

Human Resources for Tuberculosis Care in China: Gaps and Challenges from a  
Physicians' Perspective

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Thesis submitted in partial fulfillment of  
the requirements for the degree of  
Master of Science in the Graduate Program  
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ABSTRACT

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## **Abstract**

The human resources for health is one of the key building blocks in tuberculosis control. As the implementer of disease control policies and medical practices, physicians are at a core position for the health of tuberculosis patients. Unfortunately, while the tuberculosis control system is under the transition to the Trinity Model nationwide, little attention was paid to this particular workforce. This study filled the gap of little information about the challenges of tuberculosis physicians by researching on the gaps and challenges of tuberculosis physicians at prefecture-city and county level. A mixed method approach was used to collect both quantitative and qualitative data through survey and in-depth interview with physicians, directors of clinical departments and officials at disease control agencies. The shortage of physicians, difficulty in recruitment, insufficient and inappropriate use of protective equipment, unfair compensation, and insufficient training opportunities were found as major challenges of tuberculosis physicians. A collective effort from all levels of governments, CDCs, and hospitals should be made in increasing competence, ensuring health and safety, providing fair compensation, enhancing productivity, and strengthening supportive supervision of tuberculosis physicians.

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## List of Abbreviations

China CDC	Chinese Center for Disease Control and Prevention
MDR-TB	Multidrug-resistant tuberculosis
SDG	Sustainable Development Goals
TB	Tuberculosis
WHO	World Health Organization
XDR-TB	Extensively drug-resistant tuberculosis

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# 1. Introduction

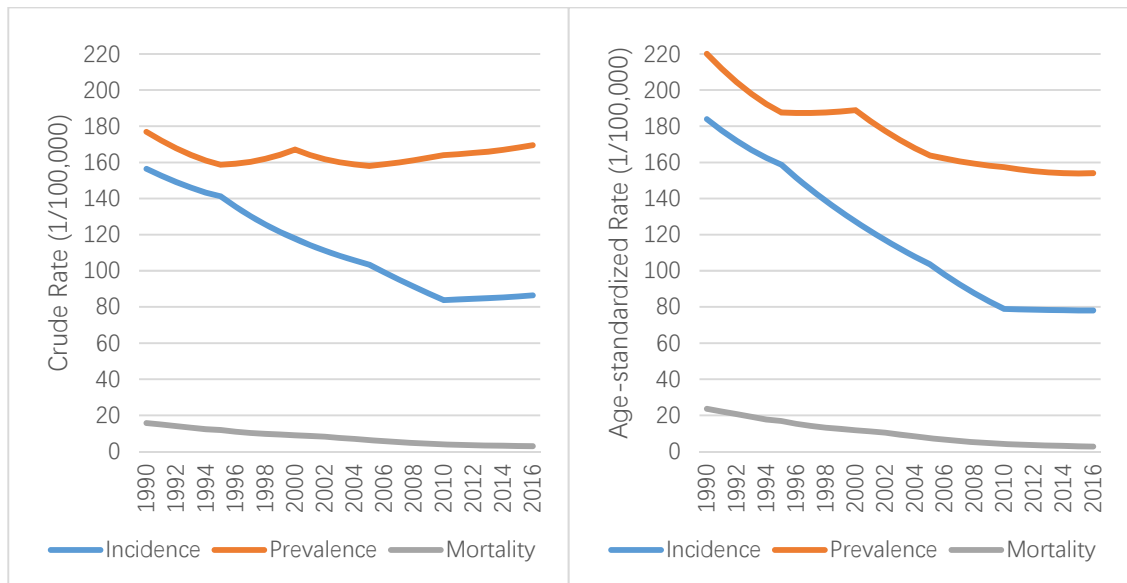
## 1.1. Tuberculosis in China

### 1.1.1. Trend of disease burden in tuberculosis

China has been heavily burdened by tuberculosis (TB) for years. As shown in Figure 1, the age-standardized incidence, prevalence, and mortality of active tuberculosis<sup>1</sup> have been declining for over 26 years (Global Burden of Disease Collaborative Network, 2017). However, due to the population aging in China, the crude prevalence rate of tuberculosis has been increasing during the last 10 years. It indicates a large number of tuberculosis patients with potential possibility for transmission to others, as the major form of tuberculosis is airborne pulmonary tuberculosis. In addition, such declining trend in incidence seems halted in 2010, imposed more challenges for future tuberculosis control.

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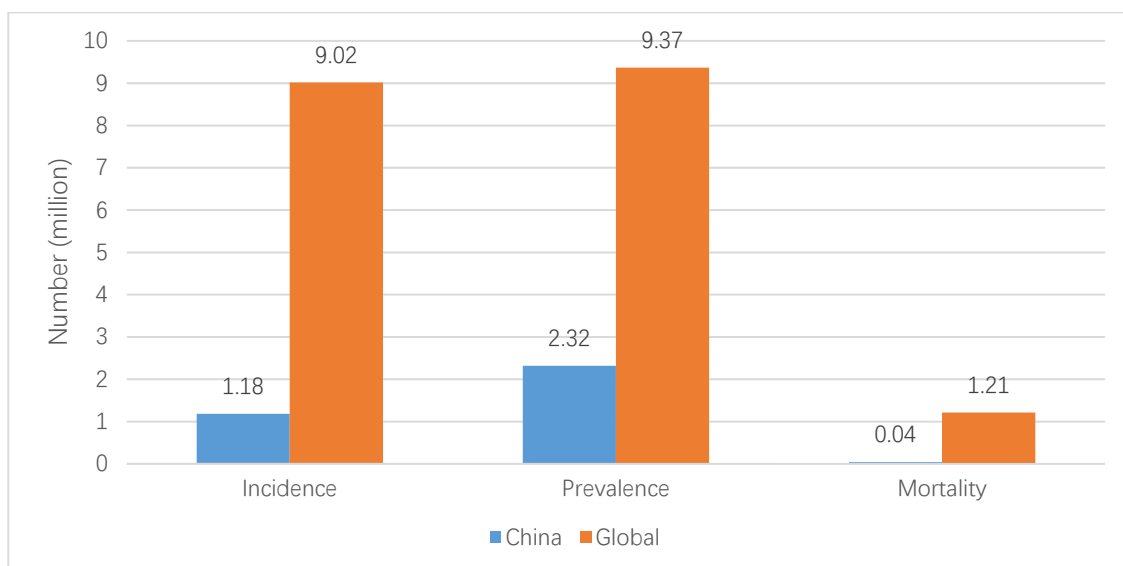
<sup>1</sup> In Global Burden of Disease 2016 Study, there is no cause named “active tuberculosis”. Here, it is generated by combining “Drug-susceptible tuberculosis”, “Multidrug-resistant tuberculosis without extensive drug resistance”, and “Extensively drug-resistant tuberculosis”, which covered all types of active tuberculosis in the GBD study but excluding TB/HIV dual infection.



**Figure 1: Trend of disease burden in active tuberculosis in China, 1990-2016**

Source: Global Burden of Diseases Study 2016

Globally, China is one of the countries that have been mostly burdened by tuberculosis. In 2016, China was estimated to have 1.18 million new active tuberculosis patients, taking up 13.09% of new cases in the world (Global Burden of Disease Collaborative Network, 2017). Among 30 high TB burden countries in 2016 reported by World Health Organization (WHO), China was the third largest country in terms of the number of new cases (895,000), which was lower than India (2,790,000) and Indonesia (1,020,000) (World Health Organization, 2017). The estimated prevalence rate of active tuberculosis was 169.55/100,000 in 2016 in China with a total of 2.31 million patients, accounting for 24.74% of all patients in the world (Global Burden of Disease Collaborative Network, 2017). Figure 2 presents the difference in disease burden of tuberculosis between Chinese and global levels.



**Figure 2: Disease burden of active tuberculosis in China and the world, 2016**

Source: Global Burden of Diseases Study 2016

In China, tuberculosis is one of the prominent epidemic diseases. As shown in Table 1, pulmonary tuberculosis, a major form of tuberculosis, was the second highest in both incidence and mortality numbers among the Category A and B<sup>2</sup> notifiable infectious diseases. Considering its airborne nature, the pulmonary tuberculosis is easier in transmitting among the population than hematogenous infectious diseases.

---

<sup>2</sup> In China, notifiable infectious diseases consist three categories. According to the Law of the People's Republic of China on Prevention and Treatment of Infectious Diseases (2013 Amendment), category A includes plague and cholera, and category B includes SARS, AIDS, viral hepatitis, poliomyelitis, human cases of avian influenza, measles, epidemic hemorrhagic fever, rabies, Japanese encephalitis, dengue fever, anthrax, bacillary and amebic dysentery, pulmonary tuberculosis, typhoid and paratyphoid, epidemic cerebrospinal meningitis, pertussis, diphtheria, neonatal tetanus, scarlet fever, brucellosis, gonorrhea, syphilis, leptospirosis, schistosomiasis, and malaria.



**Table 1: The incidence and mortality of Category A and B notifiable infectious diseases in China, 2016**

#	Incidence		Mortality	
	Name	#	Name	#
1	Viral hepatitis	1 221 479	AIDS	14 091
2	<b>Pulmonary tuberculosis</b>	<b>836 236</b>	<b>Pulmonary tuberculosis</b>	<b>2 465</b>
3	Syphilis	438 199	Rabies	592
4	Bacillary and amoebic dysentery	123 283	Viral hepatitis	537
5	Gonorrhoea	115 024	H7N9 avian influenza	73
6	Scarlet fever	59 282	Syphilis	53
7	AIDS	54 360	Epidemic hemorrhagic fever	48
8	Measles	47 139	Japanese encephalitis	47
9	Brucellosis	24 820	Measles	18
10	Typhoid fever and paratyphoid fever	10 899	Malaria	16

Source: 2017 Chinese Statistical Year Book of Health and Family Planning (National Health and Family Planning Commission, 2017a)

In addition, the existing drug-resistant tuberculosis epidemic remains as a threat for tuberculosis control. The 2010 national tuberculosis epidemiology study found the proportion of Multidrug-resistant tuberculosis (MDR-TB)<sup>3</sup> among all tuberculosis was 6.8% and estimated 0.34 million infected population in China (Technical Guidance Group for the Fifth Epidemiological Sampling Survey of Tuberculosis in China, 2012). The incidence and prevalence rates were estimated to be 3.59/100,000 and 7.07/100,000 in 2016 in China (Global Burden of Disease Collaborative Network, 2017). World Health Organization (2017) listed China in the top 20 countries burdened by MDR-TB in 2016 - 2020 with an estimation of 7.1% new tuberculosis cases and 24% previously treated cases

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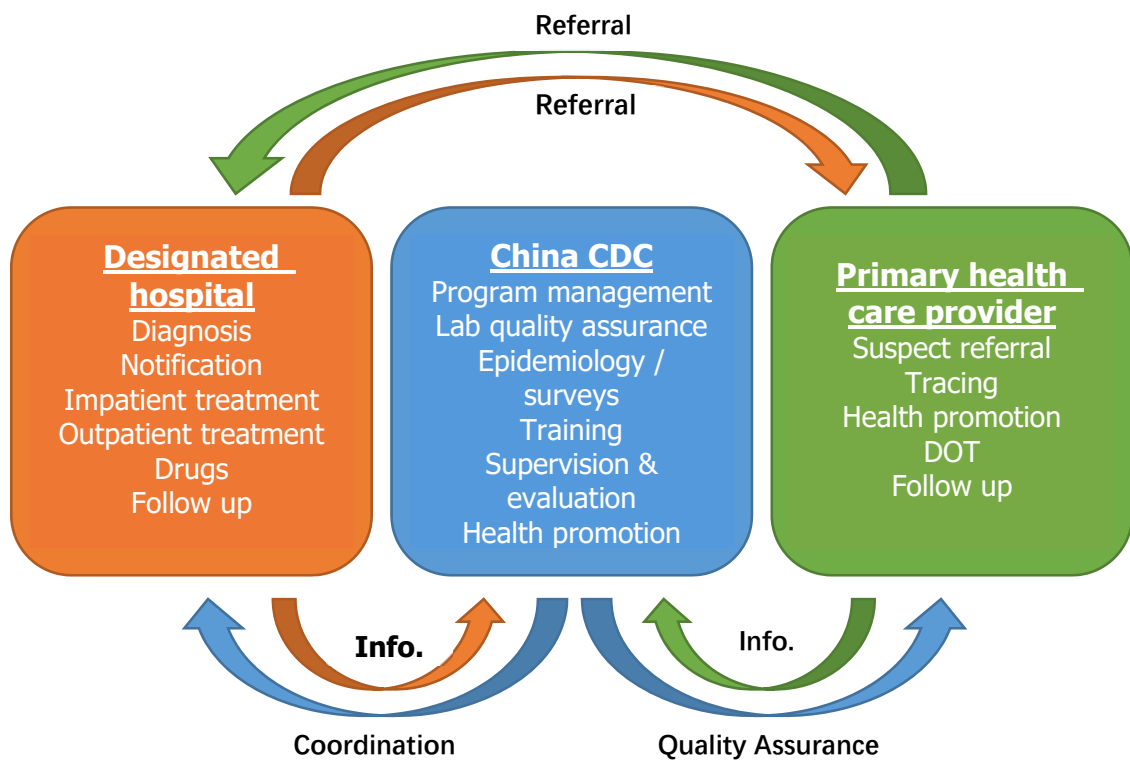
<sup>3</sup> MDR-TB is the tuberculosis resistant to, at least, rifampicin and isoniazid.

were MDR-TB or resistant to rifampicin. Meanwhile, the drug-resistant tuberculosis requires longer time and more expensive medicine for treatment. It has a lower treatment success rate and causes more death. Sun et al. (2015) found that MDR-TB had a 1.86 hazard ratio as the risk factor for death in China compared to drug-susceptible tuberculosis. Therefore, such threat deserves more attention from the health administration and public.

