ISSN 2096-7071
CN 10-1629/R1

CHINA CDC WEEKLY

Vol. 2 No. 12 Mar. 20, 2020

中国疾病预防控制中心周报

ISSN 2096-7071

Announcements

The 25th World TB Day — March 24, 2020

World TB Day is observed on March 24 each year to raise public awareness about the devastating health, social, and economic consequences of tuberculosis (TB) and to step up efforts to end the global TB epidemic. March 24 is the day in 1882 when Dr. Robert Koch announced that he had discovered the bacterium that causes TB, which opened the way towards diagnosing and curing the disease.

TB remains the world's deadliest infectious killer. Each day, over 4,000 people lose their lives to TB and close to 30,000 people fall ill with this preventable and curable disease (*1*). Globally in 2018, an estimated 10.0 million (range: 9.0–11.1 million) people fell ill with TB, equivalent to 132 cases (range: 118–146) per 100,000 population. In China, an estimated 866,000 (range: 740,000–1,000,000) people fell ill with TB in 2018, equivalent to 61 cases (range: 52–70) per 100,000 population (*2*).

Under the theme of World TB Day 2020 "It's Time", the spotlight this year is on urgently accelerating the TB response to save lives and end suffering by building on high-level commitments by Heads of State at the 2018 UN High-Level Meeting on TB and to accelerate the UN's 2030 target to end TB (*3*). In response to the theme of World TB Day 2020, the National Health Commission of China has announced China's 2020 national theme: "Working together to fight against COVID-19 and TB to promote our healthy breathing" (*4*).

References

1. WHO. World tuberculosis day 2020. https://www.who.int/news-room/campaigns/world-tb-day/world-tb-day-2020. [2020-03-05].
2. WHO. Global tuberculosis report 2019. https://www.who.int/tb/publications/global_report/en/. [2020-03-05].
3. Stop TB Partnership. World TB day 2020. http://www.stoptb.org/events/world_tb_day/. [2020-03-05].
4. China Tuberculosis Network. The theme of world TB day 2020 was released. http://tb.chinacdc.cn/. [2020-03-05]. (In Chinese).

Vital Surveillances

Characteristics and Morbidity of the Tuberculosis Epidemic — China, 2019

Wei Chen[1]; Hui Zhang[1]; Xin Du[1]; Tao Li[1]; Yanlin Zhao[1,#]

Abstract

Introduction: The year 2019 was crucial for the implementation of China's National "13th 5-Year" Tuberculosis (TB) Control Plan. We conducted this study to evaluate the characteristics and progress towards controlling TB in China.

Methods: We collected and analyzed the pulmonary tuberculosis (PTB) data of China between January 1, 2015 and December 31, 2019 from the National Notifiable Disease Reporting System (NNDRS).

Results: In 2019, there were 775,764 PTB cases reported in NNDRS, of which 349,307 were bacteriologically-confirmed (Bac+) cases. The PTB case notification rate (CNR) was 55.55 per 100,000, and the Bac+ CNR was 25.01 per 100,000. From 2018 to 2019, the number of PTB cases fell by 6.3%, but the number of Bac+ cases increased by 25.9%. The annual decrease in the rate of reported PTB was 3.4% from 2015 to 2019.

The 5 provincial-level administrative divisions (PLADs) with the highest PTB CNR were as follows: Tibet (182.38 per 100,000), Xinjiang (169.05 per 100,000), Qinghai (134.53 per 100,000), Guizhou (102.51 per 100,000), and Hainan (90.22 per 100,000).

The rate of reported PTB was 74.84 per 100,000 for males and 35.40 per 100,000 for females. There were 8,116 cases (1.0%) among children aged 0–14 years, and 197,730 cases (25.5%) among adults aged 65 years and over. Of the reported cases, 470,932 were farmers, which was the most common occupation at 60.7%.

Conclusions and Implications for Public Health Practice: The TB epidemic has decreased dramatically year by year. Most PTB cases were in the central and western regions of China, and the high-risk groups were farmers and elderly people aged 65 years and over.

Introduction

Tuberculosis (TB) is a top ten cause of death worldwide and the leading cause of death due to infectious disease in the world. TB is caused by *Mycobacterium tuberculosis* and is spread through the air from one person to another. China is one of the 30 high TB burden countries (HBCs) in the world with an estimated 0.87 million (0.74–1.00 million) TB cases in 2018. The incidence rate, however, was 61 per 100,000 population, below the world average of 132 per 100,000. China ranked 2 for new TB cases among 30 HBCs, but ranked 27 for TB incidence rate.

In 2018, the United Nations held its first ever high-level meeting on TB, discussing the status of the TB epidemic and how to end it (*1*). In order to end the TB epidemic, the National Health Commission of China constructed the Action Plan to End TB (2019–2022) in 2019 (*2*). The year was also important for China to implement the National "13th 5-Year" TB Control Plan. To understand the epidemic situation of TB in China, we collected and reported pulmonary TB (PTB) data from the National Notifiable Disease Reporting System (NNDRS) and systematically analyzed the epidemiological characteristics of TB and progress towards controlling TB in China.

Methods

Data on reported PTB cases between January 1, 2015 and December 31, 2019 were downloaded from the NNRDS. We analyzed the characteristics and morbidity of the TB epidemic by year, provincial-level administrative divisions (PLADs), and population using Microsoft Excel (version 2007) and the spatial distribution of the TB epidemic with ArcGIS (version 10.2; Esri Institute).

Results

In 2019, there were 775,764 reported PTB cases in the NNDRS, of which 349,307 were bacteriologically-confirmed cases. The rate of reported PTB was 55.55 per 100,000, and the rate of reported bacteriologically-confirmed (Bac+) was 25.01 per 100,000. Compared with 2018, PTB cases fell by 6.3%, while the Bac+ cases increased by 25.9%. The annual rate of decrease of reported PTB was 3.4% during 2015–2019 (Table 1). The number of reported PTB cases was ranked 2 in Class A and Class B notifiable infectious diseases during 2015–2019, right behind hepatitis B.

In 2019, the five PLADs with the highest rate of reported PTB were: Tibet (182.38 per 100,000), Xinjiang (169.05 per 100,000), Qinghai (134.53 per 100,000), Guizhou (102.51 per 100,000), and Hainan (90.22 per 100,000 (Figure 1A); the five PLADs with highest number of reported PTB cases were:

TABLE 1. The number and case notification rate of reported pulmonary tuberculosis (PTB) in China, 2015–2019.

Year	Population (10,000)	No. of reported PTB		Rate of reported PTB (1/100,000)	
		PTB	Bac+*	PTB	Bac+
2015	136,247	864,015	247,168	63.42	18.14
2016	137,343	836,236	237,942	61.00	17.36
2017	137,923	835,193	244,302	60.53	17.71
2018	138,910	823,342	277,439	59.27	19.97
2019	139,654	775,764	349,307	55.55	25.01

* Bac+: bacteriologically confirmed.

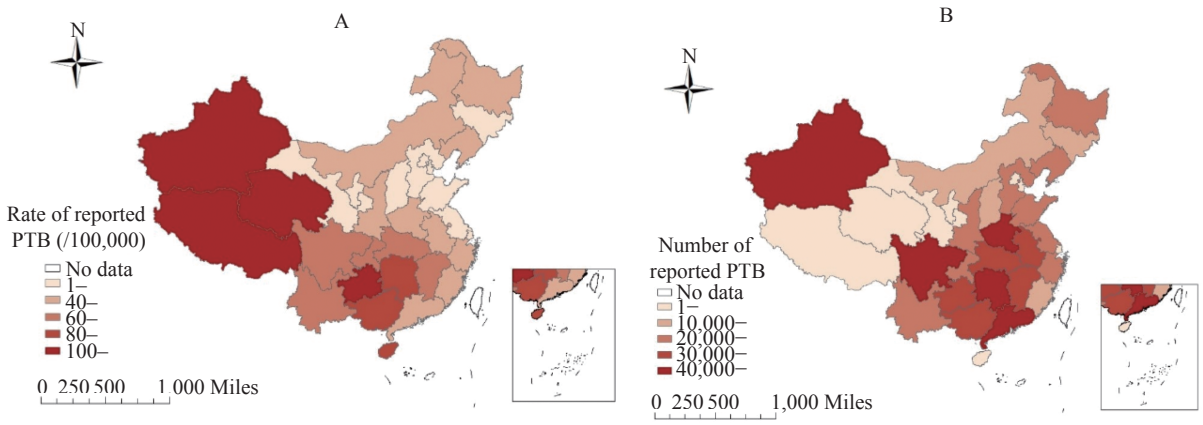

FIGURE 1. Geographical distribution of the reported pulmonary tuberculosis (PTB) in 31 PLADs of China, 2019. (A) Rate of reported PTB; (B) Number of reported PTB.

