



# Bubonic plague

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**Bubonic plague** is one of three types of bacterial infection caused by *Yersinia pestis*.<sup>[1]</sup> Three to seven days after exposure to the bacteria flu like symptoms develop. This includes fever, headaches, and vomiting.<sup>[1]</sup> Swollen and painful lymph nodes occur in the area closest to where the bacteria entered the skin.<sup>[2]</sup> Occasionally the swollen lymph nodes may break open.<sup>[1]</sup>

The three types of plague are the result of the route of infection: bubonic plague, septicemic plague, and pneumonic plague. Bubonic plague is mainly spread by infected fleas from small animals.<sup>[1]</sup> It may also result

from exposure to the body fluids from a dead plague infected animal.<sup>[3]</sup> In the bubonic form of plague, the bacteria enter through the skin through a flea bite and travel via the lymphatic vessels to a lymph node, causing it to swell. Diagnosis is made by finding the bacteria in the blood, sputum, or fluid from lymph nodes.<sup>[1]</sup>

Prevention is through public health measures such as not handling dead animals in areas where plague is common. Vaccines have not been found to be very useful for plague prevention.<sup>[1]</sup> Several antibiotics are effective for treatment including streptomycin, gentamicin, and doxycycline.<sup>[4][5]</sup> Without treatment it results in the death of 30% to 90% of those infected.<sup>[1][4]</sup> Death if it occurs is typically within ten days.<sup>[6]</sup> With treatment the risk of death is around 10%.<sup>[4]</sup> Globally in 2013 there were about 750 documented cases which resulted in 126 deaths.<sup>[1]</sup> The disease is most common in Africa.<sup>[1]</sup>

The plague is believed to be the cause of the Black Death that swept through Asia, Europe, and Africa in the 14th century and killed an estimated 50 million people.<sup>[1]</sup> This was about 25% to 60% of the European population.<sup>[1][7]</sup> Because the plague killed so many of the working population, wages rose due

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A *bubo* on the upper thigh of person infected with bubonic plague.

### Classification and external resources

<b>Specialty</b>	Infectious disease
<b>ICD-10</b>	A20.0 ( <a href="http://apps.who.int/classifications/icd10/browse/2016/en#/A20.0">http://apps.who.int/classifications/icd10/browse/2016/en#/A20.0</a> )
<b>ICD-9-CM</b>	020.0 ( <a href="http://www.icd9data.com/getICD9Code.aspx?icd9=020.0">http://www.icd9data.com/getICD9Code.aspx?icd9=020.0</a> )
<b>DiseasesDB</b>	14226 ( <a href="http://www.diseasesdatabase.com/ddb14226.htm">http://www.diseasesdatabase.com/ddb14226.htm</a> )
<b>MedlinePlus</b>	000596 ( <a href="https://medlineplus.gov/ency/article/000596.htm">https://medlineplus.gov/ency/article/000596.htm</a> )

to the demand for labor. Some historians see this as a turning point in European economic development.

<sup>[7]</sup> The term *bubonic plague* is derived from the Greek word βουβών, meaning "groin".<sup>[8]</sup> The term "buboes" is also used to refer to the swollen lymph nodes.<sup>[9]</sup>

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## Signs and symptoms

The best-known symptom of bubonic plague is one or more infected, enlarged, and painful lymph nodes, known as buboes. After being transmitted via the bite of an infected flea, the *Y. pestis* bacteria become localized in an inflamed lymph node where they begin to colonize and reproduce. Buboes associated with the bubonic plague are commonly found in the armpits, upper femoral, groin and neck region. Acral gangrene (i.e., of the fingers, toes, lips and nose) is another common symptom.

Because of its bite-based mode of transmission, the bubonic plague is often the first of a progressive series of illnesses. Bubonic plague symptoms appear suddenly a few days after exposure to the bacterium. Symptoms include:

- Chills
- General ill feeling (malaise)
- High fever (39 °C; 102 °F)
- Muscle cramps<sup>[10]</sup>
- Seizures
- Smooth, painful lymph gland swelling called a bubo, commonly found in the groin, but may occur in the armpits or neck, most often near the site of the initial infection (bite or scratch)
- Pain may occur in the area before the swelling appears

- Gangrene of the extremities such as toes, fingers, lips and tip of the nose.<sup>[11]</sup>

Other symptoms include heavy breathing, continuous vomiting of blood (hematemesis), aching limbs, coughing, and extreme pain caused by the decay or decomposition of the skin while the person is still alive. Additional symptoms include extreme fatigue, gastrointestinal problems, lenticulae (black dots scattered throughout the body), delirium, and coma.