### **1.1.2. Tuberculosis care and control system**

China has been putting efforts in tuberculosis control for years. In the 1950s, the prevalence of tuberculosis was very high in major cities in China, such as Beijing (2.6%, 1959), Shanghai (4.0%, 1957) and Tianjin (4.9%, 1950) (Wang, Nunn, & Xu, 2016). The settings of tuberculosis facilities included tuberculosis institute, sanatorium, and dispensary. In 1978, the national tuberculosis control conference was held in Liuzhou, Guangxi province, and later issued the first 10-year national tuberculosis plan. From 1990 to 2000, two major tuberculosis control programs were implemented. One was the China Infectious and Endemic Disease Control Project supported by the World Bank loans, and the other one was Tuberculosis Strengthening and Promotion using funds from central and local governments. These two projects adopted the DOTS strategy from World Health Organization. From 2000 to 2010, the coverage of DOTS has reached 100% in China.

In the past decade, the diagnosis and treatment model of tuberculosis underwent a transition. Tuberculosis suspects and patients used to receive diagnosis and treatment in tuberculosis dispensaries or tuberculosis clinics at CDC. However, this reduced the patient detection rate as these facilities were not the first choice of patients with tuberculosis-like symptoms. Meanwhile, these facilities were not able to treat the patients with comorbidities and severe conditions. Therefore, more and more regions started to explore the transition that shifting diagnosis and treatment of tuberculosis to general hospitals. Data from National TB Management System showed a 39.3% (1033/2627) of counties have completed such transition (Li, Cheng & Du, 2015). Some of them were due to the implementation of the Global Fund tuberculosis projects (Li et al., 2013a). This new model for the tuberculosis control was named as the Trinity Model. As its name was, it consisted three parties for tuberculosis control, namely, CDC system, designated hospitals, and primary health care providers (The State Council, 2012). It has been piloted in China-Gates tuberculosis control program during previous years, and now it has been issued in the National Tuberculosis Control Plan 2011-2015 (the State Council, 2012) and the 13<sup>th</sup> Five-year Plan on National Tuberculosis Control Program (the State Council, 2017). Figure 3 displays the responsibility of each party and their connections.



**Figure 3: Trinity Model - the tuberculosis control network in China**

Source: (Wang, Nunn & Xu, 2016, pp187)

First, China CDC and its branches at provincial, prefecture-city and county levels across the country take the role as a public health agency. It collects tuberculosis case information, conducts surveillance, and provides supervision and evaluation for all tuberculosis control programs. In some areas, the tuberculosis clinic and lab are set in local CDC, yet they are in the process of task shifting to designated hospitals. This was due to the increasing comorbidity of tuberculosis patients and the requirement for inpatient treatment for severe cases, while hospitals with comprehensive capabilities

and inpatient departments are more capable of diagnosing and treating tuberculosis patients.

Second, designated hospitals are selected and appointed in the county and prefecture-city level<sup>4</sup> to diagnose and treat tuberculosis patients. In each county, commonly the largest public hospital, the county People's Hospital, is selected to be designated hospital for tuberculosis care. In the city proper, several neighboring districts may share the same designated hospital. The tuberculosis specialized hospitals, such as tuberculosis dispensaries, chest hospitals, and pulmonary hospitals are also often selected as the designated hospitals in prefecture-city level. These hospitals diagnose and treat tuberculosis patients, and refer them back to primary health care providers for management through DOTS strategy. MDR-TB patients are admitted to the inpatient department for treatment, while others only need treatment from the outpatient department if not with severe comorbidities.

Third, primary health care providers include village clinics in rural areas, and township hospitals and community health centers in urban areas. They are responsible to find suspect tuberculosis patients and refer them to designated hospitals for further diagnosis. When the diagnosis is confirmed, the primary health care providers

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<sup>4</sup> In China, the administration units are divided into three levels. Simply put, they are 1) province, 2) prefecture city, 3) district and county.

implement the tuberculosis package in the Basic Public Health Services<sup>5</sup>, namely, screening, referring, and performing home-visiting, observing patients taking the medicine, following up with patients, and evaluation to close the case (National Health and Family Planning Commission, 2017b).

The tuberculosis care in China adopted the DOTS strategy recommended by WHO (National Health and Family Planning Commission, 2008). At designated hospitals or tuberculosis clinic at CDC, patients with tuberculosis symptoms or tuberculosis suspects can receive free sputum smear and chest X-ray examination. If tuberculosis is confirmed, patients will receive free anti-tuberculosis medicine at outpatient departments for 6 months. The community health worker will later observe the ingestion of medication. Other expenditures, such as the other examinations, anti-tuberculosis medicine outside the free medicine list, liver protection medicine, diagnosis and treatment for comorbidities are partially covered by patients' medical insurance, and the degree of coverage varies in different areas based on the local insurance policy.

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<sup>5</sup> In 2009, the Basic Public Health Services was implemented nationwide. It provides free public health services for all residents. In 2017, it consists of 14 services, including setting-up health record, health education, immunization, health management for children, pregnant women, elderlies, hypertensive and type-2 diabetic patients, severe mental disorder patients, tuberculosis patients, health management through traditional Chinese medicine, infectious and emergent public health incidence report and treatment, health administration assistance, free family planning medicine and devices, and health promotion. Tuberculosis patient management was included in 2015.

For drug-resistant tuberculosis patients, the treatment is much longer and complex. According to the national guideline for drug-resistant tuberculosis control (Wang, 2012), The diagnosis and treatment of MDR-TB are performed at the prefecture-city level. The duration of MDR-TB treatment could last for 24 months or more, and Extensively drug-resistant tuberculosis (XDR-TB) could last for 30 months or more. Patients are recommended to be admitted to inpatient departments for the first two months of treatment. After discharged from the hospital, patients need to visit CDC, hospitals, and village clinic or community health center to take medication under the direct observation of health workers or trained observer for the complete period of treatment. However, the diagnosis and treatment of MDR-TB are not free but very expensive. The estimated cost of diagnosis, treatment, and care is 4,151 RMB Yuan for drug-susceptible tuberculosis, and 42,129 RMB Yuan for MDR-TB (Li et al., 2013b).

## ***1.2. Human resources for health in China***

### **1.2.1. Overview of human resources for health**

Human resources for health is at the center in each health systems in the world to advance the health of everyone (World Health Organization, 2006). It was defined as all people engaged in actions whose primary intent is to enhance health (World Health Organization, 2006), including health services providers and other staff in the health industry, from both health and other sectors. The performance of health systems depends on the people who implement interventions. Evidence shows that the

proportion of health workers per capita is correlated with the maternal, child and infant survival (World Health Organization, 2016a).

Yet, all countries in the world are facing, to different extents, challenges in the education, deployment, retention, and performance (World Health Organization, 2016a). In China, low quality, shortage, and mal-distribution have been identified as the major challenges of health workforce (Anand et al., 2008). WHO (2016) has issued a global strategy on human resources for health as recommendations to its member states to address the related challenges. The health workforce is also one of the targets in the Sustainable Development Goal adopted by the United Nations General Assembly (2015), as “substantially increase...the recruitment, development, training and retention of health workforce in developing countries...”<sup>6</sup>

### **1.2.2. Human resources for tuberculosis care in the world**

The importance of human resources for tuberculosis control has been well-understood by global health actors in the world. The Global Fund to Fight AIDS, Tuberculosis and Malaria increasingly valued the importance of human resources in combating AIDS, tuberculosis, and malaria, and allowed the intervention towards health workforce in its rounds of proposal callings (Dräger, Gedik, & Dal Poz, 2006). It

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<sup>6</sup> SDG target 3.c, “Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States.”



reflected, to some extent, that in low- and middle-income countries, the limitation of Human resources for health was the primary obstacle for health intervention implementation.

The End TB Strategy was approved in May 2014 by the 67<sup>th</sup> World Health Assembly as the post-2015 global strategy of tuberculosis prevention, care, and control. In the vision of “a world free of tuberculosis”, the Strategy introduced many interventions as the pillars and components, including early diagnosis, systematic screening, treatment for all patients, preventive treatment, and vaccination (World Health Organization, 2014). However, these interventions require qualified, adequate and well-distributed health workforce to implement in all urban and rural areas in the world. As stated in the Strategy, “Scaling up and sustaining interventions for tuberculosis care and prevention will require high-level political commitment along with adequate financial and human resources” (World Health Organization, 2014).

Globally, many challenges in the human resource are hindering for tuberculosis control. Low salaries, long-term underinvestment in education and training, out-migration and HIV infection are affecting, especially, low-income countries in the world (Atun et al., 2010). To address these challenges, community health workers, NGOs and private health care providers were recruited and trained to implement tuberculosis control programs in many high-burden countries (Atun et al., 2010).

In addition, most countries lack knowledge in the human resources for tuberculosis care (Harries et al., 2005). An international survey collected information of human resources for tuberculosis care from the government of 22 countries with high burden of tuberculosis, yet only 9 reported the complete information of staff number at all service level, as well as 6 countries which reported skill level and training information (Figueroa-Munoz et al., 2005).

### **1.2.3. Human resources for tuberculosis care in China**

The condition of tuberculosis workforce in China is unsatisfactory. Shortage and low quality were major issues among the tuberculosis physicians (Xie et al., 2011). The county hospitals and the hospitals in western and central provinces had less tuberculosis workforce in China (Xu, Liu & Liu, 2008). The shortage of health workforce may influence the incidence of tuberculosis, as Zhou et al. (2005) found the association between more tuberculosis workforce and lower tuberculosis incidence in some provinces in China. The prevalence and incidence of latent tuberculosis infection were also found high among primary health providers in the rural area in China (He et al., 2015).

In addition, during the recent transition of the tuberculosis control model, its impact on tuberculosis workforce has been observed. Several issues concerning health workforce have been found in such model, including lack of human resources and funding (Tong et al., 2012), heavy workload in paperwork (Wu & Liu, 2014) and unclear

responsibility for workforce training (Zhang et al., 2012). As newly released Healthy China 2030 Plan and the 13th Five-year Plan for National Tuberculosis Control Program identified the requirement for “establishing a comprehensive model of treatment and prevention for tuberculosis” (The State Council, 2017), the momentum for such transition is projected to increase and its impact on health workforce deserves further research.

### **1.3. Research purpose**

Previous research on tuberculosis workforce have been conducted mostly in TB dispensaries and TB clinics at CDC in traditional tuberculosis control model. During the recent transition of tuberculosis control model to the Trinity Model, few research and literature have been conducted and published on tuberculosis workforce in general hospitals. In addition, the tuberculosis physicians under the new model are less understood through research.

This research aims to identify the gaps and the challenges in human resources for tuberculosis care in China with a specific concentration on tuberculosis physicians. It aims to elucidate the current situation of tuberculosis physicians in China, identify the key challenges and provide policy recommendations. Specifically, this study has the following objectives:

- i. Understand the current situation of tuberculosis physicians in designated facilities;

- ii. Identify gaps in quantity and quality of tuberculosis physicians, factors associated with the gaps, and the differences of key variables between provinces, administrative levels, and types of tuberculosis facilities; and
- iii. Examine the national plan on tuberculosis control and organizational policies of tuberculosis facilities in addressing these gaps and challenges.

## **2. Methods**

### **2.1. Study design**

This research is a cross-sectional study on the health workforce for tuberculosis in China with a concentration on tuberculosis physicians, using a mixed method approach to collect and analyze both quantitative and qualitative data. First, research sites were selected based on the local economic level and epidemiological situation. Then, during the fieldwork, quantitative and qualitative data were collected through survey and in-depth interviews, and later analyzed for elucidating gaps and challenges in tuberculosis physicians in China. Policy documents, reports, and guidelines were also collected to identify targets and examine their effects in the support and performance of tuberculosis physicians.

#### **2.1.1. Settings**

##### **2.1.1.1. Selection criteria and process**

This research selected two prefecture cities in two provinces as the study sites. The selected provinces were from central and western China to capture the relatively resources-limited circumstances.

The selection of prefecture cities was based on the gross domestic product per capita, the number of administrative units (counties and districts), the tuberculosis epidemic situation and the availability of research. Considering the representativeness of study sites, the city with a median level of economic development was preferred,

which was reflected by the rank of GDP per capita in the province. To ensure the range of selection of counties, the total number of counties in the prefecture city should be above three. The reported incidence of tuberculosis should not be much lower than the average level in the province. Considering the transition of tuberculosis control model in China, this study tried to cover different types of tuberculosis control models.

In each prefecture city, three tuberculosis designated clinical facilities were selected. One was at the prefecture-city level, and the other two were at the county level. Facilities in the two counties with highest and lowest GDP per capita in the prefecture city were selected. These facilities include tuberculosis dispensary, tuberculosis clinic at local CDC, and the infectious diseases department of a general hospital.

#### **2.1.1.2. Study sites**

Two prefecture cities in two provinces, Hubei in central China and Yunnan in western China were selected. For the confidentiality, this paper hereinafter refers them as City H and City Y. The names of counties are not disclosed anywhere in this paper.



**Figure 4: The location of two selected provinces**

A total of six tuberculosis facilities were visited as study sites during the fieldwork, including one tuberculosis dispensary, one tuberculosis clinic in CDC, and four hospitals. The coverage of different types of tuberculosis facilities reflected the current situation about the institutional transition to the Trinity Model.

**Table 2: Types and location of tuberculosis clinical facilities as study sites**

Facility type	TB dispensary	TB clinic in CDC	Infectious diseases
---------------	---------------	------------------	---------------------

	department in hospitals		
Administrative level			
Prefecture-city	1	0	1
County	0	1	3
Location			
City H, Hubei	1	1	1
City Y, Yunnan	0	0	3
Total	1	1	4

## **2.2. Data collection**

### **2.2.1. Quantitative data**

#### **2.2.1.1. Data sources**

Quantitative data were collected through self-administrated questionnaires. The questionnaire was provided to participants on research sites, filling out by tuberculosis physicians. This survey was designed for inquiry of tuberculosis physicians' demographic information, educational background, professional experience, knowledge of tuberculosis, and attitudes towards employment.

