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NARRATIVE REVIEW (PULMONARY TUBERCULOSIS)

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ABSTRACT :

Pulmonary tuberculosis (TB), caused by Mycobacterium tuberculosis, remains a significant global health challenge despite advances in diagnostics and treatment. This narrative review synthesizes current knowledge on pulmonary TB, covering its epidemiology, pathophysiology, clinical presentation, diagnosis, treatment, and ongoing challenges. Globally, TB affects 10.6 million people annually, with high burdens in low- and middle-income countries driven by socioeconomic factors and HIV co-infection. The disease progresses from latent infection to active pulmonary TB in 5-10% of cases, characterized by necrotizing granulomas and lung cavitation. Clinical features include persistent cough, hemoptysis, and systemic symptoms, though atypical presentations complicate diagnosis in vulnerable populations. Diagnostic tools like GeneXpert MTB/RIF and sputum culture are critical, yet access remains limited. Standard treatment involves a 6-month regimen for drug-susceptible TB, while multidrug-resistant TB requires longer, more toxic therapies. Challenges include drug resistance, diagnostic delays, and social determinants like poverty and stigma, exacerbated by the COVID-19 pandemic’s disruption of TB services. Future directions emphasize rapid diagnostics, shorter regimens, and addressing social determinants to achieve WHO’s End TB Strategy goals. This review underscores the need for integrated approaches to control this persistent infectious disease.

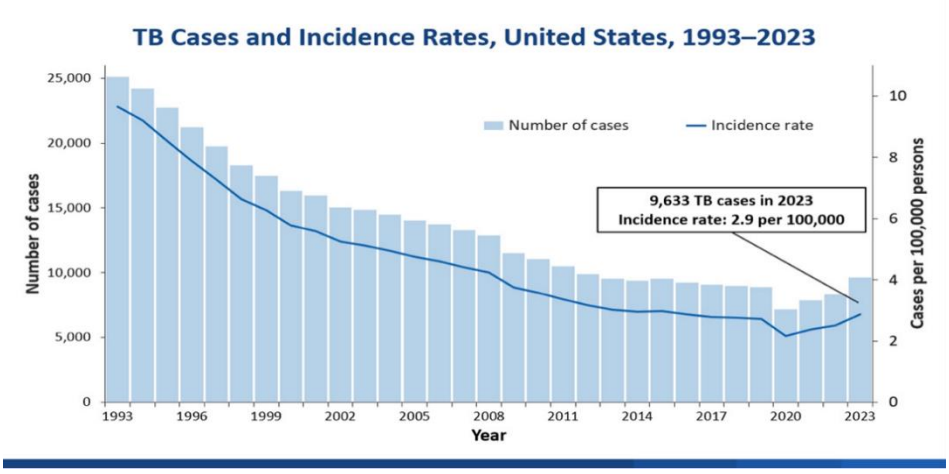
Keywords: Pulmonary tuberculosis, Mycobacterium tuberculosis, epidemiology, pathophysiology, diagnosis, treatment, multidrug-resistant TB, HIV co-infection, social determinants, GeneXpert, End TB Strategy, drug resistance, global health.

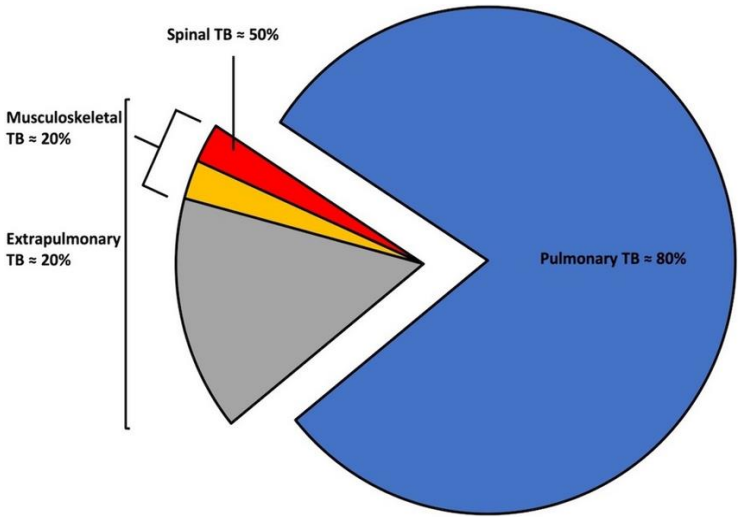
Introduction

Pulmonary tuberculosis, caused by Mycobacterium tuberculosis, is a leading infectious disease with significant global health implications. Despite advances in diagnostics and treatment, TB remains a major cause of morbidity and mortality, particularly in low- and middle-income countries. This narrative review synthesizes current knowledge on pulmonary TB, addressing its epidemiology, pathophysiology, clinical features, diagnosis, treatment, and challenges, drawing on peer-reviewed studies, World Health Organization (WHO) reports, and recent literature.

Epidemiology

Pulmonary TB accounts for approximately 80-85% of TB cases worldwide. The WHO estimated 10.6 million new TB cases in 2022, with 1.3 million deaths, making TB the second leading infectious killer after COVID-19 (WHO, 2023). High-burden regions include sub-Saharan Africa, Southeast Asia, and parts of Eastern Europe, where socioeconomic factors like poverty, overcrowding, and malnutrition drive transmission (Chakaya et al., 2021). TB incidence is also rising in urban settings and among immunocompromised populations, particularly those with HIV/AIDS, with co-infection rates as high as 50% in some African countries (Furin et al., 2019). Social determinants—poor housing, limited healthcare access, and stigma—sustain TB epidemics, as highlighted in recent reviews (Hargreaves et al., 2020).





