



REVIEW ARTICLE

Epidemics before microbiology: stories from the plague in 1711 and cholera in 1853 in Copenhagen

ADAM BENCARD

Medical Museion and NNF Center for Basic Metabolic Research, University of Copenhagen, København, Denmark

INTRODUCTION: LOOKING FOR LESSONS IN HISTORY

Amongst the many spiraling effects of the current pandemic has been an intense interest in finding historical frames of reference for our current predicament [1]. Past epidemics, from the Plague to the Spanish Flu, have been brought back to the public consciousness, both to search for instructive patterns and lessons, and perhaps also as a way to cope with uncertainties and anxieties; a reminder that we have been here before, facing down an unknown disease. As hand-washing, mask wearing, and quarantining suddenly have become part of our everyday lives, images of plague doctors with beaked masks, photographs from 1918 of mask-wearing citizens, or tuberculosis campaign posters reminding people to not spit in public, all suddenly hold renewed relevance and resonance.

The long history of epidemics, long before the advent of microbiology and the deepened understanding of disease biology that followed from it, might seem antiquated or even pointless. Are we not armed with scientific knowledge and technical mastery that puts us in a completely different position than, say, 18th-century doctors still leaning on medical theories developed in Antiquity? Yes and no. One of the interesting lessons from the history of epidemics is that there are also patterns that hold greater continuity as much as there are real differences across time, space, and disease. As the medical historian Charles Rosenberg pointed out in his classical text “What is an epidemic?” from 1989, epidemics tend to have a distinct narrative. They unfold as dramas in three acts: “Epidemics start at a moment in time, proceed on a stage limited in space and duration, follow a plot line of increasing revelatory tension, move to a crisis of individual and collective character, then drift toward closure” [2]. The first act takes the shape of a progressive revelation. It starts with the subtle signs, often willfully overlooked, that something is awry. Concern

and worry sweep across the population, but action is often stalled in the hopes of maintaining social stability and economic interests. As illness and deaths accelerate and the reality of the epidemic can no longer be ignored, the second act begins, in which explanations are demanded and offered. These explanations can be either moral, social, cultural, or scientific, and generate a cascading set of public responses. The explanations are motivated by a desire to control randomness, to assign blame and fault, and to find courses of action. Before the advent of microbiology, religious or moral interpretations dominated. Epidemics, with all their suddenness and randomness, slotted easily into explanatory paradigms focused on divine power and human fallibility. Social and cultural explanations have also abounded, focusing on particular groups or social classes as particularly dangerous or susceptible. Finally, in the third stage, the epidemic subsides and society regathers into a new normality, and the primary task is to negotiate the public responses that developed in the second act. The rituals invoked, the societal actions taken, the cultural beliefs stirred up, the lessons learned, and all have to be reckoned with and their trailing effects understood. This paper unfolds two examples of such narratives, both in Copenhagen, Denmark: The plague in 1711 and cholera in 1853. It will describe both medical and political responses. These stories are small examples of the narrative laid out by Rosenberg, and the hope of the article is that by recounting them, we might get a different perspective on the pandemic that, at the time of writing, is still ongoing.

CASE 1: THE PLAGUE, COPENHAGEN 1711–1712

The Black Plague was a constant threat in northern Europe in the early 18th century, as it had been in previous four centuries [3]. In 1708, reports starting

arriving in Copenhagen about cases in several of the major trading hubs around the Baltic Sea [4]. In 1709, all trades with Danzig and neighboring cities were forbidden. Warships were placed in all harbors, in order to screen incoming ships for the plague. King Frederik IV anxiously gathered his council with orders to begin preparing for the crisis. Warehouses were built in an area outside the city, to serve as quarantine stations for those arriving from areas suspected of plague. The clergy were instructed to gather the public for extra services and prayer, to plead with God to spare the country from the plague. A health commission was installed to organize the handling of the emergency, and authorities in the capital of Copenhagen were given resources to keep the city with food and kindling for at least six months should the plague disrupt trade and regular life. Citizens were required to carry documentation stating that they had not been in contacts with infected people or buildings for at least six weeks. The efforts to stop the plague were far reaching, encompassing all parts of civil society, free movement, and trade.

