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The Plague Causes and Impact: A Detailed Pharmacological Review

Rohan Kumar[1], Dr. Abhishek Soni[2], Mr. Bhopesh Kumar[3], Dr. Chinu Kumari[4], Mr. Nishant Sharma[5]
Student, Department of Pharmacy[1]
M. Pharm, PhD in Pharmaceutics, Dean of Pharmacy[2]
M. Pharm in Pharmacognosy[3]
M. Pharm, PhD in Pharmacology, HOD of Pharm D[4]
M. Pharm in Pharmaceutics[5]
School of Pharmacy, Abhilashi University, Mandi, H.P., India
rohan05259@gmail.com[1], abhisoni.phd@gmail.com[2], bhopeshkumar3233@gmail.com[3],
Chinu990@gmail.com[4], nts539@gmail.com[5]

Abstract: *Plague is a deadly infectious disease that is caused by the enterobacteria Yersinia pestis, named after the French-Swiss bacteriologist Alexandre Yersin. Primarily carried by rodents (most notably rats) and spread to humans via fleas, the disease is notorious throughout history, due to the unrivalled scale of death and devastation it brought. Until June 2007, plague was one of the three epidemic diseases specifically reportable to the World Health Organization (the other two being cholera and yellow fever).*

Keywords: *Plague*

I. INTRODUCTION

Plague is a deadly infectious disease that is caused by the enterobacteria Yersinia pestis, named after the French-Swiss bacteriologist Alexandre Yersin. Primarily carried by rodents (most notably rats) and spread to humans via fleas, the disease is notorious throughout history, due to the unrivalled scale of death and devastation it brought. Until June 2007, plague was one of the three epidemic diseases specifically reportable to the World Health Organization (the other two being cholera and yellow fever).

Plague is a bacterial disease, caused by Yersinia pestis, which primarily affects wild rodents. It is spread from one rodent to another by fleas. Humans bitten by an infected flea usually develop a bubonic form of plague, which is characterized by a bubo, i.e. a swelling of the lymph node draining the flea bite site.

If the bacteria reach the lungs, the patient develops pneumonia (pneumonic plague), which is then transmissible from person to person through infected droplets spread by coughing. Initial symptoms of bubonic plague appear 7–10 days after infection.

If diagnosed early, bubonic plague can be successfully treated with antibiotics. Pneumonic plague, on the other hand, is one of the deadliest infectious diseases; patients can die 24 hours after infection. The mortality rate depends on how soon treatment is started, but is always very high.

HISTORY

Three major plague pandemics have been recorded in human history: in the 6th century, in the 14th century (known as the 'Black Death,' which killed up to one-third of the European population or an estimated 17 to 28 million people, and at the end of 19th century following the spread of infection from China. The plague bacillus was isolated during the third pandemic by Alexandre Yersin in 1894.

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The Justinian Plague:

The first recorded pandemic, the Justinian Plague, was named after the 6th century Byzantine emperor Justinian I. The Justinian Plague began in 541 AD and was followed by frequent outbreaks over the next two hundred years that eventually killed over 100 million people (Khan, 2004) and affected much of the Mediterranean basin--virtually all of the known world at that time.

"Black Death" or the Great Plague

The second pandemic, widely known as the "Black Death" or the Great Plague, originated in China in 1334 and spread along the great trade routes to Constantinople and then to Europe, where it claimed an estimated 60% of the European population (Benedicto, 2008). Entire towns were wiped out. Some contemporary historians report that on occasion, there were not enough survivors remaining to bury the dead (Gross, 1995). Despite the vast devastation caused by this pandemic, however, massive labour shortages due to high mortality rates sped up the development of many economic, social, and technical modernizations (Benedicto, 2008). It has even been considered a factor in the emergence of the Renaissance in the late 14th century.