#### **2.2.1.2. Sample**

The participants for the survey were tuberculosis physicians who were working in the diagnosis and treatment for tuberculosis suspects and confirmed patients at both inpatient and outpatient departments.

This research planned to visit six health facilities from which participants are recruited. For the survey, this research adopted opportunistic sampling strategy, recruiting all physicians on duty on the date of visit. Detailed characteristics and clustering of survey respondents are described in the result section.



### **2.2.1.3. Data collection tool**

The questionnaire was developed to understand tuberculosis physicians' demographic information, educational background, professional experience, the knowledge of tuberculosis and attitudes towards their employment. Some questions were adopted and modified from a previous research project (Baseline investigation of China-Gates Phase III Tuberculosis Control Program). The pre-test of data collection tool has been conducted among research assistants to understand the time consumption and potential unclear expression in this questionnaire.

## **2.2.2. Qualitative data**

### **2.2.2.1. Data sources**

The qualitative data in this research include the published policy documents, reports, guidelines, field notes and photos, and interview transcripts.

This research collected relevant policy documents and reports on the topic of 1) tuberculosis treatment and control, 2) health workforce, and 3) health workforce for tuberculosis at international and national levels. National tuberculosis control guidelines were also collected to identify the gaps in human resources for tuberculosis care. These data were collected from the official websites of governments and international organizations.

During the fieldwork to the research sites, researchers visited local tuberculosis facilities and conducted interviews with informants. The recording files of interviews

have been transcribed into words for analysis. Field notes and photos were also used for analysis.

#### **2.2.2.2. Sample**

Three types of interviewees are recruited in this research, namely, the tuberculosis physicians, the directors of the clinical departments, and the CDC officials at national, provincial, and prefecture-city levels. Detailed information about the clustering of interviewees are described in the result section.

During the fieldwork, one director and one physician at each tuberculosis facility were recruited through a purposive sampling strategy. The director was defined as the administrative staff who manage the clinical department, especially who understand the human resources issues in the department. The physicians who were specialized in tuberculosis diagnosis and treatment and undertaking most of the tuberculosis cases in the department were preferred.

The CDC officials for tuberculosis control at national, provincial and prefecture-city levels were also recruited for interviews.

#### **2.2.2.3. Data collection tool**

Three interview guidelines were developed for deepening the understanding of challenges of human resources for tuberculosis care in China. Questions for physicians included workload, working environment, working motivation, training opportunity, and attitude towards tuberculosis control policy. Questions for department directors

included department situation, recruitment, motivation, training, and retention of tuberculosis physicians. For CDC officials, questions included human resources related tuberculosis control policy in China, challenges from health workforce in tuberculosis control, and the consideration and future plan for addressing these challenges. All interview guidelines were semi-structured with probing during the interview.

### **2.2.3. Procedures**

Before conducting the fieldwork, two research assistants were recruited from local universities. A half-day training about the method of survey and interview was provided to two research assistants.

When visiting a tuberculosis facility, researchers first had a discussion with the department director to understand the basic information about the department, and decided the time and location for survey and interview. Informed consent forms were provided to each participant and an oral consent was obtained before any data collection. Questionnaires were filled in doctor's office or department meeting room. Interviews were conducted in a private environment to ensure confidentiality. After the data collection, an appropriate amount of compensation was provided to each participant. Data were soon digitalized or transcribed after data collection.

### **2.2.4. Quality control**

A series of measures were taken to ensure the quality of the data collected from the fieldwork.

Questionnaires were filled under the direct observation of on-site research assistant. After participants submitted the questionnaire, a research assistant would conduct a preliminary check for the completeness of all option and blanks on the questionnaire. Any missing option or blank, if found by the research assistant, would be filled immediately before the participants left. The data on questionnaires were later input into computers by researcher and research assistants, respectively. EpiData was used for data entry, and the double entry verification function was used to ensure the accuracy of data input.

Two audio recorders were used during each interview in case of technical malfunction. The transcription of interview recording was verified for accuracy by listing to the original recording file while reading the transcription. Words or phrases incomprehensible will be transcribed by using recording file from the second recorder or by asking for advice from tuberculosis experts.

## **2.3. *Data management and analysis***

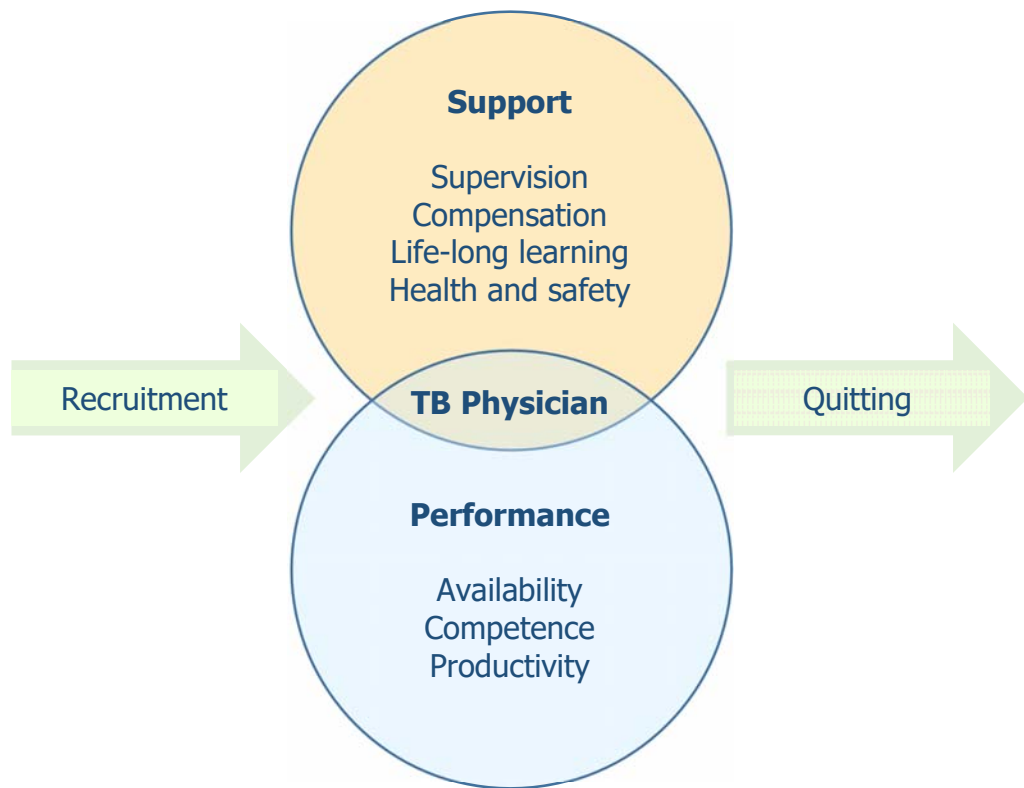
### **2.3.1. Data management**

Data on the questionnaire were digitalized before the end of fieldwork. It was properly cleaned and coded for further statistical analysis. Audio recording files of interviews were sent to a professional transcription service company for transcription without any personally identifiable information. All research data were kept on an encrypted USB disk and the principal investigator has the only access to it.

## **2.3.2. Data analysis**

### **2.3.2.1. Conceptual framework**

The conceptual framework for this study was derived from the Working Lifespan Framework from 2006 World Health Report (World Health Organization, 2006). It modified the components of WHO framework based on the availability of data and topic of interest in this research. As shown in Figure 5, the major dimensions to analyze the gaps and challenges were the support and performance of tuberculosis physicians. For the support of tuberculosis physicians, the supervision, compensation, life-long learning, and health and safety are four major areas that were explored by this research. Another aspect of this research was to examine the performance of tuberculosis physicians that consisted three dimensions of availability, competence, and productivity. This framework also considered the entry and exit of tuberculosis physicians by examining their recruitment and quitting.



**Figure 5: Conceptual framework for gaps and challenges of tuberculosis physicians**

This framework is of advantages in considering both the health worker’s perspectives and the system approach. The WHO framework was originally used for developing global and national strategies for health workforce, therefore the sub-categories in each part of this framework were key issues for policy making in human resource for health.

In this study, the conceptual framework was adopted to organize data and guide the analysis process. Based on the review of previous literature, the core issues of tuberculosis physicians fit well in this framework. The presentation and analysis of results followed the order in this framework.

### **2.3.2.2. Quantitative analysis**

Descriptive analysis was conducted to illustrate the characteristics of the sample. Fisher's exact test and two-sample T-test were performed to discover the difference among all variables between two provinces, between levels of administration, and between types of facilities. Stata 15 (Stata Corp, College Station, TX, USA) was used for statistical analysis.

### **2.3.2.3. Qualitative analysis**

Analysis of the interview transcription, field notes, and photos was conducted to find issues behind the answers from the questionnaire. The analyst conducted most of the interviews and therefore was familiar with the data. After all interview transcripts were proofread and input into the qualitative analysis software, the potential codes were developed from the conceptual framework, interview guideline, and field notes. All transcripts went through indexing process and finally interpreted by different themes. The results of the qualitative analysis were later reported in a side-by-side comparison with the finding from quantitative analysis at interpretation level through a mix-method approach. Nvivo 11 (QSR International Pty Ltd, Melbourne, Australia) was used for the coding, indexing and management of qualitative data.

## **2.4. Ethical consideration**

This research had no foreseeable risk for participants. All data from surveys and interviews had no identifiable information attached, as the questionnaire was

anonymous and the recording files of interviews were labeled by series numbers. An informed consent form was given to each participant and a verbal informed consent was obtained before any further data collection process. After participants completed the questionnaire or interview, an appropriate amount of compensation was provided to all participants for their time and efforts.

This research was funded by the Global Health Master Program at Duke Kunshan University. The researcher and funder have no conflict of interests in this research.

The research has been approved by Duke Kunshan University Institutional Review Board. The research proposal, data management plan, and all data collection tools have been reviewed for the protection of research participants and revised according to suggestions.



### 3. Results

#### 3.1. Characteristics of samples

A total of 31 tuberculosis physicians were recruited for the survey from six tuberculosis facilities in Hubei and Yunnan provinces, including 2 prefecture-city level facilities and 4 county-level facilities. Detailed information about the clustering of survey respondents can be found in Table 3.

**Table 3: Clustering of research participants**

Facility no.	Location	Type	Survey respondent	Interviewee		
			Physician	Department director	Physician	CDC official
1	City H	PCL TB dispensary	11	1	1	0
2	City H	County general hospital	7	1	1	0
3	City H	County CDC	2	1	1	0
4	City Y	PCL general hospital	4	1	1	0
5	City Y	County general hospital	3	1	1	0
6	City Y	County general hospital	4	1	1	0
-	Beijing	National CDC	0	0	0	1
-	Hubei	Provincial CDC	0	0	0	1
-	Yunnan	Provincial CDC	0	0	0	1
-	City Y	PCL CDC	0	0	0	1

Note: PCL: Prefecture-city level.

The characteristics of respondents are shown in Table 4. Respondents showed a balanced gender ratio. The age of physician respondents ranged from 22 to 54, and mean age was 40.20 years old.

Physician respondents received different types of medical education before practice. As shown in Table 4, most of them (87.10%) had a bachelor degree and few had a junior college degree (12.90%), while none had a degree higher than bachelor level.

Over 90% of them majored in clinical medical sciences (Western medicine), and the rest

of them majored in traditional-Chinese-medicine-related specialties. Mean length of medical education was 4.67 years.

The working experience of physician respondents varied largely. Working years ranged from 1 to 35 years as a physician, and from 0.92 to 26 years as tuberculosis physician. The mean length of working was 17.15 as a physician, and 10.60 for tuberculosis care.

**Table 4: Characteristics of physician respondents**

<b>n</b>	31
<b>Sex</b>	
Male	16 (51.61)
Female	15 (48.39)
<b>Age, years</b>	
Mean	40.20 (7.87)
Range	22-54
Age group, years	
≤35	6 (19.35)
36-44	14 (45.16)
≥45	10 (32.26)
Missing	1 (3.23)
<b>Years of medical education, mean</b>	4.67 (1.21)
<b>Highest education level</b>	
Medical doctor or PhD	0 (0.00)
Master	0 (0.00)
Bachelor	27 (87.10)
Junior college	4 (12.90)
<b>Major in college</b>	
Clinical medical science	28 (90.32)
Traditional Chinese medicine	2 (6.45)
Chinese and Western medicine	1 (3.23)
<b>Years of work</b>	
Mean	17.15 (8.37)
Range	1-35
Year groups	
≤5	5 (16.13)
6-10	1 (3.23)
≥11	25 (80.65)
<b>Years of work for tuberculosis care</b>	
Mean	10.60 (7.99)
Range	0.92-26
Year groups	

≤5	13 (41.94)
6-10	4 (12.90)
≥11	13 (41.94)
Missing	1 (3.23)

Note:

1. Data are reported in the format of n, n (%) or mean (SD);
2. For all variable in the table, no statistically significant difference is found between different administrative levels of facilities and between different provinces.

A total of 16 interviewees were also recruited in the research for in-depth interviews. Recruited interviewees included 6 tuberculosis physicians, 6 department directors, 2 prefecture-city level tuberculosis control administration officer, 2 provincial tuberculosis control administration officer, and 1 national tuberculosis control administration officer, among which one of the department directors was also an officer of prefecture-city level tuberculosis control administration. Table 3 shows the location and facility of the interviewees.

### **3.2. Recruitment**

The clinical department directors of TB facilities expressed the desire to recruit new physicians, but all of them expressed difficulties as well. These difficulties lay in the risk of infection, working environment, stigma, low remuneration and other benefits, and hospital administration's preference.

