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**THE PLAGUE: REGIONAL SITUATION ANALYSIS AND  
MULTISECTORAL METHODS TO FIGHT IT**

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## 1. History of the Plague

Three major pandemics have taken place since the beginning of the Christian era: Justinian's plague, which began in the year 542 and caused an estimate of 100 million deaths; one in 1346, that lasted three centuries and was responsible for approximately 25 million dead and, finally, one in 1894 that lasted until the 1930's. As a result of the last pandemic, natural foci of *Yersinia pestis* were established in South America, Western Africa, South Africa, Madagascar and Indo-China .

Few cases of urban plague have been reported in recent years, but sylvatic plague still persists in some places and causes occasional epidemic outbursts and isolated cases.

In Asia, plague is located in China, Saudi Arabia, Iran, Kazakhstan, India, Mongolia, Indonesia, Nepal and Viet Nam. The latter country has reported 3,104 cases and 124 deaths between 1978 and 1992.

In India, the last plague outbreak —from 26 August to 5 October 1994— accounted for more than 5,000 suspect cases of pneumonic and bubonic plague with 53 deaths. During this outbreak up to 3,701 plague-suspect cases were reported on a single day in the State of Maharashtra.

In Africa, during the 1978-1994 period, 1,536 cases were recorded with 156 deaths (letality rate of 10%). The most affected countries were Madagascar, Mozambique, Zaire, Zimbabwe, Malawi. Other cases were reported from the following endemic areas: Angola, Kenya, Libya, Namibia, South Africa, Tanzania, Uganda.

The last pandemic began in China in the 1860's and appeared in Hong Kong in 1894 and reached the Americas by sea through the United States of America in 1899 and spread throughout the western half of the United States by the end of the 1930's.

The plague appeared in Peru in 1903, affecting the sea ports from which the disease spread to the rest of the country, including the rural areas.

In the following 50 years, 12 of the 24 departments of the country were affected and over 22,000 cases were reported. Fifty per cent of the patients died. After 1953, there were outbreaks of lesser intensity in rural areas of three departments in the northern part of the country: Piura, Lambayeque and Cajamarca. In 1966, epidemic outbreaks caused 678 cases (102 deaths) and in 1984, 51 of the 457 reported victims died. These epidemic outbreaks were located in inter-andean valleys and in places that had not featured this disease during the previous 20/30 years.

The last reported epidemic in Peru started in October 1992. Until December 1994 --i.e., in less than two years-- 2,011 suspect cases were reported with 88 deceased. The epidemic was located in the rural andean areas of Cajamarca, Lambayeque and Piura. In June 1994, the plague reached peri-urban areas with a focus in the district of Morrope, department of Lambayeque.

## 2. Description of the Disease

The plague is a zoonosis that affects rodents and their fleas but it can be transmitted to other mammals and, accidentally, to human beings. The disease's onset is sudden causing acute infection and high fever (39 to 41°C), comprehensively severe condition, anxiety, widespread pain, staggering, mental confusion, prostration, delirium and often lymphadenopathy. In fatal cases, patients die within 24 to 72 hours.

There are three clinical forms of plague: Bubonic plague (the most frequent one) which, in addition to the above-mentioned symptoms features acute and painful swelling of lymphatic ganglion (bubo). This disease is usually focused in the inguinal, axillar and cervical lymph nodes. Septicemic plague, another clinical form of the plague, which appears when there is massive bloodstream invasion by the plague bacilli. Pneumonic plague, which occurs when the massive invasion of plague bacilli allows them to establish themselves in the lungs. Pneumonic plague patients eliminate plague bacilli in saliva by coughing. This pneumonic plague is a public health issue because respiratory droplets may cause localized outbreaks or devastating epidemics.

Untreated bubonic plague may cause a 50% lethality rate, while the septicemic and pneumonic types may be lethal in 100% of the cases .

In the United States of America no cases of direct human-to-human transmission have been reported since 1924. In recent years, 20% of pneumonic plague cases were due to contact with household animals, like the case in California in 1980, when the patient was exposed to a cat affected by pneumonic plague .

In Peru, during the last outbreak, 94% of suspect cases were clinically affected by bubonic plague , 5.3% by septicemic plague , and 0.24% by pneumonic plague . From 2,011 reported cases 158 were confirmed by laboratory test. Most of the reported patients were in the 0 - 14 years of age bracket (55.48%).

## 3. Etiology

*Yersinia pestis*, the plague's etiological agent, is scarcely resistant to physical and chemical agents. It dies promptly at 55°C and after 4 to 5 hours of direct sun exposure.

In 2-3 days it loses viability by simple desiccation, however, it may prove resistant in wet and dark environments such as bone marrow, where it can survive up to 50 days.

