Name

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Tuberculosis

9 April 2019

Tuberculosis

**Taxonomy:**

Binomial name of tuberculosis is Mycobacterium tuberculosis. Mycobacterium tuberculosis is one of the species of pathogenic bacteria. Pathogenic bacteria classified into the family known as Mycobacteriaceae. Tuberculosis was first discovered by Robert Koch in 1882. Mycobacterium tuberculosis bacteria form colonies and clusters. There are four species in total collectively regarded as Mycobacterium tuberculosis. The four species are named as Mycobacterium tuberculosis, Mycobacterium africanum, Mycobacterium bovis, and Mycobacterium microti. All four species grouped into Mycobacterium tuberculosis based on 88 characteristics (Organization, *Global Tuberculosis Report 2018*). Due to no clear differences between the four species they are placed into a single cluster known as Mycobacterium tuberculosis. The following table shows the scientific classification of Mycobacterium tuberculosis;

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| --- | --- |
| Kingdom | Bacteria |
| Subkingdom | Posibacteria |
| Phylum | Actinobacteria |
| Subclass | Actinobacteridae |
| Order | Actinomycetales |
| Suborder | Corynebaterineae |
| Family | Mycobacteriaceae |
| Genus | Mycobacterium |
| Species | Mycobacterium Tuberculosis |

There are 159 strains of Mycobacterium tuberculosis. Two subclusters are formed within the main cluster, where some strains are not entirely belonging to the single subcluster. One subcluster contains only Mycobacterium tuberculosis except two of its strains. The second subcluster contains Mycobacterium bovis, Mycobacterium africanum strains only. The sub-cluster classifications are also known as subspecies respectively named as subspecies tuberculosis and bovis (Organization, *WHO Treatment Guidelines for Drug-Resistant Tuberculosis*). An intermediate subcluster or subspecies group was also observed by the researchers that contain strains of tuberculosis not relevant to any of the subspecies. Isolated strains of tuberculosis discovered in 1970 to 1985 were found to have lower resistance to thiophene-2-carboxylic acid hydrazide as compared to the tuberculosis strains discovered earlier (Getahun et al.). These isolated strains of tuberculosis also found to have a stronger arylsulfatase activity as compared to the previously discovered stains of the same subcluster. In earlier classifications, all of the three subspecies of tuberculosis were considered to be distinct species. However, on serological basis all of the three groups unified into single species known as tuberculosis or Mycobacterium tuberculosis.

**Main Characteristics:**

Tuberculosis is a well-known infection that is caused by the aerobic bacterium Mycobacterium tuberculosis which is a rod-shaped and non-spore forming bacteria. Mycobacteria have a typical measure of 0.5 micrometers by 3 micrometers. They are classified as acid-fast bacilli. Structure of their cell wall is unique in many ways and is responsible for their survival in extreme conditions. Mycolic acid is found to be present in the cell wall of Mycobacterium tuberculosis in considerable amounts along with other fatty acids (Lönnroth et al.). Mycolic fatty acid is covalently attached to the peptidoglycan-bound polysaccharide arabinogalactan. The layer form a lipid barrier in the cell that is responsible for special characteristics of tuberculosis bacteria. The lipoid barrier formed in cell wall is considered to be responsible for physiologically challenging characteristics of tuberculosis. Resistance to the antibiotics and formation of host defense mechanisms are subject to the presence of this lipid within cell wall structure.

Composition and quantity of various fatty acids and other components information of cell wall of the bacteria affect the virulence and growth of the bacteria as well. Peptidoglycan polymer is responsible for the rigidity of the cell wall that is only external to bacteria. A carbohydrate structural antigen known as lipoarabinomannan is present external to the cell wall. It is responsible for survival of Mycobacterium tuberculosis in macrophages. Primarily tuberculosis spread by small airborne droplets that are generated by coughing or sneezing of a person having pulmonary or laryngeal tuberculosis (Cadena et al.). These microdroplets can stay in the atmosphere for minutes to hours depending on various conditions. The factor influencing the transmission of tuberculosis bacteria are known as the number of bacilli in the droplet released, exposure of the bacilli to ultraviolet light sources, virulence of the bacilli, etc. Presence of Mycobacterium tuberculosis into the lungs leads to severe infections in the respiratory system. When a person inhales the droplets they settle usually in upper parts of the airway. Majority of tuberculosis bacteria is trapped in the mucus-secreting goblet cells (Houben and Dodd). However, the bacilli can spread to other organs as well such as lymphatic, pleura, meninges, and can cause extra-pulmonary tuberculosis.

**Pathogenicity:**

Tuberculosis infection transfer happens when a person inhales droplet nuclei that contain the bacilli of tuberculosis. After inhaling the infected droplet the bacilli reaches the alveoli of the lungs. After reaching the alveoli the tubercle bacilli then ingested by the alveolar macrophages. Most of the tubercle bacilli are destroyed in the macrophages but a small number of bacilli can multiply intracellularly. Which are released when the macrophages die. If they are able to survive the lifetime of macrophages then they are free to infect lymphatic channels or body level spreading with bloodstream (Walters et al.). Tuberculosis bacilli prefer to infect the parts of the body more prone to the development of tuberculosis disease. Within two to eight weeks of their release from macrophages of alveoli, the reaction from the immune system is triggered against the tubercle bacilli.

