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Tuberculosis in 2023: Assessing the Current Landscape and Progress towards Elimination Goals

Dr. Abhishek Dhawan[1], Dr. Andrea Almeida[2], Dr. Adchitre S. A.[3], Dr. Salve S. B.[4], Dr. Mahajan S. M.[5]

[1]Resident, Department of Community Medicine, MGM Medical College, Aurangabad

[2]Resident, Department of Community Medicine, MGM Medical College, Aurangabad

[3]Professor Department of Community Medicine, MGM Medical College, Aurangabad

[4]Professor and Head, Department of Community Medicine, MGM Medical College, Aurangabad

[5]Professor, Department of Community Medicine, Shri Ramchandra Institute of Medical Sciences, Aurangabad

Abstract: ***Tuberculosis (TB) remains a global public health challenge, necessitating a comprehensive assessment of the current landscape and the progress made towards the ambitious goal of elimination in 2025 in India. Despite significant strides in TB control, the disease continues to afflict millions worldwide, with diverse challenges complicating the path to eradication. This abstract encapsulates an in-depth exploration of the multifaceted dimensions surrounding TB in 2023. It delves into the epidemiological aspects, emphasizing the geographical disparities in TB prevalence, exploring the impact of social determinants on disease transmission, and scrutinizing vulnerable populations that remain disproportionately affected. The analysis incorporates a global perspective, considering regional variations in TB burden and the unique challenges faced by low- and middle-income countries in their pursuit of elimination. In assessing progress towards elimination goals, this abstract scrutinizes the efficacy of existing diagnostic tools, treatment modalities, and preventive strategies. Advances in technology, such as molecular diagnostics and artificial intelligence applications, are examined for their potential to revolutionize TB detection and management. The abstract also evaluates the accessibility of essential TB medications, the emergence of drug-resistant strains, and the effectiveness of ongoing vaccination campaigns, casting a critical eye on the factors influencing the success or failure of elimination initiatives. The abstract highlights collaborative efforts between governments, non-governmental organizations, and international bodies, emphasizing the importance of a unified approach in the global fight against TB. It explores the role of research and innovation in shaping policies, with an emphasis on fostering international partnerships for resource-sharing and capacity-building. In conclusion, this abstract provides a comprehensive snapshot of the TB landscape in 2023, offering insights into the challenges hindering elimination and the promising strategies driving progress. It serves as a valuable resource for policymakers, researchers, and healthcare professionals engaged in the ongoing battle against tuberculosis, urging a collective commitment to achieving the ambitious goal of global TB elimination.***

Keywords: Tuberculosis, elimination, healthcare professionals, in depth exploration

1. Introduction

Tuberculosis (TB) stands as an enduring global health challenge, demanding vigilant scrutiny and concerted efforts to assess the evolving landscape in 2023. The quest for a TB-free world has been a persistent goal, underscored by international initiatives and frameworks aimed at curbing the spread of this ancient disease. This introduction delves into the historical context of TB, explores the current global scenario, and sets the stage for a comprehensive evaluation of progress towards elimination goals for the year 2025 for Indian Community.

2. Historical Context of Tuberculosis:

Tuberculosis (TB) has deep historical roots, dating back centuries and impacting societies across the globe. Often referred to as the **"White Plague"**, TB has left an indelible mark on human history, shaping medical, social, and cultural landscapes.

a) Early Recognition and Misconceptions:
Historical records indicate that TB has afflicted humanity since ancient times. Skeletal evidence of TB has been found in archaeological remains, suggesting its presence in various ancient civilizations. However, the understanding of the disease was limited, and it was often surrounded by misconceptions. In medieval Europe, TB was sometimes associated with divine punishment, and various myths and superstitions surrounded its causes and transmission.

b) Sanatoria and the Rise of Public Health Measures:
The late 19th and early 20th centuries witnessed a growing awareness of the contagious nature of TB. As industrialization led to urbanization, crowded living conditions exacerbated the spread of the disease. This period saw the establishment of sanatoria—dedicated facilities for TB patients—aimed at isolating and treating individuals with the infection. Concurrently, public health campaigns emerged, emphasizing the importance of fresh air, hygiene, and preventive measures.

c) Antibiotics and the Post-World War II Era:
The discovery of streptomycin in the mid-20th century marked a turning point in TB treatment. Antibiotics revolutionized the approach to TB, offering effective medication to combat the Mycobacterium tuberculosis bacterium. This era witnessed the advent of combination drug therapies, further improving treatment outcomes. As a result, TB mortality rates began to decline in many parts of the world.

d) Challenges of Drug Resistance and the 21st Century:
Despite advancements, new challenges emerged in the late 20th and early 21st centuries. Drug-resistant strains of TB, including multidrug-resistant (MDR-TB) and extensively drug-resistant TB (XDR-TB), posed formidable obstacles to effective treatment. The global health community faced the daunting task of addressing these resistant strains and preventing their further spread.

