cases of gastrointestinal disorder, that is, diarrhea, be reported to city hall. Here municipal and borough authorities met a resolute barrier of noncompliance. An epidemic of concealment confronted the epidemic of cholera. Everywhere in the Lower City families refused to inform city hall that a case

of the disease had broken out in their midst, and they protected their possessions from the purifying flames. When physicians and their armed guards nonetheless appeared unasked, tenants denied them entry and barricaded themselves in their rooms. People preferred to die where they were rather than to entrust themselves to the care of strangers. On numerous occasions a crowd gathered and forced unlucky physicians to open their phials of laudanum and castor oil and to swallow the contents that residents thought were poisons.

Physical violence often followed. The arrival of physicians and armed escorts easily unleashed a fracas. Hostile crowds assembled to confront the outsiders, hurling epithets and accusing them of murder. Sometimes doctors and stretcher-bearers were handled roughly—pushed down stairs, beaten, or stoned. Local newspapers were filled during the emergency with accounts of “tumults,” “mutinies,” and “rebellions”; the population of the Lower City were called “beasts,” “rabble,” “idiot plebeians,” and “mobs.” The mayor noted that many guards and doctors were injured by missiles hurled by angry residents.

On some occasions unwanted medical interventions ignited full-scale rebellions. One example occurred in the borough of Mercato when the outbreak was just gaining force. On August 26 the municipal doctor Antonio Rubino and a police escort were sent to examine a stricken child in a notoriously unhealthy tenement. There a crowd armed with cobblestones greeted them and shouted, “Get them! Get them! They’ve come to kill us!”

Rubino and his guard were rescued by the arrival of military police summoned by a passing street-sweeper. By then the swelling crowd numbered several hundred, and the arrival of the troops only inflamed the situation. People who had come to assault the doctor now vented their fury by stoning the soldiers. A street battle unfolded, and the troops gained control only by drawing their weapons and opening fire.

An equally revealing and fortunately bloodless event happened a day later when a grocer named Cervinara lost his young son to cholera at the Conocchia Hospital. Grief-stricken and convinced that the child had been murdered, Cervinara and his brothers took up arms and forced their way onto the wards with the intention of killing the attending physician. The intervention of the chaplain saved the situation. He calmed the brothers and talked them into surrendering their weapons to the orderlies. Their action ended the first of several invasions of the cholera wards intended to liberate relatives who were still alive or to avenge the deaths of those who had perished.

Cholera hospitals rapidly became the scenes of full-scale riots as the epidemic reached its peak in September. By that time the Conocchia Hospital was filled to capacity and the city had opened two new facilities—the Piedigrotta and the Maddalena. These institutions were anathema to the neighborhoods in which they were located. Cholera hospitals were the most dreaded feature of the municipal campaign to contain the epidemic. Neapolitans regarded them as places of death and horror from which no one ever returned. At a time when miasmatic theories still prevailed, these institutions were considered a danger to everyone because of the lethal effluvia that emanated from them. It seemed clearly malevolent to place sources of poisonous gas in the midst of densely populated neighborhoods.

At the Piedigrotta, a former military hospital converted to treat infectious diseases, opening day on September 9 sparked an insurrection. A crowd gathered around the facility and forced the first stretcher-bearers to drop their charges on the ground and withdraw in haste. Encouraged by initial successes, the throng grew in size and purpose. Intent on frustrating the plans of city hall, residents hastily erected barricades and armed themselves with paving stones, sticks, and firearms. When the police arrived in force, a pitched battle ensued until, having sustained heavy injuries, they withdrew and were replaced by mounted police who attempted to force a passage and were also beaten back. Calm was restored only when parish priests intervened as mediators, bearing the welcome news that the people were victorious and the city would not force the issue by opening the hospital.

Identical scenes followed a week later with the opening of the Maddalena Hospital. Stretcher-bearers were met with violent opposition, and residents gathered at the windows of the upper stories and hurled tables, chairs, mattresses, and stones at the hapless porters below, some of whom were seriously injured. The crowd again barricaded the streets and forced the city to cancel the hospital's opening.

Meanwhile, mutinies broke out in both of the city's prisons, where the inmates concluded that they had been left to die. Detainees attacked the guards and seized the wardens in separate and uncoordinated but almost simultaneous riots. Prisoners attempted to force the gates and opened fire from the roofs. Only the full-scale intervention of the army in battle gear restored authority and order.

