TUBERCULOSIS: AN OVERVIEW

Amit Gupta*, Arsh Singh, Simran Srivastava, Dr. Mandakini Sharma**

Department of Life Sciences (Biotechnology), Graphic Era Deemed to be University, Dehradun
**Associate Professor, Department of Visual Arts, Graphic Era Hill University, Dehradun,
Uttarakhand, India

ABSTRACT
Tuberculosis or commonly called TB is a bacterial illness that typically targets our lungs. It can also infect some other parts of the body like the spinal cord and brain. It is caused by a bacterial species known as Mycobacterium tuberculosis (MTB). In the pulmonary infection which is the most common one, the patient suffers from cold and flu like symptoms and can spread the infection through micro droplets expelled during speaking coughing and sneezing. It is a highly infectious disease and is diagnosed with sampling/culturing of bodily fluids. In some cases, patients showed symptoms but it may not be suffered from TB infection, known as latent tuberculosis. Roughly 10 percent of active diseases emerge from latent infections, which, if untreated, cause the death of about 50% of those who are infected. Chronic cough with blood-coloured sputum, fever, excessive sweating, and loss of weight are classic indicators of active TB. Because the condition is linked to weight loss, it was formerly referred to as consumption. In this study, we give the overall view of TB in terms of its signs and symptoms, transmission, pathogenesis, diagnosis, and prevention.

Keywords: Tuberculosis; pulmonary; infection; disease; prevention

INTRODUCTION
Mycobacterium tuberculosis (MTB), a tiny, aerobic, nonmotile bacillus, is the primary cause of TB. The high lipid composition of this bacterium accounts for several of its distinctive clinical features. When compared to other bacteria, which typically multiply in less than an hour, it divides at an incredibly sluggish rate every 16 to 20 hours. Mycobacteria contain a lipid bilayer in their outer membrane. Because it has a significant mycolic acid and lipid composition of its cell wall, MTB either stains extremely faintly "Gram-positive" or it does not absorb dye when stained. MTB is resistant to weak disinfectants and can endure weeks of dryness. MTB could be grown outside of the host organism's cells, which is how the bacterium grows naturally, but it can also be grown in the laboratory [1-3]. MTB can be recognized under a microscope by scientists using histology dyes on expectorated samples of phlegm (also known as sputum). MTB is categorised as an acid-fast bacillus because it retains specific dyes despite being treated with an acidic solution. The Ziehl-Neelsen stain and the Kinyoun dye are the two most used methods for acid-fast staining. Both dyes i.e. acid-fast bacilli and vivid red which stands out from a blue background. Additionally, employed are auramine-rhodamine staining as well as fluorescence microscopy [4-6].

Four more mycobacteria that cause TB are part of the MTB complex: M. africanum, M. bovis, M. microti, and M. canetti. M. africanum is a rare but important agent of tuberculosis in several parts of
Africa. *M. bovis* was originally a prevalent trigger of tuberculosis, but since pasteurised milk was introduced, this condition has all but disappeared as a public health issue in developed nations. Although a few instances have been reported among African immigrants, *M. canetti* is an uncommon disease that appears to be exclusive to the Horn of Africa. *M. microti* too is uncommon and nearly exclusively found in immunocompromised individuals, albeit its frequency may be greatly overestimated. The pathogenic mycobacteria *M. kansasii*, *M. avium*, and *M. leprae* are among the others. Non-tuberculous mycobacteria (NTM) or atypical mycobacteria are the terms used to describe the latter two species. Neither *TB* nor leprosy is caused by NTM, however they do produce lung conditions that resemble TB [7-9].

A wide variety of symptoms can result from infection in other organs. A patient who have potent TB disease in their pulmonary, speak, sneeze, spit, or cough can transmit the disease to others through the air. Latent TB carriers do not disseminate the illness. Persons with HIV/AIDS and those who smoke are more likely to have an active infection. Active TB is diagnosed by chest X-rays, microscopic examination, and culture of body fluids. Blood tests or tuberculin skin tests (TST) are used to diagnose latent TB. According to estimates from 2018, latent TB infection affected one-fourth of the global population. Every year, 1% of the community develops new illnesses. With 1.5 million deaths and an anticipated 10 million new cases of active TB in 2020, it overtook COVID-19 as the second greatest cause of infectious death [3-7].