Modern Plague

The third pandemic, the Modern Plague, began in China in the 1860s and appeared in Hong Kong by 1894. Over the next 20 years, it spread to port cities around the world by rats on steamships. The pandemic caused approximately 10 million deaths (Khan, 2004). During this last pandemic, scientists identified the causative agent as a bacterium and determined that plague is spread by infectious flea bites. Rat-associated plague was soon brought under control in most urban areas, but the infection easily spread to local populations of ground squirrels and other small mammals in the Americas, Africa, and Asia. These new species of carriers have allowed plague to become endemic in many rural areas, including the western U.S.

However, as a bacterial disease, plague can be treated with antibiotics, and can be prevented from spreading by prompt identification, treatment and management of human cases. Applications of effective insecticides to control the flea vectors also provide assistance in controlling plague.

Recent Outbreaks

The most recent plague epidemics have been reported in India during the first half of the 20th century, and in Vietnam during wartime in the 1960s and 1970s. Plague is now commonly found in sub-Saharan Africa and Madagascar, areas which now account for over 95% of reported cases (Stenseth, 2008).

CAUSAL AGENT

Plague is an infection caused by the bacterium Yersinia pestis. Yersinia pestis, a member of the Enterobacteriaceae family. The bacillus to have a bipolar or "safety pin" appearance.

Scientific Classification

- Domain: Bacteria
- Kingdom: Eubacteria
- Phylum: Proteobacteria
- Class: Gammaproteobacteria
- Genus: Yersinia
- Species: Y. pestis
- Binomial name: Yersinia pestis

(Lehmann & Neumann, 1896) van Loghem 1944

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FORMS OF PLAGUE

The most common form of plague results in swollen and tender lymph nodes — called buboes in the groin, armpits or neck. The rarest and deadliest form of plague affects the lungs, and it can be spread from person to person.

There are three forms of plague:

• Bubonic plague causes the tonsils, adenoids, spleen, and thymus to become inflamed. Symptoms include fever, aches, chills, and tender lymph glands.

• In septicaemic plague, bacteria multiply in the blood. It causes fever, chills, shock, and bleeding under the skin or other organs.

• Pneumonic plague is the most serious form. Bacteria enter the lungs and cause pneumonia. People with the infection can spread this form to others. This type could be a bioterror agent.

ECOLOGY

The bacteria that cause plague, Yersinia pestis, maintain their existence in a cycle involving rodents and their fleas. In urban areas or places with dense rat infestations, the plague bacteria can cycle between rats and their fleas. The last urban outbreak of rat-associated plague in the United States occurred in Los Angeles in 1924-1925.

Fig: Yersinia pestis

Since that time, plague has occurred in rural and semi-rural areas of the western United States, primarily in semi-arid upland forests and grasslands where many types of rodent species can be involved. Many types of animals, such as rock squirrels, wood rats, ground squirrels, prairie dogs, chipmunks, mice, voles, and rabbits can be affected by plague. Wild carnivores can become infected by eating other infected animals.

Scientists think that plague bacteria circulate at low rates within populations of certain rodents without causing excessive rodent die-off. These infected animals and their fleas serve as long-term reservoirs for the bacteria. This is called the enzootic cycle.

Occasionally, other species become infected, causing an outbreak among animals, called an epizootic. Humans are usually more at risk during, or shortly after, a plague epizootic. Scientific studies have suggested that epizootics in the southwestern United States are more likely during cooler summers that follow wet winters. Epizootics are most likely in areas with multiple types of rodents living in high densities and in diverse habitats.

EPIDEMIOLOGY

Distribution

The natural foci of plague found on all continents except Australia. The natural foci of plague are situated in a broad belt in the tropical and sub–tropical latitudes and the warmer parts of the temperate latitudes around the globe, between the parallels 55 degrees North and 40 degrees South.