Such pervasive and violent opposition to the city's public health program prevented the plan from being implemented as every municipal initiative provoked a violent backlash and drove Naples to a state of near anarchy. The *Times* of London commented that the port was afflicted with

something worse than cholera—“medieval ignorance and superstition.”⁹ In mid-September the secular mayor of the largest city in a kingdom that the papacy had condemned appealed to the cardinal archbishop of Naples for help. Through this unprecedented cooperation of church and state in Italy, a public health plan was slowly deployed—under new auspices and without further displays of force.

The city was also assisted by the arrival of a thousand volunteer health workers organized by a nongovernmental organization founded by private donors and philanthropists to combat the Neapolitan emergency. The White Cross functioned as a nineteenth-century precursor to the present-day Doctors without Borders. Its mission was that of emergency response—to treat patients in their homes and to provide assistance to their families. An international agency with no ties to Neapolitan or Italian authorities, it rapidly gained the trust of the population, calmed social tensions, and cared for a significant proportion of the victims of the 1884 calamity.

Many European cities struck with cholera suffered events similar to the tumults in Naples. Suspicions did not run solely in one direction, however; the “rebellious” century was a time when fear among the social and economic elite was widespread concerning the “dangerous classes.” The poor and working classes had already demonstrated that they were dangerous politically and morally; now cholera revealed that they presented a medical peril as well.

It is thus possible to speculate that cholera formed part of the background to the century’s two most egregious examples of extreme class repression, both of which occurred in Paris, where social tensions ran highest. These were the violent crushing of the 1848 revolution by the army commanded by General Louis-Eugène Cavaignac, and the “Bloody Week” in 1871, when Adolphe Thiers destroyed the Paris Commune in a frenzy of bloodshed. Cholera was by no means a direct cause of those reactionary excesses, but at the time, the disease had recently passed, it was deeply dreaded, and it had revealed yet another reason to fear the dangerous classes. Perhaps this revulsion played some part in the buildup of tensions that exploded in the repression carried out by Cavaignac and Thiers, who regarded the working classes of the French capital as enemies to be destroyed.

Sanitation and Cholera: Transforming Cities

Although antiplague measures were largely discarded early in the nineteenth century as defenses against cholera, the disease did give rise to enduring

public health strategies. Of these the most influential and effective was the British sanitary movement theorized in the 1830s and progressively implemented in stages until World War I. Cholera, as we saw in Chapter 11, was not the only disease that contributed to the sanitary idea, but it was an important factor that Edwin Chadwick carefully pondered. The goal of preventing its return was a central consideration in the drafting of the *Sanitary Report* and the urban reform movement that followed.

Elsewhere in Europe the sanitary idea took root as well in the aftermath of cholera visitations, but sometimes in very different forms. Of these the most dramatic and far-reaching were the efforts not to retrofit the cities of Paris and Naples, but rather to rebuild them comprehensively.

The Haussmanization of Paris

Modern Paris is part of the lasting legacy of cholera. Under the Second Empire, Napoleon III charged the prefect of the Seine, Baron Georges-Eugène Haussmann, with the project of demolishing the squalid slums in the center of Paris in order to erect a salubrious modern city worthy of being an imperial capital. This vast project involved the digging of underground sewers while creating an aboveground network of broad boulevards, an array of gardens and parks, bridges, and straight lines of imposing modern buildings. The displaced population was exported, together with its urban problems, to the periphery.

Many of the motives for the reconstruction had nothing to do with disease. Haussmann acted in part to create—through the “Grands Travaux” that he oversaw—an enormous public works project that would provide employment for thousands of workers. He also intended to bring the long history of revolutions in the city to an end because his boulevards would facilitate the movement of troops across the city while also making the construction of barricades impossible. The new city would display the power and grandeur worthy of an imperial regime. As Haussmann makes clear in his memoirs, however, a crucial motivating force was the desire to stop the return of cholera. The disease was intolerable under the Second Empire because it suggested disorder, incivility, and Asia.