Guangdong (66,261), Hunan (56,620), Sichuan (50,337), Henan (49,753), and Xinjiang (42,043) (Figure 1B).

TB affects both males and females in all age groups. There were 533,981 reported male PTB cases with a case rate of 74.84 per 100,000 population and 241,783 reported female cases with a case rate of 35.40 per 100,000. There were 8,116 cases in children aged 0–14 years (1.0%), and 197,730 cases in the adults aged 65 years and over (25.5%). The case rate of reported PTB increased with age and was higher in older age groups (Table 2).

Of the reported cases, 470,932 were farmers (60.71%), the highest among all occupations, 111,006 were house workers (14.31%), 47,732 were students (6.15%), 41,324 were retirees (5.33%), and 34,094 were factory workers (4.39%) (Table 3).

Discussion

TB is one of the major infectious diseases affecting public health in both China and the world. The TB epidemic in China is still severe. China is one of the highest 30 HBCs, and the number of new estimated TB cases is second only after India (*3*–*6*). Reported PTB cases ranked second in Class A and Class B notifiable infectious diseases in China from 2015 to 2019.

During the period of 13th 5-Year National Plan, the Central Government of China regarded TB as one of the priority infectious diseases to be controlled. Government at different levels, from the national level to the county level, have made political commitments on TB control. With such measures as optimizing the TB service provision systems and improving the quality of case detection and treatment management, TB cases have decreased dramatically year by year. The annual decrease of the TB incidence rate in China was 3.4% during 2015–2019, which was higher than the global average (1.6%). Compared with 2018, the reported number of cases of PTB in 2019 decreased by 6.3% (*3*,*4*,*6*), while the number of Bac+ cases increased by 25.9%. This indicates that designated TB hospitals have attached importance to sputum collection and testing. As a result, the bacteriological confirmation rate has been improved remarkably.

The number of reported PTB cases and the case rates were higher in Xinjiang, Guizhou, Guangxi, Hunan and Jiangxi, which are located in the central and western part of China, the priority regions for TB control in the country. TB cases were mainly distributed in low-income and other high-risk groups, such as farmers in the central and western regions and elderly people aged 65 years and over. In addition, the case rate of students aged 15–25 years increased dramatically, so these groups of people will be the priority for TB control in the future (*7*–*9*).

This study is subject to some limitations. The reported number cases of PTB by the NNDRS was affected by the severity of the epidemic situation and the work of case detection, so considering these factors upon comparing the reported rate with different provinces is necessary to assess the level of the TB morbidity.

Although much progress has been made in TB control, TB still remains a major public health threat in China. Further progress in controlling the disease could be long, complex, and arduous. More funding and specialized human resources are needed for TB high burden areas, such as poor areas in the central and the western areas with a focus on some high risk

TABLE 2. The number and case notification rate of reported pulmonary tuberculosis (PTB) in different gender and age groups, 2019.

Age group (years)	Population (10,000)			No. of reperted PTB			Rate of reported PTB		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
0–	4,406	3,992	8,397	398	350	748	0.90	0.88	0.89
5–	8,272	7,032	15,303	3,558	3,810	7,368	4.30	5.42	4.81
15–	8,187	7,239	15,425	66,038	38,929	104,967	80.67	53.78	68.05
25–	11,834	11,293	23,127	70,973	41,444	112,417	59.97	36.70	48.61
35–	10,260	9,948	20,207	56,276	27,233	83,509	54.85	27.38	41.33
45–	12,248	11,923	24,171	98,033	35,739	133,772	80.04	29.98	55.35
55–	8,311	8,212	16,523	100,432	34,821	135,253	120.84	42.40	81.86
≥65	7,831	8,668	16,500	138,273	59,457	197,730	176.56	68.59	119.84
Total	71,348	68,305	139,654	533,981	241,783	775,764	74.84	35.40	55.55

TABLE 3. Reported pulmonary tuberculosis (PTB) cases by occupation, 2019.

Category	No. of reported PTB	Proportion (%)
Child	1,433	0.18
Student	47,732	6.15
Teacher	4,280	0.55
Service staff	16,087	2.07
Healthcare worker	4,018	0.52
Factory worker	34,094	4.39
Farmer	470,932	60.71
Government official	12,742	1.64
Retiree	41,324	5.33
House worker	111,006	14.31
Others	20,547	2.65
Not applicable	115,69	1.49
Total	775,764	100.00

groups, such as farmers, elderly people aged 65 years and over, and students aged 15–25 years (*10*–*11*). By implementing comprehensive control measures, we could decrease TB incidence and mortality dramatically in China. This will in turn contribute to achieving the goals of "Health China 2030" and "Poverty Alleviation in China" (*12*).

Acknowledgments

The authors would like to thank all participants of the national surveillance program. Many thanks to Zhijun Li from US CDC China Office for reviewing and editing the manuscript. Lijia Yang and Yanfei Liu for reviewing the reference literature. This work was supported by the China National TB Program and the National Special Science and Technology Project for Major Infectious Diseases of China (2017ZX10201302007).

Conflicts of interest

All authors have completed and submitted the ICMJE form. And no conflicts of interest were reported.

[#] Corresponding author: Yanlin Zhao, zhaoyl@chinacdc.cn.

[1] National Center for TB Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, China.

Submitted: March 06, 2020; Accepted: March 19, 2020

References

1. Herbert N, Sharma V, Masham BS, Sheehan BS, Hauser J, Zumla A. Concrete action now: UN high-level meeting on tuberculosis. Lancet Infect Dis 2018;18(7):709 – 10. http://dx.doi.org/10.1016/S1473-3099(18)30171-3.
2. Action Plan to End TB (2019-2022). http://www.nhc.gov.cn/jkj/s3589/201906/b30ae2842c5e4c9ea2f9d5557ad4b95f.shtml.[2020-03-08]. (In Chinese).
3. World Health Organization. Global tuberculosis report 2019. https://www.Who.int/tb/publications/global_report/en/.[2020-03-08].
4. Floyd K, Glaziou P, Zumla A, Raviglione M. The global tuberculosis epidemic and progress in care, prevention, and research: an overview in year 3 of the End TB era. Lancet Respir Med 2018;6(4):299 – 314. http://dx.doi.org/10.1016/S2213-2600(18)30057-2.
5. Mao Q, Zeng CH, Zherng DC, Yang YH. Analysis on spatial-temporal distribution characteristics of smear positive pulmonary tuberculosis in China, 2004-2015. Int J Infect Dis 2019;80 Suppl:S36 – 4. http://dx.doi.org/10.1016/j.ijid.2019.02.038.
6. Ragonnet R, Trauer TM, Geard N, Scott N, McBryde ES. Profiling *Mycobacterium tuberculosis* transmission and the resulting disease burden in the five highest tuberculosis burden countries. BMC Med 2019;17(1):208. http://dx.doi.org/10.1186/s12916-019-1452-0.
7. Tanimoto T, Wang N, Yamamoto K, Morita T, Zhao GM. Incidence of active tuberculosis in rural China. Lancet Infect Dis 2018;18(2):144 – 5. http://dx.doi.org/10.1016/S1473-3099(18)30021-5.
8. Guo ZY, Xiao D, Wang XH, Wang YY, Yan TC. Epidemiological characteristics of pulmonary tuberculosis in mainland China from 2004 to 2015: a model-based analysis. BMC Public Health 2019;19(1):219. http://dx.doi.org/10.1186/s12889-019-6544-4.
9. Cai XT, Du YH, Zhong J, He G, Jiang KH. Epidemiological characteristics of tuberculosis patients in Haizhu District of Guangzhou from 2014 to 2018. J Tubercul Lung Health 2019;8(2):100 – 5. http://dx.doi.org/10.3969/j.issn.2095-3755.2019.02.006. (In Chinese).
10. Lin HH, Wang LX, Zhang H, Ruan YZ, Chin DP, Dye C. Tuberculosis control in China: use of modelling to develop targets and policies. Bull World Health Organ 2015;93(11):790 – 8. http://dx.doi.org/10.2471/BLT.15.154492.
11. Guo Y, Huang YM. New challenges for tuberculosis control in China. Lancet Glob Health 2016;4(7):e434 – 5. http://dx.doi.org/10.1016/S2214-109X(16)30112-7.
12. The outline of the healthy China 2030 plan. http://www.nhc.gov.cn/guihuaxxs/s3586s/201610/21d120c917284007ad9c7aa8e9634bb4.shtml. [2020-03-08]. (In Chinese).

