Plague is one of the oldest identifiable diseases known to man which remains endemic in many natural foci around the world, including some countries of the WHO South-East Asia Region. Plague, a vector-borne zoonotic disease, remains a significant public health threat in affected countries and of major concern to the World Health Organization because of its inherent communicability, rapid spread, rapid clinical course, and high mortality if left untreated. The revised International Health Regulations (IHR) 2005, which came into effect in June 2007, require notification to WHO of the occurrence of a suspected case of plague in an area not known to be endemic.

The Operational Guidelines on Plague Surveillance, Diagnosis, Prevention and Control were first published by the WHO South-East Asia Region in 2004. These were revised and updated in the context of new case definitions adopted in 2006 and the enforcement of the IHR (2005). These revised and updated guidelines of 2009 provide comprehensive knowledge and information on plague epidemiology, surveillance, diagnosis, case management and prevention and control, and can be adapted by Member States to suit their technical requirements.
Operational Guidelines on Plague Surveillance, Diagnosis, Prevention and Control
Contents

Preface ........................................................................................................ v
Acknowledgements .......................................................... vii

1. Introduction ......................................................................................... 1
   1.1 Historical perspective ............................................................ 2
   1.2 Current global situation ...................................................... 3
   1.3 Plague in the WHO South-East Asia Region ...................... 4
   1.4 Purpose of the revised guideline .................................... 5

2. Epidemiology .................................................................................... 7
   2.1 Infectious agent .........................................................................
   2.2 The human host .........................................................................
   2.3 Reservoir ....................................................................................
   2.4 Vector .........................................................................................
   2.5 Risk factors ............................................................................... 12
   2.6 Mode of transmission and period of communicability ....... 13
   2.7 Types of plague ......................................................................... 16

3. Clinical manifestation ................................................................. 18
   3.1 Bubonic plague ................................................................. 18
   3.2 Septicaemic plague .......................................................... 19
   3.3 Pneumonic plague ............................................................ 20
   3.4 Differential diagnosis ......................................................... 21

4. Standard case definition ............................................................... 22

5. Laboratory in surveillance and diagnosis ................................. 24
   5.1 Laboratory and surveillance ................................................ 24
   5.2 Collection, storage and transport of samples .................... 24
   5.3 Laboratory diagnosis of plague .......................................... 30
   5.4 Safe handling of infectious materials
      in the laboratory ....................................................................... 32

6. Prevention and control ............................................................... 34
   6.1 Surveillance ................................................................. 34
   6.2 Organization of surveillance activities ............................. 35
   6.3 Components of surveillance ............................................. 37
6.4 Early warning signals .............................................41
6.5 Rodent surveillance and de-ratting in seaports ..........42
6.6 Health education and community participation ...........44
6.7 Intersectoral coordination ........................................45
6.8 Rodent control .......................................................45
6.9 Vector control ........................................................51

7. Epidemic preparedness .................................................54
  7.1 Identification of rapid response teams .................54
  7.2 Logistics ...............................................................54
  7.3 Hospital preparedness ............................................56
  7.4 Manpower development ...........................................56

8. Management of an outbreak ...........................................57
  8.1 Identification of an outbreak ....................................57
  8.2 Outbreak investigation ............................................58
  8.3 Activation of Crisis Management Committee .............60
  8.4 Case management ................................................62
  8.5 Prophylaxis ..........................................................65
  8.6 Infection control ....................................................66
  8.7 International Health Regulations (2005) and plague notification ...........................................71

9. Partnership with mass media ...........................................74

10. Lessons learnt from plague outbreaks .....................79
  10.1 Plague outbreak in Surat and Beed, Maharashtra (India), 1994 ...........................................79
  10.2 Pneumonic plague in Shimla district, Himachal Pradesh (India), 2002 ...........................................80

References .......................................................................85
Further readings ...............................................................86

Annexes
  1. Method to collect bubo pus...........................................87
  2. Instruction for the use of the rapid tests .........................88
  3. Decision instrument for the assessment and notification of events that may constitute a public health emergency of international concern........89
Plague is one of the important vector-borne zoonotic diseases that remains endemic in many natural foci around the world, including some countries of the South-East Asia Region. Human plague outbreaks have been reported from India and Indonesia in 2004 and 2007 respectively. Plague evokes considerable fear among people because of its historical reputation of killing millions of people. The lessons learned during the major plague outbreak in 1994 in Surat and the effective measures taken by the Government of India were helpful in early detection and rapid containment of the 2004 outbreak. Recent outbreaks have shown that plague may re-emerge in areas after a long period of silence. There is need, therefore, for concerted efforts to strengthen plague surveillance activity and build adequate capacity for timely detection and rapid containment of outbreaks should an outbreak occur in previously silent natural foci in all countries of the South-East Asia Region.

The need for regional “operational guidelines” to provide a comprehensive knowledge and information on plague epidemiology, surveillance, diagnosis, case management and prevention and control was felt for the benefit of national health authorities in all Member countries. These guidelines were published by the WHO South-East Asia Region in 2004 and it was necessary to revise and update them in the context of new case definitions adopted in 2006 and the enforcement of the International Health Regulations (2005) from June 2007.

The revised and updated operational guidelines have been developed through a process of consultation and inputs from a number of experts on plague and public health, both from within and outside the World Health Organization. As there is continued threat of plague outbreaks in our Region,
effective surveillance of existing natural foci of sylvatic plague and preparedness at the national, provincial and district levels is important. I am confident that these guidelines will be useful to those responsible for communicable disease surveillance and response in Member countries and will be of immense benefit to health officials responsible for emergency preparedness.

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Regional Director
Acknowledgements

A revised and updated draft document was prepared by Dr Gyanendra N. Gongal and Dr K.N. Tewari. The original draft was peer reviewed extensively by a consortium of technical experts in various disciplines as listed below at the expert consultation meeting held in the Plague Surveillance Unit of the National Centre for Disease Control, Bengaluru, on 7-8 August 2009. The role of the following at the consultation is acknowledged:

(1) Dr Veena Mittal, Joint Director & Head, Incharge, Central Plague Laboratory, National Centre for Disease Control, Delhi, India.

(2) Dr Shyam Lal Biswas, Joint Director & Incharge, Plague Surveillance Unit, Bengaluru, India.

(3) Drh Wilfried H. Purba, Head of Sub-Directorate for Zoonotic Diseases, Directorate of VBDC, Directorate-General, Disease Control & Environmental Health, Ministry of Health, Jakarta, Indonesia.

(4) Dr Si Si Tun, Senior Consultant, 1000-bed General Hospital, Nay Pyi Taw, Myanmar.

Further technical input was also obtained from Dr Eric Bertherat, WHO HQ, before finalizing the final draft. The valuable contribution of Dr Rajesh Bhatia, Regional Adviser, Blood Safety and Laboratory Technology, in finalizing the guidelines is gratefully acknowledged.
Plague is an acute communicable disease caused by a bacterium called *Yersinia pestis* and transmitted to man by the bite of infected rat fleas. It is primarily a zoonosis, being a disease of rodents, and humans are affected incidentally.

Plague has an important place in history. For centuries the disease represented “disaster” for those living in Asia, Africa and Europe. Because the cause of plague was not known, plague outbreaks contributed to massive panic in places where they appeared; indeed, it continues to invoke an intense, irrational fear even in an era when antibiotics and insecticides are available. This disease may have caused over 200 million deaths in the history of humanity.

Plague is often classified as a problem of the past or an ancient disease that is not likely to disappear. But continued outbreaks throughout the world attest to its tenacious presence. It remains a current threat in many parts of the world, particularly in Asia. Following the reappearance of plague during the 1990s in several countries, plague has been categorized as a re-emerging disease.

The plague organism is considered as a potential biological weapon for bioterrorists.

Despite the availability of a number of highly effective therapeutic agents, mortality due to plague remains very high because most outbreaks occur in remote places and there is delay in proper diagnosis and treatment of disease.
Underreporting of plague due to lack of laboratory facilities for diagnostic confirmation is also common. Many countries have dismantled a surveillance system for plague because of a lack of funds and the absence of periodic outbreaks. But there is a constant threat of a plague outbreak, particularly in plague-endemic areas and known natural foci, and hence the disease should be made an integral part of the national public health surveillance system.

Plague was one of the three diseases reportable under International Health Regulation (1969). It has a great significance under IHR (2005) as a public health emergency of international concern.

1.1 Historical perspective

In the course of history, plague has been responsible for at least three widespread pandemics with high mortality. The first (the “Justinian plague”) spread around the Mediterranean Sea in the 6th century of the current Era; the second (the “Black Death”) struck Europe in the 14th century; and the third started in China during the middle of the 19th century and spread throughout the world.

The Black Death caused an estimated 75–200 million deaths, approximately half of them in Asia and Africa and the other half in Europe. The Black Death decimated Medieval Europe, and had a major impact on the continent’s socioeconomic development, culture, art, religion and politics. The fourteenth century plague is estimated to have killed a third of the population of China.

The third pandemic killed 12.5 million people in India alone. Large plague outbreaks occurred during the first half of the 20th century in India. Each pandemic was caused by a different biovar of *Y. pestis*, respectively, *Antiqua* (still found in Africa and Central Asia), *Medievalis* (currently limited to Central Asia) and *Orientalis* (almost worldwide in its distribution) 6, 7.
Island countries were in a better position to defend themselves through strict quarantine measures at seaports. Plague first appeared in Indonesia during the last pandemic, when the disease was introduced into Java in 1910. Almost a quarter of a million fatal cases were recorded during the period 1911-1960.

Following the introduction of antimicrobial therapy after World War II, plague mortality declined sharply, but the disease remained persistent in some areas. During the second half of the twentieth century, more than 85,000 cases of human plague with 7000 deaths were officially reported from 38 countries. These figures are obviously underestimates of the real situation because of inadequate surveillance and the reluctance of many countries to notify the World Health Organization for fear of adverse impacts on travel, trade and tourism.

1.2 Current global situation

Plague continues to be a threat because of vast areas of persistent wild rodent infection. Natural plague foci exist in several countries of Asia, Africa and the Americas, and sporadic cases in humans as well as outbreaks have been reported every year. Reported human plague outbreaks during the period of 2004 to 2008 is presented in Table 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Reporting countries</th>
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<tbody>
<tr>
<td>2004</td>
<td>China, Democratic Republic of Congo, India, Madagascar, Peru, Uganda, USA.</td>
</tr>
<tr>
<td>2005</td>
<td>Brazil, Democratic Republic of Congo, China, Madagascar, Peru and USA.</td>
</tr>
<tr>
<td>2006</td>
<td>Democratic Republic of Congo, Madagascar, Peru, Uganda and USA.</td>
</tr>
<tr>
<td>2007</td>
<td>Democratic Republic of Congo, China, Indonesia, Madagascar, Mongolia, Peru, United Republic of Tanzania, Uganda, USA and Zambia.</td>
</tr>
<tr>
<td>2008</td>
<td>Algeria, Democratic Republic of Congo, China, Libya, Madagascar, Peru, United Republic of Tanzania, Uganda, USA and Zambia.</td>
</tr>
</tbody>
</table>
A total of 11,479 cases of human plague and 772 deaths were reported by 14 countries in Africa, the Americas and Asia from 2004 to 2008. Four countries reported cases of human plague every year (Democratic Republic of Congo, Madagascar, and Peru and the United States) from 2004 to 2008. The global distribution of natural plague foci is shown in Fig. 1.

**Figure 1:** Global distribution of natural plague foci (in rodent populations), 1999

Human plague outbreaks have a correlation with natural foci of plague in rodents. A small number of African countries with well-known natural plague foci reported the highest number of cases in recent years. Although it is predominantly a rural disease, there have been outbreaks of plague in urban populations in Madagascar and the United Republic of Tanzania. China, Democratic Republic of Congo, Libya, Madagascar, Mongolia, Peru, Uganda, United Republic of Tanzania and USA reported plague outbreaks in 2009. A general upward trend in the incidence of human plague has been observed since 2005, with a global average incidence of 2,083 cases annually. Recent outbreaks have shown that plague may re-emerge in areas after a long period of absence.
1.3 Plague in the WHO South-East Asia Region

Plague remains endemic in many natural foci around the world; in the WHO South-East Asia Region, endemic foci are found in India, Indonesia and Myanmar. Natural foci of plague exist in parts of Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Himachal Pradesh and Uttarakhand in India. There were plague outbreaks in India in 1954 and 1963, and then again 30 years later in 1994. A large plague outbreak in India in 1994 was responsible for a US$ 3 billion loss due to inadequate and delayed response at the national level as well as the overreaction of the international community, which imposed restrictions on international travel and commercial exchanges. A pneumonic plague outbreak was reported in February 2002 in Himachal Pradesh. A localized outbreak of bubonic plague occurred in Dangud village in district Uttarkashi, Uttarakhand, in October, 2004.

At present, two active plague foci are known to exist in Indonesia, one located in the Boyolali district of Central Java and the other in the Pasuruan district of East Java. Both of these foci have been sources of human plague outbreaks in the past 40 years. The last plague outbreak was reported in Pasuruan district of East Java province in February 2007.

Myanmar reported its last human plague outbreak in 1994. Till 1994, Myanmar reported cases virtually every year. Nepal reported its last plague outbreak in 1968 in Bajhang district of western Nepal. Plague is notifiable disease in Bhutan, India, Indonesia, Maldives, Myanmar and Sri Lanka and many countries are preparing to reintroduce plague surveillance in rodent population.

