Historical and Modern Responses to Plague Epidemics: What Lessons Can Be Drawn from Case Studies in France, the United States and Madagascar?

Hugo Carnell
University of Malta; hugo.carnell.20@um.edu.mt

Abstract
Despite its long history, plague has not been an internationally significant disease since the mid-twentieth century, and it has attracted minimal modern critical attention. Strategies for treating plague are generally outdated and of limited effectiveness. However, plague remains endemic to a few developing nations, most prominently Madagascar. The outbreak of a major plague epidemic across several Madagascan urban areas in 2017 has sparked a wider discourse about the necessity of improving global preparedness for a potential future plague pandemic. Beyond updating treatment modalities, a key aspect of improving preparedness for such a pandemic involves a process of sophisticated review of historical public health responses to plague epidemics. As part of this process, this article outlines and compares public health responses to three separate epidemics from the early modern era onwards: Marseille in 1720–22, San Francisco in 1900–04 and Madagascar in 2017. Based on this process, it identifies three key themes common to successful responses: (1) clear, effective and minimally bureaucratic public health protocols; (2) an emphasis on combating plaque denialism by gaining the trust and cooperation of the affected population; and (3) the long-term suppression of plague through the minimisation of contact between humans and infected small mammals.

Keywords: plague; epidemic control; historical public health perspectives; Marseille; San Francisco; Madagascar

Introduction
Plague is a disease which most lay observers would associate with history, rather than modern public health. Looming particularly large in any general understanding are the estimated 75–200 million people that were killed in Europe, Asia and North Africa during the Black Death of the fourteenth century. However, plague outbreaks occurred continuously across Europe until the end of the seventeenth century, and the most recent plague pandemic was not brought under control until 1960 (Casey et al., 2021: 5–6). The mass general improvement in living standards and health services which has taken place throughout the twentieth century has strongly reduced both the prevalence of plague epidemics and mortality rates after infection (Centers for Disease Control and Prevention, 2020a). However, it is estimated that several hundred plague cases, and a small number of deaths, continue to occur worldwide every year (Baraniuk, 2020).

Plague remains a diminished public health threat, but one that is arguably re-emerging. The 2017 Madagascar epidemic was the first mass outbreak of pneumonic plague in an urban area in a century, and this has been characterised as a paradigm shift which signals the re-emergence of plague as a major global disease. If a future outbreak spread from Madagascar into mainland sub-Saharan Africa, a plague epidemic could be catastrophic in an overcrowded and unsanitary space, such as a refugee camp. The development of new clinical responses to plague has been largely neglected across recent decades. Although plague is, for now, treatable with antibiotics, antibiotic-resistant strains of plague have begun to spread in Madagascar.

It is therefore necessary to identify public health lessons learnt during past plague epidemics, as plague
is increasingly likely to become a disease which the humanitarian sector will consistently engage with in the coming years. This research article conducts a comparative historical survey of public health responses to three separate plague epidemics, spanning pre-bacteriological, early bacteriological and modern eras of public health – Marseille in 1720–22, San Francisco in 1900–04 and Madagascar in 2017. Following this analysis is a more general perspective on the status and possible epidemiological future of plague in 2022, attempting to draw practical lessons for the humanitarian sector from the case studies.

**Plague: Clinical Profile, Treatment and Epidemiological History**

Plague is the result of infection by the *Yersinia pestis* bacterium, which occurs in a variety of small mammals. Although transmission can take place through direct contact between a human and an infected animal, plague is normally transmitted from animals to humans when a parasitic rat flea feeds on its host and then bites a human (World Health Organization, 2017).

Once infection has taken place, the bacteria colonise the closest lymph gland, leading to the two key symptoms: painful round gland swellings known as buboes and dark-coloured bruises on the skin caused by internal haemorrhaging (Centers for Disease Control and Prevention, 2020b). Bubonic plague is fatal when untreated in about 50–70 per cent of cases, but this rate drops to 10–15 per cent with treatment (Bandolier, n.d.). If the bacteria enter the bloodstream, bubonic plague can progress to septicemic plague, which systematically infects the body and is virtually 100 per cent fatal if untreated (Center for Health Security, 2013).

Alternatively, if the bacteria enter the lungs, bubonic plague can progress to the highly infectious pneumonic plague. This condition is characterised by major respiratory shock, aggressive pneumonia and the coughing of blood. Pneumonic plague can be transmitted human-to-human through the coughing and subsequent inhalation of infected droplets. Pneumonic plague is virtually 100 per cent fatal unless treated within twenty-four hours (Center for Health Security, 2013).