“First, it is an infectious disease. Second, the environment in our hospital is too poor. Third, remuneration is what they fully considered. Due to the condition in the first two reasons, they will rise higher requirement for the remuneration.”  
Department director, TB dispensary at prefecture-city level

“Nowadays most of the physicians do not like to work in the infectious diseases department for two reasons. One, income is not high; second, social reputation is not good. When I walk outside, some people pretend not knowing me. Who is that? The leaders and those who have high social status. They care about their

privacy, and talking to you implies that they may have some diseases...In addition, the risk of infection, which I understand. It does not mean an absolute infection, but there is a risk." Department director, general hospital at the county level

"Now people usually do not like to (come to work). Remuneration is low, and welfare is also low." Department director, TB clinic at county-level CDC

"We openly recruit physicians from the society, and no one wants to come. Why? One is low remuneration, and the second is high risk. Third, as you can see, our location is far away, the working and life are inconvenient." Department director, general hospital at the prefecture-city level

"People don't want to come, as our income and remuneration is too poor, and infection protection is also not in a good condition that you may be infected at any minute. You know, you see around and how could this condition here meet the requirement for infectious diseases care...hospital recruited graduate students before, but as long as they know that other departments are also recruiting, they are reluctant to come to our department." Department director, general hospital at the county level

"No, it is also about hospital's arrangement. Even if someone is willing to come, the hospital will arrange him or her into other departments that need more people. The hospital seems to think fever clinic, intestine clinic, and even TB clinic are not a very necessary thing, but it contradicts our guidelines. This is the contradiction. But even if we have set these clinics, I cannot estimate how many patients will visit them, so, at least, the hospital thinks that it is wasting manpower." Department director, general hospital at the county level

As the occupational infection repeatedly mentioned by the department directors as a factor deterring recruitment, the response from survey participants coincided this point. Table 5 shows which factors physicians considered important to work for tuberculosis care. "Risk of infection" and "infection protection provided by employer" ranked top two of the most important factors. The working environment had 4.26 points and ranked fourth. Rather, income had 3.97 points and ranked 11<sup>th</sup>, near to the "4 points - important".

**Table 5: Self-perceived importance of factors associated with the employment as tuberculosis physician**

<b>Rank</b>	<b>Factor</b>	<b>Score</b>
1	Risk of infection	4.71 (0.53)
2	Infection protection provided by the employer	4.53 (0.78)
3	Workload	4.37 (0.72)
4	Training opportunity (p=0.0356, between provinces)	4.26 (0.66)
4	Working environment	4.26 (0.77)
6	Welfare (vacation, housing, holiday gifts, etc.)	4.23 (0.84)
7	Work stress	4.10 (0.70)
7	Reputation of employer	4.10 (0.87)
9	Patient-physician relationship	4.06 (0.77)
9	Variety of tasks of work	4.06 (0.68)
11	Income	3.97 (0.87)
11	Workplace location	3.97 (0.84)
11	The frequency of overtime working	3.97 (0.91)
14	Child's education	3.94 (1.03)
15	Career development	3.90 (0.94)
16	Challenges in the work	3.84 (0.93)
16	Staffing of government-affiliated institutions	3.84 (0.90)
18	Support from family	3.81 (0.87)
19	Psychological consulting service provided by the employer	3.73 (0.87)
20	Household registration provided by the employer	2.77 (1.28)

Note:

1. Data are reported in the format of mean (SD);

2. The mean is from a 5-point Likert scale: 1-very unimportant, 2-unimportant, 3-neutral, 4-important, 5-very important.

Some tuberculosis facilities took measures to cope with the difficulty in recruitment. However, they mainly lowered the requirement for recruitment in educational background.

“In the past, we want to recruit a male physician with a bachelor degree, and we realized that this was a high requirement. Later, female physician or married physician was also OK, but it was still hard to recruit, or the one comes doesn’t meet our requirement.” Physician, TB dispensary at prefecture-city level

“We loosened the requirement for recruitment. As long as we need to recruit, we propose to human resources department, and they discuss it in the board meeting, then we can start recruiting, but nobody comes...and hospital lowered requirement for educational background. The hospital primarily recruits graduate students and did not recruit those with an only bachelor degree. For our infectious diseases department, as well as the emergency department,

obstetrics, and pediatric departments, we lowered the requirement to bachelor degrees." Department director, general hospital at the prefecture-city level

### **3.3. Support of tuberculosis physicians**

The support of tuberculosis physicians include supervision, fair compensation, life-long learning, and ensuring the health and safety. The supervision of tuberculosis physicians aims to improve their performance in following tuberculosis guidelines. The fair compensation can motivate tuberculosis physicians and stabilize the workforce. Through life-long learning, the knowledge and competency of tuberculosis physicians can be enhanced. The ensuring of health and safety of tuberculosis physicians will keep them as effective labor taking the tuberculosis care work.

#### **3.3.1. Supervision**

Supervision is an effective instrument to improve the individual and organizational performance. It was designed to support the tuberculosis facilities to better report cases and provide services. During the fieldwork, the majority of supervision was found to be focus on the case registration and report at the tuberculosis clinic, while the physicians' clinical practice was less valued. Under the Trinity Model, the designated hospitals for the treatment of tuberculosis received technical supervision from CDC.

"The core party of the Trinity Model is CDC. It does not diagnose and treat patients, but it supervises whether hospitals follow the nationally standardized guideline, and how grassroots facility manage the patient." CDC TB official at the prefecture-city level

Although the Trinity Model gave CDC the duty of supervision, the coordination between CDC and hospitals were facing challenges. One was from the administrative structure of different facilities. As CDC was not the direct superior organization of hospitals, it was administratively difficult for CDC to “supervise” hospitals.

“Hospitals usually has a higher or equal administrative level compared with CDC, so it is to some extent difficult for us to direct the hospital.” CDC TB official at the prefecture-city level

“The Trinity Model is...what to say...overall well designed...but what the problem is now, say, if we want a community hospital to cooperate, but we are not its superior hospital. We do not have a say in their human and financial resources, so sometimes they may not be very active...Even though we are all in the health system, but community hospital answers to district health administration, and CDC answers to city administration. We also answer to the city administration, but to a different leader. Therefore, sometimes the coordination is challenging, and this is a difficulty we met in our daily work.” Department director, TB dispensary at prefecture-city level

As the ultimate health administration, all levels of health and family planning committees were at the position to better coordinate all three parties of Trinity Model.

“I think that the technical issues are not the biggest issue...the hardest parts are policy and coordination. As you know, the three parties in the system, including hospitals, CDC, and community, are cooperating, and I think the key of cooperation to coordinate their people. The health and family planning committee has the most important role, and it has to unite the forces from different sources. That is the key.” CDC TB official at the national level

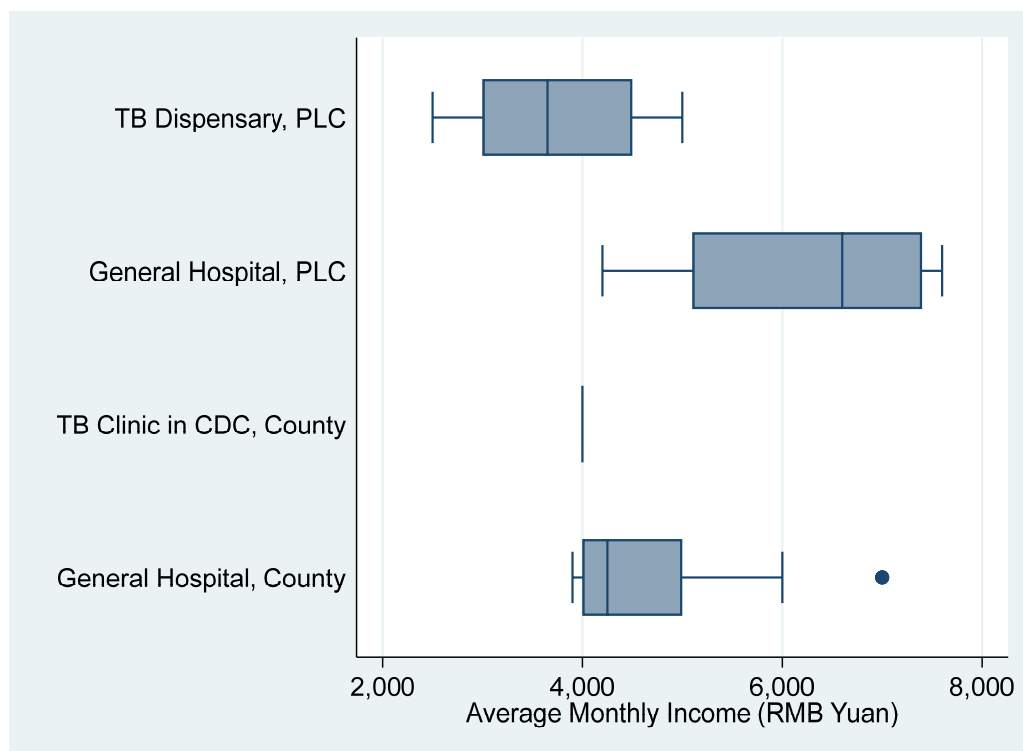
The other challenge was the contradiction between supervision and the profit-pursuing nature of hospitals. Compliance to the treatment guideline would limit the physical exams that may bring revenue to the hospital.

“The new Trinity Model is under a key phase of transition. Especially, some designated hospitals...commonly have over-treatment for profits. It increased the financial burden of patients...after these hospitals became designated

hospitals, they must receive our supervision and inspection. We have always been requiring them to follow the guideline, and it contradicts their profit making.” CDC TB official at the provincial level

### 3.3.2. Compensation

A fair and reliable compensation is important to tuberculosis workforce. Figure 6 shows the salary levels in the TB dispensary, general hospitals, and TB clinic at CDC. Among all three parties of the Trinity Model, the salary level of general hospitals was higher than that of other facilities at the same administrative level. Among all visited facility, the TB dispensary provided the lowest mean monthly income.



**Figure 6: Average monthly income of TB physicians in different facilities**

Note:

1. PLC: Prefecture-level city;
2. In January 2018, 1 USD  $\approx$  6.3 RMB Yuan.



The low income was widely complained by the physicians in different facilities.

Table 6 presents the self-reported income comparison with the average level of income in the facility.

**Table 6: Self-reported income information of physicians**

	Total	General hospital	TB dispensary	TB clinic at CDC
<b>N</b>	31	18	11	2
<b>Income related to revenue made by department</b>				
Yes	28 (90.3)	17 (94.4)	10 (90.9)	1 (50.0)
No	3 (9.7)	1 (5.6)	1 (9.1)	1 (50.0)
<b>Income related to revenue made individually</b>				
Yes	15 (48.4)	9 (50.0)	6 (54.6)	0 (0.0)
No	16 (51.6)	9 (50.0)	5 (45.5)	2 (100.0)
<b>Income compared with average level of physicians in the facility***</b>				
Lower	13 (42.0)	12 (66.7)	1 (9.1)	0 (0.0)
Equal	11 (35.5)	3 (16.7)	6 (54.6)	2 (100.0)
Higher	4 (12.9)	0 (0.0)	4 (36.4)	0 (0.0)
Don't know	3 (9.68)	0 (0.0)	0 (0.0)	0 (0.0)
<b>Satisfactory about income</b>				
Satisfied	3 (9.7)	2 (11.1)	1 (9.1)	0 (0.0)
Neutral	15 (48.4)	8 (44.4)	5 (45.5)	2 (100.0)
Unsatisfied	13 (42.0)	8 (44.4)	5 (45.5)	0 (0.0)

Note:

1. Data are reported in the format of n (%);
2. The P-value is from Fisher's exact test.
3. \*\*\*:p<0.001

In general hospitals, the income level of physicians in the infectious diseases department was lower than the average level. Near half of the physicians reported "lower than average level". The words from department directors and physicians supported this opinion.

"(What is the position of the income level of infectious diseases department in the hospital?) It should be in the middle and lower reaches." Department director, general hospital at the county level

“Our infectious diseases department makes the fewest revenue in our county hospital, and our salary is relatively low. Although we have high risk, high workload, but due to the low profits, our remuneration is accordingly low.” Physician, general hospital at the county level

“(Regarding the remuneration, compared with other clinical departments in the hospital, what is the position of infectious diseases department?) Lower middle.” Department director, general hospital at the prefecture-city level

“(Among the whole hospital, what is the position of the income level of physicians in the department?) It is at the last position.” Department director, general hospital at the county level

In TB dispensary and TB clinic at CDC, the comparison was only between tuberculosis physicians as they were the only physicians in the hospital. Therefore, the distribution of answers was fair. However, the income of physicians is still low compared with tuberculosis physicians in the hospital.

The low income caused unsatisfactory among tuberculosis physicians. As shown in Table 6, only 9.7% expressed satisfactory towards their salaries, while 42.0% of physicians were unsatisfied with their income.

The income for tuberculosis physicians commonly included basic salary fixed based on the working years, professional title, educational background, and position, etc. The other part was performance-related incentive related to the patient visits and exam prescribed, on a fee-for-service basis. Tuberculosis physicians, as well as other health staff working for infectious diseases, received a health and epidemic prevention subsidy (hereinafter known as the epidemic subsidy).

The performance-related incentives served as an encouragement for physicians to work more in a high quality, and sometimes creating more revenue for the hospital.

“We have three dimensions. First is the position index, and the physician has the highest index among the whole hospital. Second is the workload – how many tasks you have finished, how many patients you have seen, how many clinical tasks you have completed. The third is the quality of work based on the evaluation of work quality.” Department director, TB dispensary at prefecture-city level

“The hospital is not fully covered by the government financial budget, so it needs to consider its performance... The performance evaluation for other department is based on their patient visits and bed days, and ours is ‘semi-hooked’ based on average performance... If we use the same method to calculate our performance, it doesn’t work for us, as we don’t have too many patients.” Department director, general hospital at the county level

“(Is the remuneration related to the performance of the department?) Yes, medicine is not related. We have a medical examination and other many indicators.” department director, general hospital at the prefecture-city level

“It is mainly about how many patients were admitted, how many beds you managed, and how many severe patients you cared. It is mainly about workload.” Department director, general hospital at the county level

“It consists basic salary and performance-related salary. It is not decided by the department, but the hospital using a proportion based on your departmental income...the high-income department will have a higher salary, but not significantly higher than others, because the hospital will adjust all proportions at a macro level...for those departments with extremely high income, their proportion will be reduced.” Department director, general hospital at the county level

This was supported by the response of physicians. As shown in Table 6, most physicians reported that their incomes were related to the departmental revenue. Yet, the relationship with individual revenue making was mixed based on the survey results.

