ORIGINAL ARTICLE

Pre-diagnosis and pre-treatment attritions among presumptive MDR/RR-TB patients in Chonburi province, Thailand, 2015-2017

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ABSTRACT

The low detection rate of multidrug-resistant tuberculosis (MDR-TB) is one of the major obstacles to TB control in Thailand. Thus, this study aimed to assess pre-diagnosis and pre-treatment attrition rates among patients suspected of having MDR-TB, identify factors related to pre-diagnosis attrition, and determine the turnaround times (TAT) of diagnosis and treatment pathway. A retrospective cohort analysis was conducted using a record review. Among 972 presumptive MDR-TB patients, only 354 (36.4%) underwent drug-susceptibility testing (DST). Multidrug-resistant and rifampicin-resistant tuberculosis (MDR/RR-TB) was found in 32 patients, consisting of 26 (81.2%) males and 6 (18.8%) females. Pre-diagnosis and pre-treatment attrition rates were 63.58 % and 28.1%, respectively. Furthermore, the median (interquartile range [IQR]) turnaround time for MDR-TB testing was seven days (IQR 0-62 days), and the median time to the start of MDR-TB treatment was 20 days (IQR 2-38 days). Meanwhile, the factors associated with pre-diagnosis attrition were migrants, presumptive TB cases presenting at secondary-level hospitals, TB patients identified from hospitals outside the Ministry of Public Health, and extrapulmonary TB cases. The results of this research demonstrated that only one-third of patients at risk of MDR-TB underwent DST. Therefore, it is essential for healthcare workers at all levels to be educated and trained to identify patients that are eligible for DST. In addition, other interventions such as the decentralization of laboratory services and MDR-TB treatment to secondary-care district hospitals are also urgently needed.

Key words:
attrition; MDR/RR-TB; diagnosis; presumptive MDR-TB

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INTRODUCTION

Multidrug-resistant and rifampicin-resistant tuberculosis (MDR/RR-TB) cases have become a global issue with substantial morbidity and death[1]. Around 465,000 cases of rifampicin-resistant tuberculosis were reported in 2019 worldwide, with 78 % being multidrug-resistant tuberculosis (MDR-TB)[2]. Furthermore, only one-third of MDR-TB patients have access to effective treatment[3,] and the treatment success rate remains low (57%) globally[1]. In Thailand, an estimated 1,341 cases of MDR-TB were reported in 2018. Of these, 931 (69.4%) cases had started the second-line treatment[4]. Furthermore, the number of extensively drug-resistant tuberculosis (XDR-TB) cases has continued to increase from four cases in 2015[5] to 29 cases in 2018[4].

Undiagnosed and untreated MDR/XDR-TB cases pose a high risk due to the potential spread of MDR-TB strains to others. Thus, there is an urgent need to increase the capacity for rapid diagnosis and improve MDR-TB treatment. In recent years, molecular techniques to detect drug-resistant tuberculosis were introduced, providing results within two hours of initiating the test. Therefore, the World Health Organization (WHO) recommended molecular testing as an initial diagnostic tool for all patients with presumptive MDR-TB, especially in high burden TB countries[6]. However, previous research found substantial pre-diagnosis and pre-treatment attrition rates for MDR-TB cases in high burden TB countries such as India, Bangladesh, and Cambodia[7-11]. Therefore, the gaps in detection and treatment for MDR-TB remain challenging in these countries.

In Thailand, molecular diagnostic tests (GeneXpert® IV and Line Probe Assay [LPA]) were implemented across the country, but less than 30% of the estimated MDR-TB cases were reported to the national tuberculosis control program (NTP)[12]. This indicated a huge gap in the MDR-TB detection and treatment, thus necessitating a multifaceted approach to address the issue. Therefore, the objectives of this study were to determine pre-diagnosis and pre-treatment attrition among patients suspected of drug-resistant TB, explore factors associated with attrition, and determine turnaround times of diagnosis and treatment pathway. The findings from this study can contribute to policymaking in improving case detection and reducing treatment delay for MDR-TB in Thailand and other similar settings.

