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Persistent Pestilence: The Plague

One of the most well-known and cataclysmic pandemics to have ever afflicted humans, in known history, is the plague. Originating from a bacteria found in infected fleas, and their host animals, the plague is the general disease responsible for all of the known plague pandemics, including the Plague of Justinian (541-542 AD) and the Black Death (1340s AD). The plague is an extremely lethal disease that comes in many forms, depending on the infected area, and offers a fairly low survival rate, making it incredibly virulent and among the most dangerous diseases in the world. Recently, however, the plague is believed to have provided some immunity to another prevalent and lethal affliction, the Human Immunodeficiency Virus, thought to have arisen centuries ago while it wreaked havoc across Europe. Over the millennia since it's the discovery, there have been various techniques and medical paradigms utilized and exercised for plague prevention and treatment, ranging from the humoral system of the medieval era to the scientific system of the modern era.

Plague is an infectious zoonotic disease caused by a bacteria called *Yersinia pestis*, or *Y. pestis* for short. The main vector of the disease are infected fleas, which often inhabit small rodents (which are known as the host species), typically rats and marmots, all of which are capable of transmitting plague to humans via biting; this allows the disease to enter the bloodstream, which is the mode of transmission from the animal vector to humans, as well as to

other animals. It can also be transmitted by handling an infected animal, if the animal is wounded or dead, and its blood enters an open wound, or in some cases by air, if an infected individual coughs or sneezes on a healthy individual, though this is only true for one form of the plague (“What” 15-16; Littman 456, 461).

Although it is often colloquially thought that the plague comes from rats, the bacterium actually originates in the fleas, and is more often transmitted directly by the fleas; it is much less commonly transmitted by the rodents, themselves, although it is certainly possible (“What” 15). The plague can affect up to two hundred mammalian species, including humans, non-human primates, and insectivores, however birds and reptiles appear immune to the disease (Colman 2). However, despite the vast number of species that can be afflicted, it is primarily a rodent’s disease; according to Colman, “*Yersinia pestis*... is most commonly a disease of rodents. Humans serve only as incidental hosts for this zoonotic disease” (1).

While the plague is essentially one disease that is caused by one bacterium, there are multiple forms of the disease that manifest depending on which region of the body is infected by said bacterium. The most common form of plague is bubonic plague, and is the same type that primarily ravaged Europe in the fourteenth century in a pandemic known as the Black Death. This form of plague attacks the lymphatic system, particularly the lymph nodes, which ultimately cause the nodes to become inflamed, swollen, and painful. These swollen nodes were called buboes (which is where the name of the plague originates), and typically appear on the neck, groin, or armpits. Symptoms of bubonic plague initially include chills and a fever, sore throat, and muscle and head aches, and ultimately include seizures, vomiting, diarrhea, and respiratory failure. If treated immediately, there is only a one to fifteen percent chance of death, and without treatment, there is a forty to sixty percent chance of death. (“What” 19).

The second form of plague is referred to as septicemic plague, and occurs when the *Y. pestis* infects the bloodstream. Septicemic plague can form directly as a result of a flea bite, or it can develop as a symptom of bubonic plague. Symptoms of septicemic plague include a high fever, abdominal pain, diarrhea, and vomiting, as well as hemorrhaging through the mouth, nose, or rectum. Extreme hemorrhaging can cause septic shock, which is a drastic, potentially fatal, loss of blood pressure. Another severe symptom of septicemic plague is gangrene, which is the blackening of skin tissue due to the destruction of blood vessels, typically occurring in smaller blood vessels such as in the extremities (hands, feet, arms, and legs) and the nose. This blackening was what led to the naming of the Black Death. This form is much deadlier than the first form; even with treatment, the mortality rate is around forty percent, and without treatment, the mortality rate is one hundred percent (20-21).

The third form of plague is pneumonic plague, and is typically the least common form of plague. It occurs when the bacterium infects the lungs, and is considered the most dangerous form. While the other two forms are transmitted exclusively via a flea (or infected animal) bite, pneumonic plague can be transmitted via fluids, particularly droplets produced from coughing or sneezing. Because of this, the disease can be spread much more easily, and over greater distances, than the other two forms, which is believed to be the reason behind the pandemics. Symptoms of pneumonic plague initially include fatigue, headaches, vomiting, and nausea, and swiftly escalate to high fever, coughing up blood, and difficulty breathing. As the condition continues to worsen, the victim ultimately dies of blood loss and respiratory failure. Much like the septicemic plague, pneumonic plague is always fatal if untreated, though even with treatment, the mortality rate is more than fifty percent, most patients dying before they are even diagnosed (21-22, Littman 461).