Treatment for all forms of plague is given through a fourteen-day IV course of antibiotics, usually one or more of a tetracycline, a fluoroquinolone and an aminoglycoside (Center for Health Security, 2013). This is supplemented with general supportive care such as analgesics.

On a historical level, plague is one of the oldest diseases known to humanity. DNA evidence indicates that it has infected humans in Eurasia from as early as 3000 BCE (Rascovan, 2019: 295–6). The Book of Samuel in the Bible describes a plague epidemic among the Philistines around 1320 BCE (Khan, 2004: 271).

In terms of plague’s wider spread, it is conventional to identify three separate historical plague pandemics. The First Plague Pandemic originated in sub-Saharan Africa in the sixth century AD, spreading to Europe by 541 and continuing to rage the Mediterranean Basin until around 750 (Keller et al., 2019: 12363–4).

This was followed by the Second Plague Pandemic, which arrived in Europe from East Asia in the fourteenth century. Although this pandemic is associated most strongly with the Black Death of 1347–50, outbreaks of plague continued to periodically devastate more limited regions of Europe into the nineteenth century (Spyrou et al., 2019: 2). Although it is conventionally held that this strain died out by the nineteenth century, recent scholarship has argued that modern reservoirs of plague in East Africa are its direct descendants (Green, 2018: 67–8).

The Third Plague Pandemic began to spread out of China in the late nineteenth century and was not suppressed until 1960, spreading to all inhabited continents via ocean-going trade and killing more than twelve million people in India and China alone (Xu et al., 2019: 11833–4). Modern strains of plague are conventionally identified as the descendants of this pandemic (Earn et al., 2020: 27703).

**Building a Comparative Historical Survey: Pre-bacteriological vs Early Bacteriological vs Modern Responses to Plague Epidemics**

Public health responses to the broad history of plague epidemics over time can be effectively assessed through a process of comparative historical analysis, which has three core features: ‘concern with causal analysis, the exploration of temporal processes, and the use of systematic and contextualized comparison typically limited to a small number of cases’ (Mahoney and Rueschemeyer, 2003: 14). Comparative analysis is a relatively new public health research framework, but Worboys (1994) identifies it as particularly valuable because it allows the tracing of common themes, like diseases and treatment strategies, and their gradual evolution, across often radically different contexts (89–90). It has become a mainstream research framework over the past few decades, incorporating sophisticated book-length critical studies like the work of McKay (2017) on the concept of ‘Patient Zero’ in an epidemic.

The onset of the COVID-19 pandemic has cemented the popularity of comparative analysis. Work like
Mooney’s (2020) contextualisation of contact-tracing has enabled current attempts to map the transmission of infectious disease to be assessed within a timeline of similar practices stretching back to the nineteenth century (1806–08). The innovation of forums like the University of Oxford’s ‘How Epidemics End’ project, drawing together specialists from across the natural, social and formal sciences, has laid the ground for a new era of complex interdisciplinary study of public health centred on comparative analysis (Charters and Heitman, 2021: 211–13).

With an awareness of this broader academic context, selecting a few case studies from thousands of years of plague epidemics was a complex process. Existing comparative analyses of plague, such as Bigon’s (2016) work on early twentieth-century West African epidemics, have tended towards a more limited chronological and geographical scope (218–19). The intention for this study, however, is to conduct a more broadly ambitious ‘big picture’ analysis of plague: this analysis aims to demonstrate what responses to plague epidemics have looked like in the past, how they have changed in the face of major scientific advances, and what they look like in the present day, through this process obtaining generalisable public health lessons relevant to combating future epidemics. The decision was made to structure the research by basing case selection on a tripartite chronological division, using the following categories of plague epidemics:

1. **Pre-bacteriological epidemics**, taking place before the isolation of the *Y. pestis* bacterium in 1894 enabled major advances in clinical understanding and treatment of plague, marked by an embryonic and generally *ad hoc* understanding of medicine and public health.

2. **Early bacteriological epidemics**, taking place between 1894 and the end of the Third Plague Pandemic in 1960, marked by a demonstrated and rapidly developing clinical understanding of plague but where treatment methods and wider public health strategies remained relatively experimental.

