Original Article

Factors Influencing Drug-Resistant Tuberculosis Treatment Outcomes in Banda District of Bundelkhand Region

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Abstract

Introduction

Tuberculosis (TB) remains a critical public health challenge in India, claiming nearly half a million lives annually. Additionally, around one million cases go undiagnosed or inadequately diagnosed each year, leaving them unreported. TB, caused by the airborne bacterium *Mycobacterium tuberculosis*. (1-3)

Drug-resistant tuberculosis (TB) is a growing threat worldwide. At the molecular level, *Mycobacterium tuberculosis* acquires resistance through chromosomal mutations in drug-target genes (*rpoB*, *katG*, *inhA*) and mechanisms like efflux-pump overexpression, altered cell-wall permeability, and metabolic adaptation, which reduce antibiotic effectiveness. (15)

DRTB remains prevalent globally, with population growth driving a modest 0.2% increase in incidence from 2022 to 2023. In 2023, TB occurrence was recorded at 134 new cases per 100,000 people. High-burden countries accounted for 87% of all cases, with India alone contributing 26%. Males represented 55% of TB cases globally, while women constituted 33% and children, along with young adolescents, accounted for 12% .(1-3)

India and the WHO South-East Asia and African regions bore the majority of TB-related deaths in 2023. Among HIV-negative individuals, 80% of global TB deaths occurred in these regions, with India alone responsible for 30%. Combined deaths of HIV-positive and HIV-negative individuals also followed a similar trend, with these regions accounting for 81% of fatalities and India contributing to 26% of the total. India's overwhelming TB burden is exacerbated by drug-resistant TB (DR-TB), which accounts for 27% of global DR-TB cases. DR-TB treatment poses significant challenges due to its complexity and associated poor adherence, making it more difficult to manage than drug-sensitive TB.(2)

DR-TB in India has been proactive in combating TB through initiatives like the revised National

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Strategic Plan to eliminate TB by 2025. India has a significant burden of drug-resistant tuberculosis (DR-TB), with 2.5% of new TB cases and 13% of previously treated cases classified as DR-TB. The country accounts for nearly 27% of the global TB incidence, making it the highest TB burden country in the world. In 2022, India recorded 2.82 million new TB cases, with an estimated 331,000 deaths due to the disease.

Aim & Objectives:

1. To estimate the prevalence of DR- TB in Banda district of Bundelkhand region
2. To determine factors Influencing Drug-Resistant tuberculosis Treatment Outcomes

Material and Methods

Type of Study: Cross-sectional study.

Sampling Unit: public and private health facilities.

Study area - Banda district of Bundelkhand region of Uttar Pradesh

Study population - All public health facilities (District Hospital, AB-HWC, PHC, CHC, and DH). All DR-TB registered patients in Nikshay portal under NTEP.

Period of Study: May 2024 to December 2024

Inclusion criteria: All Drug resistant TB patients registered in Nikshay portal under NTEP of Banda District health care facilities.

Exclusion criteria: All Drug resistant TB patients who does not give consent for participating in my study.

- DR- TB patients with severe complications and Non-registered DR- TB patients

Sample size:

All 130 Drug resistant TB patients registered in NTEP of Banda District till data saturation is achieved.

Plan of study

- DR-TB patients list was taken from district tuberculosis office and prepare structural guided questionnaire and then visit to DR-TB patients for in-depth interview.
- Written informed consent was obtained from the CMO, and DTO Banda for the study.
- All health care facilities was assessed using checklist questions as per the Differentiated Tuberculosis Care Guidelines (2021) given by Central Tuberculosis Division.
- In depth interview of In-charge of 1 district tuberculosis hospital, 2 CHC, 10 PHC and 18 AB-HWCs was conducted.
- The structured In-Depth Interview (IDI) schedule had interview questions (depending on the stakeholders for whom it was customized). Questions were close-ended and were based on factors affecting the treatment outcome of DR-TB patients which includes delay in treatment initiation, on time drug received, adherence to treatment and interruption/missed dose of drugs.

Study Tools

(A) Assessment of patients: A total of 130 drug resistant TB patients list was collected from District tuberculosis office, Banda. We visited the house of patients for their personal and family interview.

(B) All drug resistant TB patients registered under NTEP (N=130) were assessed at their residence using semi-structured questionnaire by in depth interview.

(C) In depth interviews: Structured in depth interviews were taken at each level which consist of date of diagnosis, Previous H/O contact/TB , Family H/O TB, symptoms present, adherence to treatment ,drug availability on time, missed dose and social stigma faced.

- **Ethical approval:** Ethical approval was taken from the institutional ethical review board at RDMC, Banda**. (IEC/RDMC/Cert/18; Date:24/08/2023) (Appendix)** Participants were informed of the research objectives and assured that their identities would remain confidential. All participants provided written consent before taking part in the study.
- **Statistical analysis:** the data was entered in MS excel and descriptive analysis was done using short appropriate using frequency and percentages were done using statistical tool SPSS version 2.6.

