ORIGINAL PAPER

Nagoya J. Med. Sci. **84**. 339–351, 2022
doi:10.18999/nagjms.84.2.339

Patient delay and health system delay of patients with newly diagnosed pulmonary tuberculosis in Mongolia, 2016–2017

Batmunkh Batbayar[1,2], Tetsuyoshi Kariya[1,3], Tsolmon Boldoo[4], Enkhtamir Purevdorj[4], Naranzul Dambaa[4], Yu Mon Saw[1,3], Eiko Yamamoto[1] and Nobuyuki Hamajima[1]

[1]*Department of Healthcare Administration, Nagoya University Graduate School of Medicine, Nagoya, Japan*
[2]*Ministry of Health of Mongolia, Ulaanbaatar, Mongolia*
[3]*Nagoya University Asian Satellite Campuses Institute, Nagoya, Japan*
[4]*National Center for Communicable Diseases, Ministry of Health of Mongolia, Ulaanbaatar, Mongolia*

ABSTRACT

Although diagnosis and treatment of tuberculosis (TB) have been improved in many countries, delays in the diagnosis and treatment remain problematic in resource-limited countries. This study aimed to identify factors affecting delays in TB care in Mongolia. Data on TB cases registered from January 2016 to December 2017 were obtained from the national registry of TB at the Department of TB Surveillance and Research in National Center for Communicable Disease. The total number of TB cases registered in these two years was 8,166, including 3,267 cases of newly diagnosed pulmonary TB. Pulmonary TB cases (1,836 males and 1,431 females) were analyzed to estimate adjusted odds ratios (aORs) and 95% confidence intervals (CIs). Patient delays longer than the median (28 days) were significantly associated with patient age >32 years (aOR=1.31, 95%CI: 1.14–1.51), residence in areas other than Ulaanbaatar (aimags) (aOR=1.38, 95%CI: 1.20–1.59), and smear-negative (aOR=0.57, 95%CI: 0.47–0.69). Health system delays longer than the median (7 days) were significantly associated with patient age >32 years (aOR=1.16, 95%CI: 1.00–1.33), residence in aimags (aOR=0.82, 95%CI: 0.71–0.95), special facilities including a prison hospital (aOR=4.40, 95%CI: 2.42–7.83), registration in 2017 relative to 2016 (aOR=0.83, 95%CI: 0.71–0.95), and smear-negative (aOR=1.72, 95%CI: 1.42–2.07). Total delays longer than the median (45 days) were significantly associated with patient age >32 years (aOR=1.39, 95%CI: 1.21–1.60), residence in aimags (aOR=1.27, 95%CI: 1.11–1.47), and smear-negative (aOR=0.74, 95%CI: 0.62–0.90). To shorten the total delay, improvement of the access to medical facilities in aimags is necessary.

Keywords: tuberculosis, patient delay, health system delay, Mongolia

Abbreviations:
CI: confidence interval
E: ethambutol
EPTB: extra pulmonary tuberculosis
H: isoniazid
IQR: interquartile range
MOH: Ministry of Health
NCCD: National Center for Communicable Disease

Received: October 23, 2020; accepted: August 18, 2021

Corresponding Author: Nobuyuki Hamajima, MD, PhD, MPH
Department of Healthcare Administration, Nagoya University Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya 466-8550 Japan
Tel: +81-52-744-2444, E-mail: nhamajim@med.nagoya-u.ac.jp

OR: odds ratio
R: rifampicin
TB: tuberculosis
WHO: World Health Organization
Z: pyrazinamide

INTRODUCTION

Tuberculosis (TB) caused by *Mycobacterium tuberculosis* remains one of the biggest health issues worldwide. It is the leading cause of death among infectious diseases and is a heavy burden on economy. In 2018, the incidence of TB was estimated to be 10 million, with 1.5 million deaths.[1] TB causes economic devastation and poverty not only to households but also to communities and countries. Mongolia ranked 4th in TB prevalence among the 37 countries in World Health Organization (WHO) Western Pacific Region. TB is the 6th leading cause of death in Mongolia and is the leading cause of death among communicable diseases. According to WHO Global Tuberculosis Report, the number of notified TB cases in Mongolia was 4,065 in 2018, with an incidence of 428 per 100,000 population and mortality rate of 10 per 100,000 population.[1]

Every year, TB results in huge costs related to prevention, diagnosis and care. Late diagnosis of TB leads to a more advanced and complex condition, resulting in higher total health service costs.[2] Early diagnosis and prompt treatment are crucial to decrease the burden of TB, as emphasized by the WHO in its "End TB Strategy".[3] While diagnosis and treatment of TB have already been accelerated in many countries, delayed diagnosis and treatment remain concerns in resource-limited countries. In addition, the longer is the interval from the onset of symptoms to healthcare seeking, diagnosis and initiation of treatment, the higher is the risk of TB transmission.[4-7] Early screening of suspected TB cases with rapid diagnosis and treatment can reduce the risk of TB transmission by reducing exposure to the bacteria among the public.[6]

Delay was composed of patient delay and health system delay. Several factors have been reported to affect both types of delays; factors affecting the former include patients' awareness of their illness, socioeconomic status, stigma, knowledge, severity, and distance between the patients' residence and health services, while factors affecting the latter include health system and professional expertise.[7] Although such delays and factors associated with them have been studied in many countries, there are currently no studies exploring this subject in Mongolia. Hence, the present study aimed to identify the factors associated with the delays among newly diagnosed pulmonary TB cases using national registry data on TB.