## Cause

Bubonic plague is an infection of the lymphatic system, usually resulting from the bite of an infected flea, *Xenopsylla cheopis* (the rat flea). In very rare circumstances, as in the septicemic plague, the disease can be transmitted by direct contact with infected tissue or exposure to the cough of another human. The flea is parasitic on house and field rats, and seeks out other prey when its rodent hosts die. The bacteria remained harmless to the flea, allowing the new host to spread the bacteria. The bacteria form aggregates in the gut of infected fleas and this results in the flea regurgitating ingested blood, which is now infected, into the bite site of a rodent or human host. Once established, bacteria rapidly spread to the lymph nodes and multiply.

*Y. pestis* bacilli can resist phagocytosis and even reproduce inside phagocytes and kill them. As the disease progresses, the lymph nodes can haemorrhage and become swollen and necrotic. Bubonic plague can progress to lethal septicemic plague in some cases. The plague is also known to spread to the lungs and become the disease known as the pneumonic plague.

## Diagnosis

Laboratory testing is required in order to diagnose and confirm plague. Ideally, confirmation is through the identification of *Y. pestis* culture from a patient sample. Confirmation of infection can be done by examining serum taken during the early and late stages of infection. To quickly screen for the *Y. pestis* antigen in patients, rapid dipstick tests have been developed for field use.<sup>[12]</sup>

## Treatment



Acral necrosis of the nose, the lips, and the fingers and residual ecchymoses over both forearms in a patient recovering from bubonic plague that disseminated to the blood and the lungs. At one time, the patient's entire body was ecchymotic. Reprinted from *Textbook of Military Medicine*.



Oriental rat flea (*Xenopsylla cheopis*) infected with the *Yersinia pestis* bacterium which appears as a dark mass in the gut. The foregut of this flea is blocked by a *Y. pestis* biofilm; when the flea attempts to feed on an uninfected host, *Y. pestis* from the foregut is regurgitated into the wound, causing infection.

Several classes of antibiotics are effective in treating bubonic plague. These include aminoglycosides such as streptomycin and gentamicin, tetracyclines (especially doxycycline), and the fluoroquinolone ciprofloxacin. Mortality associated with treated cases of bubonic plague is about 1–15%, compared to a mortality of 40–60% in untreated cases.<sup>[13]</sup>

People potentially infected with the plague need immediate treatment and should be given antibiotics within 24 hours of the first symptoms to prevent death. Other treatments include oxygen, intravenous fluids, and respiratory support. People who have had contact with anyone infected by pneumonic plague are given prophylactic antibiotics.<sup>[14]</sup> Using the broad-based antibiotic streptomycin has proven to be dramatically successful against the bubonic plague within 12 hours of infection.<sup>[15]</sup>

## History

### First outbreak

The first recorded epidemic affected the Eastern Roman Empire (Byzantine Empire) and was named the Plague of Justinian after emperor Justinian I, who was infected but survived through extensive treatment.<sup>[16][17]</sup> The pandemic resulted in the deaths of an estimated 25 million (6th century outbreak) to 50 million people (two centuries of recurrence).<sup>[18][19]</sup> The historian Procopius wrote, in Volume II of *History of the Wars*, of his personal encounter with the plague and the effect it had on the rising empire. In the spring of 542, the plague arrived in Constantinople, working its way from port city to port city and spreading around the Mediterranean Sea, later migrating inland eastward into Asia Minor and west into Greece and Italy. Because the infectious disease spread inland by the transferring of merchandise through Justinian's efforts in acquiring luxurious goods of the time and exporting supplies, his capital became the leading exporter of the bubonic plague. Procopius, in his work *Secret History*, declared that Justinian was a demon of an emperor who either created the plague himself or was being punished for his sinfulness.<sup>[19]</sup>