METHODS

Study design and population

A retrospective cohort analysis was conducted by reviewing the records of all patients with TB between 2015 and 2017 who were registered for treatment and met the presumptive MDR-TB criteria [12]. Data were obtained from the TB registration database of Chonburi province. This study was approved by the Research Ethics Committee of Chonburi hospital (No. 60/2560). Since this retrospective cohort study involved the analysis of secondary data from the TB registration database of the Provincial Health Office, the ethics committee granted a waiver of informed consent.

Inclusion and exclusion criteria

The inclusion criteria were as follows: 1) patients with TB aged 15 years and above who were registered in the TB registry database between 2015 and 2017, and 2) those who met the presumptive MDR-TB criteria[12]. Meanwhile, TB patients who had a change in diagnosis and those with sputum culture positive for other *Mycobacterium species* were excluded.

Operational definitions

The variables in this study were defined operationally using the following terms:

- The criteria for presumptive MDR-TB include: 1) people with HIV/TB co-infection, 2) TB patients who are in close contact with known MDR-TB cases, 3) prison inmates with TB disease, 4) TB patients who are smear-positive on the 3rd and 5th months of follow-up 5) TB patients requiring retreatment, 6) TB patients with chronic conditions such as diabetes mellitus (DM) and chronic obstructive pulmonary disease (COPD), 7) immigrants with TB, and 8) healthcare workers with TB.
- MDR/RR-TB patient is defined as a patient who developed active TB disease with strains resistant to isoniazid (INH) and rifampicin or rifampicin alone. The molecular diagnostic test or culture with drug-susceptibility testing (DST) was used to diagnose the MDR/RR-TB patients. In community hospitals, clinical specimens of patients suspected of having MDR-TB were referred to central reference laboratories at regional hospitals or regional disease prevention and control offices, where the molecular diagnostic test is available.
- Pre-diagnosis attrition refers to the failure to undergo molecular testing or culture with DST among patients at risk of MDR-TB.
- Pre-treatment attrition means failure to initiate second-line anti-TB drugs after multidrug-resistant and rifampicin-resistant tuberculosis was diagnosed.
- Delay in treatment initiation refers to the average time from MDR/RR-TB diagnosis to start MDR-TB treatment.
- Extrapulmonary tuberculosis (EPTB) is defined as the occurrence of tuberculosis in any part of the body outside of the lungs such as the pleura, lymph nodes and *bones*.
- Disseminated tuberculosis is a severe form of TB that involves two or more noncontiguous sites resulting from hematogenous dissemination of *Mycobacterium tuberculosis*.

Microbiological methods

Culture and drug susceptibility test

The BD BACTEC™ MGIT™ 960 Mycobacteria Culture System, BD BACTEC™ MGIT™ 960 Supplement Kit for TB culture, and BD MGIT™ TBc Identification Test were used for M.TB complex identification from liquid culture (Becton Dickinson, Franklin Lakes, NJ, United States). Then, BACTEC™ MGIT™ 960 SIRE Kit was used to perform an antimycobacterial susceptibility test according to the manufacturer's instructions[13].

Xpert MTB/RIF assay

The Xpert MTB/RIF assay was carried out following the manufacturer's guidelines (Cepheid, Sunnyvale, CA, USA)[14]. First, the GeneXpert sample reagent was added to the sputum specimens and incubated for 15 minutes. Next, the specimen was mixed during the incubation period by inverting the tubes twice. Finally, 2 ml of the mixed solution were transferred into the Xpert MTB/RIF cartridge and later placed in the GeneXpert machine.
The results were available within two hours after the test.

Statistical Analysis

Descriptive statistics were utilized to describe data in the study. Delays in MDR/RR-TB diagnosis and treatment initiation were summarized using median

and interquartile range (IQR). Baseline characteristics and clinical features of patients at risk of MDR-TB who did and did not undergo molecular testing or culture with DST were compared using the Chi-square test or Fisher's exact test. In addition, Logistic regression analysis was carried out to identify factors related to attrition. The variables with p-values of less than 0.2 were entered into multivariate analysis. The backward elimination analysis started with all the selected variables in the model. Then, the variable with the highest p-value was removed, and this process was repeated until all remaining variables were significant. The odds ratio (OR) and 95% confidence intervals (CI) were calculated. Statistical significance was denoted by $p<0.05$.