3. **Modern epidemics**, taking place since 1960, where plague is treatable in a comparatively straightforward and scientifically nuanced way, marked by public health strategies incorporating sophisticated international coordination and awareness of plague’s relatively limited prevalence in the modern world.

By choosing one epidemic from each category, public health strategies could be traced chronologically, examining how changes in clinical understanding have had flow-on effects on the development of public health practice. To enable fair and accurate comparisons between the three case studies, it was critical that each epidemic was both well documented contemporaneously and backed up by a large amount of recent academic work. Although the three cases are similar, they are not ideally aligned: the first two case studies are drawn from large Western seaports, located in countries with a high degree of contemporary power and authority and public health systems that were among the best available in their time. However, plague no longer significantly affects such areas, and it was therefore necessary to draw the third case study from one of the relatively poor and marginal countries where plague remains endemic.

In terms of the first category, it was decided that the case study had to have taken place since 1700 to ensure that public health responses took place in the context of an awareness of the potential role that structured, professional, centralised public health interventions could play in combating epidemics. Considering these factors, the first case study chosen is the 1720–22 Marseille epidemic, as this is particularly well documented, continues to be the subject of in-depth critical study and debate, and demonstrates an explicit transition towards the development of public health as a centralised, state-led bureaucratic enterprise.

The second case study is the 1900–04 San Francisco epidemic, as this is well documented, displays concerted but flawed attempts to incorporate contemporary medical innovations into public health practice, raises questions about the intersection of questions of race, class and power with public health interventions, and displays the efficacy of development-based solutions to plague.

The final case study is the 2017 Madagascar epidemic, as this is the most recent major plague epidemic on record, displays mass transmission of pneumonic plague in an urban area, was treated with a full range of modern public health strategies, and has been flagged as a watershed moment potentially representing a wider re-emergence of plague.

**Case Study 1: Marseille, 1720**

The so-called ‘Great Plague of Marseille’ which lasted from 1720–22 was one of the very last major outbreaks of the Second Plague Pandemic. Plague had been a regular visitor to Marseille in the preceding centuries: eleven epidemics had been noted in the region in the years since 1560 (Devaux, 2013: 172). However, no epidemic had occurred since 1650 (Barbieri and Drancourt, 2018: 7). This has been traced to the creation of successful public quarantine facilities: Marseille had constructed its first permanent *lazaret*, or quarantine station, in 1557, which allowed disembarking passengers and cargo to be systemically quarantined. Between 1663 and 1683, the ‘new *lazaret*’ was constructed: a separate compound with...
eighteen large sheds and its own port, managed by a dedicated staff (Devaux, 2013: 172). By 1720, Marseille’s quarantine system had developed into a sophisticated ‘tri-polar’ system, where health officials chosen from among the city’s merchants worked from a dedicated headquarters, assessing ships for visible signs of disease before transporting cargo and passengers by rowboat to the lazaret. The Marseille lazaret was generally recognised as one of the strictest in Europe, as the cargo of ships suspected of carrying plague could be quarantined for up to sixty days (Signoli and Tzortzis, 2018: 219).

The traditional narrative surrounding the eventual arrival of the plague in 1720 links it directly to ‘the greed of ship owners’ (Devaux, 2013: 172–3). A ship had arrived from Cyprus on 25 May 1720. Seven of its sailors had died suspiciously during the voyage and warning had been given in advance of its arrival. In accordance with Marseille’s regulations, the ship should have been isolated and burned. However, the ship’s owner, a deputy mayor of Marseille, put pressure on health officials to put the ship and its cargo of cloth through ordinary quarantine. On 20 June, the first plague case in the city was noted (Devaux, 2013: 174–5). Despite the dominance of this narrative, recent scholarship has sought to bring it into question. Varlik (2020) argues that there is no conclusive evidence linking the ship to the epidemic and the story has more to do with Orientalist ideas of a ‘sickly Orient’ than any kind of objective analysis (288–9). This is supported by a recent reconstruction of the pathogen genome, which has tentatively linked the strain of plague in Marseille to older strains which had been circulating in Europe for several hundred years – raising the question of whether, in fact, the epidemic arose from an existing European plague reservoir rather than being carried to Marseille from the East (Bos et al., 2016: 5–7).

