An Extensive Review of Tuberculosis Disease

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Abstract

Tuberculosis is a highly contagious illness caused by the bacterium Mycobacterium tuberculosis. It remains a major global public health issue. As one of the oldest known human diseases, tuberculosis still causes a substantial number of deaths, primarily in low-income and vulnerable communities. The World Health Organization classifies TB as one of the leading causes of death from infectious diseases, ranking it second to HIV/AIDS. The Indian National Strategic Plan for Tuberculosis Elimination (2017–2025) aims to eradicate TB by 2025, highlighting the need for increased awareness, rapid diagnosis, and proper treatment.

This review offers a fundamental overview of tuberculosis, covering its background, spread patterns, cause, immune reaction, and disease-linked risk factors. Both primary and secondary/ post primary types of TB are examined. The article also outlines commonly used diagnostic tests and provides simplified methods for diagnosing various forms of the disease.

Keywords include: Diagnostic, Immune Response, Mycobacterium tuberculosis, Post Primary, Pulmonary, Vulnerable.

I.INTRODUCTION

A respiratory infectious disease, tuberculosis (TB), caused by the slow-growing bacterium Mycobacterium tuberculosis, originated from a soil bacterium over 10,000 years ago. TB is the single largest infectious disease globally, with nearly 32% of the world's population infected with it. Approximately 8 million infected individuals develop active TB, with nearly 2 million of these dying from the disease annually, and 95% of new TB cases occurring in developing countries each year [6],[7],[10],[27]. This disease is associated with crowded populations, inadequate nutrition, and unsanitary conditions [5]. Every minute,

one person loses their life to tuberculosis [20].

II. TYPES OF TUBERCULOSIS DISEASE

A. Primary Tuberculosis:

Initially, the Tuberculosis bacterium presented without apparent symptoms. Occasionally, the bacterium remains in a dormant state, but if a patient's immune system remains continuously weakened, the mycobacterium will multiply, resulting in the progression to the next stage of tuberculosis.

B. Secondary/ Post-Primary Tuberculosis:

Characteristically, the reactivated stage of Tuberculosis is marked by a patient's history of a preceding Tuberculosis infection. The reactivation of the tubercle bacilli happens when the body's immune system is weakened, a scenario that parallels the aging process [4].

III.EPIDEMOLOGY

Roughly one-third of the global population is infected with Mycobacterium tuberculosis, with only around 10% of those individuals progressing to develop active tuberculosis at some point in their lives [1]. In 2017, a total of 10.4 million tuberculosis cases were reported globally, corresponding to an incidence rate of 133 cases per 100,000 population. Most cases of the disease occurred among adults aged 15 years and older, with 90% of them, 64% of whom were male, and 9% being individuals with HIV, the majority of whom (72%) resided in Africa. Additionally, in 2013, Extra pulmonary TB (EPTB) accounted for approximately 0.8 million new cases worldwide, with India reporting the largest portion at 0.35 million cases [31]. EPTB cases in India occur in 50% of individuals who are HIV-positive patients stated by the Revised National Tuberculosis Control Programme (RNTCP).

Between 15 and 20 percent of individuals without HIV. In India, the most frequently occurring sites of EPTB are lymph nodes (47%), the pleural space (30%), the abdomen (10%), bones and joints (8%), and the central nervous system (2%).

IV.PATHOGENESIS

Tuberculosis is transmitted through airborne Mycobacterium Tuberculosis bacteria that are expelled into the atmosphere when an individual with active TB coughs, sneezes, yells, or sings. When someone else breathes in this polluted air, the bacteria move into the smaller airways and alveoli, which are generally located near the top of the lungs. At the site of infection, the bacteria multiply, resulting in a reaction from the immune system,

especially T-lymphocytes, which causes macrophages to collect and form tubercles [6],[13].

Bacteria can subsequently spread through the lymphatic system and bloodstream to other areas of the body. These infections frequently affect the liver, spleen, lymph nodes, the upper parts of the lungs, the kidney cortex, and developing bones. As the infection progresses, small infection sites form in various parts of the body. People without health problems can breathe in or have the patient swallow the bacteria, which could infect the trachea, larynx, or bronchi. Tuberculosis is more likely to spread in densely populated areas where individuals and communities practice substandard personal and public hygiene [10], [33].

V.SYMPTOMS OF TUBERCULOSIS DISEASE

Investigations revealed that numerous participants

considered tuberculosis to be an infectious lung condition characterised by symptoms such as cough, weakness, night sweats, fever, chill, fatigue, and weight loss; in contrast, a minority mistakenly believed that asymptomatic latent infection is unattainable [3].

VI.IMMUNOLOGY

MTB immunity is not transferable to animals through immune serum; rather it is conveyed through CD4 T lymphocytes. It appears that the activation of macrophages by T lymphocytes serves as the primary method of protection against Mycobacterium tuberculosis (MTB). In the proximal draining lymph nodes, dendritic cells activate native T cells, with DCs also surveying loose connective tissue and areas near airways and blood vessels. Lipoarabinomannan (LAM), a mycobacterial-specific lipoglycan, gains entry by binding to a dendritic cell receptor. LAM's lipoid adjuvant activates antigen-presenting cells through toll-like receptor-2 (TLR-2). In the final stages, both dendritic cells (DCs) and antigen-presenting cells (APCs) initiate the activation of T lymphocytes, after which memory CD4 and CD8 T cells assume a central role in the immune response against MTB. CD4 and CD8 cells can eliminate intracellular MTB through the release of cytolytic molecules, including granulysin and perforin, as well as chemokines, such as CCL5, which draws in infected macrophages.