1.4 Purpose of the revised guidelines

The purpose of these Operational Guidelines is to help health personnel and health authorities at any level to:
Operational Guidelines on Plague Surveillance, Diagnosis, Prevention and Control

- update current knowledge about plague;
- provide comprehensive information on epidemiology and standard techniques in accordance with new techniques for diagnosis, case management, prevention and control of plague for both sporadic case(s) and an outbreak;
- define standards in “case definition”, “laboratory diagnosis”, “case management” and “isolation precautions” in order to meet the needs of practitioners, laboratory workers, health-care providers and public health administrators;
- provide an overview on surveillance of plague;
- detect and control outbreaks of plague as early as possible;
- strengthen the capacity of emergency response to outbreaks;
- develop an efficient partnership with mass media; and
- share lessons learnt from plague outbreaks.

These guidelines are intended as a technical support to field workers. However, these must be modified appropriately and utilized for development of manuals for field workers by the national health authorities. Such modified guidelines should have the approval of the appropriate authorities, conform with national policies and laws, and meet local needs.
Plague is primarily a disease of rodents. The infection is maintained in the natural foci of the disease in wild rodent colonies through transmission between them by their flea ectoparasites. For the most part, the wild rodent reservoirs are species that are susceptible to the infection but resistant to the disease. Wild plague exists in its natural foci independent of human populations and their activity. Domestic plague is intimately associated with rodents living with humans and can produce epidemics in both human and animal populations.

The epidemiology of plague is extremely complex. Infection depends upon the maintenance of a great variety of rodents and vectors, which differ from country to country and also over time. Ecological studies point to a multiplicity of factors concerned in the fluctuating balance that exists between rodents of greater and lesser degree of susceptibility to the plague bacillus, and also in the degree of risk to which humans is exposed.

2.1 Infectious agent

*Yersinia pestis*, the plague bacillus, is a non-motile, non-acid-fast, non-spore-forming, and gram-negative coccobacillus measuring 1.5 by 0.75 microns. When stained with aniline dyes, the ends of the bacillus take the stain more intensely; this is known as “bipolar staining”. True capsules are seen in
living tissues but less readily seen in culture. The capsular material is important for antigenicity and protectivity and is used for preparation of Fraction I antigen for serological test.

The organism is pathogenic to common laboratory animals like mice, guinea pigs, etc. The inoculated animals die in three to four days. The characteristic coccobacilli are seen in large numbers in films made from lymphnodes, spleen pulp and heart blood as shown in Fig. 2.

Figure 2: Plague bacterium

Y. pestis belongs to the group of bacilli with low resistance to environmental factors. Sunlight, high temperatures and desiccation have a destructive effect, and ordinary disinfectant preparations containing chlorine kill it within ten minutes.

2.2 The human host

All ages and both sexes are susceptible to plague. Mortality depends on the type of plague:

- Bubonic plague is fatal in about 50%–75% of untreated cases, but perhaps 10%–15% when treated.
- Septicaemic plague is almost fatal, and perhaps 40% with treatment.
- Pneumonic plague is fatal if not treated within 18%–24% hours of infection.
2.3 Reservoir

A large number of mammals may be infected with *Y. pestis*. More than 200 animals have been shown to be susceptible. Of the domestic animals, cattle, horses, sheep and pigs are not known to develop plague. Goats and camels have reportedly developed clinical illness. Rabbits are susceptible to infection. Ground squirrels are highly susceptible. Cats are severely affected by *Y. pestis* infection; They can develop all three forms of plague. Dogs seem to be somewhat resistant to *Y. pestis* infection. Dogs may become infected without showing any sign of illness and act as sentinel animals. Sero-testing of carnivores can be an indicator to assess the prevalence of plague in that area. If they do become ill, the only symptoms may be fever or lymphadenopathy. All the aforesaid animals are basically accidental hosts of *Y. pestis*.

Rodents are the true natural and maintenance hosts of plague. At least 220 species of rodents, which inhabit mountains, plains, steppes, deserts, cultivated field and forests in both temperate and tropical climates, are well known to be infected with plague bacillus. Many species of rodents (wild and domestic) and other small mammals are susceptible to infection but are only occasionally infected, and are not necessarily important reservoirs of infection. The infection persists in some rodent species and a few other animal hosts. While wild and peri-domestic rodents are susceptible to the infection but resistant to the disease, domestic rodents are susceptible both to the infection and the disease—hence the phenomenon of “rat falls”*.

Among the wild and peri-domestic rodents, the role of Indian gerbil (*Tatera indica*) and bandicoot rat (*Bandicota bengalensis*) as a natural reservoir of plague is well established. Among the commensal rodents, *Rattus rattus* and *Mus musculus* are hosts for *Y. pestis*. The marmot is a

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* Rat fall is defined as more than one dead rat in a house, or more than one house with dead rats, where it has been ascertained that the deaths among the rats have not been due to poisoning.
primary carrier of the plague bacillus in many Asian countries. Marmots are the only creatures besides humans who can pass pneumonic plague from one to another under normal (not laboratory) circumstances.

**Maintenance of epizootic cycle**

A rodent species may be highly susceptible but if it is rare it is not important in the spread of plague. In colder climates, because the breeding of both rodents and fleas occurs in summer and spring, the outbreaks may take place during these seasons. In warmer climates the breeding occurs throughout the year. The population density builds up quickly and outbreaks can occur any time. The turnover of rodent population is very fast and the population pressure keeps fluctuating up and down and this prevents the build-up of a stable, resistant generation. This also keeps the yersinia-rodent-flea cycle going, yet some resistance is essential on the part of the host for the maintenance of a plague foci. A totally susceptible population would soon die out.

Many biotic and abiotic factors influence the persistence of the disease in the wild rodent population and epizootic plagues. The natural foci of plague are known to be completely independent of humans. A balance is maintained between susceptible and resistant hosts. Voles and gerbils are resistant hosts to plague. Voles and field mice are natural reservoirs and keep the enzootic cycle ongoing. Time and again this balance is seen in any plague foci. Among susceptible rodents--at varying intervals, sometimes many years apart--there is an outburst of plague among animals (known as an epizootic). Another rodent, often a smaller animal, may live alongside and carry the infection between the outbreaks with little, if any, sign of disease. Even when conditions become unfavourable for the rodent or the flea (or both), the infection can persist; the rodent goes into hibernation and at low body temperature becomes more resistant. The adult flea can survive without food or host for a year or more, and larvae can prolong the pupa stage until a new host enters the burrow and vibrations from its
body call the new flea forth. And even if the flea dies out, *Y. pestis* can apparently survive in the soil of burrows, though this seems to vary between areas.

### 2.4 Vector

Many species of fleas can act as vectors for *Y. pestis*, but the rat flea is the most important vector for the plague bacterium. Rat fleas (domestic plague) and wild rodent fleas (natural foci) are important for plague transmission. The rat flea is shown in Fig. 3. The fleas are piercing, sucking, wingless insects. Both the sexes can transmit the disease. *Xenopsylla cheopis* is the commonest vector of plague among rats. It likes to live in rat burrows; the male cheopis may desert the rat to live exclusively in its burrow. But the rat flea can adapt at various other locations as in the cities, especially if it is a port; if rats are not available, the flea can bite human beings. *X. brasiliensis* is an equally efficient vector but it prefers to inhabit roofs rather than burrows and prefers a rural rather than urban environment.

**Figure 3:** Rat flea

To act as an efficient plague vector, the flea must be able to:

- ingest the plague organism with its blood meal;
live long enough for the pathogen to multiply sufficiently;
transfer the pathogen to an animal or human host in sufficient concentrations to cause an infection in the local rodent hosts; and
be present in large enough numbers to maintain infection in the local rodent hosts.

After the flea has taken the infected blood, the average time between the feed and infectivity is about 21 days, with a range of 5–31 days (extrinsic incubation period). A vector must have facilities for receiving the pathogen, and it must be able to maintain the pathogen in its body. It must live long enough to allow the pathogen to multiply. All three of these factors contribute to the extrinsic incubation period of the disease. The flea then must be capable of passing the pathogen to the next host in sufficient numbers to cause infection, and the flea must be present in sufficient numbers in any focus to keep the infection going in the rodent hosts of the area.

The feeding habits of the vector are related to the foraging habit of the host. One flea may feed on its host only in its burrow, another when the host is moving around outside burrows. The habits of the flea and host must coincide. The breeding pattern of the flea and the host must also be related. Fleas must be active in peak numbers in the adult biting stage when the rodent hosts are breeding freely. These are physiological factors. In addition, purely physical factors also come into the picture.

2.5 Risk factors

Geographical, meteorological and climatic factors, as well as the degree of advancement civilization--the type of buildings, amount of overcrowding, forms of sewerage, activity of shipping and other forms of transport, and the degree of sanitation—along with other factors have an indirect influence
on the qualitative and quantitative distribution of the rodents and insects that act as potential reservoirs and carriers of *Y. pestis*. Though bubonic plague has occurred in every part of the globe, it is confined chiefly to warmer latitudes. Extreme heat and dryness of atmosphere are inimical to its spread; thus in tropical countries it occurs during the colder months of the year, when the mean temperature is between 10°C and 30°C and the air has high relative humidity.

A combination of conditions (e.g. environmental, climatic, hygienic) and a certain relationship between the host-reservoir–flea vector–microorganism and humans are necessary. Sociocultural factors; certain occupations and lifestyles such as hunting, cat ownership, sleeping on floors, etc. and religious myths and beliefs carry an increased risk of exposure. Pneumonic plague may be highly communicable under appropriate climatic conditions; overcrowding and cool temperatures facilitate transmission.

Ecological changes created by natural disasters such as earthquakes, volcano, flooding, drought, or human activities such as encroachment, deforestation and mining disturb the equilibrium density of rodents and their fleas. As a result, human populations can be exposed to vectors of plague.

### 2.6 Mode of transmission and period of communicability

Plague can be transmitted indirectly or directly.

**Indirect transmission**

Such transmission occurs:

- Through the bite of a flea originating from plague-infected rats;
- from the bite of a flea originating from a rodent that has died of plague;
- through the biting of humans by wild rodent fleas
among people exposed to wild rodents in their natural habitats; and

- through consumption of camel meat infected with *Yersinia pestis*.

**Direct transmission**

This form of transmission occurs:

- From a plague-infected rodent or others while handling infected animals or carcasses. If the animal is infected, some of the bacteria could enter the human body through breaks in the skin. Hunters skinning animals are at risk for this type of transmission.

- Through person-to-person transmission through airborne droplets from patients with pneumonic plague (secondary or primary).

- Through direct contact with droplets contaminated with sputum. Infection through direct contact with objects contaminated with sputum from pneumonic plague patients can lead to the development of bubonic plague.

- Through contact with an animal with pneumonic plague which occurs when *Y. pestis* infects the lungs, or when the infected animal coughs near another person or animal. If cats develop a pneumonic plague, they can become a source of infection for people through aerosol transmission.

- During a laboratory accident. Plague may become a nosocomial infection and requires strict use of proper biosafety measures.

Bubonic and septicaemic plague do not spread from person to person.

Untreated pneumonic plague patients can transmit disease when they cough starting from onset till full recovery or death.
Treated patients can still transmit the disease during the first 48 hours after beginning of appropriate antibiotic treatment.

The incubation period for bubonic plague varies from two to six days. For pneumonic plague, it is between one and four days.

**Dynamics of transmission**
The dynamics of plague transmission are extremely intricate. This can be gauged from the simple fact that there are 3000 flea species, of which at least 31 are proven vectors of plague, and there are around 220 rodent species that can carry plague.

A focus may remain apparently static for years, during which the bacterium is passed from rodent to flea and from flea to rodent without any variation. This enzootic plague is kept going by the balance between resistant and susceptible hosts in the foci. After an interval of many years, if the balance between the susceptible and resistant rodents gets upset, the disease spreads rapidly and widely and causes many deaths among rodents. This is called epizootic plague. Humans are usually not at risk from epizootic plague, unless they intrude as hunters, trappers or nomads into the infected area.

In pneumonic form, *Y. pestis* is present in human sputum and infection spreads rapidly by direct contact from person to person. But apart from that form, and the septicaemic form that ends in pneumonic form of plague, the continuance of epidemic plague depends mainly upon close association between humans, rats and fleas. The epidemic wave in people follows closely the wave of infection and death in rats.
2.7 Types of plague

Sylvatic plague
The sylvatic plague is maintained in relatively resistant hosts called permanent reservoir hosts. These transmit the infection to less resistant animal hosts resulting in epizootics. When infection is endemic in sylvatic rodents, it may remain dormant a long time before circumstances favour its epidemic spread. During this time human beings in villages occasionally contract the infection through handling an infected animal, but the disease usually does not become epidemic unless infection spreads to what is sometimes termed a “liaison” rodent, meaning a species of rat that comes in contact with people. An epidemic starting in this way runs a characteristic course, which consists of three phases: a pre-epidemic phase, an epidemic phase and a decline phase.

In the pre-epidemic phase, the few cases that occur are separated by considerable intervals of time. This is followed by the rapid occurrence of a large number of cases. Finally, there is a decline, but not so long drawn out. Infection does not occur by direct contact with the sick. The epizootic spreads by contiguity from place to place, so that an increasing number of small foci are established.

Domestic plague
Domestic plague is intimately associated with humans and rodents living among them, and occurs when infection is picked up from permanent reservoir hosts by peri-domestic rodents, which in turn transmit it to the commensal rodents and thence to people. The rat fall (rodent epizootic) may be an early warning signal of imminent outbreak of bubonic plague.

Per saltum infection
Plague may also occur per saltum, in which a focus of plague suddenly appears several miles from the primary focus. This new focus acts as the centre from which the infection can
spread to the surrounding localities. While the contiguous mode of spread is dependent upon the gradual dissemination of plague among the rats, *per saltum* infection results from the transport of infected rats or rat fleas by railways, ships or other means. It is probably owing to importation of plague from cities that villages are infected.