#### 4. Forms of Transmission

Plague in humans is most often due to infected flea bites and, occasionally, it may be caused by direct contact of injuries with tissues from infected animals. Person-to-person transmission of the pneumonic plague can be done through inhalation of infectious respiratory droplets. Persons handling cats with plague pneumonia also have been infected after inhalation of infectious aerosols from these animals. However, human patients are most frequently infected under the rodent-flea-person mode. In Peru, human-to-human transmission was proved in only 0.22% of the five pneumonic plague cases recorded during the last outbreak.

#### 5. Reservoirs

Wild rodents are the plague's natural vertebrate reservoirs. In the United States land squirrels, rabbits and hares are described as major plague reservoirs.

In Ecuador, the plague's main vertebrate hosts are: *Rattus rattus* in the highlands and *Rattus rattus alexandrinus* and *Rattus norvegicus* in the coast; and the following native rodent species: *Akodon mollis*, *Oryzomys phaeopus*, *Oryzomys xanthaeolus*, *Phyllotis fruticolus*, and *Sciururs stramineus*.

During the last recorded outbreak in Peru the following rodent species were involved in the plague's area: *Akodon*, *Orizomys*, *Sigmodon*, *Phyllotis*, *Rattus rattus* and *Mus musculus*. The widespread breeding of *Cavia porcellus* (guinea pigs) in households of affected areas is believed to play a major role in the human transmission chain.

Guinea pigs are heavily infected with fleas, especially *Pulex irritans* and *Tiamestus cavicola*. Although *Pulex irritans* is considered to be poor vector of plague, they have been proposed to transmit plague to humans when they are extremely abundant in or near human habitations.

Rodents in Peru present the following characteristics:

Most plague susceptible rodents ("plague rodents") are nocturnal and activity during day hours can be indicative of over-population. Rodents' proliferation is subject to weather conditions, rain, humidity, natural predators, parasites, space availability, shelter, protection, human activities and sufficient quantity and quality of available food.

During the last two plague outbreaks, the above-mentioned conditions were favoured in Peru by natural phenomena like El Niño. A remarkable increase of the rodent population was evident approximately two months before a great mortality occurred among these rodents. These die-offs usually occurs 15-20 days before the appearance of cases in humans; die-offs among household rodents (guinea pigs) also resumed at the same time as cases in humans.

Wild rodents usually nest among shrubs and under "pircas", the stone piles that act as boundaries between houses and farm plots, and the appearance of dead rodents in these areas should serve as a warning of increased human plague risks.

## 6. Vectors

Not all fleas transmit the plague; approximately 200 of the 1,500 flea species in the world have been reportedly linked to the disease.

In Peru, 40 flea species were identified in plague-infected areas. Among these species, the following have been reported to be naturally infected with *Y. pestis*: *Xenopsylla cheopis*, *Pleochaelis dolens*, *Pleochaelis ecuatoris*, *Polygenis litargus*, *Tiamastus cavicola*, *Haplopyllus manconis* and *Polygenes brachinus*.

## 7. Incubation Period

Incubation periods for the bubonic and the pneumonic plague strains last 2-6 and 2-3 days respectively, according to the literature reviewed.

In Peru, the duration of the incubation period was established by observing contacts (friends and relatives) who attended a plague victim's wake. Some of them presented bubonic plague 2-7 days after the wake. The four reported cases of pneumonic plague took place two days after their contact with the pneumonic case.

## 8. Transmissibility

Some fleas can transmit *Y. pestis*, 3-5 days after they became infected and may continue to do so thereafter for days, weeks or months. The etiological agent's survival in fleas has been reported to last for as long as 396 days .

The pneumonic type of plague may be extremely transmissible under hoarding/overcrowding conditions. Cool, humid environments also favor transmission.

## 9. Susceptibility and resistance

Most authorities believe that every person is susceptible to the plague and those who once suffered this disease may be infected once again because they only acquired relative and temporary immunity.

In Peru, 0.30% of the patients (6/2011) suffered two episodes of bubonic plague in a 6-12 month span .

## 10. Plague Control

Sanitary preventive measures should emphasize the reduction of food and shelter for plague-susceptible rodent species by improving: housing conditions, grain crops' protection, and waste disposal. Knowledge of the disease among the population, direct community participation in plague areas, and insecticidal control of fleas and, perhaps, use of rodenticides to control rodent populations will be stressed.

International recommendations for plague control encourage countries to implement the following:

- Sanitary education.
- Periodical studies on the rodent population and its fleas.
- Control of rodents and their fleas in ships, docks and warehouses.
- Possibility of mass vaccination to the people living in high incidence areas and to field and lab personnel handling plague-affected animals.
- Reporting of plague cases.
- Search and treatment.
- Disinfection.
- Disinsectization.
- Rat-extermination.

In Peru, plague control activities were implemented by a Multisectoral Committee for Plague Control, coordinated by the Ministry of Health and formed by the Ministries

of Agriculture, Education, Defense, Industry and Tourism, Fisheries, of the Presidency, Economy; Regional and Local Governments, Universities and Peasant Communities.