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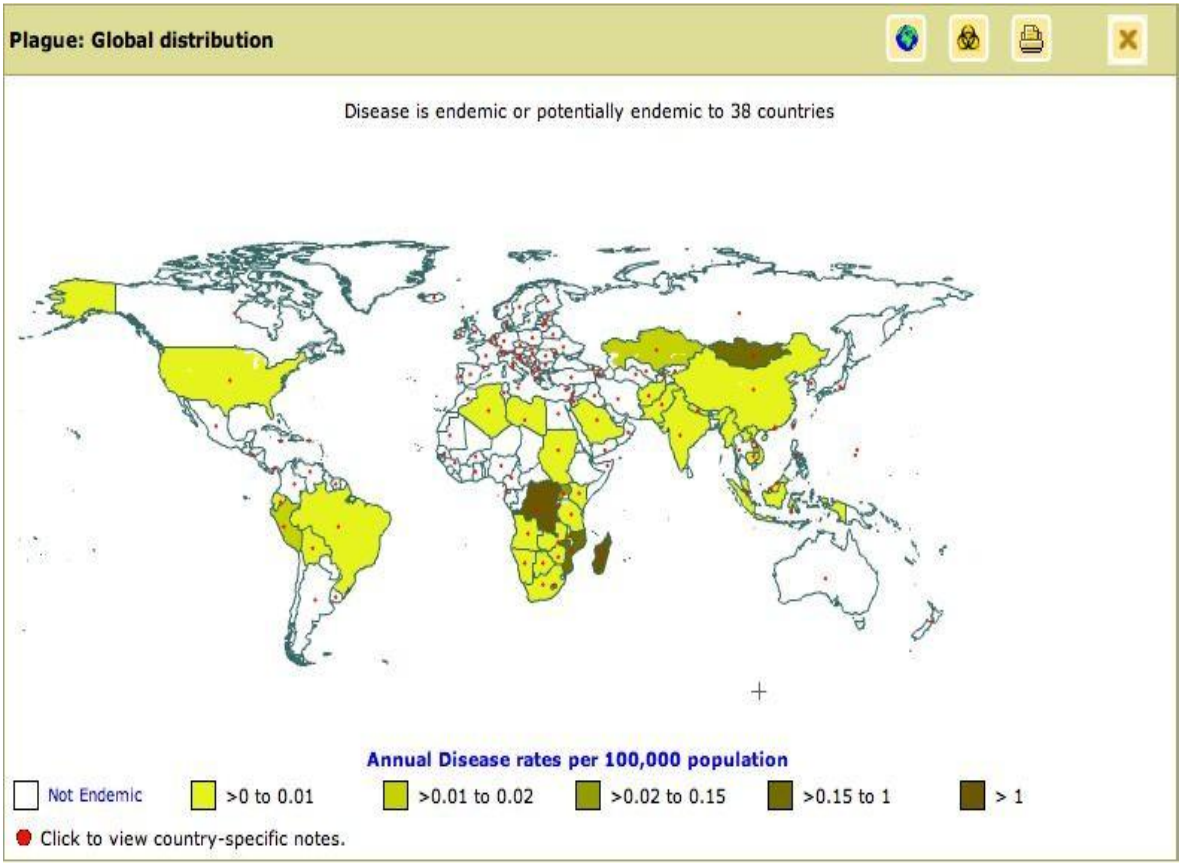

Reservoir host

- Rats
- Squirrels
- Rabbits
- Prairie dogs
- Chipmunks

Yersinia pestis circulates in animal reservoirs, particularly in rodents, in the natural foci of infection found on all continents except Australia.

Susceptible host: Human

Vector

This species of flea is the primary vector for the transmission of Yersinia pestis the organism responsible for bubonic plague in most plague epidemics in Asia, Africa, and South America.

Both male and female fleas feed on blood and can transmit the infection.