Part of the innate immune system, natural killer cells have bactericidal properties that target Mycobacterium tuberculosis. Activated T lymphocytes release

interferon-gamma, tumour necrosis factor-alpha, and interleukin-2, which subsequently activate other resting cells. monocytes /macrophages. Interferon-gamma also boosts the production of tumour necrosis factor, toxic oxygen species, and nitric oxide in macrophages. The containment of MTB is effectively achieved through the formation of granulomas[15].

VII.RISKS OF TUBERCULOSIS DISEASE

A. Risk of Infection:

The risk of a person contracting tuberculosis following exposure to an infected individual is largely influenced by three main factors: 1) the transmissibility of the source case, 2) the level of contact between the exposed person and the infected individual, and 3) the exposed person's susceptibility to infection. A case's infectivity is established by its coughing frequency, the density of bacilli in sputum [21] and the microbe's virulence [16],[28]. Evidence suggests that people with pulmonary tuberculosis who have positive sputum smears are more likely to infect their contacts than those with negative sputum smears [11], [21].

B. Risk of development of disease:

Mycobacterium tuberculosis can develop in infected patients at a variable time, resulting either from the reactivation of a latent infection or a new reinfection, with the likelihood of reactivation or reinfection probably influenced by the epidemiological context [29].[29]. Any condition altering the balance between M. tuberculosis and the host's immune system can impact the likelihood of disease development in infected individuals. Conditions such as HIV infection, immunosuppressive treatment, diabetes, malnutrition, and alcoholism have been found to influence this balance and are considered inherent to the susceptible host [2].

VIII. METHODS OF TB CONTROL

There are three approaches to managing tuberculosis: (i) preventing infection through vaccination of uninfected people, (ii) halting the development from latent infection to active TB using medication or post-exposure vaccination, and (iii) treating active TB disease. Effective prevention, treatment, and self-recovery methods are therefore assumed to provide lifelong protection. [2]

IX. TUBERCULOSIS DIAGNOSIS METHODS

A. Microscopy:

First, a sample of bacteria is stained using the Ziehl-Neelsen technique, resulting in

the bacteria appearing red. By employing this technique, the bacteria can be clearly observed under the microscope, which enables an accurate count of Mycobacterium colonies [19].

B. Tuberculin Skin Test/ Mantoux Test:

The Mantoux test, also known as the tuberculin skin test, is another diagnostic test. In this tuberculosis test, a special reagent called purified protein derivative is injected onto the patient's skin surface. The amount used is 0.1 ml [21]. An induration on the skin's surface typically develops within 48-72 hours. The results of the induration size measurement analysis were carried out according to. A 10 mm measurement classifies the patient as positive for tuberculosis [21].

C. Cultures Mycobacterium Tuberculosis:

The conventional culture method is employed to identify Mycobacterium tuberculosis. The method is extremely time-intensive due to Mycobacterium tuberculosis's slow growth, requiring approximately 4 weeks for the bacterium to multiply. Typically, Lowenstein-Jensen medium is employed in the experiment to culture Mycobacterium tuberculosis.

D. Enzyme Linked Immunosorbent Assay [ELISA]:

ELISA is a biochemical method for detecting tuberculosis. The method involves identifying and quantifying infectious agents in the sample to detect tuberculosis. Biochemical enzyme-linked immunosorbent assay procedures have been previously described [10]. In the ELISA, Tween 20 functioned as a detergent that eliminated all glycolipids from the microtitre well, except for the cord factor.

E. Quantiferon Gold Test:

The Quantiferon-TB Gold blood test is used to detect infections caused by tuberculosis bacteria. The measurement assesses interferon-gamma released from white blood cells in response to exposure to TB antigens. The test helps identify latent or active TB infections, yet it cannot distinguish between the two.The BCG vaccination has no impact on this condition, and it usually only requires one patient visit.

X. TREATMENT OF TUBERCULOSIS DISEASE

The National Tuberculosis Elimination Programme, formerly known as the RNTCP, has put in place a daily treatment regimen for pediatric TB patients who are drug-sensitive nationwide, as well as for all TB patients in 104 districts. The intensive phase for all new drug-sensitive TB cases involves Isoniazid, Rifampicin,

Pyrazinamide, and ethambutol for 8 weeks, with dosages based on 4 weight band categories; after this, Isoniazid, Rifampicin, and ethambutol are continued for another 16 weeks. TB patients previously treated received a combination of isoniazid, rifampicin, pyrazinamide, and ethambutol for 12 weeks, and also streptomycin injections for the first 8 weeks. They then underwent 20 weeks of treatment with isoniazid, rifampicin, and ethambutol [29].

CONCLUSION

Globally, tuberculosis remains a considerable threat to public health, affecting millions of people worldwide. TB persistence is due to late diagnosis, the emergence of drug-resistant strains, and limited access to medical care. Early detection and proper treatment are crucial in halting the spread of disease. The management of tuberculosis has been improved by the developments in diagnostic tools, vaccines, and treatments, despite ongoing difficulties. Controlling tuberculosis effectively necessitates public enlightenment, prompt medical assistance, and comprehensive public health initiatives.

This review provides a more in-depth look at managing tuberculosis and mitigating potential risks.

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