MATERIALS AND METHODS

Data source

Data on TB cases registered from January 2016 to December 2017 were obtained from the National Registry of Tuberculosis at the Department of Tuberculosis Surveillance and Research in National Center for Communicable Disease (NCCD) in Mongolia. The median and interquartile range (IQR) were calculated for patient delay, health system delay, and total delay (patient delay + health system delay). Information regarding TB cases along with clinical data is routinely registered from all health facilities and recorded in the NCCD by local authorities

in aimags (provinces in Mongolia) and municipalities although the data of Govi-Altai aimag was not available.

Study subjects

All data on TB registered between January 2016 to December 2017 were collected in this study. In addition to those with extra pulmonary TB (EPTB), pulmonary TB which had been transfer in, default, relapse, and TB with no information were excluded from the analysis. The database included the demographic characteristics (age, sex, permanent residence and occupation), the year of registration, clinical characteristics (smear status, treatment category, treatment regimen and treatment result), and the dates of the symptom onset, the first visit to doctors, and the initiation of treatments with anti-tuberculosis drugs.

Definitions of delays

Patient delay was defined as the time interval between the onset of the symptoms of the illness and the first visit to a doctor. Health system delay was defined as the time interval between the first visit to a doctor and the initiation of treatments with anti-tuberculosis drugs. Total delay was defined as the time interval from the onset of symptoms to the initiation of treatments with anti-tuberculosis drugs (Fig. 1).

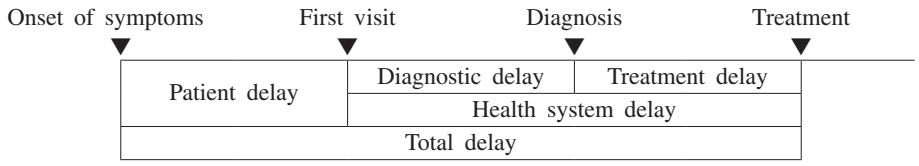

Fig. 1 Delays for healthcare on pulmonary tuberculosis patients

Definitions of treatment categories

The treatment category I was defined as smear-positive or smear-negative status with serious illness manifestation. Treatment category III was defined as the smear-negative with no serious illness manifestation. Treatment category IV was defined as multidrug-resistant tuberculosis.[8]

Definitions of treatment regimen

New patients were treated with first line drugs, ie, isoniazid (H), rifampicin (R), pyrazinamide (Z), and ethambutol (E), in Mongolia. The regimen was either 1) HRZE treatment for 2 months followed by HR treatment for 4 months (2HRZE/4HR) or 2) HRZ treatment for 2 months followed by HR treatment for 4 months (2HRZ/4HR). Since streptomycin was not used for new TB cases in Mongolia, regiments including streptomycin was not applied. For patients with laboratory-confirmed drug-resistant TB confirmed with a laboratory test, a regimen with a combination of drugs excluding the ineffective ones was applied.

Statistical analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) 26.0 software (IBM, USA). Descriptive statistics were used to analyze socio-demographic and clinical characteristics of patients with newly diagnosed pulmonary TB. Continuous variables were expressed with median and IQR. A logistic regression model was applied to estimate the

odds ratio (OR) and 95% confidence interval (CI) of patient delay (>28 days), health system delay (>7 days), and total delay (>45 days). Differences were considered statistically significant if the *P*-value was <0.05.

Ethical considerations

This study was conducted according to the ethical guidelines issued by the Ministry of Health (MOH), Mongolia. This study was approval by ethics committee of MOH, Mongolia (letter no. 122). Procedures to anonymize the patients including deletion of information such as the patient's name, identification number, and address were undertaken to maintain confidentiality.

RESULTS

A total of 3,267 (1,836 males and 1,431 females) cases newly diagnosed pulmonary TB between January 2016 and December 2017 were enrolled in this study (Fig. 2). Most cases were in patients aged 15–29 years (Table 1). The median (IQR) age of patients was 32.0 (24.0–47.0) years, ranging from 0 to 93 years. Of the total, 1,708 (52.3%) cases were reported in Ulaanbaatar, 1,478 (45.2%) were reported in aimags, and 81 (2.5%) cases were reported from the following special facilities: 429th Prison Tuberculosis Hospital, Enerel Hospital, and the National Center for Mental Health. More than 40% were unemployed or retired. The number of newly diagnosed pulmonary TB in 2017 (*N*=1,517) was slightly lower than that in 2016 (*N*=1,750).