Meanwhile, many tuberculosis facilities have reported that they have canceled the mark-up of medicines. This was due to a national policy issued in previous years. This inevitably lowered the source of revenue for the department.

“Medicine is not included. We are canceling the mark-up on the medicine, and we have never connected prescription with kickback. In addition, we have no expensive medicine...because tuberculosis patients are poor.” Department director, TB dispensary at prefecture-city level

“(Are medicine expensive?) They are all cheap, and our hospital has no add-up on medicine from one year ago.” Physician, general hospital at the county level

“(Do you evaluate performance based on prescription and check-up?) Medicine is not related. We have a medical exam and many other indicators of performance. It is a system.” Department director, general hospital at the prefecture-city level

The other component of income was the epidemic subsidy. The level of epidemic subsidy varied across different facilities. Some hospital provided an additional subsidy for the infectious department. Table 7 shows the amount of subsidy earmarked for physicians caring of infectious diseases. Most tuberculosis facilities provided the subsidy around 110 RMB Yuan, while the general hospital at the prefecture-city level in City Y provided 216 RMB Yuan subsidy plus a 500 RMB Yuan subsidy for the risk of infection.

**Table 7: Epidemic subsidy of physician**

Facility no.	Location	Type	Epidemic subsidy (RMB Yuan, per month)
1	City H	PCL TB dispensary	No information
2	City H	County general hospital	150
3	City H	County CDC	100~120
4	City Y	PCL general hospital	216+500
5	City Y	County general hospital	100~110
6	City Y	County general hospital	140

Note: PCL: Prefecture-city level.

The epidemic subsidy served as a compensation for the risk of infection and a motivation for people undertaking important but challenging tasks. However, whether this subsidy could still serve its role today is questionable, as it took up a very small proportion of the total remuneration.

“Today, how much money is 150 Yuan? It is not a big figure. Back in the 1970s and 1980s, the epidemic subsidy is indeed a money. When I came to work, my salary was 58 Yuan, and the epidemic subsidy was 12 Yuan. It was about 20% of my salary. Today, my salary is several thousand, but the epidemic subsidy is just 150. It has no effects, really.” Department director, general hospital at the county level

“(Do you think the epidemic subsidy has the effect on motivation?) Just so-so. It is just 100 per month.” Physician, TB clinic at county-level CDC

“(Do you think the epidemic subsidy has an effect on your daily work?) I don’t think it has much effect. Even if with this subsidy, the income is still at a lower position.” Physician, general hospital at the prefecture-city level

### **3.3.3. Life-long learning**

Medical science is an evolving discipline. It demand all practitioners have a life-long learning to adopt new treatment, medicine, diagnose tools, and diseases. The tuberculosis care also requires continuous training for physicians to improve their ability of diagnosis and treatment.

Table 8 shows the training experience, opportunity and satisfactory of tuberculosis physicians. As 77.4% of physicians received tuberculosis training in the past year, 35.5% of all physicians believed that the training opportunity was insufficient. The

favorite training type of 90.0% physicians was traditional face-to-face training, and it was also the major form of training in the past year.

**Table 8: Training experience, opportunity and satisfactory of tuberculosis physicians**

<b>N</b>	<b>31</b>
<b>Training opportunity</b>	
Sufficient	6 (19.4)
Neutral	14 (45.2)
Insufficient	11 (35.5)
<b>Favorite training type</b>	
Face-to-face	27 (90.0)
Teleconference	1 (3.3)
Online	1 (3.3)
Other	1 (3.3)
<b>Received TB training in the past year</b>	
Yes	24 (77.4)
No	7 (22.6)
<b>If yes, then</b>	
<b>Training type</b>	
Face-to-face	21 (87.5)
Teleconference	3 (12.5)
Online	7 (29.2)
Other	0 (0.0)
<b>Training organizer</b>	
My facility	11 (54.2)
TB dispensary	9 (37.5)
CDC	7 (29.2)
Health Administration	6 (25.0)
Other	4 (16.7)
Association of Infectious Diseases	1
China Anti-tuberculosis Association	1
Wuhan Medical Care Center	2
<b>Satisfactory of training</b>	
Satisfied	20 (83.3)
Neutral	4 (16.7)
Unsatisfied	0 (0.0)
<b>Training usefulness</b>	
Yes	24 (100.0)
No	0 (0.0)

Note: Data are reported in the format of n or n (%).

Most of the physicians were satisfied with the training they received, and all of them believed that they could use the knowledge from training in their daily work. Many physicians have recognized the importance of training during the interview.

“One is that you can update the new knowledge. Why is that? The grassroots like us, frankly speaking, our workload is very high. We are not like you, a researcher. When I complete the clinical tasks, no energy was left. That is to say, if you say whether we should spend some time – of course. However, people’s energy is limited. If we have a chance, through a conference where we no longer care patients, we can indeed learn from your colleagues and professors. The new stuff in the class must be helpful to us.” Physician, prefecture-city level TB dispensary

“It must be of help. If we meet a difficult case, or some new progress, technology, it is helpful.” Physician, general hospital at the county level

“For example, drug-resistant tuberculosis, as we often met this kind of patients. At least you should familiarize the prescription and treatment.” Physician, TB clinic at county-level CDC

“It is helpful. For instance, like drug-resistant tuberculosis, we have some choices and sometimes changing the treatment plan. It is of significance as we cannot do culture here, and you can’t remember the name of medicine. You can only depend on these experiences to modify.” Physician, general hospital at the prefecture-city level

Meanwhile, most of the training was organized within the tuberculosis facility.

These internal trainings were in forms of lecture, seminar, ward round, case discussion, and WeChat course.

“Training organized by our hospital is even more with various forms, such as lecture and WeChat course, once a month, at least 12 times.” Department director, prefecture-city level TB dispensary

Our internal training about tuberculosis is four to five times per year.” Department director, general hospital at the prefecture-city level

“Our internal training often organized in WeChat, you see, it’s all in my WeChat. In addition, we have seminars, but it is hard to gather people at night, so it is not convenient. Also, during the ward round and discussion, we have it every day.” Department director, general hospital at the county level

The external trainings were organized by the TB dispensary, CDC, health administration, and some academic organization at national, provincial, and prefecture-

city levels. As most trainings were in a form of traditional face-to-face training, these external training required physicians to travel to a different city and leave their work and patients temporally. However, many tuberculosis facilities reported obstacles in sending physicians to participate training, namely, shortage of workforce, costly expenditure, and restrictions from hospital policy.

“I want to send people, but I cannot. (Because of a shortage of physicians?) Yes, it is one of the limiting factors. If I have enough people, I of course want to send them to receive training.” Department director, general hospital at the county level

“Every year, for tuberculosis, there are two or three times, from provincial tuberculosis dispensary, Wuhan tuberculosis hospital. The medical care center has a training about TB/HIV. These are all free, and they are OK. However, at the national level, the one of China Medical Association was in Xiamen the year before last year. I didn’t go, and I’m afraid of going. The conference fee is 2000 RMB Yuan, and maybe four to five thousand with travel expenditure, not to mention the accommodation. This is too expensive.” Department director, general hospital at the county level

As for external training for tuberculosis, due to the limitation of people and opportunity, about two or three physicians per year will be trained by academic association, Kunming Third Hospital, or Yunnan Provincial Anti-tuberculosis Association. For those training outside the province, we are...one is because of high expenditure, the other one is about our hospital policy, that every year the people going out for training cannot exceed the 3% of your total staff.

(Is there any compulsory training ordered by health administration?) Yes, if the health committee issued a document. Last month, the provincial agency asked our health committee to let two of our physicians to a conference. I said that none of them could go...Sending two physicians, then who is going to manage the patients. (If there are more physicians, is it better?) Of course. Moreover, we are facing infectious diseases, and each one is important. Dengue is important, malaria is important, tuberculosis is important, they are all important. However, you see, all the department are asking us to attend all their training, and we just have few people. We will be traveling everywhere all the time.” Department director, general hospital at the prefecture-city level

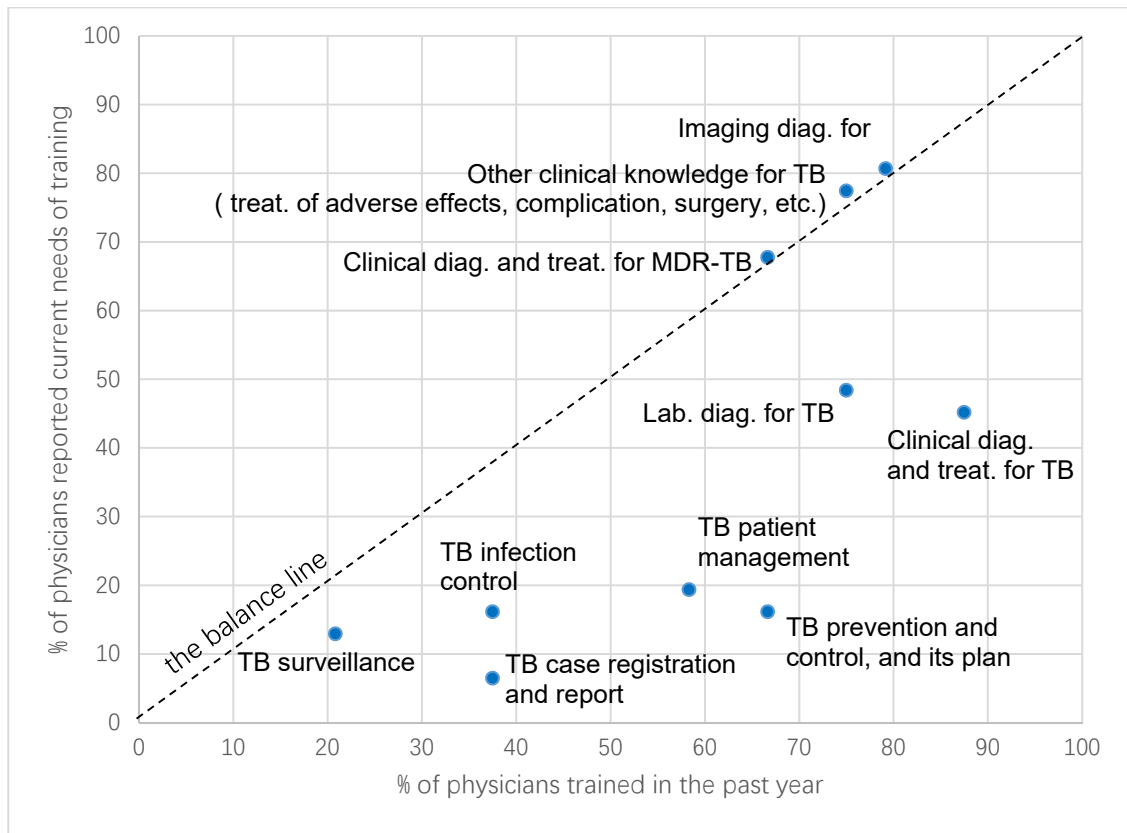


“Because I’m the only one at this position. If I leave, another physician can help me diagnose and treat, but the case input and patient management required by CDC, others cannot help.” Physician, general hospital at the county level

“County CDC and city CDC will organize training sometimes. We also have some materials for learning. Yet, due to the limitation of human resources and some policy of hospital, say, each person cannot go out more than twice a year for training...sometimes we should send people, but there no people. In my department, I used to plan one physician studying outside, but based on the current situation, how can I send people out...” Department director, general hospital at the county level

In addition, the training received by physicians did not match their needs. Figure 7 illustrates the common training topics among physicians. While physicians received clinical training about diagnosis and treatment, they also received training on tuberculosis control, including tuberculosis control plan, surveillance and case registration and report. The dashed line in the figure is an estimation of the proper balance between training provided and needed. Three topics, namely, imaging, MDR-TB, and other clinical knowledge of tuberculosis care were close to the balance line. Other topics under the balance line were considered to be relatively over-provided. As shown in the Figure 7, most of the over-provided trainings were about disease control. The response from a department director coincided this phenomenon.

“Training is relatively fewer. Every time the meeting is about policy. The training of professionals is fewer, and they were about the working arrangement.”  
Department director, general hospital at the county level



**Figure 7: Training received and needed by physicians (n=31)**

Note: Treat.: treatment; diag.: diagnosis

Apart from the formal training, tuberculosis physicians also sought new knowledge and information from different channels. Table 9 shows the active learning experience and the learning channels. Over 70 percent of physicians learned new knowledge actively, and none of them reported “never” learning new knowledge by themselves. The most common channels included academic journal and conference. WeChat was also a popular channel for physicians to learn new information. The use of WeChat public account among tuberculosis physicians in prefecture-city was significantly higher than that in the county ( $p=0.004$ ).

**Table 9: Active learning experience of tuberculosis physicians**

<b>n</b>	31
<b>Active learning</b>	
Never	0 (0.0)
Occasionally	9 (29.0)
Often	22 (71.0)
<b>Learning channel</b>	
Academic journal	18 (58.1)
Academic conference	18 (58.1)
WeChat public account (p=0.004, between admin. levels)	14 (45.2)
WeChat Friends and colleagues	10 (32.3)
Mobile news APP	8 (25.8)
Government or CDC website	7 (22.6)
News website	5 (16.1)
Newspaper and magazine	4 (12.9)
Other	3 (9.7)
International organization websites (e.g. WHO)	2 (6.5)
Television news	1 (3.2)
Weibo	0 (0.0)

Note:

1. Data are reported in the format of n or n (%).
2. P-value is the Fisher' Exact Test.

### **3.3.4. Health and safety**

Health and safety are the prerequisites for health workforce to continuously work for the improvement and maintenance of people's health. As pulmonary tuberculosis is an airborne infectious disease, the physicians, nurses, lab technicians and other health workforces who are exposed to tuberculosis patients and sputum samples are at risk of infection. Apart from the diseases, the pregnancy is also a reason that reduced the productivity of health worker, as pregnant female physicians are unable to work for a period of time before and after labor. They may also shift to other departments due to the risk of infection and its potential harm to the fetus.