### Second outbreak

In the Late Middle Ages (1340–1400) Europe experienced the most deadly disease outbreak in history when the Black Death, the infamous pandemic of bubonic plague, hit in 1347, killing a third of the human population. It is believed that society subsequently became more violent as the mass mortality rate cheapened life and thus increased warfare, crime, popular revolt, waves of flagellants, and persecution.<sup>[20]</sup> The Black Death originated in or near China and spread from Italy and then throughout other European countries. Arab historians Ibn Al-Wardni and AlMaqrizi believed the Black Death originated in Mongolia, and this was proven correct as Chinese records showed a huge outbreak in Mongolia in the early 1330s.<sup>[21]</sup> Research published in 2002 suggests that it began in early 1346 in the steppe region, where a plague reservoir stretches from the northwestern shore of the Caspian Sea into southern Russia. The Mongols had cut off the trade route, the Silk Road, between China and Europe which halted the spread of the Black Death from eastern Russia to Western Europe. The epidemic began with an attack that Mongols launched on the Italian merchants' last trading station in the region, Caffa in the Crimea.<sup>[15]</sup> In late 1346, plague broke out among the besiegers and from them penetrated into the

town. When spring arrived, the Italian merchants fled on their ships, unknowingly carrying the Black Death. Carried by the fleas on rats, the plague initially spread to humans near the Black Sea and then outwards to the rest of Europe as a result of people fleeing from one area to another.

There were many ethno-medical beliefs for avoiding the Black Death. One of the most famous was that by walking around with flowers in or around their nose people would be able to "ward off the stench and perhaps the evil that afflicted them". People believed the plague to be a punishment from God, and that the only way to be rid of the plague was to be forgiven by God.<sup>[22]</sup> One such method used was to carve the symbol of the cross onto the front door of a house with the words "Lord have mercy on us".<sup>[23]</sup>

Pistoia, a city in Italy, went as far as enacting rules and regulations on the city and its inhabitants to keep it safe from the Black Death. The rules stated that no one was allowed to visit any plague-infected area and if they did they were not allowed back into the city. Some other rules were that no linen or woollen goods were to be imported into the city and no corpses were to be buried in the city. Despite strict enforcement of the rules, the city eventually became infected.<sup>[24]</sup> People who were not infected with the plague gathered in groups and stayed away from the sick. They ate and drank with limited food and water and were not even allowed oral communication because it was believed that merely talking with one another increased the chance of passing on the disease.<sup>[25]</sup>

While Europe was devastated by the disease, the rest of the world fared much better. In India, population rose from a population of 91 million in 1300, to 97 million in 1400, to 105 million in 1500. Sub-Saharan Africa remained largely unaffected by the plagues.<sup>[26]</sup>

The next few centuries were marked by several localized or regional outbreaks of lesser severity. The Great Plague of Milan (1629-1631), the Great Plague of Seville (1647), the Great Plague of London (1665–1666), the Great Plague of Vienna (1679), Great Baltic plague (1708–1712), the Great Plague of Marseille (1720), the Great Plague of 1738 and Caragea's Plague (1813–1814) were the last major outbreaks of the bubonic plague in Europe.

## Traditional treatment

Medieval doctors thought the plague was created by air corrupted by humid weather, decaying unburied bodies, and fumes produced by poor sanitation. The recommended treatment of the plague was a good diet, rest, and relocating to a non-infected environment so the individual could get access to clean air.



Citizens of Tournai bury plague victims. Miniature from *The Chronicles of Gilles Li Muisis* (1272–1352). Bibliothèque royale de Belgique, MS 13076-77, f. 24v.



Bubonic plague victims in a mass grave from 1720–1721 in Martigues, France

This did help, but not for the reasons the doctors of the time thought. In actuality, because they recommended moving away from unsanitary conditions, people were, in effect, getting away from the rodents that harbored the fleas carrying the infection. However, this also helped to spread the infection to new areas previously non-infected.

