Plague

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Key facts

To better understand public health terms included in this Disease Tool (e.g. What is a case definition? or What is an infectious agent?), consult our page on Key concepts on epidemiology.

Importance

Plague has been associated with several major epidemics and pandemics throughout history and can be a very severe disease in people, with a case fatality ratio of 30 to 60 per cent for the bubonic type, 80 to 90 per cent for the septicaemic plague and almost always fatal for the pneumonic kind when left untreated. Between 2010 and 2015, 3,248 people were infected with plague worldwide, including 584 deaths. Plague is a zoonotic and vector-borne disease found in all continents, except Oceania. Currently, the three most endemic countries are Madagascar, the Democratic Republic of the Congo and Peru. It is caused by the bacteria Yersinia pestis, which is usually found in small mammals and their fleas. Currently, the three most endemic countries are Madagascar, the Democratic Republic of the Congo and Peru.

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Case definition

A **case definition** is a set of uniform criteria used to define a disease for public health surveillance. It enables public health officials to classify and count cases consistently.

The following are standard case definitions to allow national health authorities to interpret data in an international context. However, during an outbreak case definitions may be adapted to the local context and the Red Cross Red Crescent should use those agreed/established by national health authorities. NB: Consider that during community-based surveillance, ***volunteers*** *should use broad (simplified) case definitions (referred to as community case definitions) to recognize most or all possible cases, provide relevant risk communication and appropriate actions and encourage them to seek care. Other actors such as* ***healthcare workers or investigators*** *studying the cause of a disease, on the other hand, can use more specific case definitions that may require laboratory confirmation.*

Clinical description: The clinical presentations and the prognostic are closely linked to the form of plague: disease characterized by rapid onset of fever, chills, headache, severe malaise, prostration, WITH extreme painful swelling of lymph nodes (**bubonic form**) OR cough with blood-stained sputum, chest pain, difficult breathing (**pneumonic form**); both forms can progress to a **septicaemic form** with toxaemia: sepsis without evident buboes rarely occurs.

Laboratory criteria for diagnosis: Confirmation of plague requires laboratory testing. Isolation of *Yersinia*

pestis in cultures from buboes, blood, cerebrospinal fluid (CSF) or sputum OR detecting *specific Yersinia pestis antigen using different techniques.*

Case classification

Suspected: Any person meeting the clinical criteria with at least one epidemiological criteria.

Bubonic plague: Fever AND sudden onset of painful lymphadenitis

OR

Pneumonic plague: Fever AND at least one of the following three:

cough, chest pain, coughing blood.

Probable: Any person meeting the clinical criteria with at least one of the laboratory criteria for a probable case (positive direct fluorescent antibody (DFA) test for *Y. pestis* in clinical specimen OR passive haemagglutination test, with antibody titre of at least 1:10, specific for the F1 antigen of *Y. pestis* as determined by the haemagglutination inhibition test (HI) OR epidemiological link with a confirmed case.)

Confirmed: A suspected or probable case that is laboratory-confirmed.

WHO case definition source of information:
https://www.who.int/docs/default-source/outbreak-toolkit/latest-update---11-october/plague-disease-outbreak-toolbox---25092019.pdf?sfvrsn=71fecab_2
Integrated Diseases Surveillance and Response in the African Region: Technical Guidelines for Integrated Disease Surveillance and Response in the African Region: Third edition | WHO | Regional Office for Africa

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Alert / epidemic threshold

An **alert threshold** is the pre-defined number of alerts that suggest the beginning of a possible disease outbreak and therefore warrant immediate notification.
Epidemic thresholds are the minimum number of cases indicating the beginning of a particular disease's outbreak.

One confirmed case is sufficient to identify potential outbreak, but this needs to be interpreted in context. (e.g. confirmed pulmonary plague case in urban context requires immediate intervention).

Risk factors

- There is a risk of human plague wherever the presence of plague natural foci (the bacteria, an animal reservoir and a vector) and human populations co-exist. For more details see: http://www.who.int/csr/disease/plague/Plague-map-2016.pdf?ua=1)
- Outbreaks of the disease are of particular concern in settings where access to antibiotic treatment and early care is limited, such as in some overcrowded or resource-poor environments
- Lack of appropriate sanitation and hygiene measures, including rodent control. Households where food is not stored appropriately or trash is not managed well are environments that may attract rodents, therefore increasing the risk of transmission in areas where the bacteria are present in rodent populations (endemicity).

- During epizootics (outbreaks of epizootic diseases), humans are at high risk of transmission when rodents die in large numbers, attracting fleas that may afterwards bite humans. When fleas and rodent populations increase, the risk for epizootics increases as well; therefore controlling both flea and rodent host populations is an important prevention strategy.
- Ecological disruptions forcing large numbers of rodents into human populations (e.g. habitat destruction during deforestation, or conflict)
- Pneumonic plague: people in close contact to patients such as caregivers and healthcare workers who do not use correct infection prevention measures are at increased risk.

