Analysis of Tuberculosis Diagnosis Methods in Children

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Abstract

Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium tuberculosis*. According to the World Health Organization (Global TB Report, 2023), TB is still a health problem in the world today. The number of people newly diagnosed with TB globally will be 7.5 million in 2022, with 12% being children (aged 0–14 years). One of the main focuses in treating TB is knowing the correct diagnosis method. TB examination in children is usually carried out by taking a Rapid Molecular Test (TCM) sputum specimen. However, sometimes this method is less effective because the child has difficulty expelling phlegm spontaneously. To overcome this problem, various countries have implemented other TB diagnosis methods such as Stool Culture, Xpert, and Xpert Ultra diagnosis. The Xpert diagnosis method increases the sensitivity of *Mycobacterium tuberculosis* detection so that TB detection in children can be more accurate. In the future, the Xpert Ultra diagnostic method has begun to be developed, whose sensitivity is more accurate than the Xpert method. With the correct diagnostic method, it is hoped that the treatment process for children with TB can be more effective.

Keywords: Tuberculosis, TB, children, diagnosis, Xpert, Xpert Ultra

Introduction

Tuberculosis (TB) is a contagious infectious disease caused by *Mycobacterium tuberculosis* that primarily affects the lungs but can also spread to other organs, including the kidneys, bones, and central nervous system.[1,2] The disease is transmitted through the air when an infected individual coughs or sneezes, dispersing bacteria into the environment.[3] Despite

being highly contagious, TB is treatable and curable with a proper combination of antibiotics, although the treatment requires six to nine months of strict adherence to prevent drug resistance.[4] Globally, TB remains a major public health issue, particularly in developing countries with limited healthcare infrastructure, despite a decrease in incidence in many regions.[1]

Children are particularly vulnerable to TB due to their immature immune systems, malnutrition, and frequent close contact with infected adults.[2,5] In 2019, an estimated 1.2 million children worldwide developed TB, making it one of the leading causes of death among this group.[1] They are also at heightened risk of severe disease manifestations, such as miliary TB and tuberculous meningitis, which can be fatal if not treated promptly.[6] Diagnosing TB in children remains a significant challenge due to non-specific symptoms that often mimic other illnesses, such as pneumonia or other respiratory infections. This difficulty is compounded by the challenge of obtaining adequate diagnostic samples in pediatric cases.[7]

Efforts to improve TB diagnosis in children have led to the development of methods such as Xpert MTB/RIF and its improved version, Xpert Ultra. These molecular tests have been shown to enhance diagnostic accuracy, although their sensitivity and specificity remain imperfect.[8] Stool culture has also been explored as a less invasive diagnostic alternative, but its high contamination rate and relatively low sensitivity indicate that further refinement is needed.[9] Increasing awareness of TB symptoms and the importance of early diagnosis is essential, particularly in areas with high TB prevalence, to ensure timely treatment and better outcomes for affected children.[1,2]

Continued research into pediatric TB diagnosis and management is critical to addressing the challenges posed by the disease. Enhanced diagnostic tools, effective treatments, and integrated healthcare approaches are necessary to reduce the global burden of TB and improve outcomes for vulnerable populations, especially children.[3,8]

Methods

A systematic review of peer-reviewed articles, reports, and case studies from 2019 to 2024 was conducted using databases such as PubMed, ScienceDirect, and Google Scholar. Search terms included "Tuberculosis," "Pediatric Tuberculosis," "Tuberculosis in Children," "Tuberculosis Diagnosis," "Diagnosis of Pediatric Tuberculosis," and "Tuberculosis Diagnosis Using Xpert and Xpert Ultra Methods." The review focused on studies related to tuberculosis diagnostic methods in children.

Discussion

Global Impact of Tuberculosis on Children

Tuberculosis is one of the leading causes of death among children globally, with approximately 1.2 million pediatric TB cases reported in 2019. This indicates a critical need for better diagnostic and preventive measures.[1,2] Vulnerable groups, such as Indigenous populations in Canada and children in low-resource settings, are disproportionately affected due to systemic healthcare disparities. Pediatric TB diagnosis in Canada often relies on clinical tools, including Tuberculin Skin Tests (TST), Interferon-Gamma Release Assays (IGRA), abnormal chest X-rays, and evidence of contact with infectious TB cases.[5]

Comorbidities and Treatment Challenges

Comorbid conditions like HIV significantly exacerbate pediatric TB outcomes. A study in the Centre region of Cameroon reported that 20% of 610 children treated for TB experienced treatment failure, with 12% resulting in mortality. HIV co-infection and reliance on clinical diagnostic methods were key factors contributing to poor outcomes, emphasizing the importance of integrating HIV and TB healthcare services.[8,10]

TB's Impact on Child Health and Development Children under five years are particularly vulnerable to severe TB complications. In South Africa, a study involving 1,068 children demonstrated that early-life TB significantly impaired growth, lowered body mass index (BMI), and increased wheezing rates. Lung function was also adversely affected, with reduced tidal volumes and expiratory flow rates being common.[2,6] This underscores the necessity of prompt TB treatment to mitigate long-term health impacts.

Evaluation of Stool Cultures as Diagnostic Tools Alternative diagnostic tools, such as stool cultures, have been evaluated for their efficacy in pediatric TB detection. Research in Cape Town, South Africa, revealed that stool cultures had a high contamination rate (41.5%), and only 7.8% of children undergoing TB treatment tested positive for *Mycobacterium tuberculosis*. The sensitivity of stool culture was 24.0%, improving to 33.3% with the Xpert method.[7,9] These findings suggest stool-based diagnostics need further refinement for practical use.

Advances in Diagnostic Methods: Xpert Ultra The Xpert MTB/RIF Ultra method demonstrated improved diagnostic accuracy for pediatric TB. A study across three African

countries found that Xpert Ultra detected 20 additional TB cases missed by culture, with a sensitivity of 66.3% and specificity of 95.4%.[6,8] While Xpert Ultra has shown promise, continued innovation is required to improve diagnostic precision further.

Conclusion

TB remains a significant cause of morbidity and mortality among children. While advancements in diagnostic methods, such as Xpert Ultra, have improved TB detection, challenges remain. Stool cultures, while a potential alternative, currently show limited effectiveness. Comprehensive and sensitive approaches to TB diagnosis and treatment are essential to address this public health issue effectively. Continued research and development of improved diagnostic tools and treatment strategies are critical to ensuring better outcomes for children affected by TB globally.

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