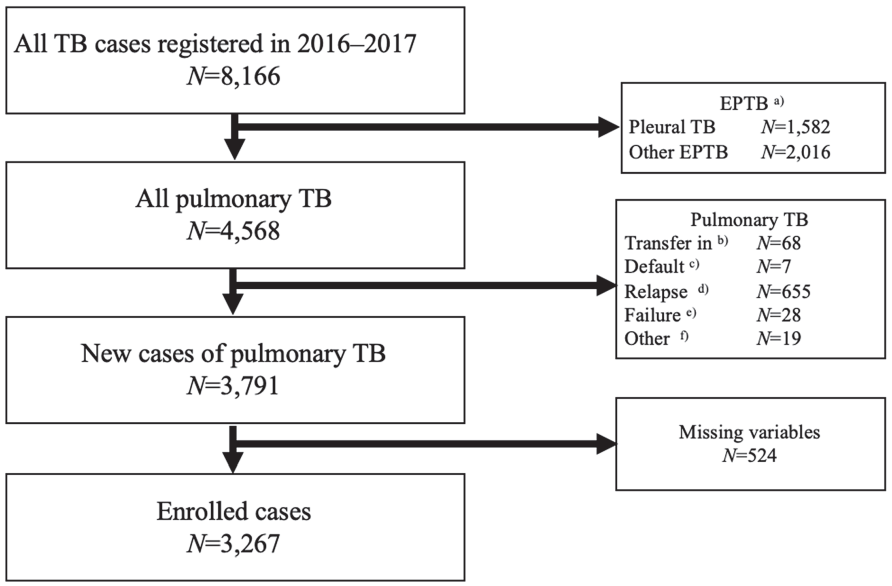

Fig. 2 Selection procedure of newly diagnosed pulmonary tuberculosis patients in Mongolia, 2016–2017

[a] EPTB: extra pulmonary tuberculosis
[b] Transferred after previous treatment more than 1 month.
[c] Previous treatment was judged as "cured" or "completed", but defaulted.
[d] Previous treatment was relapsed.
[e] Previous treatment was considered as "Failure".
[f] Previous treatment was unknown.

Table 1 Sociodemographic background of patients with newly diagnosed pulmonary tuberculosis in Mongolia, 2016–2017

Variables	Male *N*=1,836		Female *N*=1,431		Total *N*=3,267	
	N	(%)	*N*	(%)	*N*	(%)
Age group, year						
<15	32	(1.7)	56	(3.9)	88	(2.7)
15–29	669	(36.4)	670	(46.8)	1,339	(41.0)
30–44	555	(30.2)	384	(26.8)	939	(28.7)
45–59	413	(22.5)	188	(13.1)	601	(18.4)
≥60	167	(9.1)	133	(9.3)	300	(9.2)
Residence						
Ulaanbaatar	917	(49.9)	791	(55.3)	1,708	(52.3)
Aimags	843	(45.9)	635	(44.4)	1,478	(45.2)
Facilities [a)]	76	(4.1)	5	(0.35)	81	(2.5)
Occupation						
Minor [b)]	92	(5.0)	134	(9.4)	226	(6.9)
Student	158	(8.6)	164	(11.5)	322	(9.9)
Employed	385	(21.0)	357	(24.9)	742	(22.7)
Unemployed [c)]	787	(42.9)	608	(42.5)	1,395	(42.7)
Others [d)]	414	(22.5)	168	(11.7)	582	(17.8)
Year of registration						
2016	969	(52.8)	781	(54.6)	1,750	(53.6)
2017	867	(47.2)	650	(45.4)	1,517	(46.4)

[a)] The 429th Prison Tuberculosis Hospital, Enerel Hospital and National Center for Mental Health
[b)] Cases aged <18 years
[c)] Unemployed and retired
[d)] Prisoners and other occupations

As shown in Table 2, majority of the cases were smear-positive (2,376). Treatment category I was applied to 3,075 (94.1%) cases. Treatment regimen consisting of 2HRZE/4HR was used in almost all cases (*N*=3,088, 94.5%). More than half of the patients finished the treatment regimen as "cured" (*N*=1,892, 57.9%) and approximately one-third were tagged as "completed" (*N*=1,017, 31.1%). Forty (1.2%) patients died. The mean duration from initiation treatment to death was 3.5 months (115 days).