RESULTS

A total of 972 TB patients fulfilled the presumptive MDR-TB criteria. Among all eligible participants, 618 did not undergo culture-based DST or molecular testing. The presumptive MDR-TB patient's diagnostic and treatment process is illustrated in Figure 1.

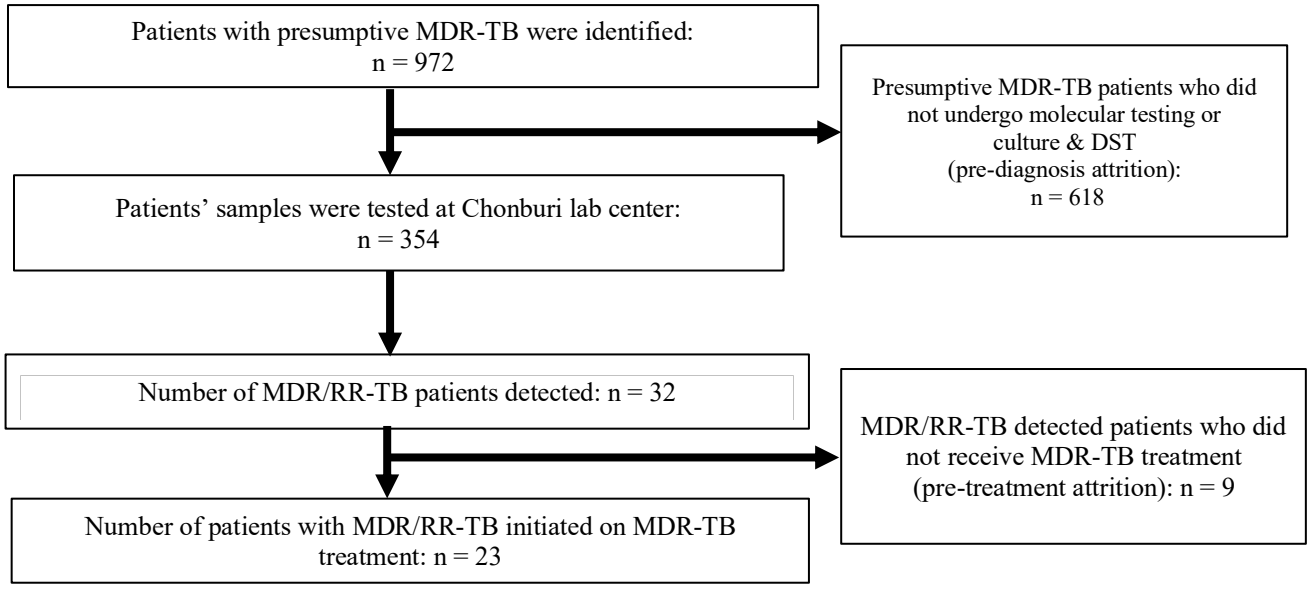

Figure 1: The diagnostic and treatment process for presumptive MDR-TB patients

The demographic and clinical characteristics of patients at risk of MDR-TB are presented in Tables 1 and 2.