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Attack rate (AR)

The **attack rate** is the risk of getting a disease during a specific time period (such as during an outbreak).

> ***Attack rates will vary from one outbreak to another. In case of an outbreak, consult the latest information provided by health authorities.***
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> In recent epidemics the secondary attack rate has varied between 14—75 per cent (note different transmission routes for bubonic and pulmonary plague: the attack rate is directly linked to the route of transmission and the form of plague. It is low for **bubonic plague** transmitted through rodents. It can be very high for **pneumonic plague** transmitted from person-to-person.).

Groups at increased risk of severe illness (most vulnerable)

- People with weakened immune systems.
- Immunosuppressed persons such as those receiving chemotherapy, transplant recipients or HIV carriers.
- People with chronic diseases such as renal disease, cancer, chronic lung or liver disease, and diabetes.

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Infectious agent

Infectious agents are bacteria, viruses, fungi, prions and parasites. A disease caused by an infectious agent or its toxic products is defined as an infectious disease.

> *Yersinia pestis* bacterium (*Y. pestis*).
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> **Vector:** fleas, particularly *Xenopsylla cheopis* (oriental rat flea) carrying the bacterium *Y. pestis*.

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Reservoir / host

A **reservoir of infection** is a living organism or material in or on which an infectious agent lives and/or usually multiplies. Reservoirs include humans, animals and the environment.

A **susceptible host** is a person at risk of being infected. The level of susceptibility depends on age, sex, ethnicity and genetic factors, specific immunity also depends on other factors that affect an individual's ability to resist infection or to limit its ability to cause infection.

A **zoonotic disease** or **zoonosis** is an infectious disease that has jumped from a non-human animal to humans.

Zoonotic disease: rodents, some other animals like prairie dogs, squirrels, rabbits, cats.

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How disease is spread (modes of transmission)

Categorisation of **modes of transmission** varies from one agency to another. In addition, some infectious agents can be transmitted by more than one mode. A list of modes of transmission can be found in the key concepts to serve as guidance to better understand the diseases included in this website.

- **Vector-borne:** Bites of infected fleas (typically for bubonic plague, and septicaemic plague), particularly *Xenopsylla cheopis* (Oriental rat flea).
- **Contact transmission:** Over 200 animal species can serve as definitive hosts of infectious bacteria. Touching or skinning infected animals (such as prairie dogs, squirrels, rats and rabbits) (for bubonic plague and septicaemic plague). Some evidence exists that plague can be transmitted by intensive handling of the corpse or carcass.
- **Vehicle-borne transmission:** *Y. pestis* is transmitted to humans via contact with food or household items contaminated with infected animal bodily fluids, or (for pneumonic plague) human respiratory droplets.
- **Droplet spread:** Inhaling respiratory droplets from the cough or sneeze of a person or animal with pneumonic plague.

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Incubation period

This time from when infection occurs to the onset of symptoms is called the **incubation period**. It is a range of days and it can be different for each disease.

- One to seven days for the bubonic plague.
- The incubation period for septicaemic plague is not well defined but likely happens within days of exposure.
- Few hours (as little as 24 hours) for the pneumonic plague.

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Period of infectiousness

Period of infectiousness is the time interval during which an infected person can transmit the infection to other susceptible persons.

Bubonic plague (the most common form) is not transmitted from person to person. Only humans with **pneumonic plague** can transmit the infection to others. Patients with pneumonic plague in the final stages of disease pose the highest risk of infection.

Clinical signs and symptoms

- Sudden onset of fever, chills, head and body aches and weakness, vomiting and nausea.
- **Bubonic plague:** one to two days after, lymph nodes become inflamed, tense and painful; they can turn into open sores with a discharge.
- **Septicaemic plague:** abdominal pain, shock, and possibly bleeding into the skin and other organs. Skin and other tissues may turn black and die, especially the fingers, toes and the nose.
- **Pneumonic plague:** rapidly developing pneumonia with shortness of breath, chest pain, cough and sometimes bloody or watery mucous; it may cause respiratory failure and shock.

Other diseases with similar clinical signs and symptoms

Anthrax, bacterial pneumonia, COVID-19 disease, bacterial sepsis, brucellosis, Rocky Mountain spotted fever and other infections.

Diagnosis

- Identification of *Y. pestis* in a sample of fluid from a buboe (painful swollen lymph nodes), blood or sputum.
- Rapid dipstick tests have been validated for field use to quickly screen for *Y. pestis* antigen in patients.

Vaccine or treatment

Please refer to the appropriate local or international guidelines for clinical management. All clinical management including the administration of any treatment or vaccine should be conducted by health professionals.