Plague epidemic cycle is depicted in Fig. 4

**Figure 4:** Plague epidemic cycle
Yersinia pestis infection in humans occurs in one of three main clinical forms: bubonic, septicaemic and pneumonic. Bubonic plague is characterized by regional lymphadenopathy resulting from cutaneous or mucous membrane exposure. Primary septicaemic plague is an overwhelming plague bacteraemia usually following cutaneous exposure. The plague agent penetrates the human organism through skin lesions or through the mucous membranes of the mouth, nose or eyes. Primary pneumonic plague results from inhalation of aerosolized droplets containing Y. pestis.

3.1 Bubonic plague

After an incubation period of two to six days, patients typically experience a sudden onset of illness characterized by malaise, headache and shaking chills, which are accompanied by fever and pain in the affected lymph nodes, which become swollen (buboes). Buboes may occur in any regional lymph node sites such as inguinal, axillary, supraclavicular, cervical, post-auricular, epitrochlear, popliteal or pharyngeal. They are usually unilateral. The bubo may remain enlarged and tender for weeks following an otherwise satisfactory clinical recovery. Buboes may also get suppurative. Necrotic material from such buboes may contain viable Y. pestis. The typical clinical bubonic plague case is presented in Figs. 5 and 6.
3.2 Septicaemic plague

This is usually secondary to bubonic plague. Primary septicaemic plague is a progressive; overwhelming infection with *Y. pestis* in the apparent absence of a primary lymphadenopathy. Plague septicaemia, whether primary or secondary to bubonic plague, may lead to metastatic infection of other organ systems. Bloodstream infection may result in a wide spectrum of pathological events including disseminated
intravascular coagulopathy (DIC), multiple organ failure, and adult respiratory distress syndrome (ARDS). Septicaemic cases also can experience endotoxic shock in some instances without localized signs of infection. Complications include pneumonia, meningitis, endophthalmitis, hepatic or splenic abscesses, or generalized lymphadenopathy.

### 3.3 Pneumonic plague

Plague pneumonia occurs in two distinct and epidemiologically significant forms. Primary pneumonic plague is the most fulminating and fatal form of plague. The incubation period is usually one to four days. The onset of the disease is typically manifested by the sudden onset of chills, fever, headache, body pains, weakness and chest discomfort. Cough, sputum production, increasing chest pain, difficulty in breathing, hypoxia and haemoptysis become prominent as the disease rapidly progresses. Death usually ensues if specific antibiotic therapy is not begun within the first 18–24 hours of disease onset.

Secondary plague pneumonia results from haematogenous spread of *Y. pestis* to the lungs and is the most common pneumonic plague. This invasive infection provokes an inflammatory response and results in bacterial multiplication in pulmonary tissue. This process then spills over into the alveolar spaces and provides a mechanism for *Y. pestis* to be expelled during coughing episodes (patient’s sputum may be bloody). Spread of *Y. pestis* to others by the respiratory droplet route can initiate an epidemic of primary pneumonic plague.

The common clinical signs and symptoms observed in different types of human plague are shown in Table 2.
Table 2: Common symptoms/syndromes of human plague

<table>
<thead>
<tr>
<th>Clinical symptoms</th>
<th>Types of human plague</th>
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<tr>
<td></td>
<td>Bubonic</td>
<td>Septicaemic</td>
</tr>
<tr>
<td>Sudden onset</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Fever</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Bubo</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Cough with blood stained sputum</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

3.4 Differential diagnosis

Bubonic plague may be confused with streptococcal or staphylococcal lymphadenitis, infectious mononucleosis, cat-scratch fever, lymphatic filariasis, tick typhus, tularemia, syphilis and other causes of acute lymphadenopathy.

Septicaemic plague mimics any non-specific sepsis syndrome, or a gram-negative sepsis. Pneumonic plague may be confused with other causes of acute, severe community-acquired pneumonia, such as pneumococcal, streptococcal, *haemophilus influenzae*, anthrax, tularemia, *Legionella pneumophila*, leptospiral, hantavirus pulmonary syndrome, and influenza virus pneumonia.
4

Standard case definition

WHO recommends the case definition on criteria based on epidemiology, and laboratory findings in accordance with new diagnostic techniques\(^1\). This case definition is a reference for International Health Regulation notification and should be used for epidemiological investigation when it is possible and appropriate.

The occurrence of a suspect case in an area not known to be endemic for plague is an event to be notified to WHO in accordance with the revised International Health Regulations (2005). This notification triggers a verification process that includes the consultation of an expert committee. The expert committee may confirm the occurrence of plague based on the available evidence and additional laboratory investigations may be recommended.

An international meeting on preventing and controlling plague was held on 7–11 April 2006 in Antananarivo, Madagascar, recommended the following case definition criteria based on epidemiology and laboratory findings.
### Table 3: Criteria for confirmation of plague

<table>
<thead>
<tr>
<th>Type</th>
<th>Features</th>
<th>Laboratory results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspected case</td>
<td>Compatible clinical presentation; and consistent epidemiological features, such as exposure to infected animals or humans and/or evidence of flea bites and/or residence in or travel to a known endemic focus within the previous 10 days.</td>
<td></td>
</tr>
<tr>
<td>Presumptive case</td>
<td>Meets the definition for suspect case plus:</td>
<td>At least 2 of the 4 following tests must be positive:</td>
</tr>
<tr>
<td></td>
<td>Microscopy: material from bubo, blood or sputum contains Gram-negative coccobacilli, bipolar after Wayson or Giemsa staining;</td>
<td>- F1 antigen detection in bubo aspirate, blood or sputum;</td>
</tr>
<tr>
<td></td>
<td>F1 antigen detection in bubo aspirate, blood or sputum;</td>
<td>- a single anti-F1 serology without evidence of previous <em>Yersinia pestis</em> infection or vaccination;</td>
</tr>
<tr>
<td></td>
<td>- PCR detection of <em>Y. pestis</em> in bubo aspirate, blood or sputum.</td>
<td>- PCR detection of <em>Y. pestis</em> in bubo aspirate, blood or sputum.</td>
</tr>
<tr>
<td>Confirmed case</td>
<td>Meets the definition for suspect case plus:</td>
<td>An isolate from a clinical sample identified as <em>Y. pestis</em> (colonial morphology and two of the four following tests must be positive: phage lysis of cultures at 20–25 °C and 37 °C; F1 antigen detection; PCR; <em>Y. pestis</em> biochemical profile;</td>
</tr>
<tr>
<td></td>
<td>Microscopy: material from bubo, blood or sputum contains Gram-negative coccobacilli, bipolar after Wayson or Giemsa staining;</td>
<td>- or a fourfold difference in anti-F1 antibody titre in paired serum samples;</td>
</tr>
<tr>
<td></td>
<td>F1 antigen detection in bubo aspirate, blood or sputum;</td>
<td>- or (in endemic areas when no other confirmatory test can be performed) a positive rapid diagnostic test using immunochromatography to detect F1 antigen.</td>
</tr>
</tbody>
</table>

**Note:** Case definitions assume that all diagnostic tests have been validated for diagnosis of *Y. pestis* in clinical specimens.
5 Laboratory in surveillance and diagnosis

The laboratory plays a vital role in surveillance and diagnosis of plague. Efficient utilization of laboratory services can be achieved only by providing the right specimens collected in the right quantity and sent in the right container at the right temperature to the right laboratory.

5.1 Laboratory and surveillance

Plague surveillance requires laboratory support for evidence of plague activity in rodents, carnivores, fleas and human beings. Fleas are processed for isolation of plague bacilli, identification and calculation of flea index (average number of fleas per rat). Serological investigations are carried out for detection of antibodies in rodent, carnivore and human sera. Rodents must be identified to as the importance in public health can differ according to the species (for instance, black rat and brown rat). Rodent organs are processed for the isolation of *Y. pestis*.

5.2 Collection, storage and transport of samples

Laboratory examination of specimens from clinically and/or epidemiologically suspected case(s) is important to establish diagnosis of plague to support appropriate preventive and control measures. When plague is suspected, clinical specimens should be collected urgently and specific
antimicrobial treatment begun without waiting for the laboratory report.

**Figure 7:** Flow of specimens, task assignment and feedback at various levels of laboratories

---

**Collection and transport of specimens**

Dead rodents—Rodent carcasses or tissues can be transported on wet ice, dry ice, freezer packs or in special containers filled with liquid nitrogen. If these are not available, samples (such as liver or spleen) can be taken from carcasses and sent at ambient temperatures in Cary-Blair transport media.

Trapping of rodents—Multiple catch live traps are preferable to snap or dead fall traps because fleas tend to leave a dead host’s body as it cools. Live traps are useful for capturing hosts for flea collection, and tissue and blood samples. Traps must be set at specific sites where there are burrows, nests, runways or other evidence of rodent activity.

Rodent sera—Blood for serology can be collected from rodents by a variety of techniques including cardiac puncture. Samples
Operational Guidelines on Plague Surveillance, Diagnosis, Prevention and Control

collected can be transported directly in sterile, sealed tubes under cold conditions (cool box with icepacks).

Vectors—If hosts are captured live, they should be anaesthetized and placed in a white enamel pan and brushed vigorously from the tail end forwards with a toothbrush or comb. This will dislodge fleas from the hosts. Fleas will fall to the bottom of the pan and can be collected by flea-sucking tubes and placed in vials. These may then be transported to the nearest laboratory capable of identification and further processing.

Fleas can also be collected from rodent burrows by burrow swabbing.

Carnivore sera—Blood from dogs can be obtained from large veins in the forelegs or hind legs after properly restraining and muzzling them. Samples collected can be transported directly in sterile, sealed tubes under cold conditions.

Human specimens—Human blood, sputum, bubo aspirates, and serum can be collected and transported to the reference lab.

Human specimens
Specimens should be obtained from appropriate sites for isolating the bacteria. As far as possible, these should be collected before initiation of antimicrobial therapy.

The preferred specimen for microscopic examination and isolation from a bubonic case is aspirated fluid from the affected bubo, which is expected to contain numerous organisms (see protocol at annex 1).

Blood specimens for culture of *Y. pestis* should be taken whenever possible. Organisms may be seen in blood smears if the patient is septicaemic. Bacteria may be intermittently released from affected lymph nodes into the bloodstream; therefore, a series of blood specimens taken 10–30 minutes apart may be productive in the isolation of *Y. pestis*.

A bronchial/tracheal washing or sputum should be collected from a suspected pneumonic plague patient. Sputum/throat smears taken from pneumonic plague patients may contain too many other organisms to be of diagnostic value when only Wayson stain is used. These smears should be stained
with the more specific direct fluorescent-antibody (DFA) test or subjected to a validated enzyme immunoassay test.

In biopsies or in specimens taken post-mortem where recovery of live organisms is compromised, lymphoid tissues, spleen, liver, lung and bone marrow samples may yield evidence of plague infection by DFA test.

A brief summary of specimens required is shown in Table 4.

**Table 4: Laboratory specimens required for Plague diagnosis**

<table>
<thead>
<tr>
<th>Clinical Presentation</th>
<th>Specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bubonic</td>
<td>Bubo fluid/aspirate</td>
</tr>
<tr>
<td></td>
<td>Serum</td>
</tr>
<tr>
<td>Pneumonic</td>
<td>Bronchial/tracheal washing</td>
</tr>
<tr>
<td></td>
<td>Sputum</td>
</tr>
<tr>
<td></td>
<td>Serum</td>
</tr>
<tr>
<td></td>
<td>Blood</td>
</tr>
<tr>
<td>Septicaemic</td>
<td>Blood</td>
</tr>
<tr>
<td>Post-mortem</td>
<td>Biopsy from lymph nodes, lungs, bone marrow, spleen, liver</td>
</tr>
</tbody>
</table>

**Precautions in handling specimens**

As these specimens are known to or thought likely to contain infectious substances, the following precautions should be applied:

- Follow strict aseptic technique (gowns, gloves, masks).
- Wash hands before and after the collection of material.
- Place the specimen aseptically in an appropriate sterile container.
- Tightly close the container.
- Label and date the container.
Packaging/transport of specimens

In accordance with currently accepted biosafety norms, *Y. pestis* is listed under Biosafety II level. Therefore, the WHO Guidelines for the safe transport of infectious substances and diagnostic specimens (WHO/EMC/97.3) for shipping dangerous goods should apply when the specimens are to be shipped via air transport either domestically or internationally.

The requirements, in brief, are:

- A watertight primary receptacle.
- A watertight secondary receptacle.
- An absorbent material, which must be placed between the primary receptacle and the secondary packaging. The absorbent material must be adequate to absorb the entire contents of all primary receptacles.
- The receptacle must be at least 100 mm in the smallest overall external dimension.
- Itemized list of contents must be enclosed.
- Receptacles must withstand, without leakage, internal pressure difference of not less than 95 kPa (0.09 bar, 13.8 lb/in²) and temperature range of –40 °C to +55 °C.
- The outside package must be marked with identification of the infectious substance, volume of contents, and the name and telephone number of the sender.

Infectious agents, serum or culture vessels should be labeled with an alcohol-resistant, permanent ink marker, giving the contents and date. The materials should be sealed with a medical-grade leak-proof tape to prevent inadvertent leakage, and then wrapped with several layers of absorbent material. The absorbent-wrapped materials are placed in a leak-proof bag, soaked with disinfectant (quaternary ammonium or phenolic solutions) and sealed. The sealed bag is then placed in the first of the above mentioned containers. Depending on the specimen and the destination, the double container is sent in a sealed box with or without coolant.
Do not use wet ice for packaging because it melts and leaks. Cool packs (plastic bags containing frozen foam/refrigerant) are acceptable but must be placed in the box in such a way that, upon thawing, they do not permit movement of materials within the box. Containers must be especially well sealed if they are being shipped under dry ice conditions. Dry ice evaporates, and this must be taken into consideration when packing.