Table 2 Clinical background of patients with newly diagnosed pulmonary tuberculosis in Mongolia, 2016–2017

Variables	Male *N*=1,836		Female *N*=1,431		Total *N*=3,267	
	N	(%)	*N*	(%)	*N*	(%)
Smear status [a]						
Smear positive	1,354	(73.7)	1,022	(71.4)	2,376	(72.7)
Smear negative	352	(19.2)	277	(19.4)	629	(19.3)
N/A	130	(7.1)	132	(9.2)	262	(8.0)
Treatment category [b]						
I	1,739	(94.7)	1,336	(93.4)	3,075	(94.1)
III	76	(4.1)	77	(5.4)	153	(4.7)
IV	21	(1.1)	18	(1.3)	39	(1.2)
Treatment regimen						
2HRZE/4HR	1,747	(95.2)	1,341	(93.7)	3,088	(94.5)
2HRZ/4HR	69	(3.8)	72	(5.0)	141	(4.3)
2HSE/10HE	20	(1.1)	18	(1.3)	38	(1.2)
Treatment result						
Cure [c]	1,046	(57.0)	846	(59.1)	1,892	(57.9)
Completed [d]	559	(30.4)	458	(32.0)	1,017	(31.1)
Died [e]	29	(1.6)	11	(0.8)	40	(1.2)
Failure [f]	126	(6.9)	78	(5.5)	204	(6.2)
Defaulted [g]	55	(3.0)	22	(1.5)	77	(2.4)
Transferred [h]	18	(1.0)	14	(1.0)	32	(1.0)
Change diagnosis [i]	3	(0.16)	2	(0.14)	5	(0.15)

N/A: data are not available
H: isoniazid
R: rifampicin
Z: pyrazinamide
S: streptomycin
E: ethambutol
2HRZE/4HR: HRZE treatment for 2 months followed by HR treatment for 4 months
2HRZ/4HR: HRZ treatment for 2 months followed by HR treatment for 4 months
2HSE/10HE: HSE treatment for 2 months followed by HE treatment for 10 months

[a] Smear status at 0 month.
[b] I, smear-positive or smear-negative with seriously ill; III, smear-negative with no seriously ill; IV, multidrug-resistant tuberculosis.
[c] Patients who has sputum smear-negative in the last month of treatment and on at least one previous occasion.
[d] Patients who completed treatment but did not meet the criteria for cure or failure.
[e] Patients who died from any cause during treatment.
[f] Patients whose treatments were interrupted for 2 consecutive months or more.
[g] Patients who have remained sputum smear-positive at month 5 or later during treatment.
[h] Patients who have been transferred to other health facilities during treatment. Treatment outcomes are unknown.
[i] Patients whose diagnoses have been changed during treatment.

Table 3 shows the distributions of the delays. The median patient, health system, and total delays were 28 days, 7 days, and 45 days, respectively. The IQRs were 12–66 days, 3–21 days, and 24–86 days, respectively. The proportion of cases with delays of more than 90 days were 17.2%, 2.8%, and 23.5%, respectively.

Table 3 Distribution of delays in newly diagnosed pulmonary tuberculosis cases in Mongolia, 2016–2017 (*N*=3,267)

Delay in days	Patient delay		Health system delay		Total delay	
	N	(%)	*N*	(%)	*N*	(%)
0 – 6	521	(15.9)	1483	(45.4)	98	(3.0)
7 – 13	370	(11.3)	669	(20.5)	240	(7.3)
14 – 30	829	(25.4)	579	(17.7)	758	(23.2)
31 – 60	653	(20.0)	341	(10.4)	910	(27.9)
61 – 90	332	(10.2)	106	(3.2)	492	(15.1)
91 – 180	374	(11.4)	64	(2.0)	512	(15.7)
181 – 365	140	(4.3)	20	(0.6)	194	(5.9)
366 –	48	(1.5)	5	(0.2)	63	(1.9)

Table 4 shows ORs and 95% CIs of patient delays, health system delays, and total delays. Patients aged ≥32 years were more likely to have patient delays (adjusted OR=1.31, $P<0.001$), health system delays (adjusted OR=1.16, $P<0.01$), and total delays (adjusted OR=1.39, $P<0.001$). Residence in aimags showed positive associations with both patient delays (adjusted OR=1.38, $P<0.001$) and total delays (adjusted OR=1.27, $P<0.01$), while it showed a negative association with health system delays (adjusted OR=0.82, $P<0.01$). Residence in special facilities was significantly associated with health system delays (adjusted OR=4.40, $P<0.001$). Cases registered in 2017 were less likely have health system delays (adjusted OR=0.83, $P<0.01$) relative to those registered in 2016. Cases with negative smear status were less likely have patient delays (adjusted OR=0.57, $P<0.001$) and total delays (adjusted OR=0.74, $P<0.01$), but more likely to have the health system delays (adjusted OR=1.72, $P<0.001$). Sex and treatment category showed no significant associations with any delays in the adjusted model.

