

Tuberculosis Vaccines in Indonesia: Importance and Future Directions

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Abstract

Background: Tuberculosis (TB) remains a major public health burden globally and in Indonesia, despite the availability of established control strategies such as case detection, treatment, TB preventive therapy, and Bacillus Calmette-Guerin (BCG) vaccination. Indonesia continues to carry one of the highest TB burdens worldwide, and ongoing transmission highlights the need for stronger preventive approaches, particularly vaccines.

Methods: A narrative review was conducted using literature retrieved from PubMed, Scopus, and Google Scholar. Search terms included "Tuberculosis," "Novel Tuberculosis Vaccine," "BCG Limitations," and "Vaccine Implementation."

Results: Current strategies remain essential but have important limitations. Diagnosis and treatment are often initiated only after disease has developed, treatment duration can affect adherence, and BCG provides limited and variable protection against pulmonary TB in adolescents and adults, the groups most responsible for transmission. In this context, new TB Vaccines may become an important complement to existing TB control efforts. For Indonesia, an ideal TB vaccine should provide durable protection against pulmonary TB in adolescents and adults, have an acceptable safety profile for broad and high-risk populations, require a feasible dosing schedule, and be suitable for integration into existing health system platforms. Successful vaccine introduction will require careful target population selection, health system readiness, public acceptance, sustainable financing, and strong policy support.

Conclusion: Strengthening preparedness for future TB vaccine implementation may help Indonesia accelerate progress toward national and global TB elimination targets.

Keywords: tuberculosis, TB vaccine, Indonesia, BCG, vaccine implementation

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INTRODUCTION

Tuberculosis (TB), as one of the ten leading causes of mortality worldwide, continues to be a pressing public health problem.¹ In 2024, over 10 million people were infected with TB globally. As many as 1.2 million died from TB annually, showing an alarming case fatality rate of 11.5%. Indonesia carried the second highest TB burden after India. It was estimated that 1.1 million new TB cases occurred in Indonesia in 2024, and 839,000 cases were notified. As many as 14% of notified cases died of TB. Although the treatment success rates for drug-sensitive TB were sustained at a high level both globally (88%) and in Indonesia (86%), transmission continues uncurbed.² Thus, incidence remains high and drug resistance poses an emerging threat. This becomes a great challenge in the attainment of the End TB Strategy milestones and goals by 2030. Therefore, substantial improvements in TB care and prevention strategies are needed.

Main prevention strategies currently utilized in Indonesia includes case-finding and prompt treatment to prevent further transmission; latent M.tuberculosis infection (LTBI) detection and TB Preventive Therapy (TPT); and Bacillus Calmette-Guerin (BCG) vaccination.^{3,4} Implementation of these strategies may encounter challenges and barriers, especially in resource-constrained areas and due to various patient-level and health system factors. Thus, a multi-pronged approach to TB prevention is needed; one that not only brings substantial health impacts but is also cost-effective.

Vaccination is proven to be a potent strategy in the fight against many infectious diseases throughout history. The only licensed TB vaccine to date, BCG, is effective in preventing severe diseases in children, but provides limited and variable protection against pulmonary TB in adolescents and adults, the age groups most responsible for transmission.^{5,6} Therefore, the development of new vaccines that are effective in broader age groups and TB manifestations are urgently needed. Novel TB vaccines have the potential to reduce incidence and

mortality, prevent antimicrobial resistance, are highly cost-effective and cost-saving, and can advance health equity.⁷ This need becomes more important because current TB control strategies remain insufficient to fully interrupt transmission. Case-finding and treatment are often initiated only after symptoms develop, allowing individuals with active TB to continue transmitting infection before diagnosis and treatment. Treatment duration also remains long, creating challenges in adherence and increasing the risk of treatment failure and drug resistance.⁸ Provision of new TB vaccines could be a breakthrough for high-burden countries such as Indonesia in their fight against TB. This review provides a comprehensive summary on the importance and future directions in TB vaccination rollout in Indonesia.

METHODS

A narrative review was conducted using literature retrieved from PubMed, Scopus, and Google Scholar. Search terms included "Tuberculosis," "Novel Tuberculosis Vaccine," "BCG Limitations," and "Vaccine Implementation." Articles were selected based on relevance to the review objectives, with no formal systematic screening applied.

RESULTS

The Role and Need for Tuberculosis Vaccination in Indonesia

Tuberculosis control in Indonesia cannot rely solely on diagnosis and treatment strategies. Although these interventions remain essential, they are largely curative and may not sufficiently interrupt ongoing community transmission, particularly in high-burden settings. Therefore, stronger preventive approaches are needed to complement existing TB control measures, with vaccination representing one of the most promising long-term strategies.

The vaccine implementation strategy is expected to adopt a stratified geographical approach, beginning in provinces with the highest disease and

greatest socio-economic burden. Achieving this goal will require innovative solutions, and the introduction of a new, effective TB vaccine for adults and adolescents is considered a critical component of this strategy.⁹

Numerous vaccine candidates developed over the years are currently in various stages of clinical development, while many others remain in the preclinical phase. Nonetheless, the goal of achieving a universally effective TB vaccine continues to face significant scientific and financial challenges. Insufficient global investment in TB vaccine research and development has slowed progress, making careful and systematic prioritization of candidates for large-scale efficacy trials increasingly important.