An important part of transportation is the proper labeling of the container and the inclusion of the paperwork that identifies the specimen(s), the clinical history or the epidemiological information, the sender’s identification and address, the purpose for which the specimen is sent and the import/export licenses if necessary. The outside of the container must be labeled with all the proper identification and biohazard warnings. If transporting with dry ice, the box must be identified with the correct label.

**Local surface transport**

A network or a courier service should be used for transport of specimens from a doctor’s office/surgery to a laboratory, from a hospital to a diagnostic laboratory, or from one laboratory to another.

The principle of safe transport by this means is the same for air or international transport—the material should not have any possibility of leaking or escaping from the package under normal conditions of transport.

The following practices should be observed:

- specimen containers should be watertight and leak-proof;
- if the specimen container is a tube, it must be tightly capped and placed in a rack to maintain it in an upright position;
- specimen containers and racks should be placed in robust, leak-proof plastic or metal transport boxes with secure, tight-fitting covers;
• the transport box should be secured inside the transport vehicle;
• each transport box should be labelled appropriately, consistent with its contents;
• specimen data forms and identification data should accompany each transport box; and
• a spill kit containing absorbent material, a chlorine disinfectant, a leak-proof waste disposal container and heavy-duty reusable gloves should be kept in the transport vehicle.

Note: The practices described above are not intended to supersede local or national requirements.

5.3 Laboratory diagnosis of plague

Specimens submitted to the laboratory are processed according to the following flow chart for isolation, identification or confirmation (Fig. 8):

Figure 8: Processing of specimens

- Negative
  - Stop
- Positive
  - Culture
  - Animal inoculation when possible
  - PCR
  - Serology

+ Positive
  - Stop
  - Negative
  - Positive
  - Sample
  - RDT available
    - Stop
  - RDT not available

For the performance of various tests, guidelines are available in manuals from WHO, the Centers for Disease Control (CDC), Atlanta, or other nationally approved documents. The interpretation of these tests should be in conformity with the case definitions described earlier in this document.

**Molecular techniques**

Molecular techniques are powerful tools that can be used to provide information about the etiological agent that cannot be obtained by traditional diagnostic methods. When standard microbiological methods fail to yield a viable isolate, molecular-based tests may be the only means available to confirm the presence of *Y. pestis*.

Molecular techniques used by the diagnostic laboratory are primarily for the purpose of grouping isolates to gain more discriminatory power, compared with the traditional biological typing methods. Reproducibility of molecular diagnostic techniques is influenced by biological and technical variability; therefore, these techniques in the diagnostic laboratory should be validated before application.

**Polymerase chain reaction for the detection of selected *YeRsinia pestis* genes**

The PCR methodology has provided exquisite discriminatory power in detecting low quantities of an infectious agent nucleic acid in a specimen. Because of PCR’s theoretical ability to detect a single DNA copy, the use of PCR methodology in a diagnostic laboratory has to be rigorously controlled to prevent false-positive results.

**Rapid diagnostic tests**

Late diagnosis is one of the major causes of deaths among human cases, as well as spread of the disease, since it limits the effectiveness of control measures.
The development of a rapid diagnostic test (RDT), based on immunochromatographic detection of the F1 antigen, which is specific to plague bacilli, is a major step forward in case management and surveillance of plague. The F1 dipstick assay on sputum and pus is an invaluable diagnostic tool for pneumonic plague. F1 antigen could be detected in sputum by ELISA and dipstick tests as early as the second day after the onset of the symptoms and also up to 48 h after treatment. This test is able to reliably confirm a suspect case in 15 minutes, and is sufficiently simple and robust for use in the field at peripheral level. The RDT contributes to the reduction in the delay in diagnosis, allowing for the early treatment – the only way for patient survival. Like other dipstick assays, it is a semi-quantitative test involving manual reading and a subjective threshold. The test was sensitive, reliable and easy to use. The test is useful for alert and response to outbreaks. Its main advantages are a low detection limit (1–5 ng/ml), results within 15 min, specificity and sensitivity of ~100%, compatibility with samples from both humans and rodents, insensitivity to contaminants, prior treatment and low cost. The test must be performed by specially trained health staff (see annexes 1 and 2 how to use it).

RDT is commercially available and can be purchased by country or provided by WHO.

5.4 Safe handling of infectious materials in the laboratory

Handling of *Y. pestis* or material suspected to harbour this organism requires biosafety level II (BSL-II) environment and precautions. However, when large volumes of cultures are handled, BSL-III facilities are required. Only trained personnel, working in a restricted area, should undertake plague diagnostic work. The infectious material must be handled only in biosafety cabinets (with vertical laminar airflow under negative pressure and vented to the outside).
In accordance with national or institutional policy, chemoprophylaxis or immunoprophylaxis, with regular monitoring, should be provided to laboratory staff. They must wear gowns, gloves (with sleeves of gowns tucked into gloves) and proper masks (if aerosol generation is expected). Hand-washing before leaving the laboratory should be mandatory.

A solution of 0.5% sodium hypochlorite should be used to decontaminate the laboratory surfaces as well as for managing the spills. In the latter case, sodium hypochlorite should be sprayed into the spill, left for 10 minutes and followed by a 70% alcohol wash. Other germicidal solutions containing phenol or quaternary ammonium compounds should be used in instances where hypochlorite is considered corrosive.

All contaminated material must be placed in highly visible biohazard bags. These should be filled only to two-thirds capacity, sealed with sterility indicator autoclave tape and autoclaved at 115 °C for 15 minutes before disposal. Sharps should be disposed of in rigid puncture-proof containers labeled with a biohazard sign and decontaminated with autoclaving.

The waste disposal must also conform to all other the national/institutional guidelines.
Long-term prevention and control of plague is primarily based on the following activities:

- Surveillance
- Rodent control
- Vector control
- Case management
- Chemoprophylaxis
- Immunoprophylaxis
- Infection control.

6.1 Surveillance

Plague is primarily a disease of rodents; therefore, a natural decline in human plague incidence would not justify the conclusion that plague has disappeared from an area. With the decline in human plague incidence in a particular biotope the infection probably recedes to its original hosts—wild rodents. Plague is not static but shifts from place to place through contiguity of colony infection among wild rodents, which eventually transfers the infection to the commensal rodents on their path. Many biotic and abiotic factors influence the persistence of the disease in wild populations and the occurrence of epizootic plague. The natural foci of plague are known to be maintained in wild rodents in a
cyclic pattern. Sudden ecological changes might create a spill-over of sylvatic plague into domestic environments. Recent outbreaks have shown that plague may re-emerge in areas after a long period of silence. Therefore, continuous surveillance and vigilance should be maintained as a part of epidemic preparedness and early warning systems.

**Objectives:**
- To **detect** early warning signals of an outbreak.
- To **institute** timely and appropriate control measures.
- To **assess** the impact of intervention measures.
- To **ensure** early containment of the outbreak.
- To **identify** local ecological factors or human activities that may result in increased plague exposure risks for humans (e.g., through study of the rodent population stress under which migration takes place, and the shifting of rodent populations).
- To **detect** trends in the epidemiology and epizootiology of plague in a given region (e.g., by mapping out the various species of fleas vis-à-vis their sustaining host).

*Surveillance is not a one-time activity, it is a continuous and ongoing systematic collection of data for action.*

### 6.2 Organization of surveillance activities

The following organizational set-up is required for plague surveillance in enzootic foci:

**Identification of a nodal officer**

One officer each at the province and district level should be identified as the nodal officer for surveillance of plague. He/she will be responsible for coordination and initiating necessary actions based on analysis and interpretation of surveillance data from all sources at the province and
district levels, respectively. He/she should preferably be the surveillance officer of the province/district and should be an experienced and senior officer trained in the principles of epidemiology, surveillance, outbreak investigation and management.

**Field surveillance functionaries**
The following team members are required for effective plague surveillance:

- Medical officers trained in epidemiology.
- Entomologists.
- Microbiologist/Veterinarian.
- Laboratory technicians/assistants.
- Field surveillance workers (rodent trappers).

**Defining geographical area for surveillance**
The geographical area for surveillance may be defined by using one or more of the following criteria:

- Known focus of plague.
- Detection of plague (\textit{Y. pestis}) activity.
- Report of suspected human case(s) of plague.

If limited resources do not permit active surveillance in a wider area, villages closest to the known foci or from where plague activity has been detected recently should be taken up first.

In the South-East Asia Region, natural foci of plague are known to exist in India, Indonesia and Myanmar. These foci require constant surveillance as plague has the potential to spread from wild rodents to peri-domestic and domestic animals and humans. Surveillance needs to be further initiated or intensified when there are ecological changes such as earthquakes, flooding or heavy rainfall, and if the
human habitation is in close proximity to the burrows of wild rodents, because the risk of transmission of infection to human beings increases in these situations.

6.3 Components of surveillance

A comprehensive surveillance system for plague comprises:

1. Rodent surveillance.
2. Vector (flea) surveillance.
3. Carnivore (dog) surveillance.
4. Human surveillance.

Rodent surveillance

Rodent populations in the wild and peridomestic areas should be continuously assessed for plague activity.

The most common techniques for monitoring plague in rodent populations include:

- collecting and examining dead rodents, including post-mortem; and
- trapping rodents for population data, serum, tissue samples and flea collection.

When collecting biological material, it is recommended that standard universal precautions should be taken.

Rodent identification is important. The reservoir hosts include many species of rodents. R. norvegicus (Norway rat) and R. rattus (Roof rat) are the commonest urban rodent hosts. Tips for morphological identification of roof rat, Norway rat and house mouse is presented in Fig. 9 and phenotypic characteristics have been presented in Table 5.
Figure 9: Roof rat, Norway rat and house mouse
### Table 5: Field characters and measurements in commensal rodents

<table>
<thead>
<tr>
<th>Character</th>
<th>Norway rat (Brown rat)</th>
<th>Roof rat (Black rat)</th>
<th>House mouse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rattus norvegicus</td>
<td>Rattus rattus</td>
<td>Mus musculus</td>
</tr>
<tr>
<td>Weight</td>
<td>150–600 gm</td>
<td>80–300 gm</td>
<td>10–21 gram</td>
</tr>
<tr>
<td>Head and body</td>
<td>Nose blunt, heavy, stocky body, 18–25 cm</td>
<td>Nose pointed, slender body, 16–21 cm</td>
<td>Nose pointed, slender body, 6–10 cm</td>
</tr>
<tr>
<td>Tail</td>
<td>Shorter than head plus body, uniformly dark coloured, naked, 19–25 cm</td>
<td>Longer than head plus body, uniformly dark coloured, naked, 19–25 cm</td>
<td>Equal to or a little longer than head plus body, uniformly dark coloured, naked, 7–11 cm</td>
</tr>
<tr>
<td>Ears</td>
<td>Relatively small, close-set, appear half-buried in fur, rarely over 20–23 mm</td>
<td>Large, prominent, thin and hairless, stand well out from fur, 25–28 mm</td>
<td>Prominent, large for size of animal, 15 mm or less</td>
</tr>
<tr>
<td>Fur</td>
<td>Brownish-grey on back, greyish on belly</td>
<td>Brownish-grey to blackish on back, belly may be white, grey or greyish-black</td>
<td>One subspecies brownish-grey on back, greyish on belly, another greyish on back and greyish-white on belly</td>
</tr>
<tr>
<td>Mammary glands</td>
<td>6 pairs</td>
<td>5 pairs</td>
<td>5 pairs</td>
</tr>
<tr>
<td>Habits</td>
<td>Burrows, swims and dives easily, gnaws, live indoors, in sewers and drains</td>
<td>Agile climber, gnaws, often lives off the ground in trees vines, etc.; lives indoors and outdoors</td>
<td>Climbs, sometimes burrows, gnaws; lives indoors and outdoors</td>
</tr>
</tbody>
</table>

While collecting biological material recommended standard universal precautions should be taken.
**Safety measures to be adopted by rodent trappers, and plague workers**

- Wear gloves and gum boots.
- Use chemoprophylaxis if there is evidence of plague activity in a trapped rodent.
- Convenient supply of snake anti-venom for rodent catchers.
- Pre-exposure immunization against rabies for those involved in carnivore surveillance.

**Vector surveillance**

Vector (rat flea) surveillance should be regularly conducted to determine the species, flea index and susceptibility to insecticides. An increase in the density of fleas increases the potential of an outbreak. The flea index (absolute and specific) or flea population density is calculated by dividing the number of fleas by the total number of rodents. Specific flea index is important to know the potential for plague transmission.

\[
\text{Specific flea index} = \frac{\text{No. of flea species collected}}{\text{Total no. of rodents collected}}
\]

A specific flea index of one or above should be treated as a high risk factor (critical flea index) and an early warning signal of the risk of a potential outbreak. However, an increase in the average number of fleas per host (absolute flea index) may be of little concern when the particular flea species is a poor vector of plague. Poor vector species identified are *Nosopsylla nilgriensis, Nosopsylla spp., Ctenocephalides felis, Ctenocephalides canis, Ctenocephalides orientalis, Styvalis aporous and Styvalis ahale*.

**Carnivore surveillance**

One of the most powerful techniques for detecting evidence of plague activity is to collect serum samples from carnivores that consume rodent prey or are likely to scavenge fresh rodent carcasses. Although some carnivore species (such
as those belonging to the cat family) often die of *Y. pestis* infection, others apparently suffer little, if any, illness. Dogs typically survive plague infection and develop antibodies that can be detected for as long as six months.