Preplanned Studies

Underreporting of Notifiable Pulmonary Tuberculosis Cases to the National Tuberculosis Information Management System — China, 2015

Tao Li[1]; Wei Chen[1]; Yanlin Zhao[1]; Lixia Wang[1]; Mingting Chen[1]; Xin Du[1,#]; Hui Zhang[1,#]

Summary

What is already known about this topic?

Tuberculosis (TB) notification data and the underreporting rate are major sources used in estimating TB incidence. China's TB Information Management System (TBIMS) was launched in 2005 but has not yet been evaluated for sensitivity.

What is added by this report?

The average underreporting rate of pulmonary TB to TBIMS in selected facilities was 8.23%. However, provincial TB or infectious disease-specific health facilities, or general health facilities had higher underreporting rates. Children, migrants, and drug resistant TB patients had higher chances to be underreported than other populations.

What are the implications for public health practice?

Underreporting surveys should be routinely implemented in the future. This will be vital for enhancing TB reporting and the transfer mechanisms in TB or infectious disease-specific hospitals, or general hospitals and improving the case information registration procedures in designated health facilities (DHFs).

The number of pulmonary tuberculosis (PTB) reported cases in the National Notifiable Disease Reporting System (NNDRS) was used to indicate TB incidence data in China. While globally, notification data based on confirmed cases were more often used to estimate or model TB incidence with quantified underreporting levels (*1–2*). China's Tuberculosis Information Management System (TBIMS) was launched in 2005 to collect diagnosis, treatment, and management information of TB cases enrolled in the National Tuberculosis Program (NTP) by designated health facilities (DHFs), but its sensitivity has never been evaluated at a national level. A retrospective cross-sectional survey was carried out by the National Center for Tuberculosis Control and Prevention (NCTB) to evaluate the underreporting level of TBIMS in 2015.

The average underreporting rate of PTB to TBIMS in selected facilities was 8.23%. Among the different levels and types of health facilities, provincial facilities had the highest underreporting rate, and general TB or infectious disease-specific health facilities or general health facilities had higher underreporting rate than DHFs in same level. Children, migrants and drug resistant patients had a higher likelihood to be underreported than other populations. Enhancing TB reporting and transfer mechanisms in TB or infectious disease-specific hospitals or general hospitals are recommended to reduce underreporting and lost follow-ups among patients referred to TB DHFs. Meanwhile, the registration procedure for patient information in DHFs also needs to be improved, especially to target patients that are children, drug resistant, or migrants.

Furthermore, reporting PTB cases is a mandatory requirement enforced by law (*3*). As part of the National Disease Control Information System, TBIMS can exchange information on TB cases with the NNDRS. When a case was considered PTB, either presumptive or confirmed, the case must be reported to the NNDRS first and then transferred to TB DHFs where the patient will undergo further diagnosis verification. With the information exchanged between NNDRS and TBIMS, DHFs can easily trace patients diagnosed by every hospital/clinic/primary health center all over the country and enroll them into NTP. TBIMS is a web-based, real-time PTB notification system for describing TB epidemic and long-term trends, which has helped improve China's TB control strategies.

The survey design and procedures have referred to the World Health Organization (WHO) guideline: *Assessing tuberculosis underreporting through inventory studies* (*4*). The study population was defined as patients whose current address was in selected areas

and eventually confirmed as PTB (clinical or laboratory confirmed) in sampled health facilities during selected months of 2015; tuberculous pleurisy didn't include.

Sampling was performed as follows: 30% of prefectures were randomly selected throughout 32 provincial-level administration divisions (PLADs); then 30% of counties or districts were also randomly selected from previously selected prefectures; a TB DHF and a general hospital were selected in each county/district and all PTB cases diagnosed in these two types of facilities were accounted for. At the prefectural and provincial level, a TB DHF, a general hospital, and a TB or infectious disease-specific hospital (if existing) were selected. The enrolled facilities must also fulfill following criteria: 1) county-level or above-county-level facilities; 2) TB diagnostic ability, which includes the ability to conduct chest x-ray examinations and/or sputum smear examinations of mycobacterium; and 3) has reported at least 1 PTB case (presumptive or confirmed) in the NNDRS in 2015. The description of final enrolled facilities is in Table 1.

The data was collected and processed as follows: record reviewing work was carried out by local NTP health workers. All medical records which contained "结核" (tuberculosis in Chinese) during designated periods were collected in enrolled health facilities' outpatient, inpatient, and laboratory departments. For the data processing procedure, see Figure 1.

Data analysis was conducted using a specific "multisystem TB records matching and linking software" that was predesigned for data matching between health facility medical records and the TBIMS notification database. SPSS Software (version 17.0, SPSS Inc., Chicago, Il, USA) was used for analysis of final dataset. Chi square tests were used for testing relationships between categorical variables. $P<0.05$ was considered statistically significant. The underreporting rate was defined as follow:

$$\text{Under reporting rate of PTB (\%)} = \frac{\text{number of cases not notified in TBIMS}}{\text{number of cases diagnosed and confirmed as PTB}} \times 100$$

A total of 902,349 cases with TB related diagnosis were collected in this survey including 631,009 (69.93%) outpatient records, 168,901 (18.72%) inpatient records, and 102,439 (11.35%) laboratory records. Among 902,349 records, 508,316 duplicated or old TB cases were excluded after preliminary data cleaning. Then another 279,583 cases were excluded by physicians and implementers due to living outside of the sampled sites or exclusion of TB. Finally, 114,450 confirmed cases from 985 health facilities in 32 PLADs were included in the survey (Table 2).

The average underreporting rate of PTB in TBIMS in selected facilities was 8.23% (9,423/114,450). The underreporting rates of cases collected from outpatient, inpatient, and laboratory records were 4.93% (4,507/91,427), 27.19% (3,939/14,485), and 11.44% (977/8,538), respectively. The underreporting rate was 22.17% (135/609) among children under 15 years old, while it was 7.37% (6,462/87,689) among those aged 15–64 years and 10.81% (2,826/26,152) among elders aged over 64 years. Among laboratory confirmed cases, 6.68% (2,206/33,037) cases were not reported to TBIMS, among which the underreporting rate of multi-drug resistant/rifampin resistant (MDR/RR) TB cases was 32.41% (317/978). Correspondingly, the underreporting rate among clinically diagnosed cases was 8.86% (7,217/81,413). When a patient was diagnosed within his or her PLAD of residence, the likelihood of not being reported to TBIMS was 7.95% (9,038/113,755). However, if a case was diagnosed out of his or her PLAD of residence, the likelihood of not being reported was 55.40% (385/695). Among

TABLE 1. Number of sites and health facilities selected in the 2015 nationwide Tuberculosis Information Management System (TBIMS) underreporting survey in China.