### 3.3.4.1. Infection protection

To protect physicians from the infection and consequent reduction of human resources, the protection equipment, such as qualified respirators, air sterilizer, UV lights, and hand sanitizer are necessary, among which the respirator is the key supply to protect airborne infection. However, some facilities were not using qualified respirators for tuberculosis or using the respirators over recommended length of time.

“(Are you using N95 respirators?) For tuberculosis, we have to use N95 respirators. However, before the culture, you don’t know what it is. For daily work, we use surgical respirators. (According to the guideline, is it required to wear N95 respirators?) That would be the best, but its cost is too high.”  
Department director, general hospital at the prefecture-city level

“(When do you use N95 respirators?) Generally, when there is a confirmed diagnosis of tuberculosis, or sputum positive, or imaging positive, and sometimes when patient reluctant to wear respirators, or with significant respiratory symptoms...I will wear N95 respirators. But when patients come for screening with suspicious symptoms, general respirators are OK. N95 is not often used...because only occasionally used, once in several days, the respirator is used for several months. If I wear it every day, it won’t last for a week, as it is expensive and hospital only provides a part of them. The rest of them have to be bought by myself.” Physician, general hospital at the county level

“One N95 respirator, as we have a disinfection room, will be washed and sterilized, and reused afterward. So it will be used quite long.” Department director, general hospital at the county level

For personal protection, we have hats, respirators, and isolation gown. We usually wear surgical respirators. For highly suspicious patients, like bird flu, or H1N1, we have N95 respirators. The physician at tuberculosis clinic will also wear N95 respirators. It is of high cost, and our department cannot afford such high expenditure. (How long are you going to use the N95 respirators?) We have an ‘indigenous’ method – after one day use of the respirator, we will immerse the respirator in the disinfectant, and reuse it. Frankly speaking, it is a pity to use them only for once. (Will it remain the same level of infection protection after you treat it this way?) We haven’t researched on it. Honestly, there is a contradiction, because it is so expensive. (When do you start to use a new one?) When it looks poor or having used it for too long time, about half a month.”  
Department director, general hospital at the county level

“We put ordinary respirator in the middle and disposable respirators at front and back sides. For the special protective respirators, when patient’s family member comes, we don’t usually wear them. Otherwise, we wear ordinary respirators all day.” Physician, general hospital at the county level



**Figure 8: Reused N95 respirators with a physician’s surname on it**

Note: the photo was shot at the physicians’ office in the infectious diseases department of a general hospital. Physicians’ coats, hats, and respirators were hung on a wall. The surname of the physician was written on the N95 respirator in case of confusion.

In addition, there was also other equipment for infection protection. However, some physicians thought that the equipment in their working environment was insufficient.

“We care a lot about the infection protection. Say, the air sterilizer in this infectious diseases clinic, we have three timeslots - morning, noon, night - three times.” Physician, general hospital at the county level

“Regarding the working environment, the only equipment is the UV light. I also often to get respirators. No other measures here. I feel the risk is relatively high.” Physician, general hospital at county level

“the protection here is insufficient. The emergency patients and we inputting data are all in this room. For the disinfection, we have only a UV light and an air sterilizer. However, these have been used for a long time and didn’t change the light for several years. So we say the safety is not guaranteed.” Physician, general hospital at the county level

The concerns of physicians were reflected in their responses. As shown in Table 10, only 16.1% of physicians believed that the workplace equipment for infection protection is sufficient.

**Table 10: Self-perceived sufficiency of protective equipment**

<b>N</b>	<b>31</b>
<b>Protective equipment provided by the employer</b>	
Sufficient	5 (16.1)
Neutral	14 (45.2)
Insufficient	12 (38.7)

The reason for insufficiency was largely due to the high cost of infection protection supply and the insufficient investment from facility and government.

“Like protective respirators, as the national guideline says, it should be N95. How much is it? In Wuhan TB Dispensary, they wear N95, but we cannot. We have only ordinary respirators...I have proposed to the hospital president, and we cannot blame him. You want those things, but where does the money come from?” Department director, general hospital at the county level

“All the protective equipment, including N95 respirators for tuberculosis are all from the department budget. So this is the biggest issue. The current situation of human resources is associated with these policies. If you invest not enough,

many tasks are difficult to implement...we find the health committee, but it will only ask us to do work, and did not solve any actual difficulty for us.”  
Department director, general hospital at the prefecture-city level

“N95 respirators are not often used...and it is expensive, the hospital will only provide parts of it, and I have to buy the rest of it.” Physician, general hospital at the county level

“(Does government has budgeted for this protective equipment, like respirators?) They are purchased by themselves. Yes, there is a lot of problems.” CDC TB official at the provincial level

### **3.3.4.2. The impact of two-child policy**

Working as a tuberculosis physician, especially in inpatient department, was challenging for pregnant women due to the risk of infection, workload, and night shifts.

“Last year one female physician left due to the consideration of having a second child. Her family thought that it is challenging to have a second child under this environment, with high pressure of work and poor environment. Her family made some efforts and she was transferred to the city center hospital.”  
Department director, prefecture-city level TB dispensary

“Some time ago, two physicians in our department were pregnant but miscarried. They felt sad and thought it was due to the work here, like a high level of stress, night shifts, and less rest. So after this physician took a maternity leave, another physician will take a maternity leave.” department director, general hospital at the county level

In addition, the newly issued two-child policy was creating more pressure in recent years. From the 1970s, China implemented the one-child policy, aiming to control the rapid expansion of its population. Most of the parents were encouraged to have only one child and fined if they had more than one child. For ethnic minority groups, couples in rural areas, and some special cases, there were some exceptions. Decades later, the two-child policy, effective from January 1, 2016, was passed as a law in 2015 (Standing Committee of the National People's Congress, 2015). The limitation of one child was

rested to two children, and sparked an increased demand for having a second child for many families in China, including many female physicians. Department directors illustrated the challenge caused by this policy in the interview:

“Last year, there is a two-child policy. As it is permitted to have the second child, and there are many female staffs in the hospital, this policy was causing many difficulties for us. We overcame the challenges, but we can only encourage staff to give us vacation if possible. For the one wants to take the vacation as scheduled or stick to the rights of vacation, I can do nothing about it. But for those who are pregnant, there is no way (to keep them working), as it is the most important thing for every family today.” Department director, prefecture-city level TB dispensary

“Another a tough nut is the second child issue as we are facing now. We are all young physicians, and except me, everyone has the demand for the second child.” Department director, general hospital at the county level

### **3.3.4.3. Patient-doctor relationship**

The tense patient-doctor relationship was causing extra stress for tuberculosis physicians. Such tense relationship may cause potential quarrel or even physical abuse, putting tuberculosis physicians at risk of safety and psychological pressure.

“It is a social issue, and no place can be immune from it. Tuberculosis patients are financially poor, and some of them will intentionally trouble you. You are a tuberculosis dispensary, so you have to admit them, and this is your social responsibility. If you admit them, they don’t have money, what should you do?” Department director, prefecture-city level TB dispensary

“The patient-doctor relationship is tense now. Patients are old, weak, in a bad mood, or pessimistic will let off the social, patient-doctor, and family conflicts with our physician. When they complained about the poor effects of the medicine and the damaged liver function, they will lose their temper on us.” Physician, general hospital at the county level

An often-mentioned source of conflicts was the contradiction between government’s publicity and reality in hospital. The government used “free treatment” to



encourage tuberculosis suspects to receive screening and treatment, but the free items were limited.



Figure 9: Posters about free treatment policy

Note:

Left photo:

Red characters: Coughing or coughing with sputum over two weeks, you should be with the caution of pulmonary tuberculosis infection.

Green characters: If you got pulmonary tuberculosis, the government will provide free treatments.

Right photo:

Topics: the country's policy about the diagnosis and treatment of active pulmonary tuberculosis – free items – self-funded items

Some physicians have mentioned the disadvantage of such publicity. As most of the tuberculosis patients were economically disadvantaged and price sensitive, the contradiction between government promises and the reality in TB facilities was causing mistrust and damaging patient-doctor relationships.

“In fact, the government said that tuberculosis treatment is free, but it should be clearer. It is vague so that people think the treatment is all free. However, there are just some free medicine, sputum smear test. If a patient comes with

hypertension, diabetes, and coughing blood, maybe 99% of the money is spent on those diseases. And the patient will ask, isn't the treatment free?" Physician, prefecture-city level TB dispensary

"From physicians' perspective, the patient-doctor conflict is a common phenomenon, and there are more conflicts in this department. First is the expectation of free treatment contradicts the reality. Second, the tuberculosis patients' mentality is worse than that of other diseases. The third, due to the risk here, many people don't come to my department. If the conflicts occur, no one here can protect me, and I am prone to attack." Physician, general hospital at the county level

### **3.4. Performance of tuberculosis physicians**

Three dimensions were used to measure the workforce performance, namely, availability, competence, and productivity. Table 11 shows the four dimensions of health workforce performance. In this study, issues concerned the availability, competence, and productivity were found and reported. The availability measures the special distribution and time attendance of tuberculosis physicians; the competence includes the tuberculosis-related knowledge, skills, and behaviors; the productivity is the efficiency of producing health outcomes by best-utilizing tuberculosis physicians' knowledge, skills, and time.

**Table 11: Dimensions of health workforce performance**

Dimension	Description
Availability	Availability in terms of space and time: encompasses distribution and attendance of existing workers
Competence	Encompasses the combination of technical knowledge, skills and behaviours
Productivity	Producing the maximum effective health services and health outcomes possible given the existing stock of health workers; reducing waste of staff time or skills

Source: 2006 World Health Report (World Health Organization, 2006)

### 3.4.1. Availability

Physician number in the six tuberculosis facilities were different due to their scales and types. As shown in Table 12, CDC had no inpatient department, so the number of tuberculosis physician was very limited. General hospitals had both inpatient and outpatient departments, and the number of physicians was larger. The TB dispensary, as a specialized hospital for tuberculosis care, had a number of physicians in both inpatient and outpatient departments, working primarily for tuberculosis care.

**Table 12: Number of physicians in different facilities**

Facility no.	Location	Type	# of TB Physician		
			Outpatient	Inpatient	Total
1	City H	PCL TB dispensary	4 (TB clinic)	7	11
2	City H	County general hospital	1 (TB clinic)	5	6
3	City H	County CDC	2 (TB clinic)	N/A	2
4	City Y	PCL general hospital	In turns (IDC)	In turns	7
5	City Y	County general hospital	1 (TB clinic)	7	8
6	City Y	County general hospital	1 (IDC)	6	7

Note: PCL: Prefecture-city level. IDC: infectious diseases clinic

However, the degree of availability varied among the visited tuberculosis facilities. As currently most of the tuberculosis patients were diagnosed, treated, and managed at outpatient departments, the schedule of working time of the outpatient department was determining whether patients could receive diagnosis and treatment in time and reduce the possibility of transmission. In general hospitals, all tuberculosis or infectious diseases clinic only opened on workdays, while tuberculosis clinic at CDC tuberculosis dispensary opened seven days per week.



**Figure 10 The working time of a tuberculosis clinic at a general hospital**

Note: On the paper: Tuberculosis clinic working time, Mon – Fri, 9am-12pm, 2:30-5:00pm, no work at Sat and Sun.

In addition, some department directors expressed the concerns of workforce shortage and the need to recruit more physicians in their facilities.

“Based on the number of our beds, we should have 15 physicians. Now we have only 11, and need 4 more.” Director, TB dispensary at the prefecture-city level, City H

“We as a hospital department, we need to apply from the hospital. Last year, I applied a quota of two people for recruitment.” Department director, general hospital at the county level

“So our department has always been in want of recruitment...I hope to recruit one in every two or three years.” Department director, general hospital at the prefecture-city level

“So do you think we have enough human resources? We are in a severe shortage of about half of physicians, almost at least five physicians.” Department director, general hospital at the county level

These directors explained the reason for the need of recruitment as extra tasks, the need to set up complete infectious diseases clinics, and pregnancy of female physicians induced by newly issued two-child policy.

“Our department often goes to the villages to screen tuberculosis patients and do health education activities. It will disturb our routine work arrangement. In addition, our hospital will also require our physicians to participate in students health check-up and military recruitment health check-up...I think our human resources are insufficient.” Department director, general hospital at the county level

“For example, if we are setting up complete infectious diseases clinics strictly following guidelines, we need a fever clinic, an intestine clinic, a tuberculosis clinic, and a general clinic; therefore we need 4 physicians on duty. So do you think we have enough human resources? We are in a severe shortage of about half of physicians, almost at least five physicians.” Department director, general hospital at the county level

“Another tough issue is the second child. We are all young physicians, and except me, our physicians all have the need of having a baby...I talked to the hospital director many times, and the director cannot help because all departments have this challenge. You can't borrow people from other hospitals as they are also facing the same challenge...although we have nominally 5 physicians working in shifts, but actually just 4 or 3.” Department director, general hospital at the county level

In addition, one physician in TB dispensary complained that the nature of its facility is not attracting medical students who could also be the workforce in tuberculosis care.