As the immune system reaction increases, the tubercle bacilli then surrounded by the macrophages forming a shell around them. The barrier shell formed by macrophages to contain tubercle bacilli is also known as granuloma. The granuloma is responsible to keep the tubercle bacilli under control. However, due to various supporting factors and medical conditions if the immune system is unable to contain and keep the tubercle bacilli under control then they begin to multiply rapidly. The process can occur in different parts of the body including bones, brain, and lungs. Such spread of the tubercle bacilli is known as the extrapulmonary spread. An extrapulmonary spread of tubercle bacilli happens due to the ability of the Mycobacterium tuberculosis to survive within mononuclear phagocytes (Zak et al.). Mycobacterium tuberculosis is capable of invading lymph nodes and spread to other parts of the body such as brain, bone marrow, kidneys via hematogenous routes.

People having tubercle bacilli in contained form present in their bodies are not considered to have a tuberculosis disease until they are able to conation the tubercle bacilli. Once, the immune system is failed to contain tubercle bacilli, then cases of tuberculosis develop complications. That is also known as the transformation of the bacteria from LTBI stage to the TB stage. The transition of LTBI to TB can occur at any stage. It may happen immediately if the person is suffering from immune deficiency or can take years to spread in the body. The persons having tuberculosis (TB) can spread the disease to other persons through coughing and sneezing.

**Epidemiology:**

Tuberculosis disease was considered to be an epidemic in earlier medical history. With the improvement in living standards and healthcare facilities, the disease is not that much fatal at all. In 1940, effective medical treatment of the disease was introduced known as streptomycin. After the introduction of streptomycin and its adoption in medical treatment facilities helped in reduction of tuberculosis patients in the United States. There was a decline in the number of people affected with tubercle bacilli from 126,000 to 22,000 during 1944 to 2004, despite the enormous growth in population from 140 million to 226 million as well (Glaziou et al.). Currently, the tuberculosis is of an all-time low in the United States of America. Healthcare providers and designated bodies have reported an annual decrease of 61 percent in the prevalence of tuberculosis disease.

During the year 2011, it was observed that only 3.4 cases of tuberculosis were reported per 100,000 persons that shows a 5.8 percent decrease in an overall number of tuberculosis cases as compared to the situation in 2010. The states of Florida, California, New York, and Texas were responsible for half of the tuberculosis cases reported during 2011. Registered foreigners residing in the United States constituted 62 percent of the total cases in 2011. Based on the ethnic and racial groups’ classifications the largest affected population was of Asian origin that accounted for 30% (Wallis and Hafner). African Americans, on the other hand, accounted for 39% for United States origin population. According to the world health organization, there were more than one out of every three individuals infected with tuberculosis bacteria.

As per the data collected and made available by the world health organization, there were 8.8 million cases of tuberculosis worldwide during 2010. There were almost 1.1 million deaths from tuberculosis with human immune deficiency virus tested negative and 0.35 million deaths from tuberculosis with human immune deficiency virus tested positive. The data further revealed that during 2009, almost 10 million children across the globe suffered orphanage due to the deaths of their parents from tuberculosis (Lu et al.). The countries most affected by the tuberculosis disease were Pakistan, India, China, Indonesia, and South Africa. It is a fact that the prevalence of tuberculosis has declined in both genders across the globe. However, it has been observed that tuberculosis rates decline in women with age but an increase in men with age. In some countries, it has been observed that men have more positive results in tuberculin skin test as compared to women. The reasons for such anomalies may be social or regional rather than biological.

**Diseases and treatments:**

Tuberculosis disease is caused by the bacteria known as Mycobacterium tuberculosis. Tuberculosis can be fatal if not treated appropriately. According to the world health organization, almost 13 million people are suffering from tuberculosis and 1.5 million people die of tuberculosis every year. TB usually affects the lungs and respiratory systems. However, in some cases, the bacterial infection can also spread in extrapulmonary systems such as bones and genitourinary systems. When a person suffering from TB coughs the bacteria can be transferred to a healthy person through small droplets having the bacteria (Mishra et al.). Most of the time single contact with the droplet containing the tubercle bacilli do not cause the disease because a small fraction of it can be effectively contained by the immune system of the body. However, repeated contact with the person already sick with tuberculosis can infect the healthy person as well.

The initial symptoms of pulmonary TB are vague in nature. Therefore, a person having active tubercle bacilli in respiratory system may not notice anything wrong at first and may suffer severe conditions later in time. Symptoms can include weight loss, coughs, sneezes, and fever, etc. Although the bacteria transmits to healthy persons through microscopic droplets some people are at greater risk of catching the disease (Skoura et al.). People having direct or repeated contact with the patient, people with human immune deficiency virus, diabetes patients, and malnourished people are at high risk of getting infected with tuberculosis. Purified protein derivative test or the abnormal chest x-ray may reveal a TB infection.

As the tuberculosis is a slow-growing organism the treatment of TB requires a combination of medicines for a long time. Appropriate antibiotic treatment can cure TB. A combination of antibiotic drugs is used to cure the TB and continued for at least six months. Some strains of the tuberculosis are resistant to antibiotics and complicate the treatment of the disease. Multidrug-resistant TB is not curable through most effective antibiotic drugs as well and requires extensive chemotherapy for complete treatment. Second-line anti TB drugs are used for chemotherapy in such cases. In recent years a new form of extensive drug-resistant TB has emerged that can turn into a fatal stage within a few weeks. TB is a completely preventable disease. The spread of TB can be controlled by isolating the patients from the rest of the people and appropriate ventilation. In countries with high rates of TB the infants are required for BCG vaccine by the world health organization.

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