Administrative level	Total regions	Total No. of health facilities			Sampled regions	No. of sampled health facilities		
		TB DHF	TB or infectious disease-specific hospitals	General health facilities		TB DHF	TB or infectious disease-specific hospitals	General health facilities
Province	32	58	11	764	32	18	7	40
Prefecture	348	304	59	1,834	116	88	12	137
County/district	3,093	2,812	0	6,825	436	348*	0	335

Abbreviation: DHF=designated health facility, TB=tuberculosis.

*Generally there should be at least one DHF in each county or district, while in reality plural counties/districts may share the same DHF and upper-level DHF could also represent the role of lower DHF in its location area. Hence, there were less selected county-level DHFs than selected number of counties/districts.

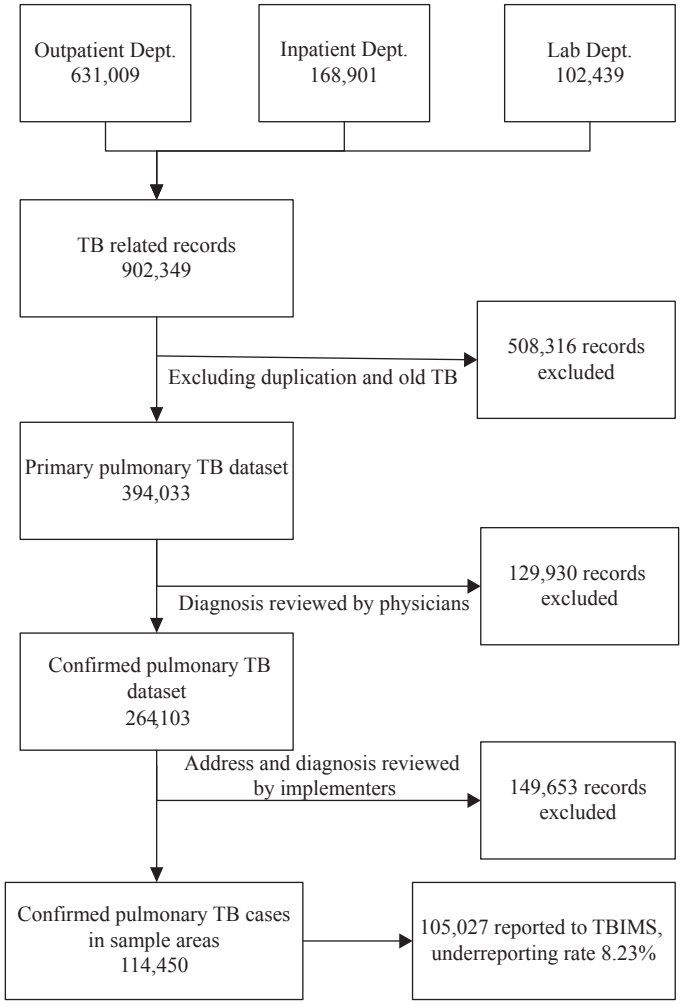

FIGURE 1. Flowchart of the 2015 nationwide Tuberculosis Information Management System (TBIMS) underreporting survey in China. Dept.=Department.

different types of health facilities, provincial general health facilities had the highest underreporting rate at 40.35% (301/746) and county level DHFs had the lowest underreporting rate at 2.23% (1,943/87,102) (Table 2).

Discussion

In 2015, about 92% (105,027/114,450) of PTB cases diagnosed in 985 sampled health facilities were reported to national TBIMS, which was higher than the WHO estimated case finding rate of 87% (notified/estimated incidence) (*5*) and could indicate China's NTP surveillance system had relatively good coverage and sensitivity. However, many challenges and barriers were also revealed in this survey.

Among different levels and types of health facilities, provincial facilities had the highest underreporting rate, and general TB or infectious disease-specific or general health facilities had higher underreporting rates than DHFs at the same regional level. This showed that quality control work should be carried out in every health facility and TB diagnostic capacity especially needs to be improved in higher level, non-designated units. Children are a vulnerable population facing TB infections, and our global society is risking a silent epidemic of childhood TB. (*6*) The much higher underreporting rate among children under 15 years revealed the urgency of involving diagnosed childhood TB into NTP management. Currently, reporting work is mostly conducted by outpatient departments. PTB cases diagnosed in outpatient departments had a smaller likelihood to be underreported in this survey, while inpatient and laboratory departments need to improve their internal information transfer work. Less than half the patients diagnosed out of their PLAD of

TABLE 2. The number and underreporting rate of pulmonary tuberculosis (PTB) cases enrolled in the 2015 nationwide Tuberculosis Information Management System (TBIMS) underreporting survey in China.

Categories	Number	Proportion (%)	Underreporting cases	Underreporting rate (%)	*p*	χ^2
Gender					<0.0001	30.23
Male	79,463	69.43	6,362	8.01		
Female	34,800	30.41	3,028	8.70		
Not recorded	187	0.16	33	17.65		
Age groups (years)					<0.0001	381.36
0–14	609	0.53	135	22.17		
15–64	87,689	76.62	6,462	7.37		
≥65	26,152	22.85	2,826	10.81		
Diagnosis categories					<0.0001*	127.27*
Laboratory confirmed	33,037	28.87	2,206	6.68		
- MDR/RR	978	0.85	317	32.41		
Clinically diagnosed	81,413	71.13	7,217	8.86		
Data sources					<0.0001	30.23
Outpatient	91,427	79.88	4,507	4.93		
Inpatient	14,485	12.66	3,939	27.19		
Laboratory	8,538	7.46	977	11.44		
Reporting area					<0.0001	1218.90
Within living provinces	113,755	99.39	9,038	7.95		
Out of living provinces	695	0.61	385	55.40		
Classification of health facilities					<0.0001	19971.59
Provincial DHFs	4351	3.80	1,090	25.05		
Provincial TB/ID-specific hospitals	1,375	1.20	468	34.04		
Provincial general health facilities	746	0.65	301	40.35		
Prefectural DHFs	8,234	7.19	1,348	16.37		
Prefectural TB/ID-specific hospitals	1,016	0.89	282	27.76		
Prefectural general health facilities	2,110	1.84	545	25.83		
County-level DHFs	87,102	76.10	1,943	2.23		
County-level general health facilities	9,516	8.31	3,446	36.21		
Total	114,450	100.00	9,423	8.23		

Abbreviation: ID=Infectious Disease, DHF=designated health facility, MDR/RR=multi-drug resistant/rifampin resistant, TB=tuberculosis.
* The chi square and *p*-value are the result of testing between laboratory-confirmed cases and clinically-diagnosed cases.

residence have been reported in TBIMS, which was quite low comparing to patients diagnosed within their PLAD of residence. This indicated great barriers in cross-area patient management. Compared to local residents, migrant PTB cases may not be appropriately reported based on many reasons such as social insurance, changing residential addresses, and stigma, etc.

China has the second highest MDR/RR TB burden in the world. There was still a big gap between notified cases and estimated MDR/RR TB incidence in recent years (*1*). In this survey, nearly one third of diagnosed MDR/RR TB cases have not been correctly reported to TBIMS. Further investigation and analysis must be done to clarify the underlying reasons in the near future.

This is the first nationwide underreporting survey that may help improve the national TB incidence estimation. Furthermore, routine surveys (e.g. every five years) are suggested in the future for evaluating the quality and progress of TBIMS. Enhancing TB surveillance work is a major request in the national "Stop TB Action Plan (2019–2022)". All relevant stakeholders, including health authorities, CDCs, and

health facilities, need to enhance their roles by following national regulations and guidelines. Enhancing TB reporting and transfer mechanisms in TB or infectious disease-specific hospitals or general hospitals are recommended to reduce underreporting and lost follow-ups among patients referred to TB DHFs. Meanwhile, the registration procedures for patient information in DHFs also needs to be improved, especially those targeting patients that are children, drug resistant, or migrant.

