

Plague

I. Introduction & history:

Last November a park ranger found a dead mountain lion. He took it home and performed a necropsy (autopsy) on the mountain lion.

- A few days later he called in sick with flu like symptoms (even went to a clinic).
- Some days after this he was found dead in his home.

He died of *Yersinia pestis*, the bacteria that causes plague.

This is probably the most serious disease ever to hit humans:

- Human population numbers actually show a dip during the 14th century.
 - It is estimated that the world population shrank from 450 million to 350 million (overall, 22% of the human population was killed off (other figures put the death toll as high as 137 million).
 - 1/2 of the population of China died
 - 1/3 of the population of Europe died
 - even Africa wasn't spared - 1/8 of the population there died.
 - It led to massive social upheaval.
 - peasant uprisings in many countries
 - exacerbated economic conditions that had been pretty awful to begin with
 - hampered trade (due to quarantines and/or unwillingness to travel)
 - One of the problems is that no one knew what caused the plague, so in many instances it was viewed as a wrath from God.
 - In Europe it increased persecutions, particularly of Jews (but also Muslims).
 - Jews were accused of poisoning wells,
 - It was also thought that allowing non-Christians to live peacefully was an affront to God (which increased persecutions, particularly in Spain (via the Inquisition)).
 - One result was the large movement of Jews, particularly to Eastern Europe.

- But it wasn't just Europe:
 - In Cairo, women were prohibited from going outside to ensure that men were not “tempted” - the plague was seen as God's punishment for fornication and promiscuity.
- The Black Death (the 14th century plague we're discussing) got started in China.
 - spread from there to to Asia, Europe and Africa (including the Middle East).
 - it didn't completely die out for many years, and kept striking again and again in different parts of Europe.
- But there are also some remarkable stories coming out of the plague:
 - in Eyam a small village in England, the plague started in 1655 (brought in on contaminated cloth (infected with fleas).
 - Villagers (on the advice of their rector) decided to quarantine themselves.
 - This prevented anyone from leaving the village to get away from the plague.
 - But, it also prevented the plague from spreading to neighboring villages and town, and most likely stopped a much larger death toll.
 - only 83 villagers (out of 350) survived.

The plague may have been around earlier:

The plague of Justinian (AD 541) is thought to have been bubonic plague:

- Justinian (Byzantine Emperor) had just reconquered the Western Empire - he might have held on to it, but just then the plague struck.
- Possibly originated in North Africa
- was killing up to 5,000 people a day in Constantinople
 - overall about 50% of the population died.
- Justinian no longer had the resources to hang on to the Western Empire.
- However, there are actually some estimates that up to 100 million people died world wide at this time (between 541 and 700 A.D.)

The plague also resurfaced in China in 1855.

- This time it “only” killed 12 million people, mostly in China and India.
- But this one too, spread world wide and recurred several times before dissipating.

There are numerous recent outbreaks of the plague, though most of these are isolated cases.

- There is a record, though, of 100 people dying of plague in the Democratic Republic of Congo; it has been hard to control because of fighting (civil war and unrest has been non-stop since 1994, but is finally beginning to die down a bit (a peace deal was signed only a month ago that might end the last fighting)).

II. Causes

The plague is caused by a bacteria, *Yersinia pestis*. It is aerobic and gram-negative.

- Isolated in 1894 by Alexandre Yersin of France (a Japanese, Kitasato, discovered the bacterium about the same time, but then caused much confusion, so Yersin gets the credit).

- Originally, he named it after Pasteur, but in 1967 it was renamed after Yersin.

- Shortly after this, another Frenchman (Simond) discovered the connection to rats and fleas.

There are three different ways the plague can spread / manifest itself:

- bubonic: Introduced into a wound (see below).
- pneumonic: Infects the lungs
- septicemic: Similar to bubonic, but disease takes a different course than in bubonic.

III. Spread and Infection

Bubonic & Septicemic plague spread through bites of infected fleas.

- Rats carry the plague, and fleas live on rats.
- As fleas get infected, it causes a blockage of the fleas gut. The flea becomes desperate for food and starts to bite any host it can find.
 - Fleas are not that rare! Even today, many people are exposed to fleas (think of pets).
- The infected flea bites a human, and introduces the bacteria into the wound (literally, the flea often throws up into the bite).

- So, rats (or the fleas on them) spread the disease (as they move or travel with people).
- Even today, rodents are a large reservoir of plague (American Southwest is endemic for plague in rodents).

Once infected, the bacteria make their way into the lymphatic system.