e) Global Efforts Towards Elimination Goals:
In recent decades, the international community, led by organizations such as the World Health Organization (WHO), has intensified efforts to combat TB. The launch of the End TB Strategy in 2015 till 2025 marked a commitment to reduce TB deaths, incidence, and catastrophic costs while increasing investments and research. However, achieving elimination goals remains a complex task, requiring innovative approaches and sustained political will.

f) Technological Advances and Research:
Advancements in diagnostic tools, such as GeneXpert and molecular testing, have enhanced early detection of TB. Research into novel drug regimens and vaccines continues, offering hope for more effective and accessible treatments. The quest for a TB vaccine, a preventive tool, remains a key focus of global TB research. In the historical context of tuberculosis, the journey from ancient misconceptions to modern understanding has been marked by both progress and challenges. As we assess the current landscape in India in the year 2023, the historical narrative sets the stage for a comprehensive understanding of the multifaceted efforts required to achieve the ambitious goal of global TB elimination.

3. Current Global Scenario

Despite decades of concerted efforts, TB remains a formidable adversary, affecting millions of people annually.

In 2021, an estimated **10.6 million** (95% confidence interval 9.9-11 million) people fell ill with TB worldwide, of which 6.0 million were men, 3.4 million were women and 1.2 million were children. People with HIV infection accounted for nearly 6.7% of the total.

According to the **WHO Global TB Report 2022**, India's TB incidence for the year 2021 is **210 per 100,000 population** (1,2) This is an **18% decline** from the baseline year of 2015, which had an incidence of 256 per 100,000 population (1). The decline is **7 percentage points better than the global average of 11%** (1)

In 2021, India had an estimated TB incidence of **2,590,000** (3). In 2017, over **400,000 people died due to TB** in India (3). India accounts for **27% of the global estimated 10 million cases** and **25% of the estimated 1.6 million deaths** (3). India is ranked first among the 30 high TB and high multidrug-resistant TB (MDR-TB) burden countries (3).

In 2022, an estimated **10.6 million** (95% uncertainty interval 9.9-11.4 million) people fell ill with TB worldwide, of which 5.8 million were men, 3.5 million were women and 1.3 million were children. People with HIV infection accounted for nearly 6.3% of the total.

According to the **Global TB Report** published by the **World Health Organization (WHO)** on November 7, 2023, India accounted for **27%** of the global TB cases in 2022. The report also states that the number of TB cases reported in India was **2.42 million**, which is higher than the pre-Covid-19 levels of 2.40 million. (4)

The disease is intricately linked to social determinants, economic disparities, and healthcare access, creating a complex web that requires meticulous unraveling. Geographical disparities in TB prevalence further complicate the situation, with certain regions bearing a disproportionate burden of the disease. Low- and middle-income countries find themselves grappling with the dual challenges of inadequate resources and high disease incidence, creating a formidable barrier to effective control.

The vulnerability of specific populations, such as those with compromised immune systems, marginalized communities, and individuals living in overcrowded conditions, exacerbates the spread of TB. Understanding these nuances is paramount to crafting targeted interventions that address the root causes of the disease's persistence.

1) Progress towards elimination goals:
With an ambitious target to eliminate TB as a public health threat by 2035 set by the World Health Organization (WHO), assessing the current landscape is crucial. In this concise analysis, we delve into the progress made towards achieving elimination goals, focusing on key areas of advancement and the persisting challenges.

a) Diagnostic Innovations:
One of the cornerstones of TB control is early and accurate diagnosis. In recent years, diagnostic innovations have revolutionized the landscape, enabling swift identification and treatment initiation. Molecular testing methods, exemplified by GeneXpert, have become invaluable tools for rapid detection, especially in regions with limited resources. The integration of point-of-care tests has further streamlined the diagnostic process, ensuring that individuals receive prompt and accurate results.

b) Treatment Advancements:
The evolving landscape of TB treatment reflects a commitment to addressing challenges posed by drug-resistant strains. Innovations in drug development and therapeutic approaches, particularly for multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB), have enhanced the effectiveness of treatment regimens. Shorter and more patient-friendly courses contribute to improved adherence, a critical factor in preventing the development of drug resistance. These advancements underscore the progress made in ensuring accessible and effective treatment for all.

c) Vaccines and Preventive Measures:
Preventing TB is as crucial as treating it, and progress in vaccine development is promising. While the **Bacillus Calmette-Guérin (BCG)** vaccine remains in use, ongoing research seeks to develop more effective vaccines. Several

candidates are in various stages of clinical trials, aiming not only to prevent infection but also to reduce the risk of disease progression. This focus on preventive measures marks a significant stride towards interrupting the transmission cycle and ultimately achieving elimination.

d) Global Collaboration and Partnerships:
The fight against TB demands a united front, and global collaboration has been instrumental. Organizations like the Stop TB Partnership and the Global Fund to Fight AIDS, Tuberculosis, and Malaria play pivotal roles in resource mobilization and support for TB programs worldwide. Collaborations between governments, non-governmental organizations, research institutions, and the private sector have accelerated progress. The sharing of knowledge, expertise, and resources fosters a collective approach to overcoming challenges.