Results

1. Prevalence and Distribution of Drug-Resistant TB Cases

Table 1: R.R. TB accounted for the majority at 68.46%, followed by MDR-TB at 27.69%. H. Mono was less common, representing 1.54% of cases. Pre-XDR had a minimal share at 2.31%, while no cases of XDR were reported (0.0%). The distribution highlights R.R. TB as the most prevalent form within this cohort, with a clear overall total of 100%.

2. Factors influencing drugs and treatment outcomes

Table 2 represents among patients with different types of drug resistance, those with H.mono all (100%) completed treatment with no cases of incomplete treatment, cure, or death. In patients with rifampicin resistance (RR), 37.08% completed treatment, 21.35% had incomplete treatment, 25.84% were cured, and 15.73% died. Among those with multi-drug resistant (MDR) TB, 44.44% completed treatment, 13.89% had incomplete treatment, 22.22% were cured, and 19.44% died. For patients with pre-extensively drug-resistant TB (Pre-XDR), 33.33% completed treatment, and 66.67% died, with no cases of incomplete treatment or cure.

Regarding adverse effects during medication, among patients who experienced adverse effects, 29.31% completed treatment, 17.24% had incomplete treatment, 18.97% were cured, and 34.48% died. In contrast, among those without adverse effects, 48.61% completed treatment, 19.44% had incomplete treatment, 27.78% were cured, and 4.17% died. When considering missed or interrupted doses, among patients who missed doses, 26.98% completed treatment, 19.05% had incomplete treatment, 26.98% were cured, and 26.98% died. Among those who did not miss doses, 52.24% completed treatment, 17.91% had incomplete treatment, 20.90% were cured, and 8.96% died.

Patients experiencing adverse effects, missed doses, non-adherence, delayed treatment, or lack of timely TB medication showed a higher risk of incomplete treatment and mortality compared to those without these complications. Among those with adverse effects, 34.48% died, whereas only 4.17% of patients without adverse effects died. Similarly, patients who missed doses had a mortality rate of 26.98% compared to 8.96% for those who adhered to their schedule. Non-adherent patients faced an even higher risk, with 47.37% mortality, while adherent patients had a significantly lower rate of 12.61%. Delays in starting treatment also negatively impacted outcomes, as 31.71% of delayed patients died versus only 11.24% of non-delayed patients. These findings highlight the crucial role of adherence and timely intervention in improving treatment success.

Further, timely sputum rechecking and hospital admission played a significant role in patient outcomes. Among patients who underwent sputum rechecking after two months, 13.39% died, compared to a much higher 44.44% mortality rate among those who were not rechecked. Hospital admission, however, had a mixed impact—those admitted had a mortality rate of 22.22%, whereas non-admitted patients showed a lower rate of 3.23%, though they had a higher rate of incomplete treatment (32.26%). Sputum test results also influenced treatment success, with patients testing positive for sputum showing a higher cure rate (27.27%) compared to 21.33% among those with negative results. Overall, treatment adherence, timely medical interventions, and monitoring through sputum rechecking significantly contributed to better patient outcomes and reduced mortality.

Table 1: Distribution of study subjects based on Prevalence of Drug-Resistant TB Cases

PREVALENCE OF TB	N	%
H.MONO	2	1.54
R.R. TB	89	68.46%
MDR TB	36	27.69%
PRE XDR	3	2.31%
XDR	0	0.0
Grand total	130	100

Table 2. Factors influencing drugs and treatment outcome.

Variables	Complete		Incomplete		Cured		Death		Total	
	N (%)		N (%)		N (%)		N (%)		N (%)	
Drug resistance TB different Categories										
H.mono	2	100.00%		0.00%		0.00%		0.00%	2	100.00%
RR	33	37.08%	19	21.35%	23	25.84%	14	15.73%	89	100.00%
MDR	16	44.44%	5	13.89%	8	22.22%	7	19.44%	36	100.00%
Pre-XDR	1	33.33%		0.00%		0.00%	2	66.67%	3	100.00%
Adverse effect during Medication										
Yes	17	29.31%	10	17.24%	11	18.97%	20	34.48%	58	100.00%
No	35	48.61%	14	19.44%	20	27.78%	3	4.17%	72	100.00%
Missed/Interrupted dose										
yes	17	26.98%	12	19.05%	17	26.98%	17	26.98%	63	100.00%
no	35	52.24%	12	17.91%	14	20.90%	6	8.96%	67	100.00%
Adherence to treatment										
Yes	46	41.44%	22	19.82%	29	26.13%	14	12.61%	111	100.00%
No	6	31.58%	2	10.53%	2	10.53%	9	47.37%	19	100.00%
Delay of more than 1 week in starting the treatment										
Yes	13	31.71%	6	14.63%	9	21.95%	13	31.71%	41	100.00%
No	39	43.82%	18	20.22%	22	24.72%	10	11.24%	89	100.00%
TB medication received on time										
Yes	39	37.50%	20	19.23%	28	26.92%	17	16.35%	104	100.00%
No	13	50.00%	4	15.38%	3	11.54%	6	23.08%	26	100.00%
Sputum rechecked after 2 months of treatment										
Yes	47	41.96%	21	18.75%	29	25.89%	15	13.39%	112	100.00%
No	5	27.78%	3	16.67%	2	11.11%	8	44.44%	18	100.00%
Result of sputum check										
Positive	27	49.09%	4	7.27%	15	27.27%	9	16.36%	55	100.00%
negative	25	33.33%	20	26.67%	16	21.33%	14	18.67%	75	100.00%
Hospital Admission during treatment										
Yes	37	37.37%	14	14.14%	26	26.26%	22	22.22%	99	100.00%
No	15	48.39%	10	32.26%	5	16.13%	1	3.23%	31	100.00%