Regardless of its origins, plague took root in Marseille and spread into Provence by the end of July (Devaux, 2013: 175–8). The French Crown moved swiftly to deal with the epidemic, in what has been characterised as an early example of centralised state-led disaster management. Crisis management was put under the control of a dedicated Committee of Health led by a senior army general, which put Marseille under martial law. Both commerce and travel in and out of the region were suspended, enforced by a military cordon which eventually involved up to a quarter of France’s standing army. The emphasis on movement control included the construction of a 27-kilometre-long wall blocking off key transportation routes. The Committee distributed food and basic supplies, trapped dogs and cats, burned infected property, buried the dead in mass graves and conducted regular disinfections of the city with vinegar. In keeping with contemporary understandings of disease, cannon shots were used to dispel the ‘miasma’ of infected air thought to lie over the city, and purificatory religious processions were also organised (Ermus, 2015: 2–3). Order was imposed through strict discipline and summary justice: looters of abandoned homes were punished with death (Devaux, 2013: 177).

Despite these measures, the plague spread rapidly through Provence, devastating the neighbouring communities of Martigues and Toulon by late 1720 (Devaux, 2013: 178–9). Plague deaths in Marseille eventually peaked at more than a thousand people per day in September 1720, but this dropped rapidly to around fifty per day by November. After the almost total suppression of the disease by the end of 1721, virtually all restrictions were lifted on Marseille (Signoli and Tzortzis, 2018: 219, 224). However, a smaller outbreak which started in May 1722 forced the re-imposition of the commercial blockade, before the epidemic was finally suppressed in December 1722 (Devaux, 2013: 179–80). The plague killed around 120,000 people across 242 affected communities, more than 30 per cent of the communities’ total population (Signoli and Tzortzis, 2018: 226).

**Case Study 2: San Francisco, 1900–04**

Almost two centuries on from the Marseille epidemic, clinical understanding of plague had progressed significantly. The Y. pestis bacterium was isolated in 1894 by the Swiss bacteriologist Alexandre Yersin, who proved that the same bacteria were present in both rats and plague-infected humans, definitively linking Y. pestis infection with plague symptoms (Butler, 2014: 202–3). Based on this knowledge, the Russian-French bacteriologist Waldemar Haffkine created the first widely effective plague vaccine in 1897, developing a heat-killed culture of plague bacteria which was distributed to several hundred thousand people during an Indian epidemic (Butler, 2014: 207).

When plague arrived in San Francisco in 1900, in one of the first epidemics of the Third Plague Pandemic to spread beyond Asia, responses to plague epidemics based on a sound clinical understanding were available – as had not been the case in Marseille (Tansey, 2019: 454–5). Plague initially arrived on a trading ship from Hawaii in late 1899, swiftly gaining traction in San Francisco’s crowded, impoverished Chinatown district. The first human victim died on 6 March 1900 and was autopsied by an official city bacteriologist who confirmed the likely presence of plague (Kinyoun and Wyman, 2006: 16). The City Board of Health took immediate action, cordoning Chinatown on 7 March 1900 (Risse, 1995: 1). However, this was immediately attacked by San Francisco business interests, who saw restrictive public health measures as a major threat to commerce (Kalisch, 1972: 116–18). They
were joined in this by many Chinese, who were wary of the discriminatory treatment they faced from public officials. White people could leave the Chinatown cordon, while Chinese were forced to stay (Risse, 2012: 12). Many Chinese were also mindful of a recent public health intervention in Hawaii, where the burning of plague-affected houses had led to a major fire in Honolulu’s Chinatown (Echenberg, 2002: 444). Faced with overwhelming opposition, the cordon was lifted after less than 60 hours (Kalisch, 1972: 118).

After plague was formally identified on 11 March 1900, the cordon was not immediately reimposed, but house-to-house searches were conducted to identify plague victims (Kalisch, 1972: 119). Chinatown community leaders were largely uncooperative, and the bodies of plague victims were regularly hidden to avoid religiously prohibited autopsies (Echenberg, 2010: 230). After four new cases of plague were confirmed by 16 May 1900, the federal Surgeon-General ordered the city’s chief federal quarantine officer to implement comprehensive public health measures. These included cordoning of the area, house-to-house inoculations with Haffkine’s vaccine, the quarantining of suspected cases, comprehensive disinfection, and the destruction of rats (Kinyoun and Wyman, 2006: 19).