### Third outbreak

The plague resurfaced for a third time in the mid-19th century. Like the two previous outbreaks, this one also originated in Eastern Asia.<sup>[27]</sup> The initial outbreak occurred in China's Yunnan province in 1855.<sup>[28]</sup> The disease remained localized in Southwest China for several years before spreading. In the city of Canton, beginning in January 1894, the disease killed 80,000 people by June. Daily water-traffic with the nearby city of Hong Kong rapidly spread the plague there, killing over 2,400 within two months.<sup>[29]</sup>

From China, the plague spread to the Indian subcontinent around 1896. Over the next thirty years, India would lose 12.5 million people to the bubonic plague. The disease was initially seen in port cities, beginning with Bombay (now Mumbai), but later emerged in Poona (now Pune), Kolkata, and Karachi (now in Pakistan). By 1899, the outbreak spread to smaller communities and rural areas in many regions of India. Overall, the impact of plague epidemics was greatest in western and northern India—in the provinces then designated as Bombay, Punjab, and the United Provinces—while eastern and southern India were not as badly affected. Ultimately, more than 12 million people died from the plague in India (including present day Pakistan and Bangladesh) and China alone.

In 1899, the plague reached the islands of Hawaii.<sup>[30]</sup> The first evidence of the disease was found in Honolulu's Chinatown on Oahu.<sup>[31]</sup> It was located very close to the island's piers, and rats in cargo ships from China were able to land on the Hawaiian islands unseen. As the rats, hosts for disease-carrying fleas, made their way deeper into the city, people started to fall ill. On December 12, 1899, the first case was confirmed. The Board of Health then quickly thought of ways to prevent the disease from spreading even further inland. Their solution was to burn down any buildings in Chinatown suspected of containing a source of the disease. On December 31, 1899, the board set the first fire. They had originally planned to burn only a few targeted buildings, and thought they could control the flames as each building was finished, but the fire got out of control, burning down untargeted neighboring buildings. The resulting fire caused many of Chinatown's homes to be destroyed and an estimated 4,000 people were left homeless.<sup>[32]</sup>

Australia suffered 12 major plague outbreaks between 1900 and 1925 originating from shipping.<sup>[33]</sup> Research by Australian medical officers Thompson, Armstrong and Tidswell contributed to understanding the spread of *Yersinia pestis* to humans by fleas from infected rats.<sup>[34]</sup>



Directions for searchers, Poona (now Pune) plague of 1897



According to the World Health Organization, the pandemic was considered active until 1959, when worldwide casualties dropped to 200 per year. In 1994, a plague outbreak in five Indian states caused an estimated 700 infections (including 52 deaths) and triggered a large migration of Indians within India as they tried to avoid the plague.

## Biological warfare

Some of the earliest instances of biological warfare were said to have been products of the plague, as armies of the 14th century were recorded catapulting diseased corpses over the walls of towns and villages to spread the pestilence.

Later, plague was used during the Second Sino-Japanese War as a bacteriological weapon by the Imperial Japanese Army. These weapons were provided by Shirō Ishii's units and used in experiments on humans before being used on the field. For example, in 1940, the Imperial Japanese Army Air Service bombed Ningbo with fleas carrying the bubonic plague.<sup>[35]</sup> During the Khabarovsk War Crime Trials, the accused, such as Major General Kiyashi Kawashima, testified that, in 1941, some 40 members of Unit 731 air-dropped plague-contaminated fleas on Changde. These operations caused epidemic plague outbreaks.<sup>[36]</sup>

## Society and culture

The scale of death and social upheaval associated with plague outbreaks has made the topic prominent in a number of historical and fictional accounts since the disease was first recognized. The Black Death in particular is described and referenced in numerous contemporary sources, some of which, including works by Chaucer, Boccaccio, and Petrarch, are considered part of the Western canon. The Decameron, by Boccaccio, is notable for its use of a frame story involving individuals who have fled Florence for a secluded villa to escape the Black Death. First person, sometimes sensationalized or fictionalized, accounts of living through plague years have also been popular across centuries and cultures.

Later works, such as Albert Camus's novel *The Plague* or Ingmar Bergman's film *The Seventh Seal* have used bubonic plague in settings, such as quarantined cities in either medieval or modern times, as a backdrop to explore a variety of concepts. Common themes include the breakdown of society, institutions, and individuals during the plague, the cultural and psychological existential confrontation with mortality, and the allegorical use of the plague in reference to contemporary moral or spiritual questions.

## See also

- List of cutaneous conditions
- List of epidemics
- Miasma theory



From a series of images depicting the state of houses and "slum" buildings in Sydney, Australia at the time of the 1900 outbreak and the cleansing and disinfecting operations which followed.

- Plague (disease)
- Plague doctor

## Footnotes

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## External links

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