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Research Article

Analysis of Susceptibility Patterns of Mycobacterial Isolates in Patients with Pulmonary Tuberculosis

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Abstract

Pulmonary tuberculosis (TB), caused by *Mycobacterium tuberculosis* (Mtb), remains a significant global health burden. This study analyzes the susceptibility patterns of mycobacterial isolates obtained from patients with pulmonary tuberculosis (PTB). The research investigates the antimicrobial resistance (AMR) profiles of clinical isolates to key anti-TB drugs, including rifampicin, isoniazid, and ethambutol, among others. In light of the rising cases of multi-drug resistant tuberculosis (MDR-TB), understanding the resistance patterns of Mtb is crucial for optimizing treatment regimens. Mycobacterial isolates from sputum samples were collected from 100 PTB patients. The susceptibility to first-line and second-line drugs was tested using the agar proportion method and the GeneXpert MTB/RIF system for rifampicin resistance. The study revealed a significant prevalence of resistance to first-line drugs, with a high proportion of patients exhibiting multidrug-resistant tuberculosis (MDR-TB). The resistance patterns were associated with clinical and demographic factors. This analysis highlights the importance of regular surveillance of susceptibility patterns, tailored treatment strategies, and the need for early detection of MDR-TB in PTB patients.

Keywords: Pulmonary Tuberculosis, Mycobacterium tuberculosis, Susceptibility Patterns, Antimicrobial Resistance, Multidrug-Resistant Tuberculosis, Rifampicin, Isoniazid

Introduction

Pulmonary tuberculosis (PTB), primarily caused by *Mycobacterium tuberculosis* (*Mtb*), continues to be a major public health problem globally. Despite advances in TB diagnosis and treatment, the persistence of *Mtb* as a leading cause of morbidity and mortality underscores the need for improved control strategies. According to the World Health Organization (WHO), tuberculosis remains one of the top 10 causes of death worldwide, with over 10 million people affected by the disease (1). Drug-resistant tuberculosis (DR-TB), particularly multidrug-resistant tuberculosis (MDR-TB), has emerged as a serious challenge in the management of PTB (2).

The treatment of PTB relies on the use of first-line antituberculosis drugs, including rifampicin, isoniazid, ethambutol, and pyrazinamide. However, the emergence of resistance to these drugs poses significant therapeutic challenges, prolonging treatment durations and increasing the risk of poor treatment outcomes (3). Rifampicin and isoniazid are the most effective first-line drugs for PTB, and resistance to these drugs forms the basis for the classification of MDR-TB. MDR-TB is defined as resistance to at least both rifampicin and isoniazid, the cornerstone drugs in TB treatment regimens (4).

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The increasing prevalence of MDR-TB is largely attributed to factors such as incomplete or inadequate treatment regimens, poor patient adherence, and the spread of resistant strains within communities (5). MDR-TB is associated with higher mortality rates, longer treatment durations, and the necessity for more expensive second-line drugs, which are often less effective and more toxic (6). The emergence of extensively drug-resistant TB (XDR-TB), defined as MDR-TB with additional resistance to second-line injectable drugs and fluoroquinolones, further complicates treatment and increases the burden on healthcare systems (7).

To address these challenges, it is crucial to monitor the resistance patterns of *Mtb* strains in patients with PTB. Understanding these patterns allows for the development of targeted treatment strategies, which can improve patient outcomes and prevent the further spread of resistant strains (8). Therefore, routine testing for drug susceptibility, particularly for rifampicin and isoniazid, is vital for guiding treatment decisions and managing patients effectively (9). Various methods have been developed to assess the drug resistance of *Mtb*, including traditional phenotypic culture-based methods and molecular diagnostic tools like GeneXpert MTB/RIF, which offers rapid and accurate detection of rifampicin resistance (10).

This study aims to analyze the susceptibility patterns of *Mtb* isolates in PTB patients, focusing on resistance to first-line drugs and the prevalence of MDR-TB. The findings will provide valuable insights for the management of PTB and contribute to the global effort to control tuberculosis.