Despite these obstacles, recent advances in TB vaccine development are encouraging. Indonesia has positioned itself strongly in the fight against TB through collaborative efforts and continued commitment to vaccine research and implementation, including active participation in clinical trials of TB vaccine candidates. This engagement not only positions Indonesia as a potential early adopter of a future TB vaccine, but also reinforces its role in the global effort to reduce TB incidence and contributes meaningfully to the long-term goal of disease elimination.¹⁰

Tuberculosis Vaccination Strategies: Needs and Implementation Challenges

The most fundamental characteristic required of a new TB vaccine is efficacy in adolescents and adults, the age groups in which BCG consistently fails to provide sufficient protection. While BCG provides moderate protection against severe forms in infants and young children, it does not adequately protect adolescents and adults, who are the main drivers of disease transmission.¹¹ Modelling studies suggest that an adult-targeted tuberculosis vaccination with an efficacy of 40% could achieve the same initial reduction in TB incidence as an infant-targeted vaccine with 80% efficacy and lifelong protection, but approximately 20 years earlier.¹² In

line with this, the WHO Preferred Product Characteristics recommend a minimum efficacy of 50% for vaccines targeting pulmonary TB in adolescents and adults, as this disease form is primarily responsible for ongoing community transmission.¹³

Beyond efficacy, a new TB vaccine must provide durable protection and demonstrate a strong safety profile across diverse populations. Ideally, protection should last for more than a decade following the completion of the primary immunization series that requires a minimal number of doses, and have a safety profile comparable to routine vaccines that do not cause immunological interference. Safety is particularly critical for vulnerable populations, including individuals living with HIV/AIDS, the elderly, and pregnant or breastfeeding women, especially given that BCG is contraindicated in immunocompromised individuals. Furthermore, an optimal vaccine should offer protection against both drug-sensitive and drug-resistant.¹⁴

Future TB vaccine implementation should consider several key factors. First, the selection of target populations is essential, as adolescents and adults account for the majority of TB incidence and mortality.¹⁵ Therefore, prioritizing these age groups is widely recommended. In addition, high-risk populations, such as people living with HIV, should also be considered. Given that BCG is contraindicated in this group, countries need to assess whether new TB vaccines should specifically target these populations or be delivered more broadly on adolescents and adults.¹⁶

Another important consideration is the integration of a new TB vaccine into existing health programs. This is essential to ensure that the program is both efficient and effective. For adolescents, the vaccine can be incorporated into the national immunization program, while for adults, delivery may occur through primary healthcare services or through programs targeting high-risk groups. It is also essential to evaluate health system

readiness. This can be done by identifying gaps in infrastructure and workforce capacity. Lessons from previous large-scale vaccination efforts, such as the COVID-19 pandemic, can also be utilized to enhance preparedness and strengthen delivery strategies.¹⁷

Public acceptance is another critical factor for successful vaccine rollout. Population readiness should be assessed prior to implementation. If readiness and acceptance is low, preliminary measures such as public education and risk communication should be implemented to improve uptake.¹⁸

Despite these considerations, the implementation of new and repurposed TB vaccines poses several challenges. Expanding vaccination to adolescents and adults represents a shift from traditional pediatric-focused programs and may be perceived differently by the public. Vaccine hesitancy may arise from TB-related stigma, limited familiarity with adult TB vaccination, and the lack of public information.¹⁹ In addition, multi-dose vaccination schedules may also affect the willingness of individuals to get fully vaccinated, as it requires commitment from the individuals to come back for the second dose.²⁰

Healthcare system readiness also remains a major challenge, particularly in low- and middle-income countries (LMICs). Regulatory processes, financing, and logistical coordination may pose barriers to effective implementation. Limited human resources, infrastructure constraints, and geographical barriers further complicate vaccine delivery in these settings.¹⁹

Mitigation strategies should focus on improving public awareness of TB and the importance of vaccination through targeted communication campaigns to reduce misinformation and increase acceptance. Integrating TB vaccination into existing health programs may improve coverage while reducing costs.

Strengthening the health system through workforce training, infrastructure development, and community engagement will be essential to ensure program sustainability. Strong commitment and coordination among stakeholders will also be critical to support successful implementation.²¹

CONCLUSION

Tuberculosis remains a major public health burden in Indonesia, and existing control strategies such as diagnosis, treatment, preventive therapy, and BCG vaccination are not yet sufficient to fully interrupt transmission, particularly among adolescents and adults who continue to drive pulmonary TB spread. Strengthening prevention through new TB vaccines should therefore be considered an important complement to existing strategies. For Indonesia, the ideal TB vaccine should provide durable protection against pulmonary TB in adolescents and adults, have an acceptable safety profile for broad and high-risk populations, require a feasible dosing schedule, and be implementable through existing health system platforms. Future vaccine introduction should be supported by careful target population selection, public acceptance strategies, health system readiness, and sustained policy commitment to ensure that vaccination can contribute meaningfully to national TB elimination efforts.

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Conflict of Interest

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