Rebuilding Naples: Risanamento

If considerations of public health were one component in the reconstruction of Paris, the renovation of Naples—a project known as Risanamento—was

conceived entirely as a means to make the city cholera-proof. Naples was unique in being a city that was rebuilt for a single medical purpose and in accord with a specific medical philosophy—the miasmatic doctrine of the Bavarian hygienist Max von Pettenkofer.

By the time of the major 1884 epidemic of cholera in Naples, advances in sanitation and hygiene had nearly banished the disease from the industrial world. To suffer a return of the unwelcome visitor was therefore to admit conditions of sanitation, housing, diet, and income that were shaming. Embarrassment was all the greater because Naples in that year was the only major European city to be so severely scourged. For that reason Italy's great seaport attracted the full attention of the international press, which carefully documented the social conditions prevailing in the Lower City.

Even while the epidemic raged, King Umberto I visited the infamous tenements of the Lower City and called for a “surgical” intervention, or *sventramento*. In his lexicon, an excision was required that would remove the hovels where *V. cholerae* had nestled. Making good on the sovereign's promise, the Italian parliament passed a bill in 1885 for the city's Risanamento, or restoration to health. Then in 1889 pickaxes struck the first blows to initiate the project, and work progressed fitfully for almost thirty years—until 1918.

According to von Pettenkofer's miasmatic philosophy, the danger posed by *V. cholerae* to Naples was not the contamination of the city's drinking water in the manner John Snow and Robert Koch suggested. In Pettenkofer's system, disease did not begin when vibrios entered the guts of the population, but when they reached the groundwater beneath the city. There, under the right conditions of temperature and humidity, they fermented and emitted poisonous effluvia that the population inhaled. Susceptible individuals among them succumbed, and half of them died.

Following this miasmatic analysis, the Neapolitan planners imagined a scheme that would make the city forever free of cholera. The first coefficient of health was to deliver clean water in abundance—not for the purpose of drinking, but to protect the soil beneath the city from contamination with sewage and to flush streets, drains, and sewers so that all excremental matter bearing the vibrios would be borne harmlessly away. Having supplied clean water, the engineers then built a great network of sewers and drains below the streets to dispose of the flow.

Having constructed waterworks belowground, the planners turned their attention aboveground. There, the first task was to demolish the overcrowded tenements, “thinning out” the population and making use of the rubble to raise the level of the streets from the first or ground floor to the

second. The idea was to place a layer of insulation between the soil and the residents, trapping vapors belowground so that they would be unable to poison the atmosphere.

Finally, Risanamento involved bisecting the city with its narrow, winding lanes with a broad major boulevard, known as the Rettifilo, built in the direction of the prevailing wind. Crossing the boulevard at right angles the planners envisaged a series of wide streets with well-separated buildings. Together, these roads constituted the city's "bellows of health." They would admit air and sunlight into the heart of the city, drying up the soil and wafting all foul effluvia harmlessly away.

Thus protected both belowground and above, renovated Naples would be impervious to the threat of a return of Asiatic cholera and would present itself as the only major city ever rebuilt for the purpose of defeating a single infectious disease.

Rebuilding: An Assessment

Inevitably, the question arises of how effective rebuilding was in achieving its great anticholera objective. In the case of both Paris and Naples, the results were mixed. The public health defenses of Paris were tested by the arrival of the fifth pandemic in 1892, the year of a major outbreak at Hamburg, the only European city to have suffered severely during that year. Paris was more fortunate than Hamburg, but it did not escape as fully as other urban centers of industrial northern Europe. The rebuilt center of Paris experienced nothing more serious than a scattering of isolated cases. On the other hand, a major limit of Haussmann's project was that it gave little thought to the fate, sanitary or otherwise, of the workers who had been resettled in the *banlieue*, or suburbs. There, problems of overcrowding, substandard housing, and poverty persisted, and cholera returned in 1892 in an epidemic substantial enough to qualify the grand claims of the Second Empire. Cholera had been banished from the center but exported to the periphery.

In the case of Naples, a final judgment is more severe. The test occurred in 1911 during the sixth pandemic, when Risanamento revealed flaws of both conception and execution. In conception the rebuilding program was anachronistic. When the pickaxe struck its first blow, the medical philosophy on which the plan was based was no longer widely accepted by the international medical profession. By 1889 Pettenkofer's miasmatic philosophy had been largely supplanted by the germ theory propounded by Pasteur and Koch. Given the new understandings, the attention devoted by Risanamento to

groundwater, soil, and effluvia on one hand and the lack of concern for the purity of drinking water on the other seemed out of date. Furthermore, the plan was flawed in execution because it was never completed. Over time significant portions of the funding for the project disappeared into mysterious channels, and *stralci*, or cuts, were made, undermining the ambitious original project.