Aim and Objectives

Aim:

To analyze the susceptibility patterns of mycobacterial isolates obtained from patients with pulmonary tuberculosis and assess the prevalence of multidrug-resistant tuberculosis (MDR-TB).

Objectives:

1. To determine the resistance profiles of M. tuberculosis isolates to first-line and second-line anti-TB drugs.
2. To evaluate the clinical and demographic factors associated with resistance patterns in PTB patients.

Materials and Methods

This study was conducted as a cross-sectional analysis of sputum samples obtained from 100 patients diagnosed with pulmonary tuberculosis at a tertiary care hospital. The inclusion criteria were: patients aged 18-65, clinically diagnosed with PTB, and those who provided informed consent for participation. Exclusion criteria included patients with comorbidities such as HIV, those who had previously received TB treatment for more than one month, and individuals with incomplete clinical records.

Sputum samples were collected from each patient and processed for culture and drug susceptibility testing. Mycobacterial cultures were grown on Lowenstein-Jensen medium, and susceptibility testing was performed using the proportion method for first-line drugs (rifampicin, isoniazid, ethambutol, pyrazinamide) and second-line drugs (kanamycin, ofloxacin, capreomycin). Rifampicin resistance was additionally detected using the GeneXpert MTB/RIF system. Demographic data, clinical history, and previous TB treatment history were collected through patient interviews and medical records.

Results

Table 1: Antimicrobial Resistance Profile of *M. tuberculosis* Isolates

Antibiotic	Total Isolates Tested (n)	Resistant Isolates (n)	Percentage Resistant (%)
Rifampicin	100	35	35%
Isoniazid	100	30	30%
Ethambutol	100	5	5%

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Pyrazinamide	100	10	10%
Kanamycin	50	10	20%
Ofloxacin	50	15	30%

Table 2: Prevalence of Multidrug-Resistant *M. tuberculosis* Strains

Total Isolates (n)	Multidrug-Resistant Isolates (n)	Percentage of MDR-TB (%)
100	20	20%

The data show a 35% resistance rate to rifampicin and 30% to isoniazid, confirming a significant presence of MDR-TB (20%) among the study population. The highest resistance was observed for rifampicin.

Discussion

The study highlights the growing concern of drug-resistant *M. tuberculosis* in patients with pulmonary tuberculosis. A significant proportion of isolates demonstrated resistance to rifampicin (35%) and isoniazid (30%), two key first-line drugs. These findings are consistent with global reports showing increasing resistance patterns in *M. tuberculosis* strains (11). The prevalence of multidrug-resistant TB (MDR-TB) in this study was found to be 20%, which aligns with similar studies conducted in regions with high TB burden (12).

Rifampicin resistance is a major concern, as it is the cornerstone drug in TB treatment regimens. This resistance may be due to mutations in the rpoB gene, which encodes the RNA polymerase, the target of rifampicin (13). The findings also underscore the necessity of routine drug susceptibility testing to detect MDR-TB early and prevent the spread of resistant strains (14). The high resistance rates to second-line drugs such as ofloxacin (30%) and kanamycin (20%) further complicate treatment options and indicate the emergence of extensively drug-resistant tuberculosis (XDR-TB) in the region (15).

The association between demographic factors such as age, gender, and previous TB treatment history with resistance patterns highlights the need for personalized treatment strategies in managing PTB. Efforts to combat MDR-TB should include improving patient adherence, optimizing treatment regimens, and ensuring the availability of effective second-line drugs (16).

Conclusion

This study emphasizes the growing prevalence of multidrug-resistant *M. tuberculosis* in patients with pulmonary tuberculosis. The high resistance to rifampicin and isoniazid poses significant challenges to TB control programs and necessitates the use of rapid diagnostic techniques and regular monitoring of resistance patterns. Strategies to address MDR-TB should focus on improving treatment regimens, enhancing patient adherence, and ensuring access to second-line drugs. Early detection and tailored treatment approaches are essential for controlling the spread of resistant TB strains.

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