Table 1 Demographics of the study population

Variables	Presumptive MDR-TB patients (Total=972)	Not undergo molecular testing or culture with DST (Total= 618)	Undergo molecular testing or culture with DST (Total =354)	Laboratory indicated MDR/RR-TB patients (Total =32)	Not initiated MDR-TB treatment (Total =9)
Gender					
Female	277 (28.5%)	172 (62.1%)	105 (37.9%)	6/105 (5.7%)	0
Male	695 (71.5%)	446 (64.2%)	249 (35.8%)	26/249 (10.4%)	9/26 (34.6%)
Nationality					
Thai	765 (78.7%)	438 (57.2%)	327 (42.8%)	31/327 (9.5%)	9/31 (29.0%)
Migrant	207 (21.3%)	189 (91.3%)	18 (8.7%)	1/27 (3.7%)	0
Age group					
<31	244 (25.1%)	166 (68.0%)	78 (32.0%)	7/78 (9.0%)	3/7 (42.9%)
31-45	449 (46.2%)	293 (65.3%)	156 (34.7%)	11/156 (7.0%)	2/11 (18.2%)
46-60	223 (23.0%)	128 (57.4%)	95 (42.6%)	10/95 (10.5%)	3/10 (30.0%)
≥ 61	56 (5.7%)	31 (55.4%)	25 (44.6%)	4/25 (16.0%)	1/4 (25.0%)
Occupation					
Labor	507 (52.1%)	377 (74.4%)	130 (25.6%)	12/130 (9.2%)	3/12 (25.0%)
Unemployment	307 (31.7%)	150 (48.9%)	157 (51.1%)	15/157 (9.5%)	3/15 (20.0%)
Others (e.g. Farmer, merchant)	158 (16.2%)	91 (57.6%)	67 (42.4%)	5/67 (7.5%)	3/5 (60.0%)
Being prison inmates					
Yes	119 (12.2%)	72 (60.5%)	47 (39.5%)	4/47 (8.5%)	2/4 (50.0%)
No	853 (87.8%)	546 (64.0%%)	307 (36.0%)	28/307 (9.1%)	7/28 (25.0%)
Underlying disease:					
HIV					
Positive test result	500 (51.5%)	299 (59.8%)	201 (40.2%)	10/201 (5.0%)	6/10 (60.0%)
Negative test result	390 (40.1%)	259 (66.4%)	131 (33.6%)	18/131(13.7%)	3/18 (16.7%)
Unknown	82 (8.4%)	60 (73.2%)	22 (26.8%)	4/22 (18.2%)	0
DM					
Yes	16 (1.6%)	10 (62.5%)	6 (37.5%)	0	0
No/unknown	956 (98.4%)	608 (63.6%)	348 (36.4%)	32/348 (9.2%)	9/32 (28.1%)
COPD					
Yes	1 (0.1%)	1 (100%)	0	0	0
No/unknown	971 (99.9%)	617 (63.5%)	354 (36.5%)	32/354 (9.0%)	9/32 (28.1%)
Contact MDR-TB cases					
Yes	13 (1.3%)	7 (53.8%)	6 (46.2%)	2/6 (33.3%)	0
No	959 (98.7%)	611 (63.7%)	348 (36.3%)	30/348 (8.6%)	9/30 (30.0%)
Hospital level[a]					
Tertiary care level (A)	337 (34.7%)	165 (49.0%)	172 (51.0%)	15/172 (8.7%)	2/15 (13.3%)
Secondary care level (S, M)	397 (40.8%)	271 (68.3%)	126 (31.7%)	15/126(11.9%)	5/15 (33.3%)
Secondary care level (F)	124 (12.8%)	89 (71.8%)	35 (28.2%)	1/35 (2.8%)	1/1 (100%)
Private Hospital	46 (4.7%)	41 (89.1%)	5 (10.9%)	1/5 (20.0%)	1/1 (100%)
University Hospital	25 (2.6%)	14 (56.0%)	11 (44.0%)	0	0
Red Cross Hospital	43 (4.4%)	38 (88.4%)	5 (11.6%)	0	0

Note: [a] *Hospital level: Advanced-level hospital (A); Standard-level hospital (S); Middle-level hospital (M); First-level hospital (F)*

Table 2 Clinical features of the study population

Variables	Presumptive MDR-TB patients (Total=972)	Not undergo molecular testing or culture with DST (Total= 618)	Undergo molecular testing or culture with DST (Total =354)	Laboratory indicated MDR/RR-TB patients (Total =32)	Not initiated MDR-TB treatment (Total =9)
Registration group					
Retreatment	156 (16.1%)	69 (44.2%)	87 (55.8%)	20/87 (23.0%)	4/20 (20.0%)
New	708 (72.8%)	485 (68.5%)	223 (31.5%)	10/223 (4.5%)	4/10 (40.0%)
Transfer in	108 (11.1%)	64 (59.3%)	44 (40.7%)	2/44 (4.5%)	1/2 (50.0%)
Site of TB					
Pulmonary	848 (87.2%)	540 (63.7%)	308 (36.3%)	31/308 (10.0%)	8/31 (25.8%)
Extrapulmonary	96 (9.9%)	75 (78.1%)	21 (21.9%)	0	0
Disseminated	28 (2.9%)	3 (10.7%)	25 (89.3%)	1/25 (4.0%)	1 (100%)
Follow up sputum AFB smear at 3rd month					
Positive					
Negative/not done	47 (4.8%)	20 (42.5%)	27 (57.5%)	3/27 (11.1%)	0
	925 (95.2%)	598 (64.7%)	327 (35.3%)	29/327 (8.9%)	9/29 (31.0%)
Follow up sputum AFB smear at 5th month					
Positive	19 (1.9%)	7 (36.8%)	12 (63.2%)	2/12 (16.7%)	1/2 (50.0%)
Negative/not done	953 (98.1%)	611 (64.1%)	342 (35.9%)	30/342 (8.8%)	8/30 (26.7%)