Much of the efforts were focused on keeping the plague out of Copenhagen, the seat of the king, and the fledgling state apparatus (Fig. 1). This apparatus had been expanding in size and power from the late 17th century onward, as Denmark from 1660 onward had been transformed into an autocracy. With this, shift in power had come an increasing emphasis on the king and his court. At the time, Copenhagen had approximately 66,000 citizens, roughly 10% of the population of the country, out of which two-thirds worked either in the army, the navy, or in the state apparatus [5]. Practically, all trade went through the ports of the city. It was a city in rapid growth that had come to play an increasingly important role in the management of the country as a whole, home to a king that had increasing power over and ability to manage the population at all levels. A paradoxical situation when facing an infectious disease: Central management is vital, but centrality is also fragility. The connections with the outside world not only gave power, influence, and control, but also exposed the heart of the kingdom to infection.

If this was the political situation in the early 18th century, how did society understand the plague? A dominant frame was, as it had been since the Middle Ages, religious [6]. The plague was divine punishment, a tool with which God scolded and tested his creation in equal measure. The bible provided ample context for such a reading, and the logical reaction was to appease the divine wrath through prayer, penance, and fasting. In Copenhagen, the church in 1709 ordained extra days of prayer in all

churches. The medical establishment had little insight to offer. Their teachings were primarily based on theories of disease and health stretching back to Antiquity, which divided the body into a system of four fluids or humors: blood, yellow bile, black bile, and phlegm [7]. All disease was said to be due to imbalances or improper mixes of these fluids within the body. The task of the physician was to intervene in and to restore balance between these fluids. This was done often in very literal ways, through bloodletting, emetics, enemas, and a regime of diet and lifestyle-based advice. When the medical doctors at the University in Copenhagen were tasked with writing a small book on the causes and origins of the plague, they wrote as follows: “hvorudi dens rette natur og egenskab bestaar, er ej med nogen menneskelig forstand at udgrunde” (of which its proper nature and qualities consists, no human mind can ascertain). Most medical theories at the time espoused the so-called miasma theory, which also dated back to Antiquity and claimed that diseases were caused by rotten organic matter [8]. The Plague was seen as an atmospheric disturbances, caused by emanations from cesspools, rotten water, open sewage, or piles of corpses. This made the doctor recommend burning of sulfur and juniper berries in the streets to clear the miasma. They also recommended keeping the streets as clean as possible from garbage and other waste.

Besides miasma theory, another understanding of disease had also been used to combat the plague since its arrival in Europe in the 14th century [9], one focused on contagion rather than “bad air.” It was based on the empirical observation that disease seemed to spread from person to person and through traded goods, houses, and infected corpses. These ideas had been developed in the city states in Northern Italy such as Florence, Livorno, and Venice, which had centuries of experience in dealing with the plague. In 1708, king Frederik IV had travelled to Northern Italy to learn of their measures, and what he had learned was implemented in Denmark. First, the aforementioned health commissions were established and given authority to quarantine travelers, close city limits, keep a watch over “beggars, prostitutes, and Jews” as the law read, as well as make regulations for markets, streets, hospitals, and cemeteries. A distant relative to our ministries of health, one might say.

Alongside the health commissions, the legislative methods developed in Northern Italy had five elements: First, controlling traffic between healthy and infected areas through quarantines—a word taken from the Italian *quarantina* meaning “forty days,” the period in which the separation should last.



Fig. 1. Map of Copenhagen around 1700. Most noticeable is the fortifications around the perimeter of the city. Original is in the Det Kgl. Bibliotek, Copenhagen.

Second, ensuring that those dead from the plague was properly buried and their belongings burned. Third, isolating the sick from the healthy once the epidemic had struck. Fourth, providing food and water to the infected, to make sure that hunger or thirst did not force them to out amongst the healthy; and fifth, that the authorities would help those who could no longer make a living due to lack of markets and trade. The prescripts combined both power and care. Actively limiting movement, trade, and freedom on the one hand, while ensuring a minimum of order by providing food, water and getting rid of the dead. It is not hard to trace the foundations of healthcare systems in these responses to epidemic disease.