**SIGNS AND SYMPTOMS**

Although it can affect any region of the body, the lungs are where it most frequently manifests itself (known as pulmonary TB). On the basis of infection, TB is divided into extrapulmonary TB (when TB originates on the exterior side of the lungs) and pulmonary TB. Flu, appetite loss, night sweats, chills, weight loss, and exhaustion are just a few of the general warning signs and symptoms [10-12]. There could also be significant nail clubbing.

**Pulmonary**- When a mycobacteria infection somehow becomes active, the lungs are typically affected. Heartburn and a protracted cough that produces sputum are examples of symptoms. 25% of folks could not be exhibiting any signs (i.e. they remain asymptomatic). Rarely, the infection may eat into the pulmonary artery, and sometimes people may cough up a small amount of blood. The uppermost portions of the lungs may experience severe scarring from tuberculosis and develop into a chronic condition. More often than the lower ones, the higher lung lobes are affected by tuberculosis. It's unclear why this disparity exists. It might be a result of improved airflow or inadequate lymph drainage in the higher lungs lobes.

**Extrapulmonary**- In active instances (15-20%), the infection mainly escalated on the exterior side of the lungs, originate different kinds of TB. Young children and those with compromised immune systems are particularly susceptible to extrapulmonary TB. This happens in much more than 50 percent of cases among people with HIV. Other notable extrapulmonary infection spot or area together with the genitourinary system (in urogenital TB), the lymphatic system (in scrofula of the neck), the pleura (in tuberculous pleurisy), the central nervous system (in tuberculous meningitis), and the bones and joints (in Pott disease of the spine). "Disseminated TB," commonly referred to as "military TB," is a possibly deadlier, widespread form of TB. Currently, 10 percent of extrapulmonary cases of TB are mild.
TRANSMISSION
Patient with an active pulmonary TB in which the symptoms are being expressed release infectious 0.5 to 5.0 m diameter aerosol droplets when they cough, sneeze, speak, sing, or spit. Approximately 40,000 droplets can be released after a single sneeze. Since tuberculosis has a relatively low infectious dosage, even the inhalation of a single droplet can cause an infection as Inhalation of only 10 bacterias can cause an infection. An estimated 22% of those who have extended, often, or direct touch with TB patients are at a very high risk of contracting the disease. Each year, a person who has active tuberculosis who is not receiving treatment may infect 10 to 15 other persons. Just those with active TB are ought to communicate the illness; others with latent infection are not considered to be infectious. The factors that affects the likelihood of the infection advancing from one person to another are efficiency of the ventilation, amount of release of aerosol droplets the carrier exhales, extent of contact, resistance of the healthy individual and lethality of the bacterial strain. By separating and containing patients who have active ("overt") TB and putting them on TB treatment regimens. Individuals with less resistant active ailments normally don't stay infectious following fourteen days of successful treatment. Assuming somebody gets the infection, it ordinarily takes around three to about a month for that person to become infectious enough to spread it to others [10-14].

PATHOGENESIS
There is a 10% chance that a symptom-less or latent infection will develop into an overt, active tuberculous disease in the 90% of people who have MTB infections (also known as LTBI). HIV-positive people have a nearly 10% annual probability of developing active TB. Active TB infections have a fatality rate of up to 66% if proper treatment is not provided. At the point when mycobacteria invade the lung's alveolar air sacs, they attack and increase in number in the endosomes of alveolar macrophages, that is the point when TB infects the body. Macrophages perceive the bacterium as being a foreign body and try to phagocytose it. Simultaneously, the macrophage encases the bacterium and momentarily stores it in a phagosome i.e. a layer bound vesicle. A phagolysosome is created once the phagosome combines with a lysosome. The cell attempts to kill the bacterium in the phagolysosome by utilizing Lysis enzymes and ROS or reactive oxygen species. However, MTB has a waxy molic acid capsule which is thick that protects it from the toxins. In the macrophage, the bacterium multiplies and in the end obliterate the immune cell. The upper portion of the lower lobe or the lower portion of the upper lobe are typically home to the Ghon focus, the predominant source of disease in the lungs. Lung tuberculosis can also develop as a result of bloodstream infection. The top of the lung is often where one may locate a Simon focus. Additionally, this hematogenous transmission has the potential to disseminate the infection to more remote locations, including the bones, kidneys, brain, and peripheral lymph nodes. The disease can affect any region of the body, but for unexplained reasons, it hardly affects the thyroid, pancreas, skeletal muscles, or heart. The TB bacteria can travel throughout the body and create several sites of infection if they are able to enter the bloodstream through a site of damaged tissue. These sites of infection will all show as little, white tubercles in the tissues. Miliary tuberculosis is the name for this extreme condition of TB disease, which is particularly prevalent in young youngsters and individuals with HIV. Even with treatment, the mortality rate for those with severe disseminated TB is significant (about 30%) [9-15].