Univariate and multivariate logistic regression analyses were conducted to identify the factors associated with pre-diagnosis attrition among presumptive MDR-TB cases. Factors associated with pre-diagnosis attrition after adjusting for the potential confounding factors are shown in Table 3.

Table 3 Characteristics, clinical factors, and associated factors with pre-diagnosis attrition among presumptive MDR/RR-TB cases

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p*	OR	95% CI	*p*
Nationality						
Thai	Ref.					
Migrant	4.97	3.24-7.64	< 0.001	2.40	1.37 – 4.22	0.002
Occupation						
Labor	Ref.					
Unemployment	0.32	0.24-0.44	< 0.001	0.51	0.32 – 0.81	0.004
Other	0.46	0.32-0.68	< 0.001	0.58	0.35 – 0.97	0.03
Underlying disease:						
HIV						
- positive HIV test results	0.71	0.54-0.92	0.01	0.42	0.27 – 0.67	<0.001
- negative HIV test results/Unknown	Ref.					
DM						
Yes	0.95	0.34-2.64	0.92	-	-	-
No	Ref.					

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p*	OR	95% CI	*p*
Hospital-level						
Tertiary care level (A)	Ref.					
Secondary care level (S, M)	2.24	1.66-3.02	< 0.001	1.65	1.04 - 2.61	0.03
Secondary care level (F)	2.65	1.69-4.13	< 0.001	2.46	1.42 – 4.24	0.001
Private hospital	8.54	3.29-22.16	< 0.001	7.76	2.62 – 22.95	<0.001
University hospital	0.49	0.58-3.00	0.49	1.39	0.52 - 3.68	0.50
Red Cross hospital	7.92	3.04-20.62	< 0.001	6.88	2.43 – 19.46	<0.001
Have health insurance						
Yes	Ref.					
No	3.66	2.25-5.95	< 0.001	-	-	-
Site of TB						
Pulmonary	Ref.					
Extrapulmonary	0.06	0.02-0.22	< 0.001	2.30	1.31 – 4.06	0.004
Disseminated	2.03	1.23-3.37	< 0.006	0.10	0.03 - 0.37	<0.001
Follow up sputum AFB smear at 3rd or 5th month						
Positive	0.36	0.21-0.61	< 0.001	0.18	0.09 – 0.36	<0.001
Negative / not done	Ref.					
Registration group						
New	Ref.					
Transfer in	0.66	0.44-1.01	0.05	0.72	0.45 - 1.16	0.17
Retreatment	0.36	0.25-0.51	< 0.001	0.32	0.20 - 0.53	<0.001

Table 4: Turnaround time (TAT) of diagnostic and treatment processes for patients with presumptive MDR-TB

Variables	Median (IQR) days (n [a])	
	Molecular testing	Culture & DST
- Days from date of eligibility for molecular testing or culture to date of sample received by Chonburi lab center [b]		
All hospital levels	7 (0, 62) (n=257)	4 (0, 54) (n=228)
Hospital-level		
Tertiary care level (A)	0 (0, 22) (n=112)	0 (0, 38) (n=157)
Secondary care level (S, M)	22 (7, 81) (n=103)	36 (5, 100) (n=49)
Secondary care level (F)	9 (2, 86) (n=27)	4 (0, 77) (n=20)
Private hospital	147 (39, 385) (n=4)	427 (n=1)
University hospital	1 (0, 1) (n=8)	1 day (n=1)
Red Cross hospital	81 (43, 157) (n=3)	-
- Days from date of sample received by Chonburi lab centre to date of dispatch results from Chonburi lab center	1 (1, 2) (n=284)	42 (26, 45) (n=242)