- there they cause massive inflammation (& bleeding).
- this, in turn, causes the lymph nodes to swell into “buboes”, or characteristic swellings.
- they lymph system opens into the circulatory system, so eventually the bacteria can move to all parts of the body.
- this entire time, they are releasing dangerous toxins.
- they also are adapted to survive being eaten by phagocytes (and actually reproduce).

If it progresses to septicemic plague, then these toxins cause small clots to start appearing in all parts of the body.

- The effect is actually the opposite of what one might guess:
 - it uses up most of the clotting factors in the body, so the person can no longer stop bleeding.
 - bleeding starts into the skin and other organs.
 - black/red rash appears.
 - other infections can then set in (e.g. gangrene).
- Without treatment fatality rate is near 100%.

Pneumonic plague infects the lungs

- Can spread through the air
- Initial symptoms are headache, weakness, coughing, vomiting blood (though often hard to tell apart from other respiratory diseases).
- Fatality rate is 50 - 90% if untreated.

So the problem is that plague can spread very rapidly through several different means.

IV. Infection (continued) & symptoms

Incubation period is between 2 and 6 days after infection (1 - 3 days for pneumonic).

Initial symptoms (non-pneumonic) include:

- fever
- headache
- general feeling of illness

(which is probably why plague wasn't immediately suspected in the park ranger).

- this is then followed by painful & swollen lymph nodes
- eventually, the disease can progress to septicemic plague:
 - bleeding from mouth, nose, rectum or under skin
 - blackening & dying of tissue in extremities (gangrene).

Initial symptoms for pneumonic were mentioned above, but if untreated, this progresses rapidly to respiratory failure.

V. Treatment

Fortunately, the plague can be treated with antibiotics (though there are some reports of resistant strains out there).

- streptomycin, tetracycline, & others.

There is also a vaccine for the plague, but it does not provide long lasting protection.

- A new vaccine is in the works and is being tested.

Note that for the plague treatment must be started early. If more than a day or so goes by after symptoms of pneumonic plague (for example), then it is largely ineffective.

VI. Current status

Right now plague is not considered that much of a problem, though even today there are between 1,000 and 2,000 cases.

- It does not exist in Australia
- It has not been seen in Europe since shortly after WW II
- It is in Asia and the southeastern corner of Europe
- It is also found in Africa, North & South America.

It is possible to convert plague into an aerosol and spread it.

- Most likely pneumonic plague would result.

- A 1970 estimate by the WHO indicated that if a city of 5 million were exposed, up to 150,000 people might be infected and 36,000 would die.
 - assuming prompt medical care?
- It has been used in biological warfare before:
 - Mongols, Chinese & Turks all hurled infected corpses into cities or tried to use them to contaminate water supplies.
 - The Japanese released large numbers of infected fleas in China during WW II.
- Both the U.S. and former Soviet Union worked on ways to “weaponise” pneumonic plague, with varying degrees of success.
- Fortunately the plague can be treated with antibiotics, so it's probably won't cause massive epidemics.

VII. Miscellaneous

- There is some discussion that the plague of the 14th century might not have been caused by *Yersinia pestis*.
 - Speculation centers on the migration patterns of rats, and the high mortality rate.
 - Some type of hemorrhagic fever has been suggested (but note that some of these are still spread by rodents)
 - However, most doctors textbooks, journals and government agencies still regard *Yersinia pestis* as the causative agent of this plague.
 - Also the descriptions of the plague that are left to us seem to vividly describe bubonic plague (followed by septicemic plague).
 - Here is a description from Boccaccio's Decameron (he is describing Florence):

...; but in men and women alike it first betrayed itself by the emergence of certain tumours in the groin or the armpits, some of which grew as large as a common apple, others as an egg, some more, some less, which the common folk called gavoccioli. From the two said parts of the body this deadly gavocciolo soon began to propagate and spread itself in all directions indifferently; after which the form of the malady began to change, black spots or livid making their appearance in many cases on the arm or the thigh or elsewhere, now few and large, now minute and numerous. And as the gavocciolo had been and still was an infallible token of approaching death, such also were these spots on whomsoever they shewed themselves.

He goes on to describe scenes of death:

Many died daily or nightly in the public streets; of many others, who died at home, the departure was hardly observed by their neighbours, until the stench of their putrefying bodies carried the tidings; and what with their corpses and the corpses of others who died on every hand the whole place was a sepulchre.

If you're interested, you can read the whole description here:

<http://www.themiddleages.net/life/decameron.html>