Table 4 Odds ratios (ORs) and confidence intervals (CIs) for delays in cases of newly diagnosed pulmonary tuberculosis in Mongolia, 2016–2017 (*N*=3,267)

Variables	Patient delays [a]		Health system delays [b]		Total delays [c]	
	Unadjusted OR (95% CI)	Adjusted [d] OR (95% CI)	Unadjusted OR (95% CI)	Adjusted [d] OR (95% CI)	Unadjusted OR (95% CI)	Adjusted [d] OR (95% CI)
Age, year						
<32	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
≥32	1.35 (1.17–1.55) **	1.31 (1.14–1.51) **	1.13 (0.99–1.30)	1.16 (1.00–1.33) *	1.41 (1.23–1.62) **	1.39 (1.21–1.60) **
Sex						
Male	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Female	0.88 (0.77–1.01)	0.93 (0.80–1.07)	1.02 (0.88–1.17)	1.07 (0.93–1.23)	0.93 (0.81–1.06)	0.99 (0.86–1.15)
Residence						
Ulaanbaatar	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Aimags	1.39 (1.21–1.60) **	1.38 (1.20–1.59) **	0.82 (0.72–0.95) *	0.82 (0.71–0.95) *	1.29 (1.20–1.48) **	1.27 (1.11–1.47) *
Facilities [e]	1.00 (0.64–1.56)	0.93 (0.59–1.47)	4.27 (2.42–7.54) **	4.40 (2.48–7.83) **	1.46 (0.93–2.29)	1.39 (0.88–2.19)
Year of registration						
2016	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
2017	1.06 (0.93–1.22)	1.01 (0.87–1.16)	0.80 (0.70–0.92) *	0.83 (0.72–0.95) *	0.91 (0.80–1.05)	0.87 (0.76–1.00)
Smear status [f]						
Positive	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Negative	0.57 (0.48–0.68) **	0.57 (0.47–0.69) **	1.71 (1.43–2.04) **	1.72 (1.42–2.07) **	0.72 (0.61–0.86) **	0.74 (0.62–0.90) *
N/A	0.58 (0.45–0.75) **	0.60 (0.46–0.79) **	1.55 (1.20–2.01) *	1.60 (1.23–2.09) *	0.73 (0.56–0.94) *	0.79 (0.61–1.03)
Treatment category [g]						
I	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
III	0.58 (0.42–0.81) *	0.88 (0.62–1.26)	1.38 (0.99–1.91)	0.96 (0.67–1.36)	0.58 (0.41–0.81) *	0.71 (0.50–1.02)
IV	0.90 (0.48–1.70)	0.98 (0.51–1.87)	1.10 (0.58–2.07)	0.91 (0.47–1.74)	0.63 (0.33–1.20)	0.62 (0.32–1.20)

N/A: data are not available

*P<0.01, **P<0.001

[a] Patient delay longer than the median (≥28 days).

[b] Health system delay longer than the median (≥7 days).

[c] Total delay longer than the median (≥45 days)

[d] Adjusted by age, sex, residence, year of registration, smear status and treatment category.

[e] The 429th Prison Tuberculosis Hospital, Enerel Hospital and National Center for Mental Health

[f] Smear status at 0 month

[g] I, smear-positive or smear-negative with seriously ill; III, smear-negative with no seriously ill; IV, multidrug-resistant tuberculosis.

doi:10.18999/nagjms.84.2.339

As shown in Table 5, most cases, irrespective of delayed treatment, led to outcomes tagged as "cured" and "completed". More cases resulting in treatment failure (7.7%) were found among those with a patient delay 28 days or over than among those with a patient delay of less than 28 days (4.8%).

Table 5 Treatment outcomes of newly diagnosed pulmonary tuberculosis cases according to delays in Mongolia, 2016–2017 (*N*=3,267)

Variables	Cured [a] *N* (%)	Completed [b] *N* (%)	Died [c] *N* (%)	Failure [d] *N* (%)	Defaulted [e] *N* (%)	Transferred [f] *N* (%)	Changed [g] *N* (%)	Total *N* (%)
Patient delay, day								
≥28	1,025 (62.0)	418 (25.3)	22 (1.3)	127 (7.7)	38 (2.3)	22 (1.3)	1 (0.1)	1,653 (100%)
<28	867 (53.7)	599 (37.1)	18 (1.1)	77 (4.8)	39 (2.4)	10 (0.6)	4 (0.2)	1,614 (100%)
Health system delay, day								
≥7	852 (52.9)	587 (36.4)	23 (1.4)	89 (5.5)	42 (2.6)	17 (1.1)	2 (0.1)	1,612 (100%)
<7	1,040 (62.8)	430 (26.0)	17 (1.0)	115 (6.9)	35 (2.1)	15 (0.9)	3 (0.2)	1,655 (100%)
Total delay, day								
≥45	950 (59.2)	447 (27.8)	25 (1.6)	123 (7.7)	39 (2.4)	20 (1.2)	2 (0.1)	1,606 (100%)
<45	942 (56.7)	570 (34.3)	15 (0.9)	81 (4.9)	38 (2.3)	12 (0.7)	3 (0.2)	1,661 (100%)

[a] Patients who has sputum smear-negative in the last month of treatment and on at least one previous occasion.