Variables	Median (IQR) days (n [a])	
	Molecular testing	Culture & DST
- Days from the date of dispatch results from Chonburi lab center to date of starting MDR-TB treatment [c]		
All hospital levels		20 (2, 38) (n=19)
Hospital level		
Tertiary care level (A)		2 (0, 21) (n=11)
Secondary care level (S, M)		36 (20, 44) (n=8)

Note:
[a] n: number of tests
[b] Excluding 1) TB patients whose sputum smear is positive at the 3rd 5th month from the presumptive MDR-TB criteria and 2) Those who underwent Xpert MTB/RIF or culture & DST before the diagnosis of TB.
[c] 1) A single test for MDR-TB detection (Xpert MTB/RIF or culture & DST) was used for each patient and 2) excluding TB patients who have initiated second-line anti-TB drugs before investigation with Xpert MTB/RIF or culture & DST

DISCUSSION

This research showed a high pre-diagnosis attrition rate of 63.6%. Previous studies have shown that pre-diagnosis attrition rates varied from 11.0% to 69%[8-10,17-22]. This finding may be explained by the criteria variation used to identify presumptive MDR-TB patients. Typically, it is recommended to perform drug sensitivity testing for all identified TB patients before starting the treatment, but the availability of rapid DST is limited in many settings. In countries with limited resources, DST is recommended for groups at higher risk of drug-resistant TB, such as retreatment of TB patients, close contacts of MDR-TB patients, patients who had persistently exhibited positive sputum at the end of the 2nd or 3rd month of treatment, and patients with HIV and active TB [7,10, 17-19]. In Thailand, DST criteria were expanded to cover all patients at risk of developing drug-resistant TB[16]. Consequently, the differences in pre-diagnosis attrition rates between settings were due to the criterion used to define patients at risk of MDR-TB.

High pre-diagnosis attrition rate in this study (63.6%) indicated that about one-third of patients at risk of MDR-TB underwent DST. This may be attributed to the failure to accurately identify patients suspected of MDR-TB for DST. Furthermore, the rate of pre-diagnosis attrition was the highest in private hospitals (89.1%), followed by Red Cross hospitals (88.4%), small community hospitals (71.8%), and large community hospitals (68.3%). Presumptive TB cases presented at secondary-level hospitals such as large community hospitals (OR=1.65; 95% CI = 1.04 - 2.61) and small community hospitals (OR=2.46; 95% CI = 1.42 – 4.24) were associated with not undergoing molecular testing or culture with DST testing. In addition, presumptive MDR-TB patients who received anti-TB treatment for drug-sensitive TB in hospitals outside Ministry of Public Health (MOPH) were identified as a strong risk factor associated with pre-diagnosis attrition (private hospital [OR=7.76; 95%CI = 2.62-22.95] followed by Red Cross hospital [OR=6.88; 95%CI = 2.43-19.46]) (Table 3). These findings indicated that the public and private health sectors performed sub-optimally in identifying patients with presumptive MDR-TB. Thus, there is an urgent need for proper training in identifying eligible cases and highly intensive supervision of healthcare staff at all levels. Additionally, the link between the NTP and hospitals outside MOPH should be strengthened.

This effort will enhance access to rapid diagnostic tests such as Xpert MTB/RIF assay, which will help improve case detection of MDR-TB and ensure the accurate reporting of MDR/RR-TB cases.

Another possible explanation for the high pre-diagnosis attrition rate is the collection of three sputum specimens. Some patients failed to provide sputum specimens because their clinical conditions might improve after receiving anti-TB drugs. Additionally, some patients failed to provide good quality sputum (salivary sputum) that had to be rejected for molecular testing or culture & DST test [23]. Thus, the specimen referral system should be improved, alongside better results dissemination to peripheral health units to address these challenges. Apart from that, laboratory services and MDR-TB treatment could be decentralized to secondary care hospitals at the district level across the country. These measures might reduce the attrition and TAT in the drug-resistant TB diagnostic processes.