“Top hospitals have a lot of interns and postgraduates to help them, and they don't need to pay them. My supervisor used to have three interns, three masters, and one Ph.D. Although he managed many beds, when all students share the workload, it is workable. Township hospitals are not in shortage of hands because they only take minor diseases like flu and fever. The hospital like us at the prefecture-city level, not too high and not too low, is in a neglected position.” Physician, TB dispensary at prefecture-city level

### **3.4.2. Competence**

Globally, two major challenges in tuberculosis control were drug-resistant tuberculosis and the dual infection of tuberculosis and HIV. These challenges required physicians to have additional knowledge and skills compared with regular treatment to drug-susceptible tuberculosis.

Table 13 shows the self-reported knowledge and skills of physicians regarding the treatment guidelines of different kinds of tuberculosis and the TB/HIV dual infection. Overall, 74.2% of physicians self-reported mastery of drug-susceptible tuberculosis treatment guidelines, 61.3% for MDR-TB, 41.9% for XDR-TB, and 51.6% for TB/HIV.

Responses were classified based on the administrative level of TB facility to compare the knowledge level in the facilities at different administrative levels. For MDR-TB and XDR-TB, results were significantly different between administrative levels. More physicians in facilities at prefecture-city level have mastered the treatment guideline for drug-resistant tuberculosis, while few physicians at county facilities mastered the treatment guideline. Results of drug-susceptible tuberculosis and TB/HIV showed no significant difference on different administrative levels.

**Table 13: Self-perceived mastery of treatment guideline by physicians**

	Total	Administrative level		P
		PCL	County	
<b>n</b>	<b>31</b>	<b>15</b>	<b>16</b>	
<b>Drug-susceptible TB</b>				<b>0.433</b>
Don't know	0 (0.0)	0 (0.0)	0 (0.0)	
Heard of it	8 (25.8)	5 (33.3)	3 (18.7)	
Mastered	23 (74.2)	10 (66.7)	13 (81.3)	
<b>MDR-TB**</b>				<b>0.001</b>
Don't know	1 (3.2)	0 (0.0)	1 (6.3)	
Heard of it	11 (35.5)	1 (6.8)	10 (62.5)	
Mastered	19 (61.3)	14 (93.3)	5 (31.3)	
<b>XDR-TB*</b>				<b>0.010</b>
Don't know	4 (12.9)	0 (0.0)	4 (25.0)	
Heard of it	14 (45.2)	5 (33.3)	9 (56.3)	
Mastered	13 (41.9)	10 (66.7)	3 (18.8)	
<b>TB/HIV</b>				<b>0.594</b>
Don't know	1 (3.2)	0 (0.0)	1 (6.3)	
Heard of it	14 (45.2)	6 (40.0)	8 (50.0)	
Mastered	16 (51.6)	9 (60.0)	7 (43.8)	

Note:

1. Data are reported in the format of n or n (%);
2. The P-values are from Fisher's exact test;
3. PLC=Prefecture-level city;
4. \*:p<0.05; \*\*:p<0.01.

### 3.4.3. Productivity

The job description for tuberculosis physicians varied according to the post.

Diagnosing tuberculosis patients and prescribing medicine were major tasks for tuberculosis. In outpatient department, physicians were also assigned to input patients' case information in an online tuberculosis reporting system, yet in one visited hospital a specially hired staff was assisting in data collection and entry. In inpatient departments, physicians would take care several beds, and work in turn at night shifts. Table 14 shows the number of visits and patients in tuberculosis facilities.

**Table 14: Visits and numbers of tuberculosis patients**

Facility no.	Location	Type	Patients for screening, diagnosis, and treatment			
			Outpatient		Inpatient	
			Visit per day	Visit per year	Average bed per day	Admission per year
1	City H	PCL TB dispensary	~27	~10000	70~90	~900
2	City H	County general hospital	10~20	800~900	a	a
3	City H	County CDC	10~20	~1000	b	b
4	City Y	PCL general hospital	a	~400 TB confirmed	a	a
5	City Y	County general hospital	10~20	700~800	a	a
6	City Y	County general hospital	a	300~400 TB confirmed	a	a

Note:

a: no data of independent counting for tuberculosis patients;

b: no inpatient department.

PCL: Prefecture-city level.

Such workload was considered to be very high for many physicians. As shown in Table 15, more than 80% of physicians reported a high workload for them. Physicians in outpatient departments usually worked for 5 working days per week during the



morning and afternoon. The physicians in the inpatient department were commonly working for 6 days per week in different shifts.

**Table 15: Self-perceived workload by physicians**

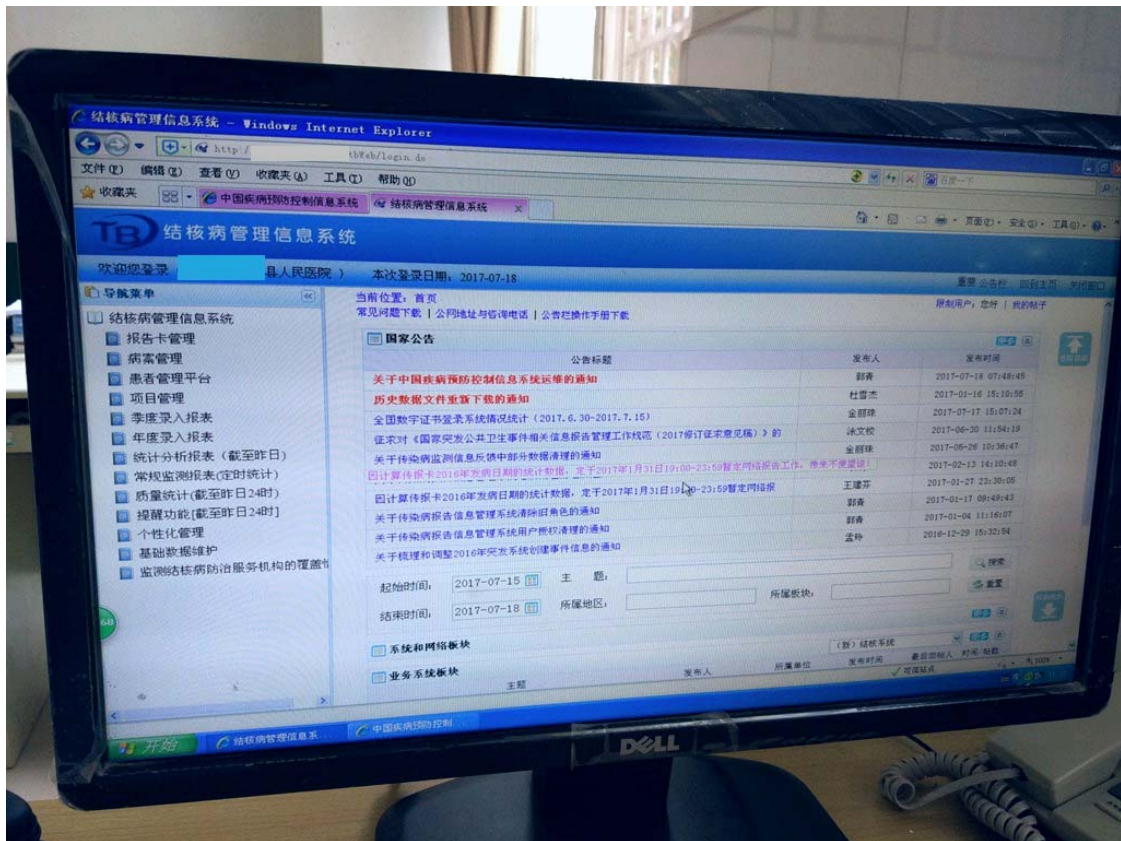
<b>n</b>	<b>31</b>
<b>Workload</b>	
Very heavy	8 (26.67)
Heavy	19 (63.33)
Appropriate	3 (10.00)
Light	0 (0.00)
Very light	0 (0.00)

One of the most complained work was the case registration and report. As tuberculosis is a type B notifiable infectious disease in China, all tuberculosis cases are required to be registered and reported on the books and online. However, all tuberculosis facilities were equipped with computer-based hospital information system. The patient record has been digitalized years ago. Yet, the regulation still required a manual registration, and this work was usually completed by tuberculosis physician.

“The care for tuberculosis is stricter and it requires more work to do. The infectious diseases require report and registration according to the national regulation. Regarding this, since our work is shifting to be computer-based, why do we have to manually do it repeatedly? In the outpatient department, we have two registration books for tuberculosis, one for hand foot and mouth disease, one for chicken pox, one for diarrhea. However, when patients are registered at the beginning, the information is already there.” Department director, general hospital at the county level

“Tuberculosis care has a large workload. No matter ordinary tuberculosis or drug-resistant tuberculosis, the paperwork is several times of other diseases. More than 10 books to fill, and also we have to input it on the internet. All these books are handwritten.” Department director, general hospital at the prefecture-city level

“The workload is quite high. Why? Because you need to follow up and register cases. The case registration is in many books. And you need to input and report it on the computer.” Department director, general hospital at the county level



**Figure 11: Webpage-based tuberculosis reporting system**

The limitation of the lab ability in the facility was also reported as a challenge to improving the productivity of tuberculosis care. Without the ability of some lab tests, tuberculosis physicians lacked evidence to make a diagnosis. It inevitably limited the ability of physician to maximize their productivity and fully utilize their knowledge to provide diagnosis and treatment.

“(What is the most challenging issue for tuberculosis care?) I think it is that our hospital cannot do culture, and therefore we lack the etiological evidence.” Physician, general hospital at the prefecture-city level

“We can’t even do a TB-Ab test. I have proposed to add more lab tests so as to reduce the difficulty of our diagnosis. Some tuberculosis has typical symptoms and easy to diagnosis; some of them are very hard to diagnosis.” Department director, general hospital at the county level

### **3.5. Quitting**

The loss of tuberculosis physicians was often from career changes. The loss of tuberculosis physicians appeared in most of TB facilities. In the past, many tuberculosis physicians left for other departments, hospitals, or even different industry.

“Last year one of our physicians shifted to city central hospital due to the willingness of having a second child. Her family members said that it is difficult to be pregnant under the high working stress and poor working environment.” Department director, prefecture-city level TB dispensary

“So far from 2004, two physicians resigned to do business and work in the different specialties. In addition, one went to another department in our hospital. We all do not want to work here, including our physicians here. Everybody will agree as long as there is a chance to shift out.” Department director, general hospital at the prefecture-city level

“(Has any physician expressed an idea about leaving?) At least not in front of me, but I don’t know if they talked about it privately. But there was a nurse requiring to shift to another department, yes. And also physician shifted out as required.” Department director, general hospital at the county level

When physicians expressed the want and desire to leave, the department directors often felt powerless to retain them. This was due to the limited resources and human resources rights of department directors.

“Our department, to be frank, has no human resources rights. That is to say, I don’t even know when people are shifted out. When the official notice from the hospital comes, how should I retain them? We don’t have any human resources rights.” department director, general hospital at the county level

“If letting you retain them, what can you put on the table and offer to them? (without these,) how can I retain them?) Department director, prefecture-city level TB dispensary

Of course, we will retain them. If someone left, the working schedule is no longer working. It is not an office job; it is about human life. The 'affection retaining', 'remuneration retaining' are all good words, but I can offer none of them." Department director, general hospital at the prefecture-city level

"Will retain them, as we have a friendship, and tell them to keep working. They certainly disagree. Since they said they are leaving, they will leave." Department director, general hospital at the county level

## **4. Discussion**

### ***4.1. Gaps and challenges***

Tuberculosis control in China follows the international strategy, national plan, and the implementation guideline. In 2014, WHO has issued the End TB Strategy as a long-term international strategy on tuberculosis control. In 2017, the State Council of China issued the National 13th Five-Year Plan on Tuberculosis Control as the national plan for overall tuberculosis control. It was a comprehensive plan for the tuberculosis control in China for the period of 2016-2020. The provincial and prefecture-city level plans were subsequently developed to guide local tuberculosis control. To guide tuberculosis facilities to implement the national tuberculosis control program, the Ministry of Health (former National Health and Family Planning Commission, current National Health Commission) and the China CDC developed in 2002 and revised in 2008 the Guideline for National Tuberculosis Control Program to guide the implementation of tuberculosis control programs. These three major policy documents and guideline have set the goals and requirements for China's tuberculosis control.

However, the findings of this research have revealed that tuberculosis physicians are facing many challenges to reach the goals and requirements. The shortage of physicians, difficulty in recruitment, unfair compensation, shortage of training opportunities, high workload, insufficient supply and inappropriate use of protective equipment were found as major challenges of tuberculosis physicians.

#### 4.1.1. Availability of tuberculosis physicians

The shortage of tuberculosis workforce has been reported in other countries. In 2003, 7 of 16 high tuberculosis burden countries reported a shortage of staff (Figueroa-Munoz et al., 2005). WHO list the critical shortage of trained staff as one of the common constraints to scale up the treatment (World Health Organization, 2013).

In China, tuberculosis physicians are seemingly available widely at both county and prefecture-city designated hospitals. Among all visited tuberculosis designated hospitals, tuberculosis physicians were on duty at both inpatient and outpatient department. This was in accordance with the requirement from the national plan.

“All levels of disease control agencies, designated hospitals, and grassroots health facilities should have a specially-assigned person for tuberculosis prevention and treatment.” *The National 13<sup>th</sup> Five-Year Plan on Tuberculosis Control*, 3.1.2

For the infectious diseases department in general hospitals, the availability of tuberculosis physicians was at the level of mere maintaining the basic departmental operation. As more and more prefecture cities and counties were transferring the tuberculosis diagnosis and treatment service into general hospitals as the Trinity Model, the shortage of human resources at the infectious departments of general hospitals was affecting the tuberculosis control. Li et al. (2012a) found that tuberculosis physicians were reluctant to work for tuberculosis care if given another chance due to the complicated working procedure, high workload, much work time needed, low income, and low variety of clinical skills. With the loss of physicians, the difficulty in recruiting

new physicians, and the increased need for maternal leave due to the newly issued two-child policy, such situation was at the edge of worsening. Nevertheless, the current shortage of workforce has been affecting the training of tuberculosis physicians as the training leave will increase the workload of remaining physicians. There was no enough extra workforce for them to support people to receive training in a different city.