However, the backlash continued. Reintroduction of the cordon on Chinatown led to riots (Risse, 2012: 134). Haffkine’s vaccine was painful and often led to severe side effects (Risse, 2012: 123–4). The State Governor blocked most federal public health initiatives, rallied against ‘plague fakers’, and suggested that plague cases were the result of importing plague samples into dead bodies (Kalisch, 1972: 127).

Amid the impotence of public health measures, the epidemic continued to claim lives, with more than twenty-five deaths by February 1901 (Kalisch, 1972: 127). Faced with a mounting crisis amid an increasingly visible national lack of confidence in Californian authorities, the state government was forced to allow federal intervention under the direct control of the Surgeon General (Kazanjian, 2012: 1376–7). Under the leadership of a new local federal quarantine officer, a public health campaign was launched based on improving wider sanitation patterns in Chinatown. Rats were trapped, rubbish was removed, houses and rat burrows were disinfected, footpaths and flooring were concreted to minimise contact between rats and humans, and positive relations between health authorities and Chinatown inhabitants were prioritised (Blue, 1909: 8; Risse, 2012: 170). The epidemic was eventually suppressed by 1904, after 121 deaths (Kazanjian, 2012: 1377). Although plague would return to California several times over the next two decades, notably following a major earthquake in 1906, the basic public health strategies for dealing with plague had been defined and implemented (Stimson, 1939: 122–3). By 1909, in San Francisco, 11,000 houses had been disinfected and hundreds of thousands of square feet of concrete footpaths and flooring had been installed (Stobbe, 2014: 43).

**Case Study 3: Madagascar, 2017**

Over the next century, the clinical understanding of, and responses to, plague continued to improve. The Second Indian Plague Commission proved definitively in 1907 that plague was spread from rats to humans via the parasitic fleas inhabiting rats (Evans, 2018: 34). The last major plague epidemic in Europe or North America was in 1924, in Los Angeles (Viseltear, 1974: 40–1). After the discovery of effective therapeutic antibiotics in the 1930s and 1940s, plague became directly treatable and death rates plummeted (Anisimov and Amoako, 2006: 1465–6). When the World Health Organization (WHO) announced the end of the Third Plague Pandemic in 1960, plague was largely confined to remote areas of Asia, South America and sub-Saharan Africa, with around 75 per cent of contemporary plague cases reported to the WHO from Madagascar (Randremanana et al., 2019: 537).

Despite plague’s endemic quality in Madagascar, the 2017 epidemic took health authorities by surprise. The normal plague season in Madagascar is from September to April, but the index case was discovered in August 2017, when an infected highland inhabitant travelled to the capital of Antananarivo, spreading the disease, before dying in a crowded taxi on the way to the coastal city of Toamasina – a place which had no previous history of plague (Mazumdar, 2017). The epidemic was eventually confirmed as highly infectious pneumonic plague on 11 September 2017, marking the first major urban outbreak of pneumonic plague in around a century (Rabaan, 2019: 236). By 14 September 2017, five deaths had been reported (World Health Organization – Regional Office for Africa, 2017: 2).

Faced with the prospect of a severe epidemic, the national Ministry of Public Health launched an immediate response centred around a full range of modern public health interventions. These included immediate notification of the WHO, field investigations and surveillance, contact tracing, distribution of health information, and spraying of the houses of confirmed cases with pesticides (WHO – Regional Office for Africa, 2017: 2). However, Madagascar is faced with significant wider health challenges: it is the fourth most undernourished country in the world, struggles with major endemic diseases such as cholera, and more than 40 per cent of the population lives in areas distant from health centres (Barmania, 2015: 729–30). Additionally, plague is highly stigmatised in Madagascar due to its...
perceived association with poor hygiene, which hampered contact tracing of the index cases (Alderson et al., 2020: 428–9). Faced with these barriers, the Malagasy Government developed a coordinated humanitarian response in partnership with the WHO, the United Nations Children’s Fund (UNICEF), the International Federation of Red Cross and Red Crescent Societies (IFRC) and major humanitarian non-governmental organisations, including Médecins du Monde and Médecins Sans Frontières (Chereau, 2018).

Plague continued to spread widely into early October, and by 3 October 2017 thirty deaths had been recorded (European Centre for Disease Prevention and Control, 2017: 1). The WHO airlifted more than a million antibiotic doses into Madagascar, and the government launched severe emergency restrictions. These included a ban on public gatherings, the closing of schools and universities, the establishment of a toll-free case-reporting number, and a crackdown on ‘fake news’ spread via social media (BBC, 2017). The government also suppressed traditional Malagasy famadihana burial practices. These involve exhuming the corpse of the dead, rewrapping them in fresh cloth, and dancing with the body around the family crypt, a practice which has been linked to the transmission of pneumonic plague (Sodikoff, 2019: 48).

