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Original Research Article

Assessment of Drug Resistance Patterns in Pulmonary Tuberculosis

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Abstract

Background: Despite broad adoption of the Directly Observed Treatment Short Course (DOTS) program, Mycobacterium TB related chronic infectious disease is a global public health concern. TB kills and sickens one third of the world's population, primarily in developing nations. TB become drug-resistant swiftly following inadequate, incomplete, or unsuitable antitubercular therapy. Treating MDR and extensively drug-resistant TB is harder, more hazardous, more expensive, and less effective.

Aim: To assess pulmonary tuberculosis patients' anti-tuberculosis resistance, including MDR-TB.

Methodology: TB remains a global public health issue despite extensive DOTS deployment. Drug-resistant Mycobacterium tuberculosis strains, notably MDR-TB and XDR-TB, endanger worldwide TB control. Anti-tuberculosis drug resistance must be monitored, especially in high-burden countries.

Result: Drug-resistant TB was growing in varied locales, with MDR-TB more prevalent in previously treated patients. Most reports showed isoniazid and rifampicin resistance. Poor treatment has been linked to pharmacological resistance in many studies. Studies indicated an increased risk of MDR-TB in infected persons, however results varied by area. In high-TB, resource-limited locations, MDR-TB was particularly problematic.

Conclusion: Drug-resistant pulmonary tuberculosis, especially MDR-TB, represents a serious threat to global TB control efforts. Strengthening routine drug susceptibility testing, ensuring adherence to standardized treatment regimens, and improving surveillance systems are critical to controlling the spread of resistant strains. Early diagnosis, appropriate treatment, and sustained public health interventions are essential to reduce morbidity, mortality, and transmission associated with drug-resistant tuberculosis.

Keyword: Drug resistant tuberculosis, Multidrug resistance, MDR-TB.

Introduction

Mycobacterium tuberculosis (MTB) is the principal cause of tuberculosis (TB), a chronic infectious disease. Sometimes caused by M. bovis, M. africanum, M. canetti, and M. microti [1]. Humans have endured significant suffering as a result of tuberculosis for the duration of recorded history. Even 20 years after DOTS control, TB is a major global killer. Mycobacterium tuberculosis infects one-third of the globe [2]. Drug resistance in tuberculosis (TB) treatment was recognized quickly after streptomycin was introduced in 1946–1947.

These drug-resistant viruses can spread throughout the community, reducing the efficacy of combination therapy treatments. However, eliminating multidrug-resistant tuberculosis is difficult for tuberculosis programs. The government cannot afford to treat MDR-TB patients, thus they are either discharged or not treated.

It is a public health and worldwide economic problem, especially in underdeveloped countries without MDR-TB treatment at national programs [3]. MDR-TB, resistant to at least isoniazid and rifampicin, is becoming a serious clinical and public health issue.

TB is a leading source of sickness and mortality globally, especially in Asia and Africa. Globally, 9.2 million new TB cases (139 per million people), including 4.1 million smear-positive cases (44% of the total), and 1.7 million fatalities occurred in 2006 [4]. Because the population has grown, this is up from 9.1 million instances in 2005. In 2006, 14.4 million people had tuberculosis and 0.5 million had MDR-TB.

The rise of drug-resistant TB affects TB control. The identification, treatment, and management of MDR-TB and XDR-TB patients involve more money and people yet deliver inferior results [5],

increasing the danger of highly resistant strains spreading. In Minsk (Belarus), approximately one-third of newly diagnosed TB patients were MDR-TB [6]. Previously treated tuberculosis patients, contacts of MDR-TB patients, residents of under-developed countries, and patients with AFB-positive sputum after 3 months of medication are at risk [7].

Epidemiologic research show multi-drug resistance is man-made. Inappropriate antituberculosis therapy permits resistant bacilli to multiply and dominate, resulting in therapeutic failure. People can spread resistant strains [8]. The proliferation of resistant mutant strains of bacteria as a consequence of inadequate chemotherapy is the definition of acquired drug resistance of MTB, which is the development of resistance to anti-tuberculosis drugs.