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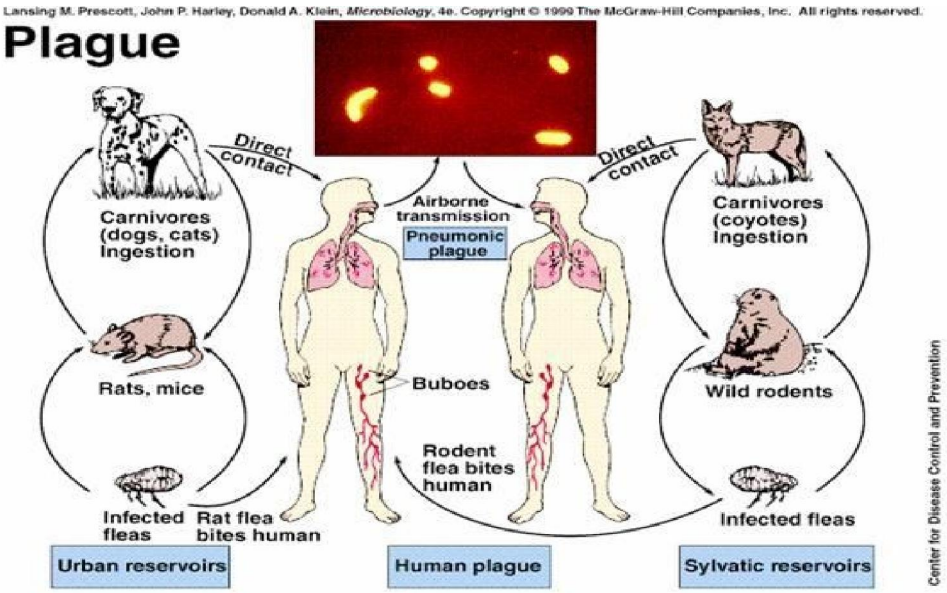
The Oriental rat flea (Xenopsylla cheopsis) engorged with blood

The roof rat (rattus rattus) is a reservoir host of bubonic plague with the oriental rat fleas that infest them being a prime vector of the disease.

Transmission



Transmission of Y. pestis to an uninfected individual is possible by any of the following means.

- Droplet contact – coughing or sneezing on another person
- Direct physical contact – touching an infected person, including sexual contact
- Indirect contact – usually by touching soil contamination or a contaminated surface
- Airborne transmission – if the microorganism can remain in the air for long periods
- Facial-oral transmission – usually from contaminated food or water sources • Vector borne transmission – carried by insects or other animals.

Incubation period

A person usually becomes ill with bubonic plague 2 to 6 days after being infected. When bubonic plague is left untreated, plague bacteria invade the bloodstream. When plague bacteria multiply in the bloodstream, they spread rapidly throughout the body and cause a severe and often fatal condition. Infection of the lungs with the plague bacterium causes the pneumonic form of plague, a severe respiratory illness. The infected person may experience high fever, chills, cough, and breathing difficulty, and expel bloody sputum. If plague patients are not given specific antibiotic therapy, the disease can progress rapidly to death.

Mortality rate

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Without treatment, fatality rates: up to 90% for bubonic plague, 100% for septicemic or pneumonic plague. Treatment, fatality rate= (5-20%). About 14% (1 in 7) of all plague cases in the United States are fatal.

Occurrence

• Plague can be acquired at anytime during the year.

• Generally, plague is most common in the southwestern states, particularly New Mexico and Arizona.

• Outbreaks in people occur in areas where housing and sanitation conditions are poor. These outbreaks can occur in rural communities or in cities. They are usually associated with infected rats and rat fleas that live in the home.

- Risk Factors
- Location

Plague outbreaks are most common in rural areas and in urban areas characterized by overcrowding, poor sanitation and a high rat population. The greatest number of human plague infections occurs in Africa.

Occupation

Veterinarians and their assistants have a higher risk of coming into contact with domestic cats that may have become infected with plague. Also at higher risk are people who work outdoors in areas where plague-infested animals are common.