Many bodies of plague victims were buried in sealed body bags in mass graves, a practice which scandalised many Malagasy and led to incidences of plague denialism and attempted body theft (France 24, 2017).

In the face of these measures, new cases declined over the course of October, with the last new case recorded on 28 October 2017. By mid-November, having killed 209 people in total, the epidemic was under control. Basic control measures continued until the end of the plague season in April 2018 (World Health Organization, 2020).

Discussion of the Situation Today: Why Is Plague a Threat in 2022?

Having assessed more than two hundred years of plague epidemics, witnessing the gradual development of a scientific consensus around plague, the end of global plague pandemics, the retreat of epidemics to a few endemic areas, and the development of consistently effective public health interventions and treatment methods, it must be asked: why consider plague a major public health threat in 2022, given that other diseases kill many more people and plague epidemics seem to be straightforwardly brought under control?

First, plague’s relatively recent confinement to a few isolated areas may ultimately prove to be an intermission rather than a full retreat. It has been recently argued, based on the way the 2017 Madagascar epidemic saw urban person-to-person transmission of pneumonic plague for the first time in a century, plague should be identified as a re-emerging disease (Vallès, 2020: 14). If plague spread into a location defined by poor sanitation and mass flows of people, such as a refugee camp, its impact would be devastating. Fortunately, plague has not yet widely affected modern refugees, with the only well-reported and significant outbreaks occurring among South Vietnamese refugees during the Vietnam War (Whitehall, 2009: 671). Given, however, that both population density and the numbers of people affected by absolute poverty have been increasing in plague’s African heartland, it is perhaps simply a matter of luck that no recent plague epidemics have coincided with a significant war, famine or natural disaster (Baril et al., 2019: 1). If plague is genuinely re-asserting itself, and there is a real chance that a major refugee population could be infected, then it is a disease that the humanitarian sector needs to take wider note of.

Plague has not been studied closely in recent decades. What studies exist have primarily focused on assessing plague’s status as a potential bioterrorist threat rather than as an endemic public health problem, and major flaws exist in existing clinical responses to plague (Vallès, 2020: 13). Pneumonic plague is difficult to diagnose with existing rapid diagnostic tests (Mead, 2018: 106–7). Existing antibiotic treatments often have a poor safety, cost and availability profile, and existing plague vaccines are not extensively used because of their dangerous side effects (Baril et al., 2019: 2–3). Most seriously, strains of plague with high-level resistance to all first-line antibiotics have been clinically noted in Madagascar since 1995 (Galimand et al., 2006: 3234–6).

Beyond treatment, we lack a context-specific eco-epidemiological understanding of how plague circulates in the environment between successive outbreaks. Why, for instance, does Y. pestis occur in a variety of small mammals in Peru, but only in rats in Madagascar (Vallès, 2020: 13)? We are unlikely to be able to understand this process or develop strategies to mitigate it without developing our knowledge of the relevant eco-epidemiology.

What Lessons Can Be Drawn from the Case Studies?

Considering all these factors, the prospect of having to address a widespread plague epidemic is growing in its likelihood every year. In preparing to confront it, the humanitarian sector is armed with treatment strategies of limited effectiveness and a public health understanding of plague that has not changed substantively over the last century. Significant research can and must be done
in this area. However, in the interim, what relevant and applicable public health lessons for the humanitarian sector can be drawn from previous responses to plague epidemics? Three main lessons can be identified.

1. To respond to a plague epidemic, public health authorities must have centralised, independently effective and minimally bureaucratic response protocols.

Marseille had a well-established and generally very effective quarantine service, but the fact that it was operated by merchants with vested commercial interests working in their spare time meant that there was clear scope for the selective non-enforcement of public health regulations. A central theme of the Marseille epidemic is the developing realisation that crisis management was the appropriate domain of centralised state authorities able to deploy sophisticated bureaucratic systems. However, it should be noted that lack of clarity within bureaucratic systems has the potential to sap the effectiveness of such systems. San Francisco saw its plague epidemic grow out of control largely because existing federal and state chains of command had very disconnected priorities. The organised public health responses became lost in denialism, racist stereotyping, greed, and bureaucratic wrangling.