The following aspects were considered:

- Sanitary education targeting the population of plague-affected areas. It focused on improving crop and food storage practices, and achieving suitable rubbish disposal methods to avoid peri-domestic rodents' access to food sources.

Considering that the highest incidence of plague was among children, school teachers were involved as promoters to prevent the disease in the school population and their families.

The population was urged to report immediately the presence of dead rodents and of human cases with plague-compatible symptoms to the sanitary authorities of the Ministry of Health and/or Agriculture.

- Periodical studies on the rodent population and its fleas, to assess the control measures' efficiency and to determine which rodent species are acting as plague reservoirs. Sentinel animals --like dogs-- are also instrumental in determining the infectious agent's circulation patterns within a given area and to promptly put control measures in place.
- The World Health Organization describes the possibility of mass vaccination although it is not considered as important as other preventive measures. Plague vaccines do not provide a long-lasting immunity and require 5-6 injections before presumably adequate levels of antibody appear in the vaccine (at least for forwarding inactivated vaccines). Frequent booster doses are required to maintain a presumed immunity. This protection method has not been used in Peru.
- If there are outbreaks, cases must be reported immediately according to the International Sanitary Regulations (1969) third revised edition, 1983, WHO, Geneva, for diseases internationally subject to quarantine (Plague, Cholera, Yellow Fever and Smallpox). In Peru, plague cases are reported within the first 24 hours .
- Search and Treatment. In the presence of plague in an area, search and treatment of cases took place. A seven-day treatment based on Streptomycin, Chloramphenicol and Sulphas was applied to plague patients. Contacts and personnel delivering health services were treated with chemoprophylaxis based on Sulphas and/or Tetracycline during the same period.



Pneumonic plague patients were subject to strict isolation with precautions against respiratory spread of the disease.

The Peruvian experience confirmed the fact that mortality in a plague outbreak is a factor related to the lack of, or untimely health care. The prompt provision of medicines to health centres and posts by the Ministry of Health and the intervention of health promoters in the communities provided immediate case reporting and health care delivery, that contributed to reduce mortality rates.

- Disinfection of sputum, purulent secretions and contaminated objects. The corpses of plague victims must be handled under the most strict asepsis precautions.
- Disinsectization. As fleas are the vectors responsible for plague outbreaks, all households (including linen, and flea-hosting household animals) are fumigated in the infected area, using insecticides of proven efficacy and innocuous to humans .
- In areas affected by plague outbreaks, rat-extermination campaigns are not recommended because released fleas could disseminate the disease. However, in epidemiologically silent areas rat-extermination campaigns may be done if and when total flea elimination is ensured simultaneously or beforehand. It should be stressed, however, that killing rats, without removal of food and shelter is unlikely to result in anything more than a temporary reduction of rodent numbers.

Peru, has taken into consideration the following risk factors in plague outbreaks:

- Sites with a background of plague.
- Environmental changes: e.g. in rainfalls:
  - increase of crops;
  - destruction of dens.
- Increase of wild rodent population.
- Rodents' epizootic (Guinea pigs, wild rodent living in fields or near homes).
- Indiscriminate rat-extermination campaigns.
- Abundance of fleas.

- Breeding of guinea pigs inside households.
- Inappropriate storage of crops.
- Overcrowded and hazardous housing.
- Lack of knowledge on the disease by the population and health personnel.
- Lengthy wakes of plague victims.

#### **11. Centres Cooperating with WHO**

The Centre for Disease Control (CDC) as a WHO Reference Center for plague control and research, cooperates closely with the World Health Organization/Pan American Health Organization, by providing their experts' advisory services on diagnosis, control of vectors and rodents, and by providing the necessary supplies for the institutional capacity building of referral, regional and local laboratories in those countries where plague outbreaks persist.

#### **12. Impact on the Country's Social and Economic Situation**

Besides being a public health issue, the plague is mainly an economic and social problem that affects production and productivity, domestic trade, exports and tourism. Although it demands urgent governmental attention, in the past, health services have fought the consequences of the plague by providing treatment to the epidemic's victims, but the causes of the disease were left untouched.

As long as depressed areas exist, lacking hygiene, health and education, there will always be the danger of suffering the plague and/or other acute diseases capable of producing highly lethal pandemics. The plague reveals the marginalization and poverty of the stricken areas. Other human related factors that foster the disease's appearance and propagation include: the migration process, poor environmental sanitation, deficient food protection practices, low levels of education and information among the population, unhealthy housing conditions, lack of participation of local governments and of the other sectors involved.

Under a comprehensive approach to this issue, the commitment of local authorities and all sectors involved, and the active participation of the community, non-governmental organizations and technical and financial cooperation agencies are definitely required if the plague is to be successfully confronted.