In 1911, therefore, Naples resisted cholera less well than Paris had in 1892, succumbing to the last significant epidemic in western Europe. Unfortunately, the exact profile of the disaster is complicated by the fact that Italian authorities at both national and municipal levels adopted a policy of concealing and then denying the existence of the outbreak. To admit an outbreak of Asiatic cholera was too dishonorable a confession of backwardness. It also entailed acknowledging that the funds allocated for the rebuilding project had been partially misappropriated, thereby legitimizing claims of corruption advanced by opposition political parties—anarchists, republicans, and socialists. Furthermore, such acknowledgment would have exposed Italy to major economic losses through the closure of emigration routes to Italian migrants and through the loss of tourism to attend the festivities marking the fiftieth anniversary of Italian unification. Rather than risk any of these consequences, Prime Minister Giovanni Giolitti ordered a policy of silence and statistical fabrication. Cholera circulated once more, but silently.

A New Biotype: *Vibrio El Tor*

In 1905 a new cholera biotype was isolated in Egypt and named for the quarantine station—El Tor—where it was discovered in the guts of pilgrims returning from Mecca. Gradually, this biotype has taken over the ecological niche formerly occupied by the classical *V. cholerae* that caused six pandemics. The seventh pandemic, which began in 1961 and is ongoing, is caused by *Vibrio cholerae* O1 El Tor, which has transformed the nature of the disease. For the purpose of making the distinction between the two radically different biotypes, we refer to the nineteenth-century bacterium as *V. cholerae* and to the twentieth- and twenty-first-century pathogen responsible for the seventh pandemic as *V. El Tor*.

A number of features give the new strain an evolutionary advantage. Most important, it is much less virulent than classic *V. cholerae*. Comparisons of cases during the sixth pandemic of 1899–1923 (the last caused by classic cholera) and the seventh since 1961 (the first caused by *V. El Tor*) indicate

that severe disease, or *cholera gravis*, affected 11 percent of patients in the former but just 2 percent in the latter. Its presenting symptoms are recognizably similar to the nineteenth-century disease, including rice-water stools, vomiting, and severe cramping. But the El Tor disease is less fulminant: its onset is less sudden, its symptoms are less florid, it gives rise to fewer complications, and its sufferers receive a far more favorable prognosis. Furthermore, transmission is enhanced by large numbers of asymptomatic carriers and by recovered patients who continue to shed bacteria for months.

In the expression of Myron Echenberg in his 2011 book *Africa in the Time of Cholera*, the disease had “changed its face,” and to such an extent that at first it was considered “para-cholera” and not cholera at all.

In the Peruvian epidemic that erupted in 1991, epidemiologists concluded that three-fourths of infected people were asymptomatic. This high incidence of inapparent cases was a prominent characteristic of the disease, and it undermined efforts at containment. Quarantine and isolation were useless when most infectious people were apparently well and detectable only by laboratory examination of their stools. Cholera El Tor was accordingly dubbed the “iceberg disease,” as diagnosed cases were only the tip of a much larger but hidden mass of cases too mild to be noticed.

All of these features dramatically increased the transmissibility of the disease by comparison with nineteenth-century cholera, whose victims were rapidly immobilized, perished in 50 percent of cases, and were no longer infectious after recovery. *Vibrio cholerae* was too lethal for the good of a microbe diffused by the oral-fecal route. There is no invariable tendency in nature for microbes to decrease in virulence, but the oral-fecal mode of transmission relies on the mobility of the host. It therefore places severe selective pressure on pathogens that immobilize and kill too rapidly. The mutations that yielded *V. El Tor* have enabled it to successfully fill the evolutionary niche once occupied by *V. cholerae*.