[b] Patients who completed treatment but did not meet the criteria for cure or failure.

[c] Patients who died from any cause during treatment.

[d] Patients whose treatments were interrupted for 2 consecutive months or more.

[e] Patients who have remained sputum smear-positive at month 5 or later during treatment.

[f] Patients who have been transferred to other health facilities during treatment. Treatment outcomes are unknown.

[g] Patients whose diagnoses have been changed during treatment.

DISCUSSION

This study characterized patient and health system delays in patients with newly diagnosed pulmonary TB registered from January 2016 to December 2017. The total number of TB cases registered in the 2 years were 8,166. Among them, 3,267 newly diagnosed pulmonary TB cases were analyzed in this study. The number of newly diagnosed pulmonary TB in Mongolia was the highest among younger people, who were in the most productive period and in their reproductive ages. The incidence rates in the capital city of Ulaanbaatar and the other aimags were similar. Out of 3.2 million Mongolian population, approximately half lived in Ulaanbaatar while the rest lived in other aimags.

In this study, median patient delay and health system delay were found to be 28 days and 7 days, respectively. They were shorter than those in the following developing countries; 30 days

and 27 days in Montenegro,[9] and around 3 weeks and 4 weeks in Botswana,[10] Philippines[11] and Ghana.[12] The median total delay of 45 days in Mongolia was shorter than 50 days in Uzbekistan.[13] In the WHO Western Pacific region, Cambodia had the longest median total delays (232 days).[14] In Afghanistan, the median of patient delay, health system delay, and total delays were 205, 151, and 356 days, respectively.[15] It has been found in the most other studies that health system delay was shorter than patient delay.[15-17] In Nigeria, median patient delay, health system delay and total delays were 8, 3 and 11 weeks, respectively.[16] In Angola, median patient delay was 30 days and health system delays was 7 days.[17] In Chad, the median patient delay, health system delay, and total delay were 15, 36, and 57.5 days, respectively.[18] In other studies, which provided insight into health system delays in Tanzania, Penang Malaysia, New York, and Japan, the median health system delay ranged from 3 weeks to 1 month, which was more than what was found in this study.[19-22]

Patient delay and health system delay were found to be more prevalent among patients aged ≥32 years. People in this age group are socially active; hence, it is speculated that their engagement in various activities hindered their proactive health seeking behaviors, therefore delaying initiation of treatment. Residence in aimags was positively associated with patient delay and negatively associated with health system delay. Both of the delays have been found to be common in rural areas of developing countries for various reasons, including distance, lack of transportation, distrust of healthcare provider, trust in alternative medicine, and inability to pay the treatment fee.[2] Delays in rural areas were reported from the studies in Pakistan,[7] Somalia,[7] Nigeria,[23] Ethiopia.[24] Difficulty of access to the health facilities due to the distance might be one of the factors responsible for patient delay in aimags of Mongolia because many people in aimags who live in remote areas have nomadic lifestyle. Knowledge and attitudes of the patients was not assessed in this study, and further studies are required to evaluate the relationship between these factors and delays in Mongolia. Living in aimags was observed to reduce health system delay. Despite TB examinations on patients in aimags typically being performed only in the aimag centers and TB dispensary laboratories at the aimag general hospitals, the Global Fund Project has been implementing a sputum transport system from over 300 soums (administrative areas under aimag) in 21 aimags since 2008 to reduce the burden on infrastructure and patient costs. This initiative might contribute to the reduction in delays in diagnosis and treatment.

This study also found that special facilities such as the 429th Prison Tuberculosis Hospital, Enerel Hospital, and National Center for Mental Health were more likely to have a health system delay. Most of the patients in this group were prisoners (84%). This group had negligible patient delay as compared to patients in Ulaanbaatar as they already lived inside healthcare facilities and had good access to health professionals. However, what contributed to the health system delay was the increased amount of time it took to transfer prisoners diagnosed with pulmonary TB to the 429th Prison Tuberculosis Hospital for treatment.

Cases registered in the year 2017 were shown to be negatively associated with health system delay. This suggests that more health system delays were observed in 2016 than in 2017. Mongolia experienced a large outbreak of measles from 2015 to 2016, which caused congestion and brought disorder to the health facilities.[25] It is highly probable that the measles outbreak affected the health system delay in 2016.