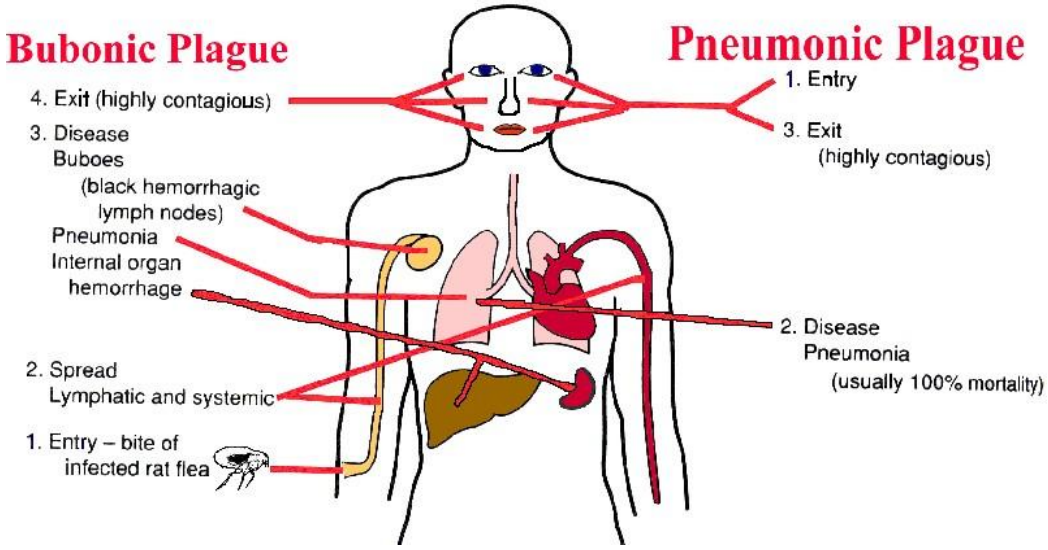
Hobbies

Camping, hunting or hiking in areas where plague-infected animals reside can increase your risk of being bitten by an infected flea.

PATHOGENESIS

Bubonic plague

When a flea bites a human and contaminates the wound with regurgitated blood, the plague carrying bacteria are passed into the tissue. Y. pestis can reproduce inside cells, so even if phagocytosed, they can still survive. Once in the body, the bacteria can enter the lymphatic system, which drains interstitial fluid. Plague bacteria secrete several toxins, one of which is known to cause dangerous beta-adrenergic blockade. Y. pestis spreads through the lymphatics of the infected human until it reaches a lymph node, where it stimulates severe haemorrhagic inflammation that causes the lymph nodes to expand. The expansion of lymph nodes is the cause of the characteristic "bubo" associated with the disease.



Septicaemic plague

Lymphatics ultimately drain into the bloodstream, so the plague bacteria may enter the blood and travel to almost any part of the body. In septicaemic plague, bacterial endotoxins cause disseminated intravascular coagulation (DIC),

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causing tiny clots throughout the body and possibly ischemic necrosis (tissue death due to lack of circulation/perfusion to that tissue) from the clots. DIC results in depletion of the body's clotting resources, so that it can no longer control bleeding. Consequently, there is bleeding into the skin and other organs, which can cause red and/or black patchy rash and haemoptysis/hematemesis (coughing up/ vomiting of blood). There are bumps on the skin that look somewhat like insect bites; these are usually red, and sometimes white in the centre. Untreated, septicaemic plague is usually fatal. Early treatment with antibiotics reduces the mortality rate to between 4 and 15 percent. People who die from this form of plague often die on the same day symptoms first appear.

Pneumonic plague

The pneumonic plague infects the lungs, and with that infection comes the possibility of person to-person transmission through respiratory droplets. The incubation period for pneumonic plague is usually between two and four days, but can be as little as a few hours. The initial symptoms are headache, weakness, and coughing with blood (haemoptysis), or vomiting blood (hematemesis), are indistinguishable from several other respiratory illnesses. Without diagnosis and treatment, the infection can be fatal in one to six days; mortality in untreated cases is approximately 100%.