**Human surveillance**

In areas known to be endemic for plague, all health functionaries and even the community should be on the alert for patients with symptoms suggestive of plague. Case definitions must be disseminated to peripheral health functionaries as well as the community in local languages to strengthen lay reporting (WHO case definitions for plague are contained herein, Chapter 4). Even a single case of suspected plague should be immediately notified to the higher authorities. Following identification of a suspected case of human plague, surveillance personnel should immediately determine whether other cases exist or have occurred recently in the vicinity.

When sentinel animal sero surveillance indicates plague activity, or during rat falls, then human serosurveillance may be undertaken.

### 6.4 Early warning signals

The surveillance system should be effective to detect early warning signals, which are the precursors of a potential outbreak.

<table>
<thead>
<tr>
<th>Early warning signals</th>
<th>Surveillance mechanism of detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat fall</td>
<td>Rodent surveillance. Community and the health personnel in the potentially “at-risk” areas must be aware of the urgency of reporting rat falls.</td>
</tr>
<tr>
<td>Specific flea index more than one</td>
<td>Flea surveillance</td>
</tr>
<tr>
<td>Seropositivity in rodent population</td>
<td>Detection of plague activity in rodents</td>
</tr>
<tr>
<td>Positive serology in canines</td>
<td>Carnivore surveillance</td>
</tr>
<tr>
<td>Suspected case of human plague</td>
<td>Clinical human surveillance</td>
</tr>
</tbody>
</table>
Health facilities must report immediately any case of suspected plague that fits into the clinical case definition as mentioned in Chapter 4. A suspected human case of plague is a medical emergency and should be treated as a potential outbreak, warranting immediate investigation and follow-up action.

All the components of the surveillance system—collection, compilation, analysis and interpretation of data, follow-up action and feedback—must be carried out in a systematic and organized manner. This must be coordinated by the nodal officer. Supervision and monitoring at all levels is mandatory for ensuring effective surveillance.

6.5 Rodent surveillance and de-ratting in seaports

Seaports were major points of entry* of food materials, other goods and people before the development of air transport. Even today, major trading of food, goods and other materials are carried out in seaports due to cost factors, and ships are frequently infested with rodents. The activities undertaken at ports, such as handling of foodstuffs, attract many species of vermin. Similarly, ports are exposed to the risk of introduction of vectors from any other part of their host country or any other port in the world. Therefore, surveillance activities in ships and seaports should be carried out in the following manner:

- Surveillance activities should include cargo vessels, passenger vessels, sailing vessels and fishing vessels.
- Surveillance activities should include all areas in and around the port areas, such as port installations and residential colonies.

*“point of entry” means a passage for international entry or exit of travellers, baggage, cargo, containers, conveyances, goods and postal parcels, as well as agencies and areas providing services to them on entry or exit.
Rats and mice can gain access to ships directly by mooring ropes, hulls and gangways. They may be concealed in cargo, ships’ stores and other materials taken onto the ship. However, prevention through appropriate construction and rat-proofing will ensure almost complete control of rodents aboard the ships. Some ships may require major alterations, but most rat-proofing measures can be readily undertaken.

**Inspection of ships and issuance of an exemption certificate**

All vessels arriving from a foreign port must have a de-ratting certificate issued in a designated approved port.

It is important that the de-ratting certificate is valid and that the ship under inspection has been de-ratted within the previous six months period.

If the de-ratting certificate was issued more than six months previously, the ship must be inspected at an approved port and, if necessary, treated to control the rodents, or another exemption certificate issued. An exemption certificate indicates that the inspected ship is free from rodents.

Note: De-ratting certificate is issued after de-ratting which is valid for six months. If it expires, then exemption certificate is issued with or without de-ratting.

**Rat elimination in and around port areas**

There are five basic steps when eliminating a rat population. For rodent control to be effective and efficient on a long-term basis, all five basic steps should be implemented:

- Inspection
- Sanitation
- Exclusion
- Population reduction (traps, baits, repellents)
- Verification.
**Rodent control in ships**

1. Deploy traps or poison bait stations near any possible spot a rat could board.
2. Use multiple approaches.
   - Deploy snap or wonder traps, sticky boards (glue traps) and rodenticides.
   - Put traps where sign is found, in dark and concealed spaces and near food or garbage.
3. Never throw a live rat overboard. They are good swimmers and may reach land.

#### Ways to prevent entry of rodents into ships in seaports

When tying up in port, look for ways rats could board the vessel, and take steps to stop them.

- Use rat guards on docklines lines where appropriate.
- Seal entry points to the vessel’s interior, such as cable chases, and put screens or louvers over windows and vents.
- Inspect and shake out fishing nets and lines before taking them aboard. Rats particularly like to nest and shelter in trawl and seine nets and coils of line.

**6.6 Health education and community participation**

People living in endemic areas should be provided with health education regarding the significance of rat falls, handling of rat carcasses, modes of transmission, symptomatology of plague and the importance of immediate reporting to the nearest health facility should a case be suspected. They should also be informed about the common myths and misconceptions about plague.

The community should be educated about prevention and control of plague. Health education can be undertaken...
by organizing talks and by involving media, public relations institutions, schools and community-based organizations and nongovernmental organizations (NGOs).

6.7 Intersectoral coordination

Various departments, such as those responsible for traditional medicine, social welfare, local development, revenue, forest, veterinary/livestock/animal husbandry and agriculture, should be involved in the surveillance activities.

The existing intersectoral coordination mechanism for avian influenza, zoonoses or emerging infectious diseases may be used for decision-making and coordinating action plans.

6.8 Rodent control

It is virtually impossible to completely control the wild rodent population and equally impossible to control the fleas that feed on them. Prevention is based on controlling rodent populations in rural and urban settings as much as possible. Rodent control activities should be undertaken during inter-epidemic periods only. Killing of rodents during epidemic situations may result in large number of fleas leaving the dead rodents and biting human beings and transmitting the infection. Therefore, rodent control measures should never be undertaken during outbreaks.

The following methods are employed for rodent control:

- Environmental sanitation
- Physical methods
- Chemical methods
- Biological methods.
Environmental sanitation

Environmental control of domestic rats involves proper garbage disposal, proper drainage systems, rat-proof food storage and the rat-proofing of building structures.

**In houses:** The following preventive measures should be taken:

- Food should be stored in rat-proof containers such as glass or earthenware jars or metal cans and bins with lids.
- Water storage containers should be covered and leaking taps repaired.
- Food wastes must not be left where rats can get at them. Tables and floors should be swept clean of leftover food. Kitchen refuse should be stored in rat-proof containers with tight-fitting lids.
- The house should be searched for holes in the walls and floor. All openings more than 6 cm wide should be sealed with rat-proof material (mortar, concrete, metal sheeting, wire mesh or other such material). Special attention should be paid to spaces under doors and where pipes pass through walls, windows and other openings, ventilation grills and gaps between tops of walls and eaves. Access to open windows and eaves can be prevented by placing metal guards along overhead cables and external pipes.
- If the exterior wall has a rough surface, a smooth band of paint 10 cm. wide can be applied below window height but preferably more than one metre above ground level so as to prevent rats from climbing up the walls.

**Around houses:** The following preventive measures should be taken:

- Premises, including yards and vacant plots, should be kept clean and free of accumulations of junk and debris.
• All plant growth likely to harbour rats or conceal their activities should be cut down.
• Branches of trees growing close to the house should be cut down to prevent easy access to roofs.

In the community: The following preventive measures should be taken:

• Solid wastes should be collected and disposed of properly. Particular attention should be given to piles of industrial refuse, including damaged packing cases and building materials, as they attract rats.
• Complete sealing of drains and the sewage system or other sanitation systems is also absolutely essential. Rat-proof covers should be placed over access points. Ends of ventilator shafts and disused drains should be sealed off at the points of entry into the main sewer. Other underground structures, such as drains for surface water and conduits for electrical cables, should also be rat-proofed as fully as possible.
• Buildings where food is stored, such as warehouses, should be made rat-proof.

Physical methods

Trap barrier system (TBS)
TBS is a type of physical control of field rodents by putting fences around crops. This system, described as eco-friendly, is improved by fencing around trap crops sown before the main crop. The trap crop lures the rodents from the surrounding areas and these rodents are trapped in large numbers.

Chemical methods
Chronic or multiple-dose poisons are slow to act, and several meals may be required over a period of a few days before they are effective. The currently and widely used poisons in this group are the anticoagulants. The best known is
Warfarin, but others are also equally effective. Table 5 shows four commonly used compounds and their recommended dosages for mice and rats. Many ready-to-use preparations of anticoagulants are available. The baits can be prepared with locally available materials. The simplest preparation is a dry medium-ground or crushed cereal to which the concentrate is added. The addition of a vegetable oil may make the bait more attractive for a time, until the oil turns rancid. Sugar added to give a concentration of about 5 per cent is also a useful additive.

<table>
<thead>
<tr>
<th>Compound*</th>
<th>Dosage in parts per million**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>House mouse</td>
</tr>
<tr>
<td>Warfarin</td>
<td>250–500</td>
</tr>
<tr>
<td>Diphacinone</td>
<td>125–250</td>
</tr>
<tr>
<td>Coumatetralyl</td>
<td>250–500</td>
</tr>
<tr>
<td>Pindone</td>
<td>250–500</td>
</tr>
</tbody>
</table>

*May be used in dry or liquid bait

**Dilution factors:

500 ppm (0.05%) = 1 part of 0.5% concentrate to 9 parts of bait
250 ppm (0.025%) = 1 part of 0.5% concentrate to 19 parts of bait
100 ppm (0.01%) = 1 part of 0.5% concentrate to 49 parts of bait
50 ppm (0.005%) = 1 part of 0.5% concentrate to 99 parts of bait

Acute or single-dose poison is effective after a single feeding by the rodent. Their action is rapid and death can occur within 30 minutes. However, such rapidity can be a drawback, for the rodent must be enticed to eat a sufficient quantity of the poisoned bait quickly before getting affected by the poison. The bait must therefore be attractive and acceptable. It is usually advantageous, if time permits, to pre-bait with unpoisoned food (pre-baiting exposure) so that the animals become accustomed to feeding at the same sites on the same foodstuff.

Acute poisons are chosen when speedy action is desired, but it must be kept in mind that these poisons present more
hazards to man and domestic animals than do anticoagulants, and strict precautions should be observed in handling and preparing the bait. These acute poisons are generally made available for only one or two nights, particularly if there has been a period of pre-baiting.

Zinc phosphide has been widely used over several decades to control rodent species. It is a fast-acting, fine-grayish black powder with garlic-like odour and strong taste. It is fairly stable in air and water. Rats may die in less than an hour. It is toxic to man and animals, and is recommended for field rodents only where rodent infestation is very high.

**Bromadiolone** is a second-generation anticoagulant used in a dose of 0.005%.

**Coumatetralyl** is a first-generation anticoagulant and is preferred for achieving an effective kill with a single dose (0.0375%).

These rodenticides in baits are recommended for rodent management in fields and also in stores and warehouses.

For effective long-term rodent control, anticoagulants may be used in permanent bait stations. Permanent bait stations may be constructed near garbage disposal areas or other places where rodent activity is noticed.

**Fumigants**

In rodent-endemic areas or when the rodent problem is quite serious, fumigants like aluminium phosphide can be used to treat all the residual rodent burrows in the field. The residual burrows are those entrances reopened after closure of all burrow entrances with mud one day prior to the activity. It is more effective in humid conditions, e.g. agricultural fields or irrigated lands.
Procedure

- Close all the surface openings of the burrow in the evening.
- The next morning, one or two tablets of aluminium phosphide (Celphos) are inserted into each reopened or new hole at a depth of 25 to 30 centimetres with a long-handled wooden spoon or aluminium pipe, and the burrow should then be sealed.
- In sandy soil, pour one litre of water in each burrow before placing tablet.
- The process should be repeated the next day in case of reopened burrows by rats and continued till the area is cleared of rats.

Precautions

- Great care should be taken in handling and using aluminium phosphide tablets, since phosgene gas produced by them is a deadly poison.
- No smoking/eating should take place while handling the tablets.
- All tablets in a tube should be used at once. If any are left unused, the tube should be closed tightly and sealed.
- The tube containing tablets should be stored safely and out of reach of children in a dry place.

Treatment cycle: This process should be gone through every 3-4 months.

Biological control

Pathogenic bacteria, viruses, protozoans as microgen and helminths, nematodes and arthropodes as micro-parasites have biocontrol potential. But not many data are available on this aspect. The WHO Committee on Zoonosis has also doubted the practical application of microbial rodenticides due to possible public health and environmental hazards.
6.9 Vector control

Flea control measures should be undertaken during the following situations:

- When any locality reports a rat fall.
- Reporting of an increase in the population of fleas/flea nuisance (an increase of the flea index).
- Specific Flea Index found to be more than 1.0 through active surveillance in areas of known foci of natural plague.
- On receipt of specific information from state or central government authorities about a flea nuisance.

The following measures are recommended for plague vector control:

- Personal prophylactic measures
- Insufflation
- Residual insecticide spray.

**Personal prophylactic measures**

- Use of repellents like benzylbenzoate, diethyltolumide (DEET), dimethylphtholate (DMP) on body or on clothing to avoid flea bites.
- Use of high-necked shoes or socks up to the knees
- Sleeping on cots at least 0.5 metre from ground level

**Insufflation**

The method of treatment of rodent burrows and rat runs with 10% DDT or 5% malathion dust powder (wettable powder or WP). Insecticide dusts should be blown with a rotary plunger-type duster or cyanogas pump into the mouth of the rodent burrows, and a patch of dusting powder about 0.5 cm to 1.0 cm thick and 20–25 cm wide should be left around the mouth of the burrow.
Residual insecticide spray
Insecticides used for residual insecticide spray are malathion, deltamethrin, cyfluthrin and lindan. Their use is described in detail below.