Acknowledgement

We thank our colleagues and healthcare workers who contributed to the survey from all levels of CDCs, hospitals, and health facilities for data collection and review.

[#] Corresponding authors: Du Xin, duxin@chinacdc.cn; Zhang Hui, zhanghui@chinacdc.cn.

[1] National Center for Tuberculosis Control and Prevention, China CDC, Beijing, China.

Submitted: March 11, 2020; Accepted: March 18, 2020

References

1. World Health Organization. Global tuberculosis report 2019. Geneva, Switzerland: WHO. 2019. https://www.who.int/tb/publications/global_report/en/.[2020-03-10].
2. Kyu HH, Maddison ER, Henry NJ, Ledesma JR, Wiens KE, Reiner Jr R, et al. Global, regional, and national burden of tuberculosis, 1990-2016: results from the global burden of diseases, injuries, and risk factors 2016 study. Lancet Infect Dis 2018;18(12):1329 – 49. http://dx.doi.org/10.1016/S1473-3099(18)30625-X.
3. National People's Congress. Law of infectious disease control. 2005. http://www.gov.cn/banshi/2005-08/01/content_19023.htm. [2019-12-27]. (In Chinese).
4. World Health Organization. Assessing tuberculosis underreporting through inventory studies. Geneva: WHO. 2012. https://www.tandfonline.com/doi/ref/10.1080/17476348.2016.1199278?scroll=top. [2020-03-10].
5. World Health Organization. Global tuberculosis report 2016. Geneva, Switzerland: WHO. 2016. https://apps.who.int/iris/bitstream/handle/10665/250441/9789241565394-eng.pdf?sequence=1&isAllowed=y. [2020-03-10].
6. International Union Against Tuberculosis and Lung Disease[Internet]. Silent epidemic: a call to action against child tuberculosis. c2018. https://childtb.theunion.org/wp-content/uploads/2018/08/Silent-Epidemic.pdf. [2020-03-10].

Preplanned studies

Effectiveness of the Integrated TB Surveillance System — China, 2018–2019

Ni Wang[1]; Tao Li[1]; Xin Du[1]; You Li[1]; Miaomiao Sun[2]; Shitong Huan[3]; Hui Zhang[1]; Lixia Wang[1]; Mingting Chen[1]; Fei Huang[1,#]; Yanlin Zhao[1,#]

Summary

What is already known about this topic?

China's national health information system provides important support and means for deepening the country's medical and health reform, for improving relevant delivery services, for enhancing the level of scientific management of health, and for promoting the goal of basic medical and health services for everyone in China.

What is added by this report?

To further the construction of the national health information system, the National Center for Tuberculosis Control and Prevention of China CDC, started a pilot project for a new tuberculosis (TB) integrated health (iHealth) surveillance system, which was integrated with regional health information platforms. The goal was to explore automatic data exchange between hospitals and disease control facilities to reduce the workload of data-entry.

What are the implications for public health practice?

This pilot proved that data sharing and automatic exchanges between different information systems can be achieved through a unified surveillance dataset, which could provide a reference point for the construction of surveillance systems for other infectious diseases or for the entire public health information system.

In 2005, China launched an electronic Tuberculosis Information Management System (TBIMS), which was the largest in the world. All TB dispensaries across the country now enter TB case information into the system via the internet in real time (*1*).

In November 2011, the General Office of the State Council issued the *National TB Control Program* (*2011 to 2015*), which requires that, in principle, each county in China should designate at least one hospital to diagnose, treat, and register TB patients. In June 2012, the former Ministry of Health and the State Administration of Traditional Chinese Medicine issued the *Guiding Opinions on Strengthening the Construction of Health Information System*, which clarifies the overall framework, basic principles, work goals, key tasks, and safeguard measures of the health information system.

By the end of 2012, 48% of health facilities nationwide had built electronic medical record systems (*2*), but could not exchange data with the TBIMS. All the surveillance data related to TB need to be re-entered into TBIMS, although these data were already electronically stored in the hospital information system. In November 2016, the National Development and Reform Commission issued the *National Health Security Project Construction Plan*, which required data aggregation and business collaboration of six major business application systems including public health. By the end of 2017, more than 75% of secondary public hospitals had established electronic medical record systems, and the overall information construction situation of China's secondary and higher medical institutions has improved (*3*).

TBIMS serves as the main data source to evaluate the implementation of the National TB Control Program. Yet with advancements in information technology, changes to TB service delivery, and the requirements of the national health information system, it was necessary to develop a new TB surveillance system. The National Health Commission of China-Bill & Melinda Gates Foundation TB Collaboration project organized a pilot of a new TB surveillance system from 2016 to 2019. The system was designed to be applicable to the current state of TB control and prevention and to be able to exchange data automatically with regional health information platforms.

The pilot first developed a unified TB surveillance dataset and data exchange interface specifications. China CDC then developed the new TB surveillance system, and the pilot areas accordingly upgraded their local hospital information systems and regional health

information platforms. With these processes and systems in place, the pilot achieved automatic data exchange and sharing between the various platforms—a requirement of the national health information system construction. The pilot further aimed to provide experience and lessons learned that could be used to build infectious disease surveillance models for other diseases or for an entire public health information system.

According to the characteristics of China's TB service delivery models, the pilot project selected one health facility each from the eastern, central, and western regions of China. The eastern region chose the Central Hospital of Huzhou City in Zhejiang Province as a designated hospital model; the central region chose the TB dispensary of Jilin City in Jilin Province as an independent TB dispensary model; and the western region chose the Fourth People's Hospital of Ningxia Hui Autonomous Region as an integrated model.

The pilot first unified the standards for TB surveillance datasets (Figure 1), which included basic information, physical examination screening history, medical history/disease, epidemiological investigation history, and so on. All the collected information was transformed into an electronic disease record (EDR) with the patient ID at its core, thereby making data exchange and full lifecycle monitoring possible. In the process of data exchange, unsuccessful exchanges and data inconsistencies were analyzed and corrected in real time. Moreover, the function of data extraction and collation of hospital information systems was improved constantly and so was data verification and logical checking of national and regional health information. The goal was to reduce the data entry burden of medical staff and ultimately improve the timeliness and accuracy of surveillance data.

After preparing for national system development and regional system upgrade, the pilot officially started in July 2018 and ended in June 2019. During the pilot period, each region automatically uploaded relevant data of TB patients to the new national TB surveillance system through the regional health information platform. According to the requirements, the infectious disease report card and medical record information of TB patients were entered into the National Notifiable Disease Reporting System (NNDRS) and TBIMS respectively. Three indicators were analyzed for each pilot area during the pilot period.

The three indicators—data exchange rate, infectious disease report card filing rate, and medical record filing rate—have all improved, reaching 95% and above by June 2019, with some indicators approaching or reaching 100% (Figure 2).