The Onset of the Seventh Cholera Pandemic

By 1935 *V. El Tor* had lodged itself in Indonesia as an endemic pathogen on Celebes (now Sulawesi) Island. Only in 1961, however, did it produce outbreaks of disease further afield. In that year El Tor cholera began a slow but relentless journey westward that ultimately circled the world. In the early 1960s epidemics of the strain broke out in China, Taiwan, Korea, Malaysia, East Pakistan (now Bangladesh), and all of Southeast Asia. By 1965 cholera reached the Volga Basin and the shores of the Caspian and Black Seas, par-

ticularly afflicting the Soviet city of Astrakhan. The disease then engulfed Iraq, Afghanistan, Iran, and Syria and spread across the Middle East, striking Turkey, Jordan, and Lebanon, and moving on to North Africa, where major outbreaks occurred in Egypt, Libya, and Tunisia.

In 1970 the World Health Organization (WHO) reported that twenty-seven nations had been stricken by *V. El Tor*. Accurate statistics of morbidity and mortality were impossible to produce, however, because many nations violated international health conventions by concealing the disease for fear of international stigma, an embargo on their exports, and a chilling impact on tourism. A widely accepted estimate, however, was that 3 to 5 million cases occurred, and tens of thousands of deaths.

During the first two decades of the El Tor pandemic, three momentous events occurred. One was positive—the development of oral rehydration therapy. In the early twentieth century Leonard Rogers had demonstrated the potential of rehydration as a life-saving procedure. Unfortunately, however, since intravenous administration of hypertonic saline solution requires trained medical personnel, who are scarce in impoverished nations, it was not available to most cholera victims. In 1963, medical scientists in Pakistan perfected the alternative methodology of administering an oral rehydration solution of salts and dextrose. The cost was minimal, and anyone could prepare and administer it, with only clean water needed. Physicians in Pakistan concluded that no cholera patient with a beating heart and the ability to mix the packet of salt and sugar in clean water would ever again die.

By contrast, two other early events in the pandemic were negative. One was that in 1971 cholera reached sub-Saharan Africa for the first time. The epidemic struck Guinea and then swept across West Africa, causing ten thousand cases and hundreds of deaths in that year alone. As public health officials immediately realized, social and economic conditions in the affected countries would enable El Tor cholera to thrive, to spread throughout the continent, and to become endemic. With considerable prescience, they also speculated that the spread of the disease across Africa posed a threat to Latin America—the second major negative event.

The epidemics unleashed by *V. El Tor* were less violent than those triggered by wandering *V. cholerae*; but since poverty, overcrowding, lack of sanitation, and unsafe water supplies persist, cholera outbreaks have become more frequent across the planet. Ever a “social disease,” cholera now erupts solely in conditions of societal neglect, especially in the presence of political crises that WHO labels “complex emergencies.”

Rita Colwell and the Discovery of the Environmental Bases of Cholera

The most striking development of the seventh pandemic is the transformation of cholera from an invader into an endemic disease. After 1970 in both Asia and Africa, El Tor cholera did not fade away. No longer “Asiatic” in any meaningful sense, *V. El Tor* became indigenous throughout the developing world.

Beginning in the late 1960s the mechanisms of El Tor cholera were gradually unraveled by the microbiologist Rita Colwell and her co-workers. Colwell discovered that attenuated virulence is not the only evolutionary advantage possessed by *V. El Tor*. An important factor is its ability to persist in the environment—unlike *V. cholerae*, whose sole reservoir is the human gut. The El Tor strain of cholera can inhabit aquatic environments, both brackish and freshwater—offshore waters, estuaries, rivers, lakes, and ponds. As Colwell demonstrated, *V. El Tor* spreads by what she called “human-environment-human transmission.” This mode complements, but does not entirely supersede, the well-known oral-fecal pathway that is the sole transmission mode of classic cholera.

Ever present in the environment, cholera is permanently capable of “spilling over” into human populations. This occurs whenever social, climatic, and sanitary conditions enable the disease to resume its older mode of transmission—from human to human via fecally contaminated food and drink.

In temperate and tropical climates, when contaminated fecal matter gains access to aquatic environments, usually through the discharge of raw sewage into rivers and coastal waters, the cholera bacteria successfully multiply on and within the bodies of amoebae, zooplankton, and copepods with which it develops a commensal relationship. Aquatic flora and fauna do not succumb to disease, as cholera El Tor is an affliction only of human beings.