However, all the attempts to keep the plague out of Denmark ultimately failed. The first infection happened in the smaller town of Helsingør, north of Copenhagen, possibly a traveler who had been to the city of Gdansk. In 1711, the city was shut down and guards were posted along the city perimeter with orders to shoot anyone who tried to leave. However, the soldiers could not catch everyone, and in July 1711, the Plague reached Copenhagen. The city panicked, and the wealthy quickly fled to estates outside the city. On July 18 the king vacated Frederiksborg Castle and travelled to Kolding. The plague raged uncontrolled, the dead littering the city streets. By August, the army was ordered to dig mass graves for the poor outside the city limits and to stop the rampant looting. By the time the plague had runs its course, around 20.000 of the city's population of 66.000 had died, almost a third of the population. The plague in 1711 turned out to be the last outbreak of this most feared of epidemics. Other would take its place as follows: smallpox, syphilis, tuberculosis, diphtheria, yellow fever, influenza, measles, typhus and more, a litany of disease, each with its own character, habits, and effects. However, the plague left a lasting effect on attempts to handle epidemics through quarantine, control and care in equal measure.

CASE 2: CHOLERA, COPENHAGEN 1853

A little less than 150 years later, Copenhagen was a very different city. Its population was rapidly growing, and due to being constrained by its military defenses, space was at a premium. There was little in the way of legislation about how tightly new housing could be built, and access to light, space, and sanitation gave way to quick profit, despite protests from the board of health. The open gutters of the time were constantly filled with stinking water and mud, and cesspools quickly formed due

to lack of drainage [10]. Often basins were dug under the houses, into which ground water could seep and then removed with pumps at a later date. As the basins quickly filled with a mixture of refuse and ground water, they had to be pumped several times a year. The smell was described at the time as horrific. The basins also often leaked into the surrounding soil, in which the wooden water pipes that brought water into the city lay. The city was, as most cities in Europe at the time, deeply unhygienic. And thus, ripe for a new epidemic disease which was ravaging Europe: Cholera.

In the middle of the 19th century, before the German microbiologist Robert Koch discovered the cholera vibrio in 1883, debates raged as to how cholera spread, and how it might be prevented and cured. In the medical establishment, views on the nature and causes of epidemic and endemic diseases could, much like during the Plague, broadly be divided into two categories: Contagionists and miasmatics. Contagionism had a particular history from the 18th century onward, too long to sketch out in this context [11], held on to the idea that a material substance transmits disease from person to person through contact in a string of successive infections. As noted, versions of contagionism can be traced back to the black plague in Medieval Europe and underlay the development of the quarantine and other similar efforts to break chains of infection through contact between the sick and the healthy. While this view seems to anticipate a more modern theory of epidemic disease, in the 19th century, this was a contentious idea for a number of reasons, not least that it ran counter to the miasmatic and humoral theories that had been a touch point in Western medicine since Antiquity. The contagionists believed in the tools learned from the plague: Quarantine, isolation of those already infected, and a measure of public hygiene, mainly to keep infect matter under control.

Miasmatics, on the other hand, did not believe in transmission from person to person. Instead, the idea was that miasma could under certain sanitary or atmospheric condition could turn into specific disease and infect those already susceptible to it due to their humoral imbalances. Miasmatics thus championed lifestyle, hygiene, and diet as tools to combat epidemics, but did not put any stock in quarantines. In the decades before 1853, the medical establishment had gone back and forth between the two positions, but by the arrival of cholera in Copenhagen, most of the leading doctors believed in miasma theory [12]. A quarantine regulation put in place in 1831 had thus been dismantled in 1852, with the money set aside for hygienic measures.

The cholera outbreak began in the middle of June in Nyboder, a part of Copenhagen built to house members of the navy. By the end of the month, nine were dead and the disease spread further into the city. There are very detailed accounts and statistics over who died where during the outbreak, kept in part by Børge Anton Hoppe, chief medical officer for Copenhagen at the time [13]. The interest in medical statistics had grown tremendously during the 19th century and was the key factor that a few years later allowed the English physician John Snow to trace the spread of cholera

in London to infected water pumps, a decade before the advent of the germ theory of disease. The epidemic continued through the year, and by the end, 4737 people out of a population of approximately 130,000 had died, and 6–7% had been infected (Fig. 2). This number was significantly higher than in other European capitals, perhaps attesting to the poor hygienic circumstances in Copenhagen at the time.