Discussion

In the early stages of the pilot, due to certain problems in the upgrade and reconstruction of the hospital information system, the lack of mastery of the new system by medical staff, and the unstable exchange link between the national system and the regional health platforms, the data quality was lacking. For example, the patient registration number is required to have a length of 21 digits. If the length of the uploaded data from each region is not exactly 21 digits, the upload will fail, the percentage of TB patients records successfully transmitted to the new system will be reduced; the patient ID number in the new system was required, while in the old system it was an optional

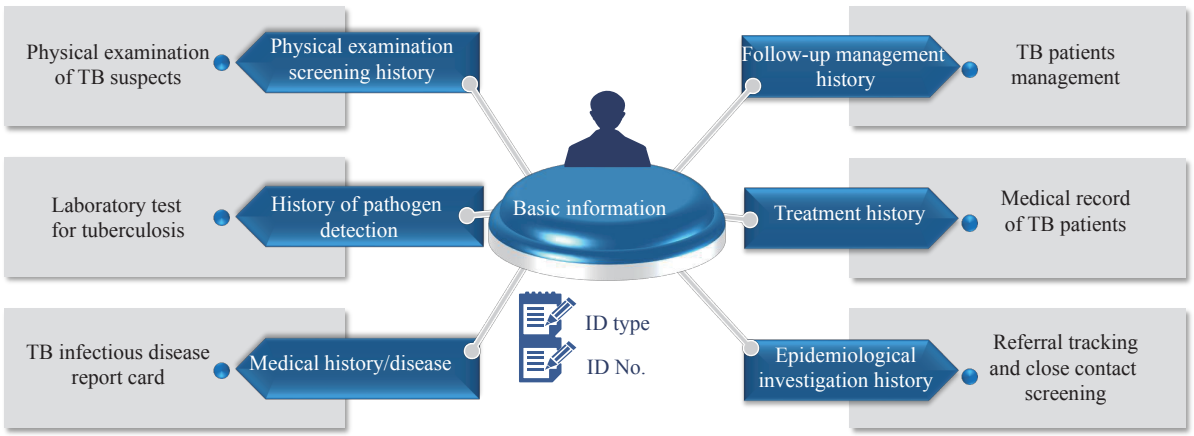

FIGURE 1. Tuberculosis (TB) surveillance dataset used for national and regional systems.

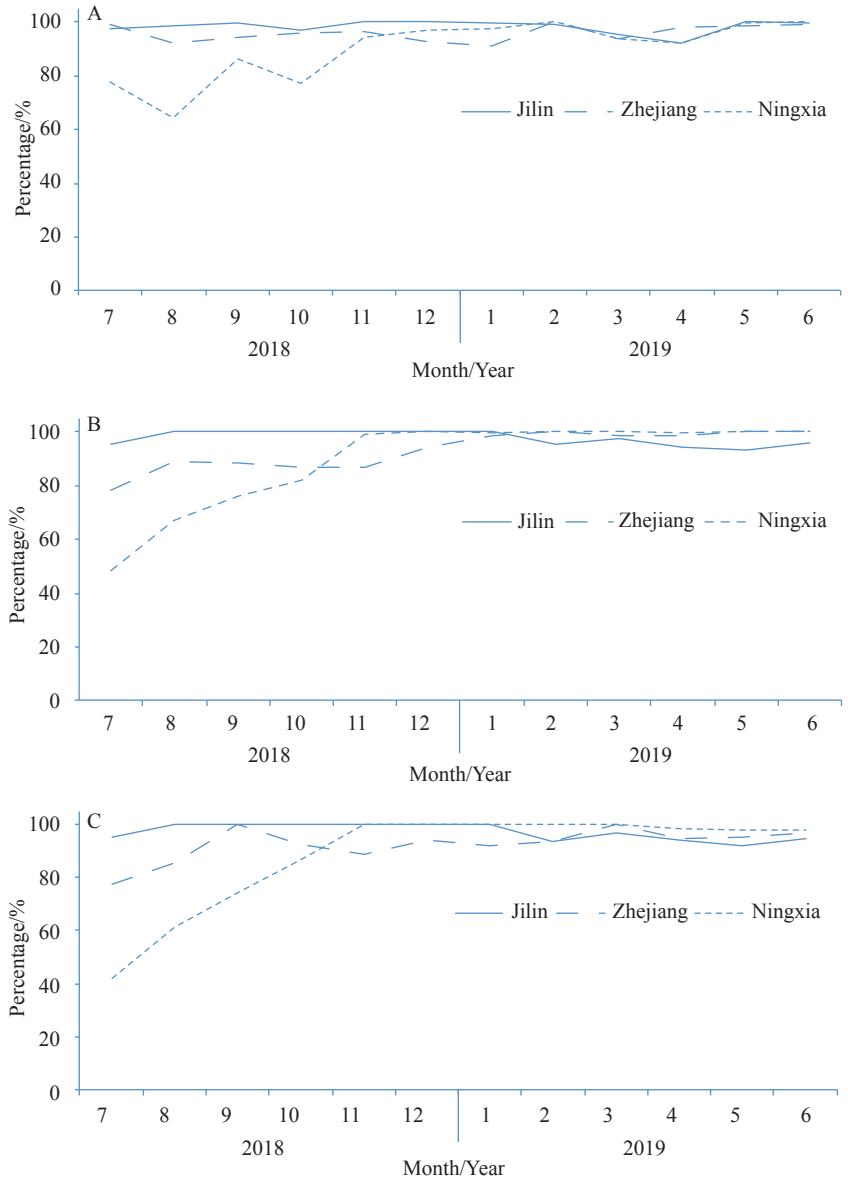

FIGURE 2. Pilot result of the new Tuberculosis (TB) integrated health surveillance system, three regions, 2018–2019. (A) Percentage of TB patients records successfully transmitted from regional health information platform to new national TB surveillance system; (B) Percentage of TB infectious disease report cards reported from National Notifiable Disease Reporting System (NNDRS) to new national TB surveillance system; (C) Percentage of TB medical records registered from TBIMS to new national TB surveillance system.

item and medical staff often didn't enter the ID number, which resulted in inconsistent matching when comparing the data records of the two systems and lower percentages of infectious report card and medical record at the beginning of operation. After discovering these problems, a data verification mechanism was developed at the national level, and records of exchange failures and records of inconsistent matching between systems were sent back to the pilot areas for verification. The pilot areas reported the reasons and solutions to the national level on a weekly basis. With continuous resolution of the problems found during monitoring, continuous improvement of information systems, and continuous improvement of data exchange links, the quality of the pilot data became better and more stable. The data quality of Jilin has, from the beginning, been better than the other two regions. One of the reasons may be that Jilin developed a new system according to the requirements of surveillance data sets and exchange specifications, while Zhejiang and Ningxia upgraded existing systems.

In this new era of big data, technologies such as the

Internet of Things and cloud computing have stepped onto the stage (*4*). Upgrade of China's medical and health information system also faces more expectations of the people, higher policy requirements, more complex construction requirements, and faster technological evolution. This sets up an urgent need to organize the information system development of the medical and health field in various stages, summarize and refine the development characteristics, and further improve the overall design (*5*). This pilot proved the design concept of case-based, lifecycle disease monitoring system with a unified surveillance dataset, which could realize automatic data exchanging, sharing among different information systems, and eradicating data islands. This pilot also could provide a reference point for the construction of surveillance systems for other infectious disease or for the entire public health information system.

This article mainly discusses the feasibility of data exchange between information systems and does not analyze the sensitivity and quality of surveillance data. The main challenge for this pilot is whether the software engineers can fully and correctly understand the surveillance dataset and upgrade the hospital information system accordingly to retrieve all the data as required. To overcome these challenges, training for engineers must be adequate and comprehensive discussions with medical staff must be held.

This study is subject to a few limitations. The pilot was implemented in three areas, and the new national TB surveillance system only exchanged data with three regional health information platforms. Given the complexity and difference of regional health information platform in China, there may be problems in exchanging data with other regional health information platforms, which need to be studied in the future.

Acknowledgments

The authors would like to thank all participants involved in the pilot. This pilot was funded by the National Health Commission of China-Bill & Melinda Gates Foundation TB Collaboration project (OPP1137180).

[#] Corresponding authors: Fei Huang, huangfei@chinacdc.cn; Yanlin Zhao, zhaoyl@chinacdc.cn.

[1] National Center for Tuberculosis Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, China; [2] PATH, Beijing office, Beijing, China; [3] Bill & Melinda Gates Foundation, Beijing office, Beijing, China.