Malathion 25% WP
Spray formulations
- Suspension is applied @ 2.0 gm/m² active ingredient.
- To get 5% suspension, 2.0 kg of 25% WP is mixed in 10 litres of water.
- Spraying may be undertaken annually or as per local requirements.

Treatment areas
- Residual spraying in indoor situations should be up to a height of one metre in the affected areas because fleas can hop only up to half a metre.
- Areas used for sleeping by human beings, bedding of animals, under rugs, and cracks and crevices in floors should also be sprayed.
- Exterior treatment should include all areas frequented by rodents, cats, dogs, etc.

Equipments for residual spray
Hand-compression pumps should be used, following the techniques used for the control of adult mosquitoes.

Deltamethrin 2.5% WP
- Suspension is applied @ 20 mg/m² active ingredient.
- To get 0.125% suspension, 400 gm of 2.5% deltamethrin is mixed in 10 litres of water.
- Spraying may be undertaken annually or as per local requirements.
**Cyfluthrin 10% WP**
- Suspension is applied @25 mg/m² active ingredient.
- To get 0.125% suspension, 125 gm of 10% Cyfluthrin is mixed in 10 litres of water.
- Spraying may be undertaken annually or as per local requirements.

**Lambdacyhalothrin 10% WP**
- Suspension is applied @25.0 mg/m² active ingredient.
- To get 0.125% suspension, 125 gm of 10% Lambdacyhalothrin is mixed in 10 litres of water.
- Spraying may be undertaken annually or as per local requirements.
7 Epidemic preparedness

7.1 Identification of rapid response teams

Rapid response teams (RRT) of existing surveillance systems may be sensitized about plague epidemiology and response mechanisms. In the event that there are no RRTs either at the state or district level, these should be identified for both levels. The composition of the RRT should ideally be as follows:

- Nodal officer – Epidemiologist or Public Health Officer
- Microbiologist
- Clinician
- Entomologist/biologist.

7.2 Logistics

Medicines, stationery, rodent traps, transport media, personal protective equipment (masks, gloves, gum boots) should be available on an emergency basis, and hence the need for logistical capacity. Ideally, these should be stockpiled at the district level, especially in endemic areas.

In addition, each district should have a contingency plan to meet any eventuality. This includes manpower deployment, procurement of materials, mobilization of finances, quick mobility of RRT and communication.
A crisis management committee should be constituted to provide overall guidance and make prompt decision on administrative, financial and technical issues during an outbreak situation.

The committee may consist of representatives from:

- decision-making authorities
- other relevant governmental bodies, transport, communications, police, agriculture, education, financial institutions, etc.
- religious authorities
- technical committee – expert or experts on plague.

Depending on the level national, regional or district, it might be changed accordingly.

Though control of plague outbreak will be seen primarily as the responsibility of the health sector, other sectors can play a very important supportive role in effective implementation of control measures. Role of crisis committee is to:

- supervise and coordinate implementation and achievement of control measures.
- establish procedure for accessing funds
- develop policies and sustain executive structures with clear responsibilities for emergency health response
- coordinate communication with and education of the health care community and the general public about the symptoms and the precautions to be observed. Common myths and misconceptions should be dispelled to reduce panic in the community. This should be monitored on a daily basis.
- communicate with local and international mass media.
- report to the higher authorities. The higher authorities must be kept informed through daily updates.
7.3 Hospital preparedness

Ideally, a plague case should be treated in a health facility nearest to the occurrence of the case to prevent the spread of the disease and help in the containment of the infection. Therefore, all health facilities in plague-endemic regions should be able to treat patients with plague. The staff should be trained in isolation and infection control measures (see section 8). This would help in preventing spread of infection.

7.4 Manpower development

The RRT at the district and state level should provide training in managing an outbreak of plague. All categories of health workers should be trained in identifying suspect cases of plague and in their initial management. The community in these areas should also be provided with health education about early warning signals such as rat falls.

Regular refresher training should be conducted for the all categories of staff to maintain a constant level of vigilance.

Basic information kits, in the local language, containing details of standard case definitions of plague, and information on collection of clinical samples, management of cases of plague and steps to be taken in the event of an outbreak should be made available to all health functionaries.
### 8.1 Identification of an outbreak

A single case of human plague is to be considered an outbreak and a public health emergency, and warrants immediate action. Line listing of cases with basic technical information is valuable for verification, further investigation and contact tracing and a standard format should be used.

#### Line listing of cases

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Age</th>
<th>Sex</th>
<th>Father/ Husband's name</th>
<th>Address</th>
<th>Date of onset of illness</th>
<th>SYMPTOMS &amp; SIGNS</th>
<th>Treatment received</th>
<th>Lab reports</th>
<th>OUTCOME</th>
<th>Exposure to risk factor</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

#### Key to the form

- **No**: serial number.
- **Name**: of all the suspected cases.
- **Age**: if there are small children involved, then better to record the age in months for ALL.
Father’s name/Husband’s name: For identification only.

Address: as detailed as possible so that later there is no problem while mapping.

Date of onset of symptoms: as accurate as possible as this gives an idea of the incubation period.

Symptoms and signs: list the common symptoms and signs in each column. It should be filled as yes and no.

Treatment received: the details as well as the place at which it was received. Details include the medicines received.

Lab reports: give the details as and when they are available. Till then, the samples taken should be filled into this column.

Outcome: whether the person is alive and well, still sick, or has died.

Exposure to risk factors: Initially this may not be clear, but as risk factors are identified, exposure to them needs to be checked. This may necessitate going back to the initial cases and checking.

Comments: any other comments related to the outbreak.

8.2 Outbreak investigation

The structure of an investigation of an outbreak is given in Fig 10.
Figure 10: Plague event investigation

Suspected case of plague (bubonic/septicaemic/pneumonic)

Immediate verification by the Public Health Officer (based on history of exposure, clinical signs and symptoms)

Suspected plague

Immediate notification of district authorities

Immediate institution of containment

1. Send RRT immediately for conducting epidemiological/clinical/laboratory investigation
2. Activate crisis committee
3. Mobilize drugs, vehicles, manpower, finances
4. Send laboratory specimens to regional/national laboratory

Laboratory reports

Positive

- National authorities to notify WHO
- Intensify containment measures further
- Information education communication

Negative

- Investigate further to find out cause of outbreak

1. Case management—appropriate antibiotics for 10 days
2. Hospitalize all suspect cases
3. Active surveillance for new cases
4. Chemoprophylaxis to all contacts
5. Flea control and sanitation measures in the event of bubonic plague
6. Health promotion (public health education)
8.3 Activation of Crisis Management Committee

The Crisis Management Committee should be immediately activated. Some of the actions that it needs to take are:

**Setting up a control room with toll-free number**

A control room should always be set up during a plague outbreak under a senior officer. The officer in charge of the control room should be in constant touch with the nodal officer identified for the outbreak and share information with him/her on regular basis. All the relevant and updated data should be available in the control room. The control room should have a dedicated telephone toll-free number, computer and email facilities, and should work 24X7.

**Organizing logistics**

The Crisis Management Committee should set up a team for organizing logistics. Depending on the scale of the outbreak, extra manpower may need to be deployed. This can easily be done by deployment of staff from unaffected areas. Adequate drugs, vehicles, insecticides and finances need to be obtained during outbreak operation.

**Public health education**

The community should be educated about the symptomatology and the precautions to be observed. Common myths and misconceptions should be dispelled to reduce panic. It can be done through interaction with the media, getting out key messages and dispelling fear through IEC campaign on a daily basis.

**Provision of a telephone helpline**

Though intensive IEC campaigns will help in spreading the right messages, a telephone helpline will be of particular use in allaying the apprehensions of the public. The telephone numbers of the help line should be widely publicized. The help line should be managed by technically competent
A communication specialist who should be properly briefed about probable queries and their appropriate response. The help line facility may be located in the control room itself for better coordination and monitoring.

**Informing the higher authorities**

The Ministry of Health must be kept informed through daily updates/situation reports. This responsibility should be assigned to the nodal officer, who should gather information from all sources and compile it. At the same time, the nodal officer should inform the neighbouring states and districts about the situation so that they can undertake the necessary measures.

**Managing media and public relations**

Plague outbreaks invite the attention of all types of media, even including international news agencies. News items that are not factually correct may appear in the media and may increase the apprehension of the public. It is therefore necessary that the media be given correct information on a regular basis. An officer may be identified to brief the press daily, and this briefing should be used to enlist the help of the media in spreading correct messages and building community participation in controlling the outbreak. It should be ensured that only an authorized officer talks to the media, and no contradictory statements are issued.

**Intersectoral coordination**

Though control of a plague outbreak will be seen primarily as the responsibility of the health sector, other sectors such as education, agriculture, forestry and local development can play a very important supportive role in effective implementation of control measures against plague.

**Documentation**

A strong surveillance system can minimize the risk of outbreaks and all efforts should be made to prevent an
outbreak of plague. However, when an outbreak does occur, it provides an excellent opportunity for obtaining epidemiological information, especially the risk factors responsible. The results of the outbreak investigation should be shared with other districts/ states so that the experience gained and lesson learnt can be effectively used to prevent such outbreaks in other areas, as well as in the future.

**Technical support**

The National Focal Agency for Control of Communicable Diseases or Emerging Infectious Disease Focal Point should be approached at the earliest for management of plague control activities. If any other help is required, the Crisis Management Committee can take up this matter in consultation with the national authorities.

**8.4 Case management**

When a case of human plague is suspected on clinical and epidemiological grounds, appropriate specimens for diagnosis should be obtained immediately and the patient should be started on specific antimicrobial therapy without waiting for a definitive answer from the laboratory (See Table 5). Suspect plague patients with evidence of pneumonia should be placed in isolation and managed under respiratory droplet precaution.

**How to manage patients with plague**

Plague is potentially fatal and should always be viewed as a MEDICAL EMERGENCY.

As contagiousness of patients with pneumonic plague is very high, isolation of patient is mandatory.

The right antimicrobial treatment is vital and should be instituted at the earliest.
Standard patient-care precautions (bubonic plague) and respiratory droplet precautions (pneumonic plague) are strongly recommended for all hospitals.

**Specific therapy**

The therapies are shown in the Table 7. Section 8.4.2 describes some specific situations in which one or the other drug is to be prescribed depending on severity of cases, availability of drugs and age group of patients.

**Table 7: Plague treatment guidelines**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Interval (hrs)</th>
<th>Route of Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Streptomycin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>2 g/day</td>
<td>12</td>
<td>IM</td>
</tr>
<tr>
<td>Children</td>
<td>30 mg/kg/day</td>
<td>12</td>
<td>IM</td>
</tr>
<tr>
<td><strong>Gentamicin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>5 mg/kg/day</td>
<td>24</td>
<td>IM or IV</td>
</tr>
<tr>
<td>Children</td>
<td>2 mg/kg loading dose</td>
<td>8</td>
<td>IM or IV</td>
</tr>
<tr>
<td></td>
<td>followed by 1.7 mg/kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ciprofloxacin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>400 mg</td>
<td>12</td>
<td>IV</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>500 mg</td>
<td>12</td>
<td>PO</td>
</tr>
<tr>
<td>Children</td>
<td>15 mg/kg</td>
<td>12</td>
<td>IV/PO</td>
</tr>
<tr>
<td><strong>Tetracycline</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>2 g/day</td>
<td>6</td>
<td>PO</td>
</tr>
<tr>
<td>Children (&gt;9) years</td>
<td>25–50 mg/kg/day</td>
<td>6</td>
<td>PO</td>
</tr>
<tr>
<td><strong>Chloramphenicol</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>50 mg/kg/day</td>
<td>6</td>
<td>PO or IV</td>
</tr>
<tr>
<td>Children (&gt;1) year</td>
<td>50 mg/kg/day</td>
<td>6</td>
<td>PO or IV</td>
</tr>
<tr>
<td><strong>Doxycycline</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>200 mg/day</td>
<td>12 or 24</td>
<td>PO</td>
</tr>
<tr>
<td>Children (&gt;9) years</td>
<td>200 mg/day</td>
<td>12 or 24</td>
<td>PO</td>
</tr>
<tr>
<td><strong>Oxytetracycline</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>250–300 mg/day</td>
<td>8, 12 or 24</td>
<td>PO or IM</td>
</tr>
<tr>
<td>Children (&gt;9) years</td>
<td>250 mg/day</td>
<td>8, 12 or 24</td>
<td>PO or IM</td>
</tr>
</tbody>
</table>

IM=Intramuscular  IV=Intravenous  PO=Orally
The antibiotic therapy should be given for at least for 10 days. Resistant strains have been isolated; treatment should be guided by antibiotic sensitivities where available. Antibiotics that should not be used for the treatment of plague include penicillins, cephalosporins, and macrolides (erythromycins) because they have poor activity against *Pasteurella* species.

Oxygen, intravenous fluids, and respiratory support are usually also prescribed. Clinician must prepare for intense supportive management of plague complications. Monitoring and management of possible septic shock, multiple organ failure, adult respiratory distress syndrome and disseminated intravascular coagulopathy should be instituted.

Patients with pneumonic plague should be strictly isolated from other patients. Contacts of patients with pneumonic plague should be observed closely and given prophylactic antibiotics as described below.