As the epidemic raged, the struggle to understand its development continued. In his first report to the board of health, Børge Anton Hoppe wrote that



Fig. 2. Map of the spread of cholera in central Copenhagen, 1853. The numbers of deaths in individual neighborhoods can be seen in red. While the parts of the city inside the fortifications bear similarities to the map from 1700, the surrounding areas were increasingly changing from farmland to more densely populated urban dwellings. Original is in the Det Kgl. Bibliotek, Copenhagen.

there was no reason to assume that the disease should have been introduced through a contagium. However, he did struggle with the fact that the disease had struck in one of the airiest, sunniest, and driest parts of the city, where the population, in general, was well fed. Furthermore, the disease seemed to stay contained in that area for at least a month, before it finally spread to other parts of the city. He was also puzzled by the fact that other areas like Vesterbro, which had the lowest quality of drinking water and the most unhygienic environment due to a number of abattoirs, pigsties, tanneries, and poor sanitation in general, had only a few cases. Hoppe ended in his report on the cholera in 1854 by stating that it seemed to have been caused neither by contagion nor by miasma, but without offering any other explanations for what had caused it or how it spread.

Other doctors were equally puzzled. Professor A.G. Sommer wrote in 1854 that he had seen no evidence of cholera being transmitted from person to person, an observation supported by the fact that other cities close to Copenhagen for the most part went entirely free from cholera. Instead, he supported the idea that diet and lifestyle was the key factor predisposing to the disease. Contagionist like the district physician Seidelin argued that the disease did in fact transmit from person to person, and that it could also be transmitted through infected clothing. He attempted to follow the transmission in his district of Amager, but had to give up, as the disease seemed to move about at random, striking in places far removed from one another. Others hypothesis were tried, including the idea that since cholera did not appear to be airborne, it must have to do with earth quality and closeness to sea level—a hypothesis that was also revealed to be inconclusive by data gathered in 1855. As the cholera waned from its highest point in the fall of 1853, no agreement was reached in the medical community (Fig. 3). Cholera thus complicated theories of disease at the time, by fitting neither of the dominant explanatory paradigms for epidemic disease. This confusion echoed international debates in the medical community; the same year, an English doctor wrote in *Lancet*: “What is cholera? Is it a fungus, an insect, a miasma, an electrical disturbance, a deficiency of ozone, a morbid off-scouring of the intestinal canal? We know nothing; we are at sea in a whirlpool of conjecture” [14].

If there was no agreement about how cholera was transmitted neither before, during nor after the cholera outbreak of 1853, how did the city prepare for the cholera? The first thing was the construction of a medical infrastructure. New cholera wards were built and offices where people could report

new cases. As the epidemic spread, a total of eight new cholera hospitals were built with beds for up to 500 patients in all, a small fraction of the 3500 new cases that were reported in the last two weeks of July when the epidemic was at its peak. As expected, data suggest that about half cholera casualties died in their own beds. Alongside, this expansion of the medical infrastructure, the board of health went to great lengths to improve hygiene in the city, particularly in its poorest and dirtiest neighborhoods. People were ordered to clear the yards, remove dirt and refuse, and flush the gutters. In dry weather, the streets were watered before sweeping and latrines were taken outside the city. Instructions to the population told them to air out their living quarters regularly, clean their rooms, air their bed linen weekly and change their hay bedding monthly, and make sure to only use clean water for drinking and cooking. If a patient was brought to the hospital, their bedding had to be cleaned and taken to the yard for airing out, before being taken back into use. Corpses had to be taken to the hospital immediately. The pharmacies were told to stock up on opium drops, camphor drops, castor oil, chamomile, and elderflower, as well as mustard powder. Diet and warm clothing were the go to treatment for those looking to avoid the cholera, but particular attention was also paid to mood and mental state; many doctors believed that nothing predisposed to cholera like a depressed, anxious, and nervous mindset. This was mostly down to the medical theories that linked body and mind much closer than later 20th-century medicine—in many ways, the mid-19th century marked the final stage of the humoral theories.