Notably, the risk of pre-diagnosis attrition among presumptive MDR-TB patients was greater in migrants (OR=2.40; 95% CI = 1.37–4.22) (Table 3). Currently, undocumented migrant workers and their dependents in Thailand can purchase a health insurance card overseen by the Ministry of Public Health[24]. The TB diagnosis and treatment are provided for free under the programmatic management of drug-resistant tuberculosis (PMDT)[16]; thus, the cost of a rapid molecular assay for migrant workers listed in the TB register can be reimbursed to the hospital through PMDT. However, those who are not listed in the TB register and have no health insurance must bear the cost of a rapid molecular assay. Therefore, migrants were less likely to undergo a rapid test for drug-resistant TB than local patients. Additionally, a significantly higher risk of pre-diagnosis attrition was observed in extrapulmonary TB cases (OR=2.30; 95% CI = 1.31-4.06) due to difficulties obtaining specimens from extrapulmonary sites. This finding is consistent with a research study conducted in India[17].

In the present study, the pre-treatment attrition rate was 28.1% (9/32), but the factors associated with this finding could not be identified because of the limited number of patients in each subgroup. Nevertheless, a possible reason for pre-treatment attrition is a long waiting period for obtaining the DST results. In addition, most MDR-TB cases not initiated on second-line antituberculosis drugs (6/9: 66.7%) received treatment for drug-susceptible TB in community hospitals. In contrast, only 2 cases were treated in a tertiary care centre, and one was treated in a private hospital. The findings showed that the median TAT for samples received in community hospitals from eligible patients for molecular testing was 22 days (IQR 7-81 days). Meanwhile, the median time to initiate MDR-TB treatment in community hospitals from the time of results dispatch was exceptionally long at 36 days (IQR 20-44) (Table 4). On the contrary, a shorter median time to treatment initiation was reported in other studies conducted in Bangladesh (5-10 days)[10] and different parts of India such as Chennai (18 days)[17] and New Delhi (18-24 days)[26]. Other factors associated with pre-treatment attrition among MDR-TB patients identified in previous studies included death, patient refusal of MDR-TB treatments, receiving treatment in the private sector, and inability to trace the patient due to wrong address [17, 27-28]. Moreover, in the present study, three drug-resistant tuberculosis patients requiring retreatment had not been initiated into MDR-TB treatment. They failed to attend follow-ups during the drug-sensitive TB treatment, resulting in the continuous spread of multidrug- resistant TB to others. Therefore, there is a dire need to address these challenges and implement necessary control measures.

Since this research relied on the recorded data, some variables concerning pre-diagnosis attrition (income, residential distance, and travel cost) and provider-related factors were not collected. These factors should be considered in future studies. Despite the limitations of the study, the current findings remain potentially important in controlling MDR-TB in Thailand and other high MDR-TB burden countries, with the necessary adjustments.

RECOMMENDATIONS

Health personnel in public and private sectors require training in identifying presumptive TB patients, and the private health sector should be integrated into the NTP. In addition, the decentralization of laboratory diagnosis for drug-resistant TB and MDR-TB treatment at secondary care centres needs to be considered. A recent study found that the distance between primary health care centers (PHC) and the GeneXpert laboratories, and the PHC's diagnostic capacity were significantly associated with patients not being tested using the Xpert MTB/RIF assay[29]. Furthermore, linkages between the reference laboratories and hospitals at all levels should be strengthened. Financial assistance for migrants should also be considered, covering transportation costs for hospital follow-up visits. This study revealed that extrapulmonary TB cases were less likely to undergo DST; therefore, clinicians should be trained to collect specimens from the extrapulmonary sites. Additionally, the TB manual should include detailed instructions on the extrapulmonary specimen collection, processing, and storage before delivery to the reference laboratory at Chonburi hospital. Most importantly, supervision of the healthcare personnel at the provincial and district levels is essential along the diagnosis and treatment pathway. Addressing the highlighted challenges and decentralizing DST and drug-resistant TB treatment services at the district level will aid in early diagnosis and treatment initiation for patients with MDR-TB, ultimately contributing to the achievement of universal access to MDR-TB care.

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CONFLICTS OF INTEREST

The authors have declared that they have no potential conflicts of interest in connection with the research, authorship, or publication of this article.

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