When plankton and algae, the preferred reservoirs of the vibrio, are eaten by bivalves or fish, and by aquatic birds such as gulls, cormorants, and herons, the bacteria are transmitted to them as alternative hosts and disseminators. Birds in particular carry the microbes to inland rivers and lakes, where they shed them from their feet, wings, and feces, enabling the vibrio to create reservoirs far from the coast. Duckweed, algae, and water hyacinth are freshwater plants that figure prominently in the bacterium’s life cycle although the vibrio can also thrive in sediment.

Spillover to human populations depends on climatic factors, and on human activities. Warm weather, rising sea temperatures, and algae blooms

promote the multiplication of bacteria, which can then be ingested by people when they eat fish and crustaceans or when they bathe in or drink contaminated water. Climate change, summer, and such weather determinants as El Niño, which circulates warm surface water and currents that bring nutrients in abundance, promote a profusion of vibrios, which are then available for human consumption.

Modern Cholera in Peru

The mechanisms of cholera El Tor were carefully documented during one of its most important outbreaks—the Latin American epidemic that began in 1991, as epidemiologists had anticipated when they witnessed the spread of the seventh pandemic to Africa during the 1970s. Peru was its epicenter. After ravaging that country, cholera then spread, less intensively, across the whole of South America. This epidemic was unexpected because the forebodings of the 1970s had been long forgotten amidst other pressing public health issues and the knowledge that cholera had not broken out in Latin America in a century.

Peruvian doctors were thus caught unprepared, knowing of cholera only what they remembered from medical school textbooks. On January 22, 1991, the Peruvian physician Walter Ortiz treated Daniel Caqui, a young and seriously ill farmworker. Caqui staggered into the Chancay hospital with puzzling symptoms that might have suggested food poisoning, a spider bite, or pneumonia. Ortiz, the first South American physician to confront *V. El Tor*, said: “I tried all the usual treatment and he just got worse. I had no idea what it was.”¹⁰ A week later, after thousands of Peruvians had fallen ill, the Ministry of Health announced the presence of epidemic cholera. Daniel Caqui was its first official victim.

Facing the outbreak, epidemiologists initially thought in traditional terms of an importation of cholera from abroad and focused on the possibility of the discharge of contaminated bilgewater from a ship that had sailed from Asia. No ship, however, was ever identified as having reintroduced cholera to the Americas. Indeed, epidemiology undermined all possibility that a single event was responsible. Instead of flaring up at a single place in Peru and then spreading in the manner of classical cholera, the El Tor epidemic started simultaneously at six different cities spread across six hundred miles of Peruvian coastline—Piura, Chiclayo, Trujillo, Chimbote, Chancay, and Lima.

Subsequent genomic investigation determined that the pathogen in Peru had originated in Africa and dated from the large-scale immigration

of Africans during the 1970s. The presence of African isolates of *V. El Tor* in the Peruvian aquatic environment was also confirmed. Persistence in the environment rather than importation laid the bases for the Latin American microbial ordeal.

In January 1991 climatic conditions in Peruvian waters were ideal for the vibrio, as summer arrived and El Niño persisted. Vibrios multiply most readily in the summer heat, and people drink water, safe or unsafe, copiously to quench their thirst. Spillover occurred when fishermen marketed their catch ashore. Having completed the human-environment-human circuit, the vibrio reached town in the bodies of mollusks and fish. It then pursued the alternative mode of transmission from human to human. Raw fish and seafood were the Trojan horses in whose guts the vibrio was carried to the population of Lima and other cities. Especially suspect at the time was ceviche, a dish of raw fish marinated in lime juice, onion, chilies, and herbs. Ceviche was a staple of the diet because fish—available at a fraction of the cost of meat and chicken—was the chief affordable source of protein. The Ministry of Health banned the sale of ceviche and sought to persuade Peruvians to avoid it in their homes.