- **Pneumonic plague** is invariably fatal unless treated early, but even **bubonic plague** has a case fatality ratio of 30—60 per cent without treatment, so early diagnosis and treatment is essential for survival and the reduction of complications.
- Antibiotics and supportive therapy are effective against plague if patients are diagnosed in time, with a fatality rate of under two per cent.
- Pneumonic plague patients must be isolated and cared for by trained medical staff with personal protective equipment. Prophylaxis should be provided to close contacts of a pneumonic plague patient.

- The World Health Organization (WHO) does not advise vaccination, except for high-risk groups such as laboratory personnel or healthcare workers.

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Immunity

There are two types of immunity:
- **Active immunity** results when exposure to an agent triggers the immune system to produce antibodies to that disease.
- **Passive immunity** is provided when a person is given antibodies to a disease rather than producing them through his or her own immune system.

> Individuals who survived a plague infection are considered to have acquired immunity against subsequent reinfection of *Y. pestis.*

Which interventions are most effective for prevention and control?

The following is a list of activities considered for Red Cross Red Crescent volunteers to take part in. It is not an exhaustive list of all prevention and control activities for the specific disease.

- Communicate risks about the disease or epidemic, not only to share information on prevention and mitigation measures, but also to encourage informed decision-making, positive behaviour change and maintenance of trust in the Red Cross Red Crescent response. This includes the identification of rumours and misinformation around disease—frequent during health emergencies—to manage them appropriately. Volunteers should use the most context-appropriate communication techniques (ranging from social media to face-to-face interactions).
- Community education and engagement activities to encourage the adoption of protective behaviours:
  - Storage of food in rodent-proof containers.
  - Use of raised beds or sleeping areas.
  - Repair and screening of holes or cracks in houses.
  - Use of rat traps.
  - Disposal of rubbish/garbage away from the home.
- Community clean-up campaigns are important to maintain environmental hygiene and may help in identifying animal carcasses or clusters of small animal deaths that could otherwise be a risk. This is important for vector (flea) control.
- To limit or eliminate zoonotic transmission, conduct vector control activities first before rodent control. This is because killing rodents before vectors will cause the fleas to jump to new hosts, and this is to be avoided.
- Rapid detection of cases and encouragement of early health-seeking behaviours at health care centres and treatment units. Early access to antibiotic treatment is key.
- Where plague is endemic, share information with the community about the importance of protecting the skin from flea bites and of avoiding handling animal carcasses.
- People should also avoid direct contact with infected people. Maintain a physical distance of at least one metre between caretakers and sick persons.
- People with pneumonic plague should be isolated to prevent droplet transmission and wear masks if in

presence of other people.

- Healthcare workers and those who care for infected patients should use personal protective equipment. Healthcare workers may also receive chemoprophylaxis as a preventive measure for the duration of exposure to infected patients.
- During outbreaks, regular handwashing with soap and disinfection of large spaces with 10 per cent diluted house bleach (made daily) should be implemented.
- Ensure safe and dignified burials. Some evidence suggests that bodies of people who have died from plague may remain infectious after death. These findings should inform precautions taken by those handling the bodies of persons or animals that died of plague. (https://wwwnc.cdc.gov/eid/article/27/8/20-0136_article).

Which interventions have NO evidence and therefore are NOT recommended?

- During a safe and dignified burial process, spraying of face/chest of bodies of people who have died of pneumonic plague should not be done. Instead, WHO recommends that the area is covered with a disinfectant-soaked piece of cloth.

Epidemic characteristics and RCRC indicators and targets

The first table below includes data that should be gathered from health authorities and relevant non-governmental actors to understand the progress and characteristics of the epidemic in the specific country and area of intervention. The second table includes a list of suggested indicators that can be used for monitoring and evaluating Red Cross Red Crescent activities; wording of indicators may be adapted to specific contexts. Target values for a specific indicator can vary widely from one context to another and therefore managers should define them based on the specific population, area of intervention and programmatic capacity. Exceptionally, some indicators in this website may include target values when these are globally agreed as a standard; e.g. 80 per cent of individuals who slept under an insecticide-treated net (ITN) the previous night—the normative World Health Organization benchmark for universal coverage with ITNs.