Clear and unambiguous public health hierarchies must, consequently, be put in place and comprehensively tested long before the outbreak of a plague epidemic. The Madagascar public health response was certainly an improvement on those of Marseille and San Francisco. The epidemic was brought under control within a few months through the joint intervention of the Ministry of Public Health and international humanitarian organisations. However, Madagascar’s existing public health services are not effective enough to respond to a plague epidemic independently, and massive humanitarian intervention at the point of an epidemic is not a sustainable solution. Permanent, development-based public health solutions to plague epidemics which meaningfully engage with societal health agendas must be sought, along the lines of those implemented in San Francisco. These must develop the ability of individual public health authorities to act independently in an epidemic, ideally reducing international humanitarian organisations to a limited support role.

2. However comprehensive any public health intervention may be, the most important factor in controlling a plague epidemic is overcoming fear and denialism by gaining the trust and cooperation of the affected population.

Over the course of its long history, plague has been consistently defined by high mortality, rapid spread and association with poverty. Dangerously, affected populations may prioritise avoiding the stigma of plague over responding to it. If plague conflicts with core cultural values, as with Chinese burial rituals in San Francisco or famadihana in Madagascar, a population with limited public health knowledge may dismiss the plague as ‘mythical’ or ‘perhaps elsewhere, but not here’. Although a full discussion of the wider ‘humanitarian-development nexus’ is outside of this article’s scope, such denialism can only be effectively addressed through wider public health education programmes which go beyond the boundaries of humanitarian health interventions and become inclusive of broader development strategies.

As has been shown in Marseille, a general and absolute suppression of civil liberties will, eventually, probably be enough to suppress a plague epidemic. However, unless public health authorities present a public health response to plague as something done with the population, rather than imposed on them, such responses will be inefficient and disconnected from local needs and priorities in a way likely to lead to lasting resentment of public health interventions. In San Francisco, where the Chinatown population was able to consistently assert its independence, public health authorities were forced to move from a narrow approach focused on direct interventions to a much wider programme of inclusive civic development. If mutually trustful and cooperative interactions between health authorities and the community are established before an epidemic’s outbreak, humanitarian interventions will become much easier. If a plague-affected community’s first major contact with public health authorities is during a humanitarian intervention, humanitarian actors will be forced to build wider relationships with a potentially mistrustful community while simultaneously trying to control the epidemic.

3. Despite the end of a visible epidemic, plague can potentially re-emerge wherever there is a stable and infected population of small mammals.

Plague has the potential to cause an epidemic in any environment where infected small mammals regularly encounter humans. Plague’s epidemiological history is defined, as one writer has pointed out, by ‘its capacity to move from one region, context, or scenario to another, or even the emergence or re-emergence in previously free areas or where human plague has not been observed for decades’ (Vallès, 2020: 14). Plague bacteria are likely to survive in some form beyond the end of an epidemic, and they can swiftly re-emerge following new patterns of human-animal contact. As we have seen in Marseille, the plague may have been waiting, forgotten, in domestic ecological reservoirs for hundreds of years before its ultimate re-emergence due to unknown factors in 1720. Consequently, if plague is only combated through direct
public health interventions at the time of an epidemic, such epidemics will remain endemic. Wider public health strategies must, in Madagascar and other endemic areas, move beyond simple patterns of treatment and population control. They must follow the example of San Francisco, emphasising the minimisation of human-animal contact through the widespread improvement of standards of living and sanitation.

Conclusion

Fundamentally, despite its long history and recent diminishment, plague is not nearly as much of a disease of the past as many observers would like to believe. Recent signs that it may be reasserting itself may be unwelcome, but they must not be ignored. Given the re-emergence of pneumonic plague in Madagascar, and the serious limitations of existing clinical knowledge and public health strategies, the world may yet see the arrival of a Fourth Plague Pandemic. Widespread outbreaks in humanitarian contexts could be devastating, especially if plague becomes endemic in refugee populations. To forestall this, it is critical for the humanitarian sector to critically assess the public health lessons learnt from past epidemics. If there is a single core lesson from the case studies analysed here, it is that widely focused public health outreach must start before the outbreak of disease. Relevant humanitarian actors must begin to engage in effective and consistent dialogue with external actors, most prominently their counterparts in the development sector.

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