During the following year, three hundred thousand people in a population of 22 million contracted cholera even though the disease was well understood and it was both preventable and treatable by oral rehydration. The reason was that Peruvian cities presented conditions of poverty, density, and sanitary neglect that were reminiscent of nineteenth-century European cities such as London, Paris, and Naples that had been so favorable for “classic” *V. cholerae*. Indeed, *Caretas*, the Lima news magazine, explicitly invoked the comparison in March 1991 when fifteen hundred people were being stricken daily. “Terrifyingly,” it explained, “health conditions in nineteenth-century London were similar to those of Lima today.”¹¹

The infrastructure of the Peruvian capital had been overwhelmed by urban growth. Lima’s population had swollen to 7 million people, 4 million of whom lived in shantytowns lacking space, water, and sewerage. As the *New York Times* described conditions in the Lima slums, or *pueblos jóvenes*, habitations were “no more than rows of cardboard shacks, with no roofs, dirty floors and no electricity or running water. Children play in the streets alongside garbage. Dogs forage among piles of trash.”¹² Two million residents had access to water only from the river in which raw sewage was dumped or from delivery trucks. They then stored it in filthy cisterns and tanks.

Unfortunately, poverty in Lima had grown exponentially throughout the 1980s while the Peruvian economy plummeted in what the press de-

scribed as a “free fall.” Industrial and agricultural production declined; unemployment and underemployment mushroomed to encompass 80 percent of the workforce; hyperinflation galloped at 400 percent a year; and real wages were halved. Malnutrition and hunger spread widely, and the incidence of infectious diseases such as tuberculosis and gastroenteritis spiked.

Conditions were also starkly worsened by ongoing guerrilla warfare, which was stoked by the economic crisis. The war, conducted amidst paroxysms of violence on both sides, was waged by the Peruvian Army against two well-organized but mutually antagonistic revolutionary forces—the Maoist party Shining Path (*Sendero Luminoso*), founded in 1980, and the pro-Russian movement named after the last Incan monarch, Túpac Amaru. As many as twenty thousand people died in the conflict, and the lack of security in the countryside decimated agricultural production and drove migration to cities that were already overcrowded.

Chairing a congressional investigation into the Latin American epidemic, Democratic representative Robert Torricelli concluded that there was no doubt about the causes that stoked the Peruvian medical crisis. Cholera, he explained, was the classic “social disease” of poverty. Throughout the 1980s, he noted, the World Bank, the International Monetary Fund, and the US Agency for International Development (USAID) had preached the doctrine of “structural adjustment,” by which Third World countries were pressed to adopt laissez-faire economic policies. Thus prodded, Latin American governments favored unfettered market forces while slashing public spending on health, housing, and education. Cholera flourished when poverty rather than economic growth ensued. “The cholera epidemic,” Torricelli explained,

is the human face of the debt problem, a repudiation of the trickle-down theories that have guided development policy for more than a decade. . . .

It occurs solely because of inadequate sanitation, because people lack access to clean water. It is a consequence of Latin America’s lost decade.¹³

All that Torricelli omitted was that on the eve of the cholera explosion, Peruvian president Alberto Fujimori brought the economic crisis to a final crescendo by implementing a program of drastic fiscal austerity measures popularly known as “Fujishock.” Even Hernando de Soto Polar, Fujimori’s economic policy advisor, bemoaned the consequences, declaring starkly in February 1991, “This society is collapsing, without a doubt.”¹⁴

Latin America in the 1990s also clearly revealed differences that distinguish “modern” from “classical” cholera. Since epidemics caused by *V. El Tor* are far less lethal than those epidemics caused by *V. cholerae*, they do not give rise to similar apocalyptic fears, riots, and mass flight. During the decades since the 1960s, Latin America, Africa, and Asia have not reproduced the social upheavals that marked the passage of Asiatic cholera through European cities in the nineteenth century.

On the other hand, modern cholera leaves a lasting and painful legacy. Most immediately and obviously, it produces widespread suffering as well as a not insignificant mortality. In addition, it overburdens fragile health-care systems, diverts scarce resources from other purposes, and decimates economies by its impact on trade, investment, tourism, employment, and public health. In Christian contexts, it also leaves an upsurge in religiosity. In Peru, for example, the passage of cholera through the country was widely experienced as a “divine curse” on the people. Journalists reported that it was popularly regarded as “something from the Bible,” a modern equivalent of the plagues of Egypt. Indeed, the magazine *Quehacer* made the point clearly when it noted, “We are experiencing something that the Pharaoh of Egypt, with his seven plagues, would not envy.”¹⁵