Submitted: March 09, 2020; Accepted: March 19, 2020

References

1. Huang F, Cheng SM, Du X, Chen W, Scano F, Falzon D, et al. Electronic recording and reporting system for tuberculosis in China: experience and opportunities. J Am Med Inform Assoc 2014;21(5):938 – 41. http://dx.doi.org/10.1136/amiajnl-2013-002001.
2. Liu XQ, Hua YL, Xue CB. Preliminary analysis of the development course on Hospital Informatization in China. Chin J Health Inform Manage 2016;13(2):142 – 52. http://dx.doi.org/10.3969/j.issn.1672-5166.2016.02.08. (In Chinese).
3. Preparation Committee of China Medical Reform Development Report of Chinese Academy of Medical Sciences. China medical reform development report (2016). Beijing: China Union Medical College Press. 2017. (In Chinese).
4. Hu HP, Xie LQ, Chen QK, Gao X, Pi YQ, Dai T. Analysis and measurement of China's Population Health Informatization development strategy. Stud Health Technol Inform 2019;264:1388 – 92. http://dx.doi.org/10.3233/SHTI190455.
5. Zhou GH, Xu XD, Hu JP. Health informatization: development, characteristics and prospects. Chin J Health Inform Manage 2019;16 (4):384 – 8, 394. http://dx.doi.org/10.3969/j.issn.1672-5166.2019.04.01. (In Chinese).

Perspectives

Multichannel Financing Reduces Economic Burden and Improves the Medical Security Level for Tuberculosis Patients

Fei Huang[1]; Ni Wang[1]; You Li[1]; Hui Zhang[1]; Yanli Yuan[2]; Xiaomeng Wang[3]; Xiaolin Wang[4]; Shitong Huan[5]; Lixia Wang[1]; Mingting Chen[1]; Yanlin Zhao[1,#]

Tuberculosis (TB) is one of the main infectious diseases to simultaneously cause poverty and be caused by poverty. Reducing the economic burden of TB patients in China is essential to improving patient compliance and reducing the impact of the TB epidemic. In accordance with the national reform of the medical and health system and the current status of the country's TB prevention and treatment service system, representatives of the government proposed the concept of a multichannel financing mechanism. This mechanism is in harmony with the overall government strategy for TB. Key provisions are that after accessing free government services, the medical expenses of TB patients should be reimbursed using medical insurance first and then the remainder should be covered by local funds. Three provincial-level administrative divisions (PLADs) have used this approach and introduced policy documents to improve the medical security and reduce the economic burden for TB patients.

Background

Tuberculosis is a major public health issue in China and a global public health problem. As a chronic infectious disease transmitted through the respiratory tract, TB is characterized by a long incubation period and a long course of disease. Most patients with TB are poor; the national TB epidemiological sampling survey in 2010 showed that the average annual household income of more than 80% of TB patients is lower than the local average (*1*), and one study in China showed that 15% of multi-drug resistant TB (MDR-TB) patients had to forgo treatment because of financial difficulties (*2*). TB is not only an infectious disease but also a socio-economic problem (*3*). Elimination of catastrophic expenditures for TB patients can help achieve the United Nations Sustainable Development Goal 3 target for TB: to end the epidemic by 2030.

In response to the World Health Organization's End TB Strategy and under the overall framework of China's National Tuberculosis Control Program, the National Health Commission and Bill & Melinda Gates Foundation cooperated to scale up a comprehensive TB control model in three PLADs in eastern, central, and western China: Jilin, Zhejiang, and Ningxia. This model included establishing a multichannel financing mechanism to improve the level of medical security and reduce the financial burden for TB patients, in line with Chinese government policy documents (*4*–*6*). As per the implementation requirements of the China-Gates Foundation TB Project (2016–2019), the three PLADs established their own multichannel financing mechanisms and successfully advocated their provincial governments to issue policy documents to improve the medical security level of TB patients. So far, the multichannel financing mechanism has been in operation for more than a year. This article aims to share the experience of establishing and implementing a multichannel financing mechanism in the project PLADs and provide reference for wider promotion.

Status of Medical Expenses for TB patients

China has implemented a policy of free diagnosis and treatment for TB since 2000, with Centers for Disease Control and Prevention (CDCs) throughout the country providing free screening, diagnosis, follow-up care, and first-line anti-TB drugs. With the deepening of the medical and health system reform, China's TB control and prevention service system has been continuously adjusted. The diagnosis and treatment of TB patients has been gradually transferred from the CDCs to designated hospitals. A new TB control and prevention service system has been established with clear divisions and coordination among the CDCs, designated hospitals, and primary

health care institutions. The central government continues to provide free smear test, chest radiography, and first-line anti-TB drugs; however, other tests such as liver and renal function test, electrocardiogram, and supplementary medication are reimbursed by basic medical insurance. Although some free examination items such as the liver function test and auxiliary medication have been added in different places throughout the country, the overall economic burden for TB patients remains heavy, and there is a large gap from the goal of the End TB Strategy (*7*–*8*).

Developing a Multichannel Financing Policy

The Chinese government launched the latest round of health system reforms in 2009, emphasizing the role of government in health investment and governance (*9*) and proposing to establish and improve a system to provide the urban and rural public with safe, effective, convenient, and affordable medical and health services. Based on this goal and combined with the current status of TB control and prevention in China, China CDC has formulated guidelines for multichannel financing of TB diagnosis and treatment. Accordingly, local governments have increased financial subsidies and established communication and coordination mechanisms among relevant departments such as finance, health, medical insurance, and civil affairs. The overall goal of financial subsidies at all levels and other funds from society is to improve the level of medical security for TB patients. To ensure this security, basic medical insurance and critical illness insurance should be appropriately tilted towards TB. At the same time, it is important to expand the scope of assistance and achieve targeted poverty alleviation for poor patients.

As participants in the China-Gates Foundation TB project, Jilin, Zhejiang, and Ningxia integrated the use of central financial funds, basic medical insurance, medical assistance, and local special funds for TB control and prevention. The PLADs also issued policy documents to establish a multichannel financing mechanism to reduce the financial burden of TB patients. The first step (Figure 1) is to access TB services through the central government, which provides free screening, follow-up, and first-line anti-TB drugs for TB suspects and patients. The second step is to fully utilize the protection of basic medical insurance for TB patients, where TB is included in the management of special, chronic, and serious diseases, and the level of compensation for outpatients is appropriately increased with reference to the inpatient reimbursement policy. The third is to rationally use medical assistance to expand the scope and target of assistance, further improving the medical security of TB patients. Finally, after reimbursement from all these funds, local financing provides subsidies for TB patients to make up the differences as required. As of MDR-TB patients, Zhejiang and Ningxia provide additional subsidies for treatment and second-line anti-TB drug respectively. In this way, the out-of-pocket expenditures of rifampin (RIF)-sensitive and RIF-resistant TB patients can be controlled at a very low level, which is less than 10% and 30%, respectively.

Discussion

Many low- and middle-income countries aim to provide TB diagnosis and treatment free of charge; however, direct and indirect medical expenses continue to account for a high proportion of the annual household income of TB patients (*10*–*12*). China is currently facing this issue; however, through step-by-step use of different funds to solve patients' medical expenses, the goal of reducing the financial burden of TB patients can be achieved.

In this mechanism, the first three steps—the central government fund, basic medical insurance, and medical assistance—all have relatively mature policies that can be carried out effectively, but difficulties may occur when applying for local financing to cover the leftover costs. The required funds at this step are not large. Furthermore, they can be successfully allocated by estimating the number of local patients along with the financial coverage provided by medical insurance and assistance policies. Leaders can play a key role in ensuring funds are available at the local level by emphasizing the dangers of TB as a respiratory-borne disease. For example, in some areas with better leadership development, local financing will cover all the leftover expenditure after the first four steps and patients will not pay for the treatment at all. At the same time, it is necessary to strengthen the supervision of designated hospitals to ensure they provide reasonable diagnosis and treatment services and avoid unnecessary items and drugs.