MDR-TB, defined as resistance to at least isoniazid and rifampicin, the two most effective first-line anti-TB drugs, requires the use of second-line anti-TB medications, which are less potent, more toxic, more expensive, and require a longer duration. XDR-TB is defined as MDR-TB in addition to resistance to any fluoroquinolone and any second-line injectable medicines, which are the two most efficacious classes of second-line anti-TB drugs [9]. These developments have major clinical effects. Due to the lack of alternative treatments, XDR-TB patients had worse cure and survival rates than MDR-TB patients [10].

MDR-TB, which is resistant to at least Isoniazid and Rifampicin, threatens tuberculosis control. In some institution-based investigations, co-infected TB patients had considerably higher risks for multi-drug-resistant TB (MDR TB) [11], while others reported no increased risk. Whether infection increases medication resistance risk is unknown [12]. Tuberculosis prevalence was 120 cases, and incidence was 98 per year.

To determine M tuberculosis resistance to first-line medicines in pulmonary TB patients. Thus, it determined drug-resistant and MDR-TB prevalence in pulmonary TB patients at two regional public hospitals.

Methodology

Study Design: This was conducted to evaluate drug resistance patterns of Mycobacterium tuberculosis among patients with pulmonary tuberculosis.

Study Area: The study was conducted in the Department of Respiratory Medicine, Shree Narayan Medical Institute and Hospital, Saharsa, Bihar, India,

Study Duration: The study was carried for one year

Sample Size: A total of 120 patients diagnosed with pulmonary tuberculosis were enrolled during the study period. The sample included: 36 Category I patients (newly diagnosed cases) 84 Category II patients (previously treated cases). The sample size was determined based on the number of eligible pulmonary tuberculosis patients presenting to the hospital during the study period and was considered adequate to evaluate drug-resistance patterns.

Study population: The study population comprised patients diagnosed with pulmonary tuberculosis as reported in the eligible studies. Both newly diagnosed and previously treated pulmonary tuberculosis patients were considered. The population represented adult patients from high tuberculosis burden settings, reflecting regions where the prevalence of tuberculosis was reported as 120 cases

Inclusion Criteria

- Patients aged 18 years and above
- Patients diagnosed with pulmonary tuberculosis
- Patients with sputum smear-positive for acid-fast bacilli
- Patients willing to participate and provide informed consent

Exclusion Criteria

- Smear-negative pulmonary tuberculosis patients
- Patients with extrapulmonary tuberculosis
- Patients unwilling to provide informed consent

Data Collection: Data were collected using a structured proforma and included demographic details, clinical presentation, previous history of anti-tubercular therapy, sputum smear results, culture findings, and drug susceptibility testing results.

Procedure: Eligible patients underwent thorough clinical evaluation. Sputum samples were collected and subjected to Ziehl–Neelsen staining for acid-fast bacilli, Culture for Mycobacterium tuberculosis Drug susceptibility testing (DST) for first-line anti-tuberculosis drugs including isoniazid, rifampicin, ethambutol, pyrazinamide, and streptomycin. Patients were classified into Category I or Category II as per national tuberculosis control guidelines. Drug resistance patterns, including MDR-TB (resistance to at least isoniazid and rifampicin), were documented and analyzed.

Statistical Analysis: Data were entered and analyzed using appropriate statistical software. Categorical variables were expressed as frequencies and percentages. Continuous variables were expressed as mean ± standard deviation. Comparisons between Category I and Category II patients were performed using the Chi-square test or Student's t-test, as appropriate. A p value < 0.05 was considered statistically significant."