Discussion

Rifampicin-resistant tuberculosis (R.R. TB) is the most common form of drug-resistant TB, accounting for 68.46% of cases, followed by multidrug-resistant TB (MDR-TB) at 27.69%. Studies from Ethiopia and India confirm the dominance of R.R. TB, likely due to the widespread use of Gene Xpert testing, which detects rifampicin resistance early. Treatment outcomes vary significantly, with H.mono cases achieving 100% success, while pre-XDR TB cases show a poor prognosis with a 66.67% death rate and no cures, aligning with global findings that highlight the challenges of treating highly resistant TB strains.

Adverse drug effects, poor adherence, and delayed treatment initiation significantly impact survival. Patients with adverse drug reactions face higher mortality rates, and missed doses reduce treatment success while increasing deaths. Studies in South Africa, India, and China indicate that adherence is a crucial factor, with non-adherent patients experiencing nearly four times the mortality of adherent ones. Delays in starting treatment also worsen outcomes, as seen in research from

Bangladesh, where delayed initiation is linked to advanced disease progression and increased mortality.

Monitoring and hospital admission further influence treatment success. Patients who underwent sputum rechecking had better completion rates, reinforcing the importance of regular monitoring. However, sputum positivity at two months, despite higher completion rates, correlated with lower cure rates and increased mortality risks. Hospitalized patients faced a significantly higher death rate (22.22%), which likely reflects the severity of their illness rather than hospitalization itself. Regular follow-ups and patient support are critical in improving treatment outcomes and survival rates in drug-resistant TB cases.

Conclusion

The study highlights rifampicin-resistant tuberculosis (R.R. TB) as the predominant form of drug-resistant TB, consistent with recent global trends. Treatment outcomes varied considerably based on the type of drug resistance, patient adherence, adverse effects, and timely initiation of therapy. Patients with H.mono had the best outcomes, while those with pre-XDR TB faced the highest mortality. Adverse drug reactions, missed doses, and poor adherence were strongly associated with unfavourable outcomes and higher death rates, emphasizing the need for better patient support and side-effect management. Delay in treatment initiation and lack of regular sputum monitoring were also critical factors leading to increased mortality. These findings reinforce global evidence that early diagnosis, consistent treatment adherence, prompt management of adverse effects, and regular patient monitoring are vital to improving outcomes in drug-resistant TB. Strengthening patient-centred approaches remains essential for tackling the complex challenges posed by drug-resistant tuberculosis.

Recommendation

The study recommends to improve outcomes in drug-resistant TB, it is essential to ensure early diagnosis, strengthen patient adherence through education and support, manage adverse effects promptly, and conduct regular treatment monitoring. Health systems should prioritize timely treatment initiation and adopt patient-centred care strategies to reduce mortality and enhance treatment success.

Limitation of the Study

This study has following limitations. The small sample size and its observational, cross-sectional design limit the capacity to infer causal relationships. Data were obtained through self-reported responses collected via semi-structured, in-depth interviews conducted at patients' residences, which may have introduced recall, reporting, response, and interviewer biases, potentially compromising data accuracy and completeness. Furthermore, key variables such as comorbidities, socioeconomic status, psychosocial factors, and precise treatment regimens were not evaluated. The exclusion of patients with severe complications and those not registered in the Nikshay portal may have resulted in the underrepresentation of more severe DR-TB cases.

Relevance of the Study

This study provides critical insights into factors influencing treatment outcomes in drug-resistant TB, highlighting the importance of early diagnosis, adherence, and managing adverse effects. By identifying key predictors of mortality and treatment failure, the findings can guide targeted interventions, improve patient management strategies, and support global TB control efforts.

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