Epidemic characteristics and progression
Suspected cases per week (disaggregate by age, sex)
Confirmed cases per week (disaggregate by age, sex)
Case fatality rate
Attack rate

Indicators for Red Cross Red Crescent activities
Number of volunteers trained on a specific topic (e.g. Epidemic Control for Volunteers (ECV); Community-based surveillance (CBS); WASH training; CBHFA training, etc.) ***Numerator*:** Number of volunteers trained Source of information: Training attendance sheets
Suspect cases detected by volunteers who were encouraged to seek healthcare and who arrived at a health facility *(NB. This indicator requires the implementation of a system in collaboration with the health facility, whereby health workers specifically asked the patient how they heard about the service)* ***Numerator:*** Suspect cases detected by volunteers in a determined period preceding this survey (e.g. two weeks) for whom advice or treatment was sought from a health facility ***Denominator:*** Total number of suspect cases in the same period preceding the survey Source of information: Survey If CBS for plague is implemented the indicator may be simpler: ***Numerator:*** No. of alerts raised by Red Cross Red Crescent volunteers confirmed as a positive case ***Denominator:*** No. of alerts raised by Red Cross Red Crescent volunteers through CBS systems
Percentage of people recognizing at least one transmission route and at least one measure for preventing it ***Numerator*:** Total number of people who cited at least one transmission route and at least one measure for preventing it during the survey ***Denominator*:** Total number of people surveyed Source of information: Survey
Please refer to this PDF document for a set of suggested key performance indicators (KPIs) for response operations to diseases that require safe and dignified burials.

See also:

- For Community Engagement and Accountability (CEA) indicators for activities accompanying ECV actions, please refer to: IFRC *CEA toolkit (Tool 7.1: Template CEA logframe, activities and indicators).* Available at: https://www.ifrc.org/document/cea-toolkit
- IFRC (2020) *Safe and Dignified Burial: An Implementation Guide for Field Managers*. Available at: https://www.ifrc.org/document/safe-and-dignified-burial-implementation-guide-field-manager
- IFRC, Norwegian Red Cross, Croix-rouge de Belgique (2022) *Community-based surveillance resources.* Available at: www.cbsrc.org/resources

Impact on other sectors

Sector	Links to the disease
WASH	Proper personal and environmental hygiene and sanitation measures to discourage rodents from entering homes decrease transmission of *Y. pestis*. *Y. pestis* is transmitted to humans via infectious body fluids or contaminated material from rodents and small mammals. Effective prevention measures include storing grains and other food in rodent-proof containers. Pneumonic plague is droplet transmitted; routine handwashing and coughing etiquette are key prevention measures.
Nutrition	Malnutrition increases the risk for severe plague.
Shelter and settlements (including household items)	As infected rodents transmit plague, rodent control is important: this includes raised beds or sleeping areas, use of rat traps and repair of holes or cracks in houses.
Psychosocial support and mental health	Plague is a highly stigmatized disease and can have several negative impacts on psychological, social and emotional aspects of a person's life, apart from its physical effects only. Psychological reactions may include fear of social stigma, anxiety and worry about the outcome, and social withdrawal, among others. Isolation, contact tracing and social distancing in communities are highly stressful situations for people and very challenging psychologically.
Education	If kindergartens and schools do not have the appropriate equipment to control fleas and rodents, like rat traps or rodent-proof containers, the number of rodents and fleas can increase and add transmission risks. Children may then be at risk of getting the disease if attending classes, or at risk of losing out on education if staying at home because of illness. Schools and other facilities dedicated to children and youth can offer an important space for them to engage, mobilize and raise awareness around health education issues. With support, trust and appropriate capacity-building, young people can be effective advocates for the adoption of preventive measures during an epidemic and are those best placed to mobilize their peers.
Livelihoods	Illness leads to reduction in productivity as people may not be able to work due to disease. This can lead to a loss of income due to the reduction in work activity and to the diversion of resources to seek medical treatment.

Resources:

- WHO (2017) *Plague Fact sheets*. Available at: https://www.who.int/news-room/fact-sheets/detail/plague
- Jullien, S., de Silva, N., & Garner, P. (2021). Plague Transmission from Corpses and Carcasses. *Emerging Infectious Diseases*, *27*(8), 2033-2041. https://doi.org/10.3201/eid2708.200136
- WHO (2019) *Integrated Diseases Surveillance and Response in the African Region: Technical Guidelines for Integrated Disease Surveillance and Response in the African Region*: Third edition. WHO Regional Office for Africa. Available at: https://www.afro.who.int/publications/technical-guidelines-integrated-disease-surveillance-and-response-afr

ican-region-third

- WHO (2016) *Global distribution of natural plague foci as of March 2016*. Available at: https://www.who.int/csr/disease/plague/Plague-map-2016.pdf?ua=1
- Pasteur institute Madagascar (2022) French website : *Peste*. Available at: http://www.pasteur.mg/thematique/peste/
- Social Science Analytics Cell (CASS) (2021). *Exploring community dynamics around the plague outbreak in Ituri province, DRC*. Available at: https://www.socialscienceinaction.org/resources/exploring-community-dynamics-around-the-plague-outbreak-in-ituri-province-drc/
- https://www.woah.org/app/uploads/2021/05/yersinia-pestis-infection-with...