Pharyngeal plague

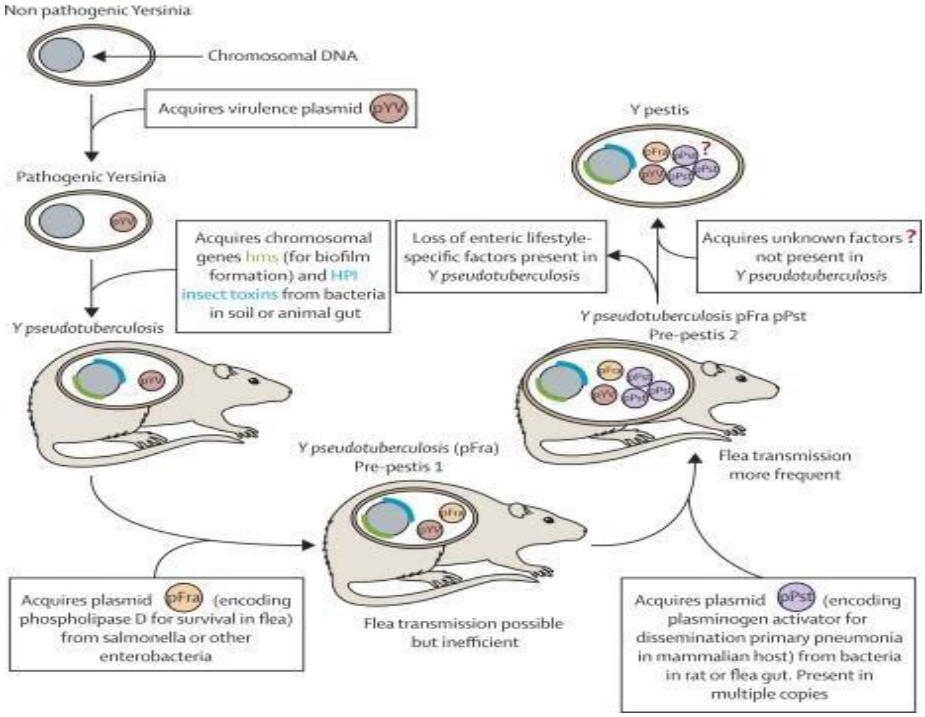
This is an uncommon form of plague that resembles tonsillitis found in cases of close contact of patients with other forms of plague.

Meningeal plague

This form of plague occurs when bacteria cross the blood brain barrier, leading to infectious meningitis.

Other clinical forms

There are a few other rare manifestations of plague, including asymptomatic plague and abortive plague. Cellulocutaneous plague sometimes results in infection of the skin and soft tissue, often around the bite site of a flea.



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CLINICAL SIGNS

Bubonic plague

Bubonic plague is the most common variety of the disease. It's named after the buboes swollen lymph nodes which typically develop within a week after an infected flea bites you. Buboes may be:

- Situated in the groin, armpit or neck
- About the size of a chicken egg
- Tender and warm to the touch

Other signs and symptoms may include:

- Sudden onset of fever and chills
- Headache
- Fatigue or malaise
- Muscle aches

Septicemic plague

Fig: A hand showing acral gangrene of the digits due to plague

Septicemic plague occurs when plague bacteria multiply in your bloodstream. Signs and symptoms include:

- Fever and chills
- Abdominal pain, diarrhea and vomiting
- Bleeding from your mouth, nose or rectum, or under your skin
- Shock
- Blackening and death of tissue (gangrene) in your extremities, most commonly your fingers, toes and nose

Pneumonic plague

Pneumonic plague affects the lungs. It's the least common variety of plague but the most dangerous, because it can be spread from person to person via cough droplets. Signs and symptoms can begin within a few hours after infection, and may include:

- Cough, with bloody sputum
- Difficulty breathing
- High fever
- Nausea and vomiting
- Weakness

Pneumonic plague progresses rapidly and may cause respiratory failure and shock within two days of infection. If antibiotic treatment isn't initiated within a day after signs and symptoms first appear, the infection is likely to be fatal.

TEST AND DIAGNOSIS

Diagnosis is done based on

Clinical history: Exposure to rodents, rabbits, or fleas.