All in all, the response to the cholera was marked by the uncertainty that characterized both specific knowledge about disease etiology and medical theories in general. Even if medical science and political administration had developed markedly in the 150 years between the plague of 1711 and the cholera of 1853, the lack of knowledge and inability to study cholera in detail meant that medical intervention had little effect outside of caring for those already infected. And one might speculate that had cholera been infectious from person to person in a manner similar to the plague, the city might even have been worse off in 1853 due to the ongoing debates between contagionists and miasmatics. The medical establishment had certainly grown both in number, power, and stature, but such an increase can be a double-edged sword when facing new and unpredictable illnesses, as it also leads to the possibility of responses that makes the problem worse—in this case, the closing of quarantine programs in 1852 could have been disastrous.



Fig. 3. A woman extravagantly equipped to deal with the cholera epidemic of 1832; representing the abundance of dubious advice on how to combat cholera. Etching, c. 1832. Moritz Gottlieb Saphir (1795–1858). Copyright Wellcome Collection, Creative Commons 4.0.

Cholera ended up having major impact on city planning in Copenhagen, as it did elsewhere in Europe. The disease brought the need for a more hygienic reshaping of urban environments into sharp focus; for better, safer water supply, better sewage systems, and less overcrowded housing. These changes did not happen overnight, at least not in Copenhagen. The politics of urban planning were embedded in wider financial and political debates, and medical science could not provide any strong arguments for specific interventions, outside of general calls for better personal and environmental hygiene.

ENDING: HOLDING ON TO UNCERTAINTY

There are many more layers to these two narratives than this paper can hold, but they serve as reminders that epidemics are not solely the function of pathogens, but are as much stories about how societies are structured, how political power is wielded, how disease is understood, and how personal and existential anxieties and loss are culturally and socially framed. And further, that the scientific ideas underpinning epidemiology—observation, use of modelling, the experimental method, data gathering—all have histories and were developed in particular contexts. In other words, a history of an epidemic is never just a medical scientific one, nor can it be fully captured from such a perspective. The task from a historian's perspective during the COVID-19 pandemic has been to ask of past societies how they inquired into the origins of the pandemic and how they use their scientific and other knowledge tools to construct theories of the disease and its patterns; to investigate what sort of societal mechanisms moved into action during the crisis, both at a state level as well as in the form of collective responsibilities. There is always a demand for action and a political response, but that action can take many different forms. To investigate the epidemic as a mirror on a given society, as much as an independent biological reality. In other words, a history of pandemics is also a history of societies.

These two vignettes are two of thousands, stretching across other diseases, other cities, other temporalities. They should remind us that while we might look for patterns and lessons in history, we will never find one voice or one single, coherent lesson. There are dangers in extracting neat narratives and seemingly obvious instructions from what has happened previously; there are always more happening that what is captured or can be explained. But there are benefits to knowing the history of

something, even if that knowledge is incomplete. It helps with discerning pitfalls and with creating a broader range of actions and interpretations. Epidemics are defined by uncertainty, and by spiraling effects of actions, both those taken and those not taken. In such situations, knowing the possible trajectories of those spirals is vital. History gives us clues as to what they might be. But, it also tempers overconfidence and bluster. Time and time again epidemics have confounded ideas and beliefs, whether they were religious, moral, cultural, or scientific. Certainty can be as problematic as uncertainty, something that holds particularly true in a modern world where scientists are expected to provide certain knowledge and clear guidance at a moment's notice. It should be a humbling reminder both to scientists, politicians, and citizens alike that we are currently all part of creating narratives that will be scrutinized and analyzed in 10, 50 or a 100 years' time, as new epidemics unbalance and upend societies in the timeless dance between humanity and disease.

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CONFLICT OF INTEREST

No conflicts of interest.

AUTHOR CONTRIBUTIONS

Adam Bencard is the sole author.

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

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