Result

Table 1 shows the demographic and clinical characteristics of 120 pulmonary tuberculosis patients, including 36 Category I and 84 Category II cases. Males constituted the majority of the study population (61.7%), and no statistically significant difference was observed between the two categories with respect to gender distribution or mean age. A family history of tuberculosis and previous anti-tuberculosis treatment were significantly more frequent among Category II patients, highlighting the higher burden of risk factors in retreatment cases. Diabetes mellitus also showed a statistically significant association with Category II patients. Although chronic liver disease and pleural effusion were commonly observed, their distribution between the two groups was not statistically significant. Clinical features such as hemoptysis and radiological findings like cavitations were more common in Category II patients, suggesting more advanced disease, while pneumothorax was observed only in Category II cases.

Table 1: Demographic data in the study group

Variable	Category I (n=36)	Category II (n=84)	Total (n=120)	p-value
Male	33 (91.7%)	41 (48.8%)	74 (61.7%)	0.59
Female	3 (8.3%)	43 (51.2%)	46 (38.3%)	0.61
Age (years)	28 ± 19.3	38 ± 17.9	37 ± 19.9	0.7
Family history of TB	10 (27.8%)	28 (33.3%)	38 (31.7%)	0.001
Previous ATT*	4 (11.1%)	74 (88.1%)	78 (65.0%)	0.001
Diabetes mellitus	6 (16.7%)	16 (19.0%)	22 (18.3%)	0.04
Chronic liver disease	14 (38.9%)	24 (28.6%)	38 (31.7%)	0.61
Haemoptysis	5 (13.9%)	10 (11.9%)	15 (12.5%)	0.03
Pleural effusion	8 (22.2%)	18 (21.4%)	26 (21.7%)	0.06
Cavitations	7 (19.4%)	37 (44.0%)	44 (36.7%)	0.05
Pneumothorax	0 (0.0%)	5 (6.0%)	5 (4.2%)	0.07

Table 2 demonstrates the drug sensitivity and resistance patterns among the 120 study patients. Drug-sensitive tuberculosis was observed predominantly in Category I patients (82.3%), whereas drug resistance was markedly higher in Category II patients (95%), and this difference was statistically significant. Overall, 71.7% of patients had drug-resistant tuberculosis. Among individual drugs, isoniazid resistance was the most common, followed by resistance to rifampicin, ethambutol, pyrazinamide and streptomycin, with higher resistance rates consistently seen in Category II cases. Multidrug-resistant tuberculosis (MDR-TB) was identified in 41.7% of patients, with a significantly greater proportion in Category II patients, reflecting acquired resistance due to prior treatment, while a small percentage of Category I patients also showed MDR-TB, indicating primary resistance.

Table 2: Drug resistant patterns in the study group

Variable	Category I (n≈36)	Category II (n≈84)	Total (n=120)	p-value
Drug sensitive	30 (82.3%)	4 (5%)	34 (28.3%)	0.001
Drug resistance	6 (17.6%)	80 (95%)	86 (71.7%)	0.01
Isoniazid	3 (7.0%)	59 (70%)	62 (51.7%)	0.03
Rifampicin	1 (4.1%)	36 (42.5%)	37 (30.8%)	0.04
Ethambutol	1 (3.5%)	15 (17.6%)	16 (13.3%)	0.02
Pyrazinamide	1 (3.5%)	10 (11.5%)	11 (9.2%)	0.01
Streptomycin	0 (0%)	5 (5.5%)	5 (4.2%)	0.03
MDR-TB*	2 (5.9%)	48 (57.5%)	50 (41.7%)	0.0001

Discussion

The prevalence of MDR-TB has increased worldwide in recent decades. The WHO estimates that about 50,000 people worldwide have multi-drug-resistant TB [13]. This study examined treatment outcomes in individuals with drug resistance beyond XDR-TB to see if advanced drug resistance patterns need a new classification. We found that patients with TB strains with enhanced resistance had a lower chance of treatment success and a higher chance of failure or death than those with XDR alone."