Clinical signs:

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i. Excruciatingly painful, inflamed regional lymph nodes.
ii. Fever,
iii. Prostration,
iv. Headache.
Isolation and identification of organism
Samples to be collected:
• Buboes. In case of swollen lymph nodes (buboes) characteristic of bubonic plague, a fluid sample can be taken from them with a needle.
• Blood. Yersinia pestis bacteria generally are present in bloodstream only if one have septicaemic plague.
• Lungs. To check for pneumonic plague, sputum or fluid from airways can be collected using endoscopy (a thin, flexible tube inserted through nose or mouth and down throat).
Blood and bubo aspirates and sputum should be Giemsa stained. Smears typically show the bacillus to have a bipolar or "safety pin" appearance.
Serological Test
• Fluorescent antibody microscopy.
• Most Gram-negative bacteria produce colonies within 24 h; F. tularensis and Y. pestis do not.

COMPLICATIONS OF PLAGUE

Complications of plague may include
• Death. Most people who receive prompt antibiotic treatment survive bubonic plague. Untreated plague has a high fatality rate due to endotoxic shock.
• Gangrene. Blood clots in the tiny blood vessels of your fingers and toes can disrupt the flow of blood and cause that tissue to die. The portions of your fingers and toes that have died may need to be amputated.
• Meningitis. Rarely, plague may cause an inflammation of the membranes surrounding your brain and spinal cord (meningitis).

THERAPY

• Without treatment, fatality rates: up to 90% for bubonic plague, 100% for septicaemic or pneumonic plague.
• Treatment, fatality rate= (5-20%). Rapid treatment is critical to improved survival.
• Gentamicin or streptomycin can be used. ß-lactams are not useful.
• Isolate patients in case pneumonia develops. By law, patients with pneumonic plague must be isolated. Patients who survive severe septic shock may show a marked necrosis or dry gangrene of the tissues on extremities, i.e., the Black Death.
• Doxycycline can be used for post-exposure prophylaxis.

PREVENTION AND CONTROL

• Habitat around home, work place, and recreational areas should free from rodent. Removal of brush, rock piles, junk, cluttered firewood, and possible rodent food supplies, such as pet and wild animal food. One should make sure that his/her home and outbuildings are rodent-proof.
• One should wear gloves during handling or skinning of potentially infected animals to prevent contact between your skin and the plague bacteria.
• Use of repellent to prevent rodent fleas during activities such as camping, hiking, or working outdoors. Products containing DEET can be applied to the skin as well as clothing and products containing permethrin can be applied to clothing.

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• Keeping fleas off of pets by applying flea control products. Animals that roam freely are more likely to come in contact with plague infected animals or fleas and could bring them into homes. If one's pet becomes sick, seeking care from a veterinarian as soon as possible.
• One should not allow dogs or cats that roam free in endemic areas to sleep on his/her bed.
• Yersinia pestis poses a serious infectious hazard for nursing and laboratory personnel. Protective clothing and a full face respirator should always be worn when working with this organism.
• Cultivation and virulence testing of this organism should be attempted only in P-3 containment facilities by staff who have been immunized recently with live attenuated vaccine.

Plague immunization

Since human plague is rare in most parts of the world, there is no need to vaccinate people other than those at particularly high risk of exposure. Routine vaccination is not necessary for people living in areas with enzootic plague such as the western United States. It is not indicated for most travellers to countries reporting cases, particularly if their travel is limited to urban areas with modern hotels. The CDC thus only recommends vaccination for:
• All laboratory and field personnel who are working with Y. pestis organisms resistant to antimicrobials,
• People engaged in aerosol experiments with Y. pestis and
• People engaged in field operations in areas with enzootic plague where preventing exposure is not possible (such as some disaster areas).

Fig: Plague immunization

PLAGUE AS A BIOLOGICAL WEAPON

As a highly contagious disease with an extremely high mortality rate if left untreated, Yersinia pestis has been used as a weapon of biological warfare for centuries. More recently, plague raised concern as an important national security threat because of its potential for use by terrorists.