Negative smear status was positively associated with diagnostic delay included in health system delay (Table 4). This could be because more time would be required to diagnose pulmonary TB in patients with negative smears. On the contrary, negative smear status was negatively associated with patient delay and total delay. The reason a negative smear status shortened patient delay is unknown. It is suggested that further studies be done to reveal the factors affecting health seeking behaviors in patients with different smear statuses. This study also suggests that it is

less likely to find delay differences between men and women, although other studies reported gender differences.[26,27]

Improving knowledge about TB can also reduce patient delay. Health system delay may be minimized by enhancing the expertise of nurses and physician assistants in diagnosing and treating TB. This way, the patients' need for regular and frequent access to health facilities is eliminated. Improving information dissemination about TB in the population with a focus on prevention, early diagnosis, and treatment, as well as increasing awareness among healthcare providers through ongoing medical education may contribute to a reduction in patient delay and health system delay. In addition, early diagnosis, follow-up, and implementation of proper TB care among rural and vulnerable people should be focused on. Lastly, an association between patient delay and the outcome of treatment failure was highlighted (Table 5). Likewise, a study in Ethiopia reported an association between delay and unfavorable outcomes.[28]

This study has several limitations. First, this study only used cases registered in the surveillance system. Misclassification and underreported cases could exist and were not taken into consideration. Detailed information on symptoms was not available, and other symptoms such as cough and weight loss could not be assessed. Knowledge and attitudes toward TB could not be evaluated with respect to patient delay. As TB has various clinical presentations such as EPTB, the clinical course of the disease and its symptoms are diverse; hence, only newly diagnosed pulmonary TB cases were included in this study. Second, recall bias of information, including symptoms and the onset of symptoms, could exist. Third, data from Govi-Altai aimag were not available. Therefore, differences among the aimags were not evaluated. Despite these limitations, this is the first study to provide information on patient and health system delays in Mongolia and revealed the risk factors among patients with newly diagnosed pulmonary TB in Mongolia during 2016–2017.

In conclusion, patient delay was positively associated with age ≥32 years and residence in aimags, and negatively associated with negative smear status. Health system delay was positively associated with age ≥32 years and residence in special facilities, and negatively associated with residence in aimags and case registration in 2017. To shorten the total delay, improvement of the access to medical facilities in aimags is necessary.

ACKNOWLEDGEMENTS

I would like to thank staffs at the Department of TB Surveillance and Research of NCCD, MOH, Mongolia, especially Dr Dulmaa Nyamkhuu, General Director of NCCD, for their assistance in data collection.

CONFLICTS OF INTEREST

The author declares no conflicts of interest for this study.

REFERENCES

1 World Health Organization. *Global Tuberculosis Report 2019*. Geneva: World Health Organization; 2019. https://www.who.int/tb/publications/global_report/en/. Accessed October 16, 2020.

2 Storla DG, Yimer S, Bjune GA. A systematic review of delay in the diagnosis and treatment of tuberculosis. *BMC Public Health*. 2008;8:15. doi:10.1186/1471-2458-8-15.