e) Addressing Social Determinants:
Recognizing that TB is intricately linked with social determinants, efforts have intensified to address underlying factors such as poverty, malnutrition, and inadequate healthcare access. Holistic strategies that consider the socio-economic context of TB have gained prominence. Initiatives focusing on poverty reduction, improved nutrition, and enhanced healthcare access are integral components of the comprehensive approach required to eliminate TB.

f) Digital Health Solutions:
The integration of digital health solutions has marked a paradigm shift in TB control. Technologies facilitating surveillance, contact tracing, and patient management have become indispensable. Telemedicine and mobile applications play pivotal roles in enhancing patient support and ensuring treatment adherence, especially in regions with limited healthcare infrastructure. The efficiency gains offered by digital platforms contribute to more effective and widespread TB control.

g) Challenges and the Path Forward:
While progress is evident, challenges persist on the path towards TB elimination. TB remains a leading cause of death globally, and drug-resistant strains continue to pose threats. Socio-economic disparities, stigma, and unequal access to healthcare remain barriers to effective TB control. Achieving elimination goals demands sustained political commitment, increased funding, and a comprehensive, multi-sectoral approach. Addressing the root causes of TB is imperative for lasting success.

2) Call for comprehensive assessment:
The call for a comprehensive assessment of tuberculosis (TB) in 2025 is both a reflection of the progress made and a recognition of the challenges that persist in the global endeavor to eradicate this ancient and formidable disease. As we stand on the cusp of a new era, it is imperative to take stock of advancements in diagnostics, treatment, prevention, and the socio-economic factors that shape the trajectory of TB. The landscape of TB control has witnessed notable strides, driven by innovations in diagnostic technologies. Molecular testing and the integration of artificial intelligence have revolutionized the identification of TB cases, ensuring quicker and more accurate results. These advancements not only facilitate prompt initiation of treatment but also contribute to the overall effectiveness of public health interventions.

In the realm of treatment, ongoing innovations and drug developments present promising avenues for redefining therapeutic regimens. Shorter, more patient-friendly courses are emerging, improving adherence and reducing the burden on individuals undergoing treatment. As we peer into the future, the anticipation of breakthroughs in TB vaccine research adds a significant dimension to prevention strategies. A successful vaccine has the potential to alter the course of the disease, preventing not only active TB but also interrupting the transmission cycle.

Global collaboration remains paramount in the fight against TB. Organizations like the World Health Organization (WHO) and the Global Fund continue to foster partnerships, channel resources, and coordinate efforts on a global scale. The collaborative ethos that underpins these initiatives ensures a collective approach to TB control, transcending borders and leveraging shared expertise and resources.

The integration of digital health solutions is poised to further augment TB control strategies. Telemedicine, mobile applications, and data analytics offer new avenues for patient management, contact tracing, and surveillance. This technological integration not only enhances the efficiency of healthcare systems but also addresses some of the logistical challenges posed by TB control in diverse and geographically dispersed populations.

However, as we anticipate progress, it is crucial to confront persisting challenges. Socio-economic determinants continue to influence the prevalence and impact of TB. Poverty, malnutrition, and limited access to healthcare remain barriers to effective TB control, necessitating a holistic and equitable approach.

In conclusion, the call for a comprehensive assessment of tuberculosis in 2025 is a rallying cry for sustained commitment, innovation, and a unified global effort. It recognizes the transformative potential of technological advancements, the importance of collaborative initiatives, and the imperative to address social determinants. A forward-looking and nuanced evaluation of the TB landscape will not only guide strategic interventions in the coming years but also propel the global community closer to the ambitious goal of eliminating TB as a major public health threat. (3,5,6)

4. Conclusion

In conclusion, the assessment of tuberculosis (TB) in 2023 reveals a landscape marked by significant progress and persistent challenges. Advances in diagnostic technologies, treatment innovations, and global collaboration underscore the commitment to addressing this age-old public health challenge. The integration of digital health solutions and a growing understanding of socio-economic determinants further enhance the comprehensive approach required for effective TB control. The global community's dedication to achieving elimination goals by 2025 is evident in the strides made towards developing shorter, patient-friendly treatment

regimens and the ongoing quest for a more effective TB vaccine.

However, as we acknowledge these achievements, it is crucial to confront the remaining challenges. Drug-resistant strains, socio-economic disparities, and unequal access to healthcare continue to impede progress. The call for a comprehensive assessment serves as a reminder that the journey towards TB elimination demands ongoing commitment, innovation, and a concerted effort across borders. Sustained political will, increased funding, and a holistic understanding of the social determinants of TB are paramount. Looking ahead, the imperative is clear – the global community must fortify its resolve, leverage advancements in science and technology, and address systemic issues to ensure that no one is left behind in the pursuit of a TB-free world.

As we navigate the path forward, a unified and multi-sectoral approach remains the key to turning the tide against TB and realizing the ambitious goal of its elimination.

Conflict of Interest:
The authors report no conflicts of interest in this work.

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