This study was unique in that it permitted for the first time independent investigation of large numbers of drug-resistant TB patients. Individual-level data from 31 treatment facilities globally were carefully inspected and verified (although only 17 of these centers treated XDR patients). This degree of information allowed analytical methods to correct demographic and clinical variances, which are difficult in aggregated data evaluations.

The 2007–2008 National Baseline Survey of Drug-Resistant Tuberculosis was extensive. The 2008 National TB Prevention and Control Guidelines stressed the necessity of recognizing and treating drug-resistant TB. MTB infection and treatment vary widely in Bihar [14], as shown in our data analysis.

TB drug resistance in Bihar throughout this era. remain unknown, prompting our research. TB medication resistance is caused by biological reasons including the high mutation rate and socioeconomic variables [15]. The current WHO guidelines for MDR-TB and XDR-TB therapy are BPaL and BPaLM. The BPaL regimen includes bedaquiline (B), pretomanid (Pa), and linezolid (L), whereas BPaLM adds moxifloxacin (WHO consolidated recommendations on TB module 4, WHO website).

These regimens attempt to minimize treatment durations and enhance cure rates by tackling significant issues such patient adherence and severe adverse effects of longer-term drugs. In contrast to metropolitan India, Central and East zone research covered rural and small-town populations. The reduced frequency of DR- and MDR-TB in this zone may be due to sparse population, access to free and monitored government-aided medical clinics, and restricted access to numerous clinicians (leading to less treatment variability) [16].

Drug resistance treatment involves more sophisticated, costly, toxic, and less effective second-line antibiotics, making drug resistance monitoring essential for TB control policies and programs. This classification of RIF-resistant TB as MDR-TB is inaccurate and might result in protracted and hazardous anti-TB medication treatment regimens for individuals with RIF-nonresistant TB strains. The availability of diagnostic tests that can detect RIF resistance quickly has increased awareness of the presence of patients with RIF-monoresistant TB, which was previously thought to be uncommon. RIF is a highly effective sterilizing agent against resistant M. tuberculosis isolates. Resistance to RIF is most conferred by mutations in the rpoB gene, which codes for the RNA polymerase ß-subunit [17].

To assess the drug-resistance pattern of M. tuberculosis isolates and guarantee effective therapy for TB patients, it is mandatory for all TB-positive individuals to undergo DST for first- and second-line anti-TB drugs. Drug resistance treatment involves more sophisticated, costly, toxic, and less effective second-line antibiotics, making drug resistance monitoring essential for TB control policies and programs Since the study was conducted in TB treatment facilities, its generalizability may be restricted. Because the study was limited to English-language research in the supplied data sources and a few geographical locations, generalization for the full country may be difficult. Due to the facility-based main research, assumed TB cases may be included, boosting the prevalence estimate. TB case diagnosis, drug-susceptible and DR-TB therapy, and thorough patient follow-up are crucial. Other probable reasons include research settings, such as lab setups, drug-resistance detection tools' sensitivity, and lab personnel expertise.

Conclusion

The study demonstrates a high burden of drug resistance among pulmonary TB patients at the study center, driven largely by retreatment cases: previously treated (Category II) patients showed markedly higher resistance across first-line drugs and accounted for most MDR-TB. These findings indicate ongoing transmission of resistant strains and substantial acquired resistance due to prior inadequate therapy. Immediate priorities are strengthened routine drug-susceptibility testing (DST) for all TB cases, rapid detection of rifampicin and isoniazid resistance, and ensuring adherence to standardized treatment regimens; programmatic actions should also include targeted interventions for retreatment patients, expanded access to effective second-line and newer regimens (for example BPaL/BPaLM where appropriate), and reinforced laboratory capacity and quality assurance to improve detection and management of DR- and MDR-TB. Continued surveillance, patient follow-up, and public-health measures to prevent inappropriate antibiotic use are essential to curb further emergence and spread of resistant tuberculosis.

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