3 World Health Organization. *Global Strategy and Targets for Tuberculosis Prevention, Care and Control after 2015*. Geneva: WHA65/2012/REC/3; 2013.
4 Bogale S, Diro E, Shiferaw AM, Yenit MK. Factors associated with the length of delay with tuberculosis diagnosis and treatment among adult tuberculosis patients attending at public health facilities in Gondar town, Northwest, Ethiopia. *BMC Infect Dis*. 2017;17(1):145. doi:10.1186/s12879-017-2240-0.
5 Lienhardt C, Rowley J, Manneh K, et al. Factors affecting time delay to treatment in a tuberculosis control programme in a sub-Saharan African country: the experience of The Gambia. *Int J Tuberc Lung Dis*. 2001;5(3):233–239.
6 World Health Organization. *Global Tuberculosis Control 2010*. Geneva: World Health Organization; 2010. https://apps.who.int/iris/bitstream/handle/10665/44425/9789241564069_eng.pdf. Accessed November 29, 2019.
7 World Health Organization. *Diagnostic and Treatment Delay in Tuberculosis 2006*. Cairo: World Health Organization; 2006. https://apps.who.int/iris/handle/10665/116501. Accessed October 16, 2020.
8 World Health Organization. *Implementing the WHO Stop TB Strategy: A Handbook for National Tuberculosis Control Programmes*. Geneva: World Health Organization; 2008. https://www.ncbi.nlm.nih.gov/books/NBK310745/. Accessed October 16, 2020.
9 Bojovic O, Medenica M, Zivkovic D, et al. Factors associated with patient and health system delays in diagnosis and treatment of tuberculosis in Montenegro, 2015–2016. *PLoS One*. 2018;13(3):e0193997. doi:10.1371/journal.pone.0193997.
10 Steen TW, Mazonde GN. Pulmonary tuberculosis in Kweneng district, Botswana: delays in diagnosis in 212 smear-positive patients. *Int J Tuberc Lung Dis*. 1998;2(8):627–634.
11 Auer C, Sarol Jr., Tanner M, Weiss M. Health seeking and perceived causes of tuberculosis among patients in manila. *Trop Med Int Health*. 2000;5(9):648–656. doi:10.1046/j.1365-3156.2000.00615.x.
12 Lawn SD, Afful B, Acheampong JW. Pulmonary tuberculosis: Diagnostic delay in Ghanaian adults. *Int J Tuberc Lung Dis*. 1998;2(8):635–640.
13 Belkina T, Khojiev D, Tillyashaykhov M, et al. Delay in the diagnosis and treatment of pulmonary tuberculosis in Uzbekistan: a cross-sectional study. *BMC Infect Dis*. 2014;14:624. doi:10.1186/s12879-014-0624-y.
14 Saly S, Onozaki I, Ishikawa N. Decentralized DOTS shortens delay to TB treatment significantly in Cambodia. *Kekkaku*. 2006;81(7):467–474.
15 Sabawoon W, Sato H, Kobayashi Y. Delay in the treatment of pulmonary tuberculosis: a report from Afghanistan. *Environ Health Prev Med*. 2012;17(1):53–61. doi:10.1007/s12199-011-0219-9.
16 Ukwaja KN, Alobu I, Nweke CO, Onyenwe EC. Healthcare-seeking behavior, treatment delays and its determinants among pulmonary tuberculosis patients in rural Nigeria: a cross-sectional study. *BMC Health Serv Res*. 2013;13:25. doi:10.1186/1472-6963-13-25.
17 Lusignani LS, Quaglio G, Atzori A, et al. Factors associated with patient and health care system delay in diagnosis for tuberculosis in the province of Luanda, Angola. *BMC Infect Dis*. 2013;13:168. doi:10.1186/1471-2334-13-168.
18 Ngangro NN, Ngarhounoum D, Ngangro MN, et al. Pulmonary tuberculosis diagnostic delays in Chad: a multicenter, hospital-based survey in Ndjamena and Moundou. *BMC Public Health*. 2012;12:513. doi:10.1186/1471-2458-12-513.
19 Wandwalo ER, Mørkve O. Delay in tuberculosis case finding and treatment in Mwanza, Tanzania. *Int J Tuberc Lung Dis*. 2000;4(2):133–138.
20 Hooi LN. Case finding for pulmonary tuberculosis in Penang. *Med J Malaysia*. 1994;49(3):223–230.
21 Sherman LF, Fujiwara PI, Cook SV, Bazerman LB, Frieden TR. Patient and health care system delays in the diagnosis and treatment of tuberculosis. *Int J Tuberc Lung Dis*. 1999;3(12):1088–1095.
22 Aoki M, Mori T, Shimao T. Studies on factors influencing patients', doctors' and total delay of tuberculosis case-detection in Japan. *Bull Int Union Against Tuberc*. 1985;60(3–4):128–130.
23 Fatiregun AA, Ejeckam CC. Determinants of patient delay in seeking treatment among pulmonary tuberculosis cases in a government specialist hospital in Ibadan, Nigeria. *Tanzan J Health Res*. 2010;12(2):113–120. doi:10.4314/thrb.v12i2.56398.
24 Mesfin MM, Newell JN, Walley JD, Gessessew A, Madeley RJ. Delayed consultation among pulmonary tuberculosis patients: a cross sectional study of 10 DOTS districts of Ethiopia. *BMC Public Health*. 2009;9:53. doi:10.1186/1471-2458-9-53.
25 Orsoo O, Saw YM, Sereenen E, et al. Epidemiological characteristics and trends of a nationwide measles outbreak in Mongolia, 2015–2016. *BMC Public Health*. 2019;19(1):201. doi:10.1186/s12889-019-6511-0.
26 Long NH, Johansson E, Diwan VK, Winkvist A. Different tuberculosis in men and women: beliefs from focus groups in Vietnam. *Soc Sci Med*. 1999;49(6):815–822. doi:10.1016/s0277-9536(99)00171-9.
27 Borgdorff MW, Nagelkerke NJ, Dye C, Nunn P. Gender and tuberculosis: a comparison of prevalence surveys

with notification data to explore sex differences in case detection. *Int J Tuberc Lung Dis*. 2000;4(2):123–132.
28 Gebreegziabher SB, Bjune GA, Yimer SA. Total delay is associated with unfavorable treatment outcome among pulmonary tuberculosis patients in West Gojjam Zone, Northwest Ethiopia: A prospective cohort study. *PLoS One*. 2016;11(7):e0159579. doi:10.1371/journal.pone.0159579.