**Treatment of plague during pregnancy and in children**

With correct and early therapy complications of plague in pregnancy can be prevented. The choice of antibiotics during pregnancy is confounded by the potential adverse effects of three of the most effective drugs—streptomycin, chloramphenicol and tetracyclines.

The preferred antibiotic for treating plague in pregnancy is gentamicin given intravenously (IV) or intramuscularly (IM).

Streptomycin may be ototoxic and nephrotoxic to the fetus. Tetracycline has an adverse effect on developing teeth and bones of the fetus. Chloramphenicol carries a low risk of “grey baby” syndrome or bone-marrow suppression.

In children, the ciprofloxacin dose should not exceed 1g/day, and chloramphenicol should not exceed 4g/d. Children younger than two years should not be given chloramphenicol. Children younger than nine years should not be given tetracycline.
8.5 Prophylaxis

Chemoprophylaxis

Persons in close contact with pneumonic plague patients, or persons likely to have been exposed to *Y. pestis*-infected fleas who have had direct contact with body fluids or tissues of a *Y. pestis*-infected mammal, or exposed during a laboratory accident to known infectious materials, should receive antibiotic preventive therapy if the exposure was in the previous seven days. The preferred antimicrobials for preventive therapy are the tetracyclines, chloramphenicol, or one of the effective sulfonamides.

True prophylaxis—the administration of an antibiotic prior to exposure—may be indicated when persons must be present for short periods in plague-active areas under circumstances in which exposure to plague sources (fleas, pneumonic cases) is difficult or impossible to prevent.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Interval (hrs)</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tetracycline</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>1–2 g/day</td>
<td>6 or 12</td>
<td>PO</td>
</tr>
<tr>
<td>Children 9 years</td>
<td>25–50 mg/kg/day</td>
<td>6 or 12</td>
<td>PO</td>
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<tr>
<td><strong>Doxycycline</strong></td>
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<tr>
<td>Adults</td>
<td>100–200 mg/day</td>
<td>12 or 24</td>
<td>PO</td>
</tr>
<tr>
<td>Children 9 years</td>
<td>100–200 mg/day</td>
<td>12 or 24</td>
<td>PO</td>
</tr>
<tr>
<td><strong>Sulfamethosazole/Trimethoprim</strong></td>
<td></td>
<td></td>
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<tr>
<td>Adults</td>
<td>1.6 g/day*</td>
<td>12</td>
<td>PO</td>
</tr>
<tr>
<td>Children 2 years</td>
<td>40 mg/kg/day*</td>
<td>12</td>
<td>PO</td>
</tr>
<tr>
<td><strong>Ciprofloxacin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>400 mg</td>
<td>12</td>
<td>PO</td>
</tr>
<tr>
<td>Children 2 years</td>
<td>Max 1 g/day</td>
<td></td>
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</tbody>
</table>

*Sulfamethoxazole component PO=Orally
The duration of prophylactic therapy is seven days.
**Immunoprophylaxis**

Plague vaccine is no longer commercially available. Plague vaccines, live attenuated and formalin killed at one time were widely used but have not proven to be an approach that could prevent plague effectively\textsuperscript{12}. The vaccine is indicated for persons whose work routinely brings them into close contact with *Y. pestis*, such as laboratory technicians working in plague laboratories and persons studying infected rodent colonies or engaged in field operations in areas with enzootic plague. The vaccine does not protect against primary pneumonic plague. Mass vaccination is of little use during human plague outbreaks, because a month or more is required to develop a protective immune response.

### 8.6 Infection control

**Guidelines for standard precautions during a plague outbreak**

**Standard precautions**

Use standard precautions for the care of all suspect plague patients.

**A. Handwashing**

Wash hands after touching blood, body fluids, secretions, excretions and contaminated items, whether or not gloves are worn. Wash hands immediately after gloves are removed, between patient contacts, and when otherwise indicated to avoid transfer of microorganisms to other patients or environments. It may be necessary to wash hands between tasks and procedures on the same patient to prevent cross-contamination of different body sites.

- Use a soap and running water for routine handwashing.
- Use an antimicrobial agent or a waterless antiseptic agent for specific circumstances (e.g., control of outbreaks or hyperendemic infections), as defined by the infection control programme.
B. Gloves
Wear gloves (clean, non-sterile gloves are adequate) when touching blood, body fluids, secretions, excretions and contaminated items. Put on clean gloves just before touching mucous membranes and non-intact skin (lacerated and/or fresh wound). Change gloves between tasks and procedures on the same patient after contact with material that may contain a high concentration of microorganisms. Remove gloves promptly after use, before touching uncontaminated items and environmental surfaces, and before going to another patient; wash hands immediately after removing gloves.

C. Masks, eye protection, face shields
Wear a mask and eye protection or a face shield to protect mucous membranes of the eyes, nose, and mouth during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions or excretions.

D. Gown
Wear a gown (a clean, non-sterile gown is adequate) to protect skin and to prevent soiling of clothing during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions or excretions. Select a gown that is appropriate for the activity and amount of fluid likely to be encountered. Remove a soiled gown as promptly as possible and wash hands.

E. Patient-care equipment
Handle used patient-care equipment soiled with blood, body fluids, secretions, and excretions in a manner that prevents skin and mucous membrane exposures or contamination of clothing. Ensure that reusable equipment is not used for the care of another patient until it has been cleaned and reprocessed appropriately. Ensure that single-use items are discarded safely.
F. Environmental control
Ensure that the hospital has adequate procedures for the routine care, cleaning and disinfection of environmental surfaces, beds, bedrails, bedside equipment and other frequently touched surfaces, and ensure that these procedures are being followed.

G. Occupational health and personal safety
Take care to prevent injuries when using needles, scalpels and other sharp instruments or devices; when handling sharp instruments after procedures; when cleaning used instruments; and when disposing of used needles. Never recap used needles or otherwise manipulate them using both hands, or use any other technique that involves directing the point of a needle toward any part of the body; rather, use either a one-handed "scoop" technique or a mechanical device designed for holding the needle sheath. Do not remove used needles from disposable syringes by hand, and do not bend, break, or otherwise manipulate used needles by hand. Place used disposable syringes and needles, scalpel blades, and other sharp items in appropriate puncture-resistant containers, which should be located as close as is practical to the area in which the items were used, and place reusable syringes and needles in a puncture-resistant container for transport to the reprocessing area.

Use mouthpieces, resuscitation bags or other ventilation devices as an alternative to mouth-to-mouth resuscitation methods in areas where the need for resuscitation can be predicted and the required equipment put in place in advance.

H. Patient placement
Place a patient in an individual room. If an individual room is not available, place the patients of the same cluster/cohort together in a room (same symptoms, same date of onset). When a separate individual room is not available and
cohorting is not achievable, maintain spatial separation of at least two metres between the infected patient and other patients and visitors. Special air handling and ventilation are not necessary, and the door may remain open.

**Droplet precautions**
In addition to standard precautions, use droplet precautions for a patient known or suspected to be infected with pneumonic plague.

**Patient placement**
Place the patient in an individual room. If an individual room is not available, place the patients of the same cluster/cohort together in a room (same symptoms, same date of onset) When a separate individual room is not available and cohorting is not achievable, maintain spatial separation of at least two metres between the infected patient and other patients and visitors. Special air handling and ventilation are not necessary, and the door may remain open.

**Mask**
In addition to wearing a mask as outlined under “Standard precautions”, wear a mask when working within two metres of the patient (some hospitals may want to require the wearing of a mask to enter the room).

**Patient transport**
Restrict the movement and transport of the patient. If transport or movement is necessary, minimize patient dispersal of droplets by masking the patient.

**Guidelines for safe disposal of the bodies of victims of plague**
The following precautions should be strictly adhered to while handling and disposing of the body of a person who dies due to plague:

- In fatal cases due to suspected plague, a post-mortem should be discouraged.
Funeral ceremonies in the houses of plague victims that may involve the assembly of people should be discouraged.

The dead bodies of plague victims should not be handled or placed in coffins by the relatives or friends of the deceased. This should be done by professional undertakers well versed in the safety procedures.

The undertakers should use masks, protective clothing, boots and thick rubber gloves (personal protective equipment or PPE).

Professionals handling dead bodies should receive chemoprophylaxis in recommended dosages as per medical advice.

A layer of lime as an absorbent material must be placed in the coffins before the dead bodies are placed in them.

The dead body should be packed in an impervious body bag for transport from the place of death and should not be extracted from the bag, and also should not be bathed before cremation/burial.

The bagged body should be placed in a hermetically sealed coffin and buried without re-opening.

The dead body should be buried in a sufficiently deep grave to prevent access by rodents and carnivores.

The garments and other belongings of a patient who dies of bubonic plague in the house must be treated to get rid of the rat fleas by the application of 5% dust formulation of malathion or 10% DDT.

The soiled articles of pneumonic plague victims should be packed in a bag, incinerated, autoclaved or fumigated and properly disposed off by burning.

**Guidelines for disposal of dead rodents during rat fall**

Use a mask of double-folded cloth to cover your face. Dead rats should not be touched by bare hands. Disposable gloves.
or polythene sheeting should be wrapped around the hands to handle the dead rats. The dead rats may be disposed off in the following ways:

- Spray insecticidal dust or powder over the dead rat (6.9.3 residual insecticide spray) and subsequently bury it in one metre deep pit.
- Pick up the dead rat by means of long forceps, long tongs, etc. and put it in a container containing cotton wool soaked in insecticide for final disposal.
- The disposable items used should be burned or buried, and other items utensils should be disinfected.

### 8.7 International Health Regulations (2005) and plague notification

The IHR (2005) require the establishment at WHO and in Member States of real-time event management systems for addressing public health risks and emergencies of international concern, which work alongside the updated permanent and routine IHR environmental and epidemiological provisions. This real-time event management system, already implemented in WHO’s alert and response operations, relies on a variety of sources to identify potential public health emergencies of international concern (PHEIC). These sources include unofficial and confidential notifications by Member States, WHO partners (such as nongovernmental organizations and research institutes) and the media.

The purpose and scope of the IHR (2005) is no longer limited to the notification of specific diseases (as was the case till 2005). States are now required to notify WHO of all events that may constitute public health emergencies of international concern in accordance with the decision instrument.
This decision instrument identifies a limited set of criteria that will assist Member States in deciding whether an event is notifiable to WHO. The criteria are:

- Is the public health impact of the event serious?
- Is the event unusual or unexpected?
- Is there a significant risk of international spread?
- Is there a significant need of international restrictions to travel and trade?

A number of specific diseases are also identified either for immediate notification under the IHR (2005) or for assessment against the criteria given above.

Reports of suspected and confirmed cases from plague-endemic areas are no longer required by the IHR (2005), but cases that occur outside plague-endemic areas or that are likely to pose a threat of spread of the disease to other areas are still reportable.

Plague cases will be notified only if the assessment done by the country show that the public health impact can be considered serious, with at least one of the following characteristics: unusual or unexpected event; risk of international spread; significant risk to international travel; or trade restriction. Thus, the occurrence of a pneumonic plague case in a well-known focus should not be systematically notified. Conversely, the appearance of a bubonic case in a non-endemic region is typically an event to be notified.

Measures applicable to ships, aircraft and land transport arriving from plague areas are specified in the International Health Regulations.

**Support for States Parties**

WHO coordinates the provision of international technical assistance at the request of States Parties in support of activities such as investigating, controlling or containing...
public health risks and emergencies. When requested, WHO will work closely and confidentially with the affected Member State on verification of a public health event and the subsequent assessment of the international risk, as well as any public health measures to be implemented.
During a disease outbreak or epidemic, the media inevitably play a vital role. Because it is news, probably the most important media—and particularly television channels—are bound to report on the disease. Given the competitive nature of media, each channel or newspaper will try to be first with the news and also be on the lookout for new angles to report.

In many countries around the world there exists a troubled relationship between the media and the health sector. The media believe that the national authorities will not reveal the full picture and deliberately underplay any health crisis. The health authorities, on the other hand, fear that the media will exaggerate, misquote and generally “get it wrong” and trigger panic.

Each side should understand that there is a symbiotic relationship between the two. The effort should be to maximize the communication channels to ensure that media received timely, authentic information from a reliable source, and that the media report on it responsibly.

Media has a critical role to play in all phases of a medical emergency. The health sector personnel should strive to understand the structure and processes of media and enable the media to play their role. Efforts to develop media relations over a period of time, rather than at the moment of the outbreak, will go a long way. A close working relationship with the media involving health professionals,
media professionals and health policy-makers, providing multisectoral perspectives, will enable the media to play a constructive role.

The media strategy should have three phases:

- The quiet period (when there is no emergency—a time to build relationships, to demonstrate one’s credibility, and to better understand the media professionals/health sector spokespersons with whom one would interact during an emergency).
- The event: the epidemic/outbreak phase.
- The post-event phase.

All the players have an equal responsibility and role to play during all three phases. The main players are the information sources—the federal/state/district administration, the media—and the information user.

The basic principles are applicable to all communicable diseases.

**Actions to be taken by the health sector:**

**Phase I:** The quiet period (focus on preparedness)

The plan for preparedness must have a well-articulated media strategy. Salient points of such a strategy should include:

**I. Background**

The health sector needs to keep media informed about:

(a) the disease, its history, technical details, etc.
(b) national status of the disease
(c) international perspective
(d) information available on the Web; in information kits, which should be periodically shared with the media; video clips about the disease (process and methodology of its surveillance) and still photographs,
to make reporting easier for the electronic media and the press.

II. Language needs of media to be addressed
Within countries, it is important to ensure that information materials are available in the national and regional languages.