DIAGNOSIS
It is challenging to diagnose active TB just based on signs and symptoms, and it is even more challenging to diagnose the illness in those with compromised immune systems. However, people who exhibit symptoms of lung disease or persistent constitutional symptoms longer than two weeks should be evaluated for TB. As part of the first evaluation, an X-ray of the chest and several cultures of sputum for acid-fast bacteria are frequently performed. In the majority of the developing world, interferon-release assays and tuberculin skin tests are not very useful. Similar restrictions apply to interferon gamma release tests (IGRA) in HIV-positive individuals. Finding MTB in a medical sample data in a conclusive diagnosis of TB (e.g., sputum, tissue biopsy, or a pus). For blood or sputum culture, the challenging culture procedure for this slowly growing organism, however, can take two to six weeks. As a result, treatment frequently starts before cultures are verified [8-12].

PREVENTION
Infant immunization campaigns and the identification and effective therapy of active cases are the mainstays of efforts to prevent and control TB. With better treatment plans and a slight drop in case numbers, the World Health Organization (WHO) has had some success. Some nations have laws allowing for the involuntary detention, examination, and treatment of anyone suspected of having tuberculosis. Bacillus Calmette-Guérin is the sole vaccination that is available as of 2021. It lowers the likelihood of infection in children by 20% and the chance of infection developing into an active disease by about 60%. With far more than 90 percent of all children receiving it, it is the vaccination that is used the most frequently worldwide. After roughly ten years, the immunity it creates starts to decline. In Western Europe, the majority of Canada, and the United States, TB is rare, hence BCG is only given to persons who are at high risk. The fact that the vaccine produces the tuberculin skin test erroneously positive and reduces the test's effectiveness as a screening tool is one of the arguments against its usage. There are numerous vaccinations being developed. In addition to the BCG injection, the intradermal MVA85A vaccination is ineffective at preventing TB [7-12].

TREATMENT
Antibiotics are used during TB treatment to eradicate the bacterium. Due to the unique shape and chemical makeup of the mycobacterial cell wall, which obstructs medication penetration and renders many antibiotics useless, effective TB treatment is challenging. To lessen the chance that the bacteria will develop antibiotic resistance, it is better to treat active TB using mixtures of several antibiotics. As of 2007, the benefits of routinely substituting rifabutin for rifampicin in HIV-positive TB patients are uncertain. Isoniazid, rifampin, or a combination/mixture of isoniazid and either rifampicin or rifapentine are used to treat latent TB. Based on the medications taken, the course of treatment can last three to nine months. Latent infections in people are treated to stop them from progressing into active TB illness in the future. The percentages of latent tuberculosis therapy completion may be increased through counselling or education [8-13].

VACCINE
The immune reaction against tuberculosis depends, to a limited extent, on CD4+ Lymphocytes. Defensive immunizations desired the acceptance of antigen-specific CD4+ T cells by mycobacterial peptides introduced by MHC class-II in infested macrophages. Recognition of MTB complex antigens which are displayed by the MHC molecules present in infected macrophages speed up the vaccine development to amplified and elevate the protective efficacy induced by BCG vaccination. Results from clinical preliminaries with BCG, are not steady, have regardless given verification of-
rule that immunization can be viable against the outcomes of contamination with MTB. In this way, in spite of the fact that protection from TB is to some extent a property of the host-interceded safe reaction, in individuals not normally safe, immunization could give an extra level of security. Since mycobacterial cell wall amalgamation is created by Mycol-transfease, Antigen 85B (Ag85B) is a secretory and immunogenic protein of MTB and BCG with mycolyl-transferase activity. M. Horwitz’s group at UCLA has developed rBCG30, which is a TB vaccine candidate that Up-regulates Ag85B and provides greater protection in contrast with parental BCG strain in preclinical (animal model) studies. More than 30 healthy adult volunteers participated in a Stage I clinical trial of rBCG30 without experiencing any significant health problems [11-15].

REFERENCES