Pulmonary tuberculosis accounts for 80% of the cases

Pathophysiology

Mycobacterium tuberculosis is an aerobic, acid-fast bacillus transmitted via aerosolized droplets. Upon inhalation, bacilli reach the alveoli, where macrophages engulf them, initiating an immune response. In most individuals, granuloma formation contains the infection, resulting in latent TB infection (LTBI). However, in 5-10% of cases, particularly in immunocompromised individuals, the infection progresses to active pulmonary TB, characterized by necrotizing granulomas, cavitation, and lung tissue destruction (Pai et al., 2016). Recent studies emphasize the role of host immune responses, including T-cell activation and cytokines (e.g., TNF-α, IFN-γ), in disease control or progression (Tiberi et al., 2018). Bacterial strain virulence and host genetic factors also influence outcomes, with certain strains linked to higher transmissibility (Dheda et al., 2017).

Clinical Presentation

Pulmonary TB typically presents with a persistent cough (>2-3 weeks), often productive, with hemoptysis in advanced cases. Systemic symptoms include fever, night sweats, weight loss, and fatigue (Lee et al., 2020). Atypical presentations are common in immunocompromised patients, children, and the elderly, complicating diagnosis. For example, HIV-co-infected individuals may have minimal pulmonary symptoms or extrapulmonary involvement (Furin et al., 2019). Chest radiographs often show upper lobe infiltrates, cavitation, or miliary patterns, but early or atypical cases may lack these findings, necessitating advanced imaging like computed tomography (CT) (Loddenkemper et al., 2018).

Diagnosis

Timely diagnosis is critical for TB control. Sputum smear microscopy, culture, and nucleic acid amplification tests (NAATs) like GeneXpert MTB/RIF are the gold standard for confirming pulmonary TB (WHO, 2023). GeneXpert, endorsed by WHO, enables rapid detection of M. tuberculosis and rifampicin resistance, improving diagnosis in resource-limited settings (Dheda et al., 2017). Chest radiography and CT aid in identifying pulmonary abnormalities, though specificity is limited (Loddenkemper et al., 2018). Advances in diagnostics, such as next-generation sequencing and biomarkers like interferon-gamma release assays for LTBI, show promise but face barriers like cost and access (Pai et al., 2016). Literature stresses the need to integrate clinical, radiological, and microbiological data, especially for smear-negative cases (Chakaya et al., 2021).

Treatment

The standard treatment for drug-susceptible pulmonary TB is a 6-month regimen: 2 months of rifampicin, isoniazid, pyrazinamide, and ethambutol (intensive phase), followed by 4 months of rifampicin and isoniazid (continuation phase). This regimen achieves cure rates >85% in controlled settings (WHO, 2023). However, challenges include patient non-adherence, drug toxicity, and the rise of multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) (Tiberi et al., 2018). MDR-TB, resistant to rifampicin and isoniazid, requires 18-24 months of treatment with newer drugs like bedaquiline and delamanid. Recent trials support shorter, all-oral regimens for MDR-TB, improving outcomes (Conradie et al., 2020). Preventive therapy for LTBI, using isoniazid or rifapentine-based regimens, is effective in high-risk groups (Hargreaves et al., 2020).

Challenges and Emerging Issues

Drug resistance is a major barrier, with approximately 450,000 MDR-TB cases annually (WHO, 2023). Early detection of resistance and access to novel drugs remain limited in many settings (Dheda et al., 2017). Socioeconomic factors, including poverty and stigma, hinder care access and adherence (Hargreaves et al., 2020). The COVID-19 pandemic disrupted TB services, reducing case detection by 18% in 2020-2021 (Chakaya et al.,

2021). Co-infections (e.g., HIV) and comorbidities (e.g., diabetes) complicate management, increasing mortality risk (Furin et al., 2019). The Bacillus Calmette-Guérin (BCG) vaccine offers limited protection against adult pulmonary TB, prompting research into new vaccines like M72/AS01E, which showed 50% efficacy in trials (Tait et al., 2019).

Future Directions

The literature highlights several priorities for TB control. Expanding access to rapid diagnostics like GeneXpert and point-of-care tests is essential, particularly in low-resource settings (Pai et al., 2016). Shorter, less toxic regimens for drug-susceptible and resistant TB could enhance adherence and outcomes (Conradie et al., 2020). Addressing social determinants through integrated care models—combining TB screening with nutrition and poverty alleviation—could reduce transmission (Hargreaves et al., 2020). Investment in vaccine development and host-directed therapies (e.g., immunomodulatory agents) is critical (Tiberi et al., 2018). WHO's End TB Strategy aims to reduce TB incidence by 90% and deaths by 95% by 2035, but success requires sustained global commitment (WHO, 2023).

Conclusion

Pulmonary tuberculosis remains a complex global health challenge, driven by biological, social, and systemic factors. Advances in diagnostics, treatment, and prevention have improved outcomes, but drug resistance, diagnostic delays, and socioeconomic barriers persist. The literature underscores the need for innovative tools, equitable healthcare access, and global collaboration to achieve TB elimination. Ongoing research and policy efforts will be pivotal in addressing this enduring disease.

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