It was noted in the Public Broadcasting Service film, *Evolutionary Arms Race*, that the descendants of those who were afflicted with and survived, or who lived through, the plague epidemics (primarily Europeans), have a slight immunity to the Human Immunodeficiency Virus, or HIV. The reason for this is a mutation that is thought to have originated approximately seven hundred years ago in Europe, around the time of the Black Death pandemic. The mutation occurs on the gene designated to CCR5 receptors, which are receptors on macrophage cells (white blood cells). CCR5 receptors are what HIV uses as an entry point into the cells, where it then wreaks havoc on the cells. The mutation eliminates the receptors, effectively eliminating the doorway into the cell, preventing the HIV from entering and infecting the cell. The complete elimination of the receptors occurs only if the individual is homozygous for the mutation; they need a copy from both parents to be completely immune. If they only have one copy (are heterozygous for the mutation), however, they can still contract HIV, although the likelihood is decreased, and the infection is more docile than in individuals who have all of the receptors, meaning they have no copies of the mutation (THE 11-12).

At the time of the pandemics, the primary paradigm of medical thought was based on Humoral pathology, which focuses on a system of balance, particularly relating to the humors in the body. However, the humoral system could not appropriately categorize the plague in terms of a humoral imbalance, so a new theory, the miasmatic theory of disease, became the frontrunner for explaining the pandemic. This theory essentially stated that the disease came from the rancid stench of decaying flesh that circulated around infected individuals. As a preventative measure, parts of the population (typically the wealthy) fled the towns and moved into the countryside where the air was cleaner and the infected were nonexistent. Townsfolk began travelling with flowers or herbs, burned incense, and tightly sealed their doors and windows to prevent the air

from getting inside. This concept is what inspired the well-known outfit of the plague doctors; plague doctors were medical physicians hired by the town to treat individuals infected with the plague, and they wore bird masks with large hollowed beaks filled with aromatic items as a way of combatting the miasma while treating their patients (“What” 47-48, Cipolla 65).

Additionally, plague treatments by physicians during ancient times were based mostly on the Galen therapeutics (which was a derivation of Humoral pathology), and focused on maintain the balance of *naturals*, which were elements, humors, and parts of the body, and *non-naturals*, which were primarily diet, exercise levels, and emotions. Since the plague was considered a ‘hot’ and ‘wet’ disease, it was often treated with ‘cold’ and ‘dry’ substances; foods such as sour pomegranate, citrus fruits, sorrel, and juices were helpful in curing the plague, as well as other herbal remedies to combat the symptoms. Physicians also often implemented theriac, which was an incredibly famous antidote “believed to possess virtually magical powers” (Fabbri 252). Theriac followed the principle that ‘like treats like’, and was initially used as an antidote for snake bites, utilizing the snake’s own skin in part of the concoction. Ultimately, the compound became a universal panacea for anything deemed poisonous, and could contain up to eighty different ingredients, including saffron, cinnamon, and, perhaps most importantly, opium. Theriac was sometimes combined with wine and honey to form a thick electuary (which is a medicinal paste administered orally). Bloodletting using leeches and scalpels, and lancing the buboes with a knife were also thought to help restore the humors and ease the progression of the plague, however the bloodletting simply hastened the patient’s demise, and the lancing did nothing to halt the progression, although it did alleviate some of the pain (“What” 48).

Contemporary treatments for the plague typically begin with the administration of antibiotics, since it is a bacterial disease and antibiotics are often the first form of treatment

administered for bacterial diseases. The go-to drug for most cases is called streptomycin, which interferes with the bacteria's ability to create proteins, which also damages the cell membrane allowing for the antibiotics to destroy the cells easier. The drug gentamycin can also be issued to treat the plague; it is a fairly popular antibacterial antibiotic that slows the growth of, and ultimately killing, bacteria ("Gentamicin" 1). Even if treated immediately, the plague is still a dangerous disease that can cause septic shock and multiple organ failures, even during treatment, making it incredibly lethal ("What" 23-24).

The plague is one of the most virulent and lethal diseases to have afflicted humans; during each of the major pandemics, the plague wiped out hundreds of millions of people, often estimated approximately five thousand to ten thousand people a day. The bacteria, *Yersinia pestis*, acquired from infected fleas and rodents, is a fast-acting time bomb, as symptoms usually begin to show within a few days, and death is often close behind; some patients, especially in the case of pneumonic plague, die before they are even diagnosed. Despite the fact that it is often considered a disease from the Dark Ages, it is still a problem in the twenty first century, having popped up in various places around the world, including China, Madagascar, and the United States (though most of the time the incidence rates are small, however it is still frightening, since it is the plague). Nowadays, advancements in scientific medicine and biology have given rise to better treatments, namely antibiotics, so much of the world is relatively safe, and the chances of another plague pandemic are slight. Regardless, the plague is not something to be taken lightly, and it is probably best to avoid places with high rat populations, just to be on the safe side.

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