Future research should further collect data such as the economic burden data of all TB patients to assess the impact and effect of this mechanism on the

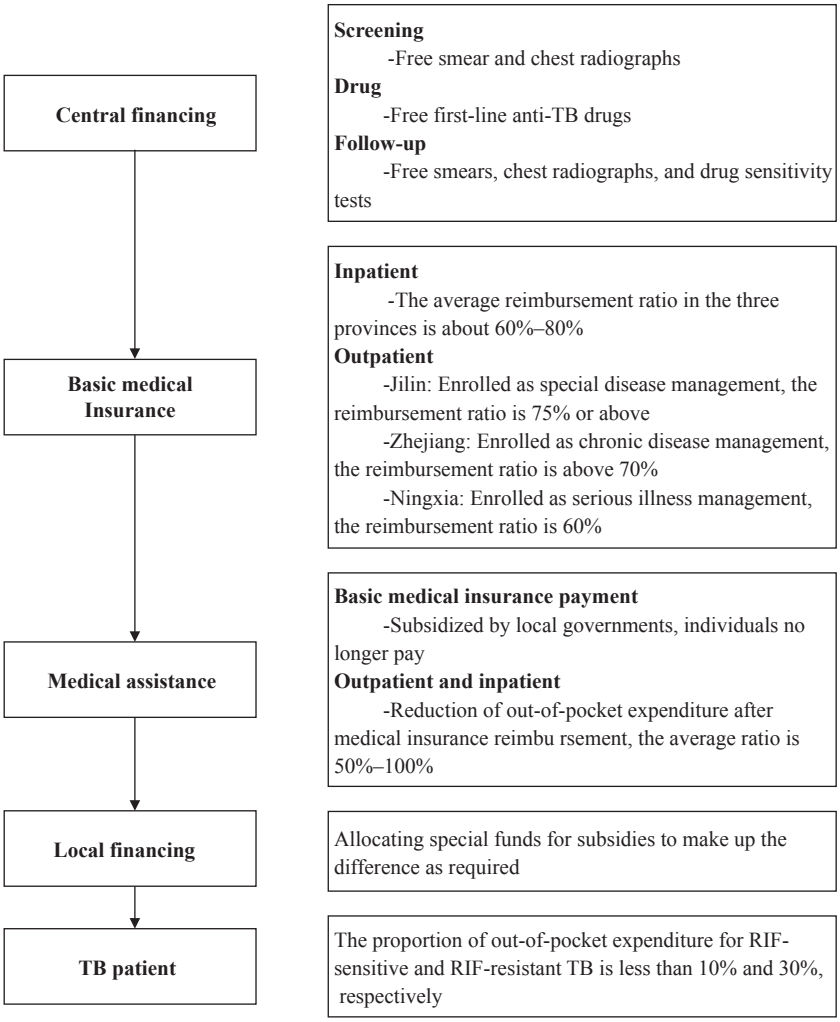

FIGURE 1. The flow chart of multichannel financing, three provincial-level administrative divisions (PLADs) in 2016–2019. RIF=rifampin.

economic burden, improve TB prevention and control, and effectively reduce the burden of TB patients.

Acknowledgments

The authors would like to thank all participants involved in the study. This study was funded by the National Health Commission of China-Bill & Melinda Gates Foundation TB Collaboration project (OPP1137180).

Corresponding author: Yanlin Zhao, zhaoyl@chinacdc.cn.

[1] National Center for Tuberculosis Control and Prevention, China Center for Disease Control and Prevention, Beijing, China; [2] Jilin Provincial Center for Tuberculosis Control and Prevention, Changchun, Jilin, China; [3] Zhejiang Provincial Center for Tuberculosis Control and Prevention, Hangzhou, Zhejiang, China; [4] Ningxia Hui Autonomous Region Tuberculosis Dispensary, Yinchuan, Ningxia Hui Autonomous Region, China; [5] Bill & Melinda Gates Foundation, Beijing office, Beijing, China.

Submitted: March 10, 2020; Accepted: March 18, 2020

References

1. Technical Guidance Group of the Fifth National TB Epidemiological Survey, the Office of the Fifth National TB Epidemiological. The fifth national tuberculosis epidemiological survey in 2010. Chin J Antitub 2012;34(8):485 – 508. (In Chinese).
2. Li RZ, Ruan YZ, Sun Q, Wang XX, Chen MT, Zhang YL, et al. Effect of a comprehensive programme to provide universal access to care for sputum-smear-positive multidrug-resistant tuberculosis in China: a before-and-after study. Lancet Glob Health 2015;3(4):e217 – 28. http://dx.doi.org/10.1016/S2214-109X(15)70021-5.
3. Wingfield T, Boccia D, Tovar M, Gavino A, Zevallos K, Montoya R, et al. Defining catastrophic costs and comparing their importance for adverse tuberculosis outcome with multi-drug resistance: a prospective cohort study, Peru. PLoS Med 2014;11(7):e1001675. http://dx.doi.org/10.1371/journal.pmed.1001675.
4. Commision NH. Healthy China initiative (2019-2030). 2019. http://www.gov.cn/xinwen/2019-07/15/content_5409694.htm. [2019-07-15]. (In Chinese).
5. Commission NH, Commission NDaR, Education Mo, et al. Action plan to stop TB (2019-2022). 2019. http://www.gov.cn/gongbao/

content/2019/content_5437149.htm. [2019-05-31]. (In Chinese).
6. Council OotS. "Thirteenth Five-Year Plan" National TB Control Programme. 2017. http://www.gov.cn/zhengce/content/2017-02/16/content_5168491.htm. [2017-02-01]. (In Chinese).
7. Jiang WX, Long Q, Lucas H, Dong D, Chen JY, Xiang L, et al. Impact of an innovative financing and payment model on tuberculosis patients' financial burden: is tuberculosis care more affordable for the poor?. Infect Dis Poverty 2019;8(1):21. http://dx.doi.org/10.1186/s40249-019-0532-x.
8. Zhou CC, Long Q, Chen JY, Xiang L, Li Q, Tang SL, et al. Factors that determine catastrophic expenditure for tuberculosis care: a patient survey in China. Infect Dis Poverty 2016;5:6. http://dx.doi.org/10.1186/s40249-016-0100-6.
9. Yip WCM, Hsiao WC, Chen W, Hu SL, Ma J, Maynard A. Early appraisal of China's huge and complex health-care reforms. Lancet 2012;379(9818):833 – 42. http://dx.doi.org/10.1016/S0140-6736(11)61880-1.
10. Oh KH, Rahevar K, Nishikiori N, Viney K, Choi H, Biermann O, et al. Action towards universal health coverage and social protection for tuberculosis care and prevention: workshop on the end TB strategy pillar 2 in the western pacific region 2017. Trop Med Infect Dis 2018;4(1):3. http://dx.doi.org/10.3390/tropicalmed4010003.
11. Pedrazzoli D, Siroka A, Boccia D, Bonsu F, Nartey K, Houben R, et al. How affordable is TB care? Findings from a nationwide TB patient cost survey in Ghana. Trop Med Int Health 2018;23(8):870 – 8. http://dx.doi.org/10.1111/tmi.13085.
12. Tanimura T, Jaramillo E, Weil D, Raviglione M, Lönnroth K. Financial burden for tuberculosis patients in low- and middle-income countries: a systematic review. Eur Respir J 2014;43(6):1763 – 75. http://dx.doi.org/10.1183/09031936.00193413.

The inauguration of *China CDC Weekly* is in part supported by Project for Enhancing International Impact of China STM Journals Category D (PIIJ2-D-04-(2018)) of China Association for Science and Technology (CAST).

CCDC weekly

Vol. 2 No. 12 Mar. 20, 2020

Responsible Authority
National Health Commission of the People's Republic of China

Sponsor
Chinese Center for Disease Control and Prevention

Editing and Publishing
China CDC Weekly Editorial Office
No.155 Changbai Road, Changping District, Beijing, China
Tel: 86-10-63150501, 63150701
Email: ccdcwjournal@163.com

CSSN
ISSN 2096-7071
CN 10-1629/R1