Plague has a long history as a biological weapon. Historical accounts from ancient China and medieval Europe detail the use of infected animal carcasses, such as cows or horses, and human carcasses, by the Xiongnu/Huns, Mongols, Turks, and other groups, to contaminate enemy water supplies.

During World War II, the Japanese Army developed weaponised plague, based on the breeding and release of large numbers of fleas. During the Japanese occupation of Manchuria, Unit 731 deliberately infected Chinese, Korean, and Manchurian civilians and prisoners of war with the plague bacterium.

After World War II, both the United States and the Soviet Union developed means of weaponising pneumonic plague. Experiments included various delivery methods, vacuum drying, sizing the bacterium, developing strains resistant to antibiotics, combining the bacterium with other diseases (such as diphtheria), and genetic engineering. Scientists who worked in USSR bio-weapons programs have stated that the Soviet effort was formidable and that large stocks of weaponised plague bacteria were produced. Information on many of the Soviet projects is largely unavailable.

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Aerosolized pneumonic plague remains the most significant threat. The plague can be easily treated with antibiotics, thus a widespread epidemic is highly unlikely in developed countries.

II. CONCLUSION

One of the oldest identifiable diseases known to man, plague remains endemic in many natural foci around the world. It is still widely distributed in the tropics and subtropics and in warmer areas of temperate countries. Essentially a disease of wild rodents, plague is spread from one rodent to another by flea ectoparasites and to humans either by the bite of infected fleas or when handling infected hosts. Recent outbreaks have shown that plague may reoccur in areas that have long remained silent.

Untreated, mortality - particularly from pneumonic plague - may reach high levels. When rapidly diagnosed and promptly treated, plague may be successfully managed with antibiotics such as streptomycin and tetracycline, reducing mortality from 60% to less than 15%.

REFERENCES

[1]. Byrne, Joseph Patrick (2008). Encyclopedia of Pestilence, Pandemics, and Plagues: A-M. ABCCLIO. p. 519.
[2]. Charles Philip Issawi (1988). Fertile Crescent, 1800-1914: A Documentary Economic History. Oxford University Press. p. 99
[3]. Duncan Chris; Scott, S; Duncan, CJ (2005). "Reappraisal of the historical selective pressures for the CCR5-Δ32 mutation". Journal of Medical Genetics 42 (3): 205–208.
[4]. Haensch S, Bianucci R, Signoli M, Rajerison M, Schultz M, et al. (2010). "Distinct Clones of Yersinia pestis Caused the Black Death". In Besansky, Nora J. PLoS Pathog 6 (10): e1001134.
[5]. Heath, D. G., G. W. Anderson, Jr., J. M. Mauro, S. L. Welkos, G. P. Andrews, J. Adamovicz, and A. M. Friedlander. 1998. Protection against experimental bubonic and pneumonic plague by a recombinant capsular F1-V antigen fusion protein vaccine. Vaccine 16:1131– 1137.
[6]. Hoffman SL (1980). "Plague in the United States: the "Black Death" is still alive". Annals of Emergency Medicine 9 (6): 319–322.
[7]. John T. Alexander (1980). Bubonic Plague in Early Modern Russia: Public Health and Urban Disaster. Oxford University Press. p. 21.
[8]. K.A. Fields, M.L. Nilles, C. Cowan, S.C. Straley. 1999. Virulence Role of V antigen of Yersinia pestis at the bacterial surface. Infect. Immun. 67(10):5395-5408.
[9]. Meyer KF (1950). "Modern therapy of plague". J Am Med Assoc 144 (12): 982–985.
[10]. Simonet, M, B. Riot, N. Fortineau, P. Berche. 1996. Invasin production by Yersinia pestis is abolished by insertion of an IS200-like element within the inv gene. Infect. Immun. 64(1):375-9.
[11]. Wagle PM (1948). "Recent advances in the treatment of bubonic plague". Indian J Med Sci 2: 489–94.