III. Regular media interaction
Besides dispatch of information materials, it is also important to create a rapport with the members of the Press. While some of them will rotate to other news beats, it is useful to get feedback from the end-users of the information. This could be done through the following ways:

   (a) media orientation programmes on communicable disease
   (b) media relations orientation for health sector personnel
   (c) identify and locate responsibility for media preparedness, within Health Ministries and WHO.

IV. Prepare a crisis management plan that includes dealing with the media
Phase 2: The event or disease outbreak:
Once an outbreak has been reported, the media plan should be promptly operationalized. Specific actions should include the following:

   (1) Create a media centre/hub to operate 24 hours a day with a designated spokesperson. The top technical authority on the subject will likely not have time to give a battery of interviews, hence it may be necessary to gather the various media queries, obtain the technical responses, and then revert to the press within their deadlines.

   (2) Prompt designation of a nodal point for information, dissemination/media relations, as well as authoritative spokespersons at district/state/national levels should
be done as appropriate.

(3) It should be expected that the scene of the first occurrence will draw media interest, and one should be prepared to provide correct information.

(4) If the disease is spreading across states/provinces, ensure that different states or provinces do not speak in different voices. It is important that the spokespersons at the central and the sub-central levels have the same information.

(5) Ensure information flow to nodal agencies.

(6) Hold regular media briefings, preferably at pre-announced and fixed times. Accessibility of experts/senior officials is essential. While they cannot answer every media interview request, it is important that they meet the press regularly as a group.

(7) Transparency/candour is vital.

(8) Supplement official briefing with press release.

(9) Activate/update website on daily/weekly depending on outbreak situation.

(10) In most countries, the media, both national and international, operate on a 24-hour, 7-day a week news cycle. Health staff must be prepared to meet this need.

(11) The various media—TV, radio, print, online, wire agencies—have different needs. These individual needs have to be addressed, e.g. giving a printed handout to the visual media will not meet their needs; they will want a “sound bite” from a recognizable authority. Ensure that the spokesperson is clear, articulate and succinct.

(12) Given the normally very short duration of interview excerpts, it is important to decide ahead of a press meet/interview what is the main message to be conveyed, and learn to get it across in 30 seconds or less. A rambling presentation may have the result
that the part featured on the evening television program is the least important.

(13) Guidelines for the media should be in place. If certain information should be embargoed to give government time to put measures into place, the ground rules for the media. Better if these rules are put into writing.

(14) Media looks for different perspectives—disease, causes, health, sanitation and national and international perspectives. Answers should be prepared.

(15) Be ready to field composite teams; set up teams consisting of officials from different sectors.

(16) Provide prompt clarification/correction of misreporting and dispel rumours.

(17) Do not be provoked by uncomfortable questions and negative reports. Respond with positive information.

(18) Do not miss out on media opportunities. News windows are important.

(19) Rehearse for television and prepare for tough questions.

(20) Body language is important. Be aware of how you sit, where you look, etc.

Phase 3

Post-event

(1) Do not disband the information control room or post.

(2) Rehabilitation or post-trauma efforts should be highlighted.

(3) Recurrence prevention steps should be stressed.
Lessons learnt from plague outbreaks

10.1 Plague outbreak in Surat and Beed, Maharashtra (India), 1994

The outbreak of plague in 1994 in India came after a gap of 28 years. The outbreak was initially notified from Mamla village, Beed district, in Maharashtra state. This was preceded by a devastating earthquake in September 1993 in adjoining districts of Latur. The Beed district was known in the past for sylvatic plague. The episode of rat fall and flea nuisance was also notified by the villagers during the first week of August. During the month of August-September 1994, a total of 63 cases of bubonic plague were reported from Mamla and surrounding villages. The aetiological agent from human tissue samples could not be isolated. However, F1 genes of *Y. pestis* were later demonstrated in fleas through PCR, and *Y. pestis* was isolated from the tissues of one rodent, giving laboratory evidence pointing to *Y. pestis* as the causative agent of the outbreak.

Simultaneously, during the third week of September 1994 an outbreak of pneumonic plague was notified in Surat district of Gujarat. A total of 876 cases with 54 deaths due to pneumonic plague took place during that period. The pure culture of *Y. pestis* was obtained in 11 out of 82 pneumonic plague cases.
There was a mass exodus of people from the affected areas. The outbreak affected trade and tourism and unnecessary restrictions on the movements of people were made. The changed epidemiological pattern of disease and delay in diagnosis of disease created uncertainty in the minds of people regarding its diagnosis. The outbreak investigation could not discover the linkages between the simultaneous occurrence of outbreak and the one in Beed and Surat. The Government of India then constituted a high-level technical advisory committee on plague. This episode taught a number of lessons as listed below.

10.2 Pneumonic plague in Shimla district, Himachal Pradesh (India), 2002

The outbreak of plague in Himachal Pradesh during 2002 came after a gap of eight years. The outbreak took place in one village of Shimla district, where a total of 16 cases with 4 deaths were reported during the first half of February 2002. A further four cases with one death due to pneumonitis were also noted among contacts during the second half of February 2002. The investigation began after the first index case had died. The index of suspicion was made by the treating doctor. The diagnosis was further confirmed in the laboratory by isolating *Y. pestis* from three cases. The entomological investigation did not provide evidence of plague activity among rodents and animals in the village. The outbreak was controlled by initiating early treatment, isolation of cases, and tracing of all possible contacts and ensuring their chemoprophylaxis in the least possible time.

**Lesson 1:** Strengthen and maintain continued surveillance.

Surveillance is an important activity for early detection of an outbreak of any communicable disease. The early warning signals of plague need to be identified. Surveillance should
continue in spite of the absence of the disease for a long time. The sudden ecological changes might create a spillover of sylvatic plague into domestic environments.

**Lesson 2:** Establish rapid response mechanisms with trained persons.

The early detection of an outbreak through the surveillance system may help in controlling the further spread of disease only when it is coupled with a rapid response mechanism. There is a need to identify and train a rapid response team in all the districts/provinces to respond to any threat of an outbreak. The rapid response to a situation is possible only when such teams are available at the local level instead of having to be called from state/central headquarters.

**Lesson 3:** Adopt a standard case definition during an outbreak situation.

During an outbreak situation, the case definition to be adopted is very important. Varied and loose case definitions may register large numbers of suspected plague cases. This would create panic in the minds of people and media regarding the seriousness of the situation. It is recommended that standard case definitions of “suspected”, “presumptive” and “confirmed” cases must be adopted during an outbreak situation.

**Lesson 4:** Strengthen laboratory services to make prompt and accurate diagnoses.

During an outbreak situation, prompt action to identify the causative agent is of utmost importance, leaving no scope for controversies. However, the capabilities for identification of plague bacillus were found lacking in the peripheral level during outbreak. Therefore, state/provincial public health laboratories and medical colleges need considerable upgrading of their skills to enable prompt and accurate diagnosis of plague.
Lesson 5: Improve networking of laboratories to utilize available expertise.

Rapid mobilization of institutions and experts around the country can help in the early identification of the causative agent. In this regard, there is a need to strengthen the networking of laboratories so that their expertise can be used quickly.

Lesson 6: Identify and develop a national reference laboratory for plague.

The identification and development of at least one national reference laboratory—high standard and fully equipped, including molecular technique such as PCR is extremely important. A state-of-the-art national reference laboratory will help in confirming (or discounting) an outbreak in the shortest possible time.

Lesson 7: Orient of clinical doctors in endemic states.

The orientation of clinical doctors in the detection of suspected cases and detection of early warning signals of disease may help in mounting a rapid response to an outbreak situation. This can also help in initiating early treatment and control measures to prevent further spread of disease.

Lesson 8: Ensure availability and use of clear guidelines.

Guidelines for community and health professionals should be distributed, covering transportation of dead bodies, quarantine of villages, closing of schools and offices, actions on the part of medical officers and state programme officers, media management, the role of chemoprophylaxis, and the role of rodent and flea control measures.

Lesson 9: Strengthen intersectoral coordination on a permanent basis.

The coordination with other sectors, such as veterinary medicine, the media, and police, should be strengthened
on a continuous basis, which will improve the management of outbreak response.

**Lesson 10:** Allaying public fears through mass education campaigns.

The education of people through media or other modalities during an outbreak situation is crucial. The public should be made aware of “do’s and don’ts” related to the disease so as to take appropriate corrective measures. The regular education of the public during the outbreak builds the confidence of the people.

**Lesson 11:** Judicious handling of media.

The handling of media during an outbreak situation is very important. The media can play a positive role during the episode, and should be used constructively to educate the community in recognizing early warning signals and reporting early if experiencing symptoms. The cooperation of the community can be ensured through judicious handling of the media.

**Lesson 12:** Treat the patient locally.

Experience shows that there is no need to refer patients to higher institutions; otherwise, the number of contacts with the patient will grow so large that it would be difficult to handle chemoprophylaxis for all contacts. The cases should be treated at the site of diagnosis as a probable case to prevent the spread of infection during transportation.

**Lesson 13:** Ensure compliance of chemoprophylaxis.

The mere distribution of chemoprophylactic drugs is no guarantee of usage. Therefore, the immediate close contacts of confirmed cases should be given chemoprophylaxis under supervision. During the outbreak situation, people tend to store medicines unnecessarily. This point should also be taken into consideration, and people should be told that contacts of contacts don’t need chemoprophylaxis.
Lesson 14: Orientation of the medical fraternity during a plague outbreak.

Plague outbreak is a rare event these days and medical professionals may require orientation to understand clinical recognition of plague, infection control strategies and existing emergency response and referral system. The orientation of the medical fraternity during an outbreak situation may allay unnecessary fears among them. The orientation may provide updated guidelines and cover referral support systems available in the area of the outbreak.
References


Further readings


Annex 1

Method to collect bubo pus

Write down patients name on all tubes

1. Disposable and sterile syringe + 18G needle
   - Aspirate all the PBS

2. Gloves, Alcohol pads
   - Wear gloves
   - Desinfect the skin with the alcohol pad
   - Immobilize the bubo

3. Introduce the needle perpendicularly
   - Inject half of the sterile PBS in the bubo and aspirate the pus

4. Harmonize the sample in the eppendorf tube
Annex 2
Instruction for the use of the rapid tests (dipstick)

Materials provided: dipstick in an aluminium foil bag
Equipments necessary for the test but not provided: Test tube, PBS (Phosphate Buffer Saline), disposable pipette, blotting paper, transparent scotch tape, timer.

Step 1: Identification
Put the patient name on the test tube

Step 2: Preparation of the sample
Take 150-200µl pus of bubo or sputum and put in the test tube already labelled
- For the viscous pus, dilute 5 times or 10 times in PBS
- For the sputum, dilute 3 times in PBS

Step 3: Testing procedure
Introduce the dipstick in the test tube containing sample, coloured side up

Step 4: Interpretation
Reading of results between 15 minutes

- **Negative**: 1 pink line (control C)
- **Positive**: 2 pink lines (test T and control C)
- **Ininterpretable**: 0 line

Step 5: Archiving the strip
Dry the strip in a blotting paper
Stick the strip on the patient file by covering it completely with transparent scotch tape. Note the result and relating information to the test (batch).

Caution!
- Put the bag of dipstick at 37 °C or at room temperature before opening
- Take the strip using a pair of forceps at the level of its coloured side.
- Unused tests should be kept preferably at 4 °C in the hermetically sealed aluminium foil bag with the dessicant
- Follow the appropriate precaution for safety when handling infectious material: wear gloves, decontaminate used materials and disposables.
Annex 3

Decision instrument for the assessment and notification of events that may constitute a public health emergency of international concern

Events detected by national surveillance system (see Annex 1)

- A case of the following diseases is unusual or unexpected and may have serious public health impact, and thus shall be notified: Smallpox, Poliomyelitis due to wild-type poliovirus, Human influenza caused by a new subtype, Severe acute respiratory syndrome (SARS).

- Any event of potential international public health concern, including those of unknown causes or sources, and those involving other events or diseases than those listed in the box on the left and the box on the right shall lead to utilization of the algorithm.

- An event involving the following diseases shall always lead to utilization of the algorithm, because they have demonstrated the ability to cause serious public health impact and to spread rapidly internationally:
  - Cholera
  - Pneumonic plague
  - Yellow fever
  - Viral haemorrhagic fevers (Ebola, Lassa, Marburg)
  - West Nile fever
  - Other diseases that are of special national or regional concern, e.g. dengue fever, Rift Valley fever, and meningococcal disease.

Is the public health impact of the event serious?

Is the event unusual or unexpected?

Is there a significant risk of international spread?

Is there a significant risk of international travel or trade restrictions?

EVENT SHALL BE NOTIFIED TO WHO UNDER THE INTERNATIONAL HEALTH REGULATIONS

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*As per WHO case definitions.

The disease list shall be used only for the purposes of these Regulations.
Plague is one of the oldest identifiable diseases known to man which remains endemic in many natural foci around the world, including some countries of the WHO South-East Asia Region. Plague, a vector-borne zoonotic disease, remains a significant public health threat in affected countries and of major concern to the World Health Organization because of its inherent communicability, rapid spread, rapid clinical course, and high mortality if left untreated. The revised International Health Regulations (IHR) 2005, which came into effect in June 2007, require notification to WHO of the occurrence of a suspected case of plague in an area not known to be endemic.

The Operational Guidelines on Plague Surveillance, Diagnosis, Prevention and Control were first published by the WHO South-East Asia Region in 2004. These were revised and updated in the context of new case definitions adopted in 2006 and the enforcement of the IHR (2005). These revised and updated guidelines of 2009 provide comprehensive knowledge and information on plague epidemiology, surveillance, diagnosis, case management and prevention and control, and can be adapted by Member States to suit their technical requirements.