But the most enduring legacy is the threat of recurrence. Unlike classic cholera, the seventh pandemic has already lasted for more than half a century and, showing no signs of abatement, is capable of causing outbreaks wherever poverty, insecure water supplies, and unsanitary conditions persist. Indeed, in 2018 WHO reported that “every year there are roughly 1.3 to 4.0 million cases, and 21,000 to 143,000 deaths worldwide.”¹⁶

Such an ongoing threat, concentrated in Asia, Africa, and Latin America, carries additional risk related to climate change. Absent technological interventions such as a successful vaccine, or major programs of social uplift and sanitary reform in vulnerable countries, global warming is certain to promote the survival of *V. El Tor* and to enhance the number and severity of outbreaks. Far from vanquished, modern cholera is what might be termed a perpetually reemerging disease.

Haiti since 2010

Cholera in Haiti, which began in 2010 and continues in mid-2018, is an important reminder of the threat of modern cholera. Nepalese soldiers, arriving on Hispaniola as part of the UN peacekeeping mission, brought cholera to the Caribbean. As the United Nations—fearful of the political and finan-

cial implications of admitting responsibility—belatedly acknowledged, some of the Nepalese contingent suffered from mild cases of the disease. Unfortunately, the peacekeeping force improperly disposed of their excrement by dumping it into the Arbonite River. This waterway serves the domestic, agricultural, and drinking needs of those inhabiting the valley through which it flows. In the words of observers, contaminating the Arbonite River in this manner was just as certain to trigger a conflagration as lighting a flame in a dry forest.

When the match was lit in October 2010, Haiti, the poorest nation in the Western Hemisphere, provided an ideal setting for cholera to take hold. Its citizens lacked all of the prerequisites of a healthy existence. They were hungry and malnourished; they already suffered disproportionately from a long list of diseases associated with poverty; the country had only an embryonic medical and sanitary infrastructure; and the people possessed no “herd immunity” to resist a disease that had been unknown in the hemisphere for more than a century.

A major earthquake in October 2010 prepared the way for the transmission of bacteria. Seismic shocks displaced people, shattered an antiquated system of water supply and sewerage, and damaged the fragile Haitian network of clinics and hospitals. Thus introduced and welcomed, *V. El Tor* multiplied exponentially in its new human hosts. Within weeks of the earthquake, every province of the country was infected, while 150,000 cases and 3,500 deaths had occurred.

The epidemic thereafter proved refractory to all efforts to contain it. For most of the population, safe water was unavailable, and clinics rapidly ran out of oral rehydration packets, intravenous rehydration solutions, and antibiotics. Meanwhile, the international public health community indulged in endless debate over the ethics and efficacy of an anticholera vaccine that in any case had not been approved for distribution and was in such short supply as to be useless. Lack of physical security also severely hampered relief efforts.

Natural disasters other than the earthquake also played a lethal role in the health crisis. Unusually heavy rains flooded water sources with runoff, and then in October 2016 Hurricane Matthew, a category 4 storm, made landfall and left a trail of devastation. It rendered hundreds of thousands of people homeless, wrecked health-care facilities, and ruined existing networks of sewerage and drainage. Meanwhile, as the epidemic held firm year after year, cholera faded from the international news, donor fatigue overcame philanthropic intentions, and charitable NGOs withdrew. By 2018, Haiti, a

nation of nearly 10 million people, had already suffered a million cases by conservative estimates and ten thousand deaths. But these totals, dramatic as they are, are only provisional because the epidemic still prevails. The most recent available figures at the time of writing in spring 2018 indicate 249 new cases in February and 290 in March.¹⁷

But the Haitian epidemic also raises anxiety about the attenuated virulence of *V. El Tor*. Although a low level of virulence provides selective Darwinian advantage, there is no assurance that future epidemics will not again become more virulent. In Haiti the percentage of mild and asymptomatic cases was significantly lower than in previous outbreaks during the seventh pandemic, and physicians noted that the incidence of severe rehydration, or *cholera gravis*, was substantially higher. As recent studies indicate, a feature of the cholera genome is that it “readily undergoes change, with extensive genetic recombination . . . , resulting in what have been termed shifts and drifts in the genome sequence.”¹⁸ With such a high level of plasticity, *V. El Tor* is unpredictable, and one cannot assume that future epidemics will not be characterized by a renewed violence reminiscent of the nineteenth century.