The shortage of tuberculosis physicians was the result of many factors. Difficulty in recruitment and loss of physicians were direct causes of it. What behind these two causes were deep reasons associated with the daily work of tuberculosis physicians. In this study, the low income, high workload, and risk of infection were found as the most prominent reasons. However, current coping mechanism was not a right approach, for instance, reducing the requirement for educational background. Such measure increased the quantity of workforce but might compromise its quality. In all visited facilities, no physician received master or doctoral degree. Although a higher degree is not necessarily able to improve their clinical skills, it might limit the ability of research in tuberculosis care. Therefore, the key to address the shortage of tuberculosis physicians should be based on other factors.

#### **4.1.2. Compensation**

A fair compensation is crucial to stabilize human resources for tuberculosis care and also to recruit graduated medical students. This research found that the current compensation for tuberculosis physicians was not fairly reflecting the value of their

work. In a profit-driven health facility, the performance-related payment, in addition to the basic salary received, was often based on how much revenue each department of the hospital can generate. The performance-related payment often did not consider the value of tuberculosis physicians in controlling the transmission of epidemics and improving the public health. The social value of their profession was often neglected, or at least not valued, as it should be, in current performance evaluation.

“Establish and improve the performance evaluation and motivation mechanism to motivate the tuberculosis workforce and stabilize the team.” The National 13th Five-Year Plan on Tuberculosis Control 2.1.2

The compensation today does also not consider well the risk of infection of tuberculosis care. As the current epidemic subsidy has not been changed for over a decade, its proportion in total salary keeps decreasing. Comparatively, the additional epidemic subsidy now is not enough to balance the additional risk of tuberculosis care.

“Each region should implement well the epidemic subsidy policy for the staff of infectious disease prevention and control, and provide treatment and remuneration as occupational injury or indemnity when they infected with tuberculosis.” The National 13th Five-Year Plan on Tuberculosis Control 2.1.2

The cost of human resources takes a large share in tuberculosis care in designated hospitals. Wang et al. (2011) found that the tuberculosis clinic was a deficit to the hospital, and the cost of human resources was 80-90% of the direct cost in two study hospitals. In such situation, the hospital may feel difficulty to allocate more financial resources to subsidize tuberculosis physicians. Therefore, a sustainable financing mechanism is needed.



As tuberculosis physician is producing a public good, the government should take more responsibility in this matter. Gu (2017) found that the different subsidy mode from the government was influencing the compensation of tuberculosis workforce. When government subsidized both human resources and services, the income of tuberculosis workforce was slightly above the hospital average line; while in partial or none subsidy mode, the income of tuberculosis workforce was lower than hospital average level. It showed the importance of government subsidy in physicians' compensation.

#### **4.1.3. Productivity**

Given the shortage of physicians in general hospitals, it is even more important to improve the productivity of current physicians to use fully their time, energy, and capability for tuberculosis care. This applies to physicians at both infectious disease department clinic, tuberculosis clinic, and inpatient department, and it could be achieved by reducing unnecessary workload and providing sufficient diagnostic assistance.

In this study, both of the hand-written case registration and input of them on the computer appear at every tuberculosis facility. Such repeated work was regarded unnecessary and complained by many physicians and department directors. As the computer was equipped at all designated hospitals, hand-written case registration can

serve as complementary only in case of computer malfunction and network disconnection.

Meanwhile, as most of the hospitals are using hospital information system to manage patients' registration, case report, the patient's personal information, the diagnosis, and treatment progress are technically possible to be directly transmitted to the national tuberculosis report system. In this way, the physicians can complete the registration and report without any extra operation on the computer compared to current data entry on a webpage without connection with hospital information system. Liu et al. (2015) found that using HIS to report infectious diseases significantly improved the timeliness, accuracy and reduced the time used by physicians. Policymakers have recognized the advantage of using HIS to report cases as the national plan pointed out:

“Along with the construction of regional population health information platform, the current health information system of designated hospitals and grassroots health facilities should be fully utilized to gather data and improve the integration of information.” The National 13th Five-Year Plan on Tuberculosis Control, 3.8

Nevertheless, the major challenge to achieve this function is the coordination between national epidemic disease reporting system and multiple manufacturers of hospital information systems. Among all the designated hospitals in City H, no more than three of them were using the same hospital information system. The development of this function and a further update will cause extra expenditures. Considering that the national CDC is in charge of the current online reporting system, it should take the

initiative in the system building and connection with hospital information systems made by different manufacturers.

The other challenges restricting the capability of physicians is the gap of lab ability. Some designated hospitals have no lab ability to conduct sputum culture and drug-sensitivity test on which physicians' diagnosis is based. This leads to the diagnosis without etiological evidence, posing challenges for physicians when the symptom and imaging are untypical. Considering more and more tuberculosis patients showed no symptoms in China, such challenge is escalating in near future.

The national plan requires tuberculosis designated hospitals to upgrade their lab ability to meet the needs of diagnosis. It is estimated that the tuberculosis physicians will have more tools to make an accurate diagnosis and improve their productivity.

“All prefecture-city level designated hospital should be able to conduct drug sensitive test, strain identification and molecular biological diagnosis. All county designated hospitals should be able to conduct sputum smear and sputum culture. 80% of the county in eastern and central China and 70% of counties in western China should be able to conduct a molecular biological diagnosis.” The National 13th Five-Year Plan on Tuberculosis Control, 2.3.4

#### **4.1.4. Health and safety**

To ensure the availability of tuberculosis physicians, maintaining the health and safety of current physicians are equally important as increasing recruitment. As tuberculosis is an infectious disease, the physicians are always at the risk of infection during the diagnosis and treatment of suspect or confirmed patients. Tudor et al. (2014) found in a cohort from 2006 to 2010 in South Africa that 9% of health workers were

identified with tuberculosis infection. In Mozambique, health care workers reported the shortage of material, lack of clear guidelines, insufficient motivation, and inadequate training to reduce their high risk of tuberculosis infection (Brouwer et al., 2014).

In China, He et al. (2010) found the prevalence of tuberculosis among tuberculosis workforce at outpatient and inpatient departments were 7.6/1,000 and 15.2/1,000, respectively, which 4.81 and 9.62 times of the prevalence in the same year. Globally, 9977 tuberculosis were found among health care workers in 2015, and China accounted for 30% of them (World Health Organization, 2016b); this figure increased to 39% in 2016 (World Health Organization, 2017). The national plan emphasized the importance of protecting tuberculosis workforce.

“Protect well the staff in CDC, designated hospitals, and grassroots health facilities, and reduce the infection rate of tuberculosis workforce.” The National 13th Five-Year Plan on Tuberculosis Control 3.1.2

To reduce the risk of infection, several measures by the Guideline for National Tuberculosis Control Program (2008). Air articulation was the most basic way. Yet, the diagnosis room in many facilities was not designed for infectious diseases and poor in air circulation.

The protective respirators, e.g. N95 respirators, are also recommended as a personal protective method. The Chinese guideline, though mentioned the high cost of the N95 respirator, recommended it as the personal protective device for physicians (National Health and Family Planning Commission, 2008). This recommended

protective device has been required by the CDC of the United States for years as the minimum respiratory protection device for tuberculosis suspects and patients as well as persons exposed to them (Jensen et al., 2005). The comparative superiority in infection protection of N95 respirators has been confirmed among health workforce in hospitals in China (Yang et al, 2011). Yet, this study found that the N95 respirators were insufficiently provided to and inappropriately used by tuberculosis physicians. No using, conditional use, and repeated use of N95 respirators were found in different facilities. As the N95 respirators are reused by tuberculosis physicians, the protective effect of these reused respirators remains questionable.

The major obstacles to supply the sufficient N95 respirators are its high cost and the low affordability of hospitals. The N95 respirator is 10 - 20 RMB Yuan each reported by directors of departments, but it was 5 – 10 RMB Yuan each from online vendors. Nevertheless, it is much higher than the surgical respirators that it around 0.5 RMB Yuan each. Among all visited tuberculosis facilities, the cost of protective equipment was bared by the department. No external funding is supporting the purchase of these respirators.

Also, the conflicts between of “free treatment” publicity and actual limited free service items are causing tension between tuberculosis patients and physicians. It is widely reported by different facilities. The aim of free treatment publicity is certainly to encourage more patients to receive treatment. However, when patients feel deceived

after realizing the actual policy, it was causing tensions and psychological pressure on tuberculosis physicians. The publicity should be clear about the range of free treatment to avoid unnecessary high expectation. Meanwhile, considering the high coverage of basic medical insurance in the urban and rural area, the coverage of insurance, if any according to local insurance policies, could also be included in the publicity to increase the demand and utilization of tuberculosis care.

#### **4.1.5. Competence**

The Competence of physicians is mainly reflected by the work ability in diagnosis, treatment, and case report in some areas. It can be improved through on-the-job training activities. The importance of training has been recognized by national policy makers and it was mentioned repeatedly in the national plan for tuberculosis control.

“To conduct multiple levels and forms of academic exchange and medical education to cultivate talents for tuberculosis prevention and treatment and elevate the work capability and research skills.” *The 13<sup>th</sup> Five-year Plan for national tuberculosis control, 4.4*

“Enhance the training to improve the service ability of staff in tuberculosis diagnosis, treatment, and prevention administration.” *The National 13<sup>th</sup> Five-Year Plan on Tuberculosis Control, 3.1.2*

Based on the finding of this research, the current Competence of tuberculosis physicians is significantly different between prefecture-city and county levels in terms of the mastery of guideline for drug-resistant tuberculosis. More physicians at prefecture-city level have mastered the treatment of MDR-TB and XDR-TB, which is in accordance with the policy that the MDR-TB should be treated in the designated hospitals at

prefecture-city level. Yet, they are still in need of training as the WHO End TB Strategy states:

“Importantly, all care providers managing drug-resistant tuberculosis should have access to continued training and education, enabling them to align their practices with international standards.” *End TB Strategy*

What’s more, as the national plan will greatly improve the coverage of new diagnosis tool in designated hospitals, physicians must learn the indication to use the tool and the interpretation of test results. It requires proper training for all tuberculosis physicians.

“Introduction of the new molecular diagnostics will require a change of diagnostic policies and training at all levels.” *End TB Strategy*

The training has also other benefits. Li et al. (2017) investigated the tuberculosis physicians in Yunnan province and found that “more than three times of training per year” was a protective factor for tuberculosis physicians from occupational fatigue.

However, this study found that there are many challenges for physicians to receive training. Hospital restriction, the concern of high expenditure, high workload are three major factors deterring physicians from receiving training outside the hospital. These challenges cannot be resolved shortly, but new technology can contribute to this matter. The national plan encourages remote education to provide training for the physicians.

“Utilize the remote health care and remote education network to provide guidance and training of tuberculosis prevention and treatment skills.” *The National 13<sup>th</sup> Five-Year Plan on Tuberculosis Control*, 3.8

Indeed, the remote training has advantages that can precisely resolve these challenges. No need to leave hospital means it is not violating hospital regulation. No long distance travel indicates no high expenditure on conference fee, accommodation, and travel expenditure. Physicians can also stay in the workplace so it will not worsen the shortage of labor by leaving the post. A remote training of malaria diagnosis and treatment on a Chinese website ([www.yiboshi.com](http://www.yiboshi.com)) was conducted and evaluated in Yunnan province with 98.55% completion rate and 97.30% passing rate (Zhou et al., 2017). A similar approach can be well applied to tuberculosis physicians.

Nevertheless, this research found that most of the physicians prefer the traditional face-to-face training, which its reason should be well understood and considered by the remote education program developer. When developing the program, the interaction and communication should be enabled in the remote education program. Additional live sessions could also be added to promote communication between expert lecturer and physician trainees.

#### **4.1.6. Supervision**

During the transition to the Trinity Model, the clinical care was transferring from tuberculosis clinics at CDC to designated hospitals. However, the supervision of tuberculosis physicians was weaker in designated hospitals than in TB clinics at CDC. It



has been reported that tuberculosis physicians are over-ordering health exams, over-prescribing medicines, and over-admitting patients into the inpatient department (Xu, Qian, & Xu, 2015). Such behavior increased the burden of both patients and health insurance, which is violating the national guideline for tuberculosis treatment. The national plan posed emphasized on the supervision of tuberculosis care practice:

“Enhance the quality control of tuberculosis care. Each region should improve quality management mechanism for tuberculosis care, and made regulation, guidelines and implementation plan. Include tuberculosis care into the health care quality control system. Each province should assign 1 provincial health facility to organize experts to conduct the tuberculosis care quality evaluation that should be used as an important factor for a hospital evaluation.” The National 13th Five-Year Plan on Tuberculosis Control 3.3.5

However, one provincial health facility is not enough nor available to provide supervision to all designated hospitals in the province. On the other hand, the county and prefecture-city CDC can supervise the case registration and reporting but has no human resources to guide the clinical practice of tuberculosis physicians considering the clinical professionalism. In addition, CDC has no control of the human and financial resources of designated hospitals and is often at equal or lower administrative level than general hospitals. It inevitably caused political difficulty in the supervision process. The coordination between CDC and designated hospitals urgently needs a reform.

Currently, the national guideline has not been updated for the Trinity Mode yet, and there is no detailed requirement for designated hospitals in current 2008 guideline. The need of a national guideline to regulate and guide designated hospital has been

found in other research (Li et al., 2012b). An updated guideline will be of great value in practicality, especially for the designated hospitals.

## **4.2. Study strengths and limitations**

### **4.2.1. Strengths**

This research is one of the few studies that focus the physicians for tuberculosis care in China. This specific concentration on tuberculosis physicians provided policy makers valuable information regarding the policy on tuberculosis physician and workforce. As most of the tuberculosis policies are made by public health professionals, this research will fill the gap of their understanding in the clinical professionals' situation and challenges.

Under the current window of the transition to Trinity Model across all provinces in China, this study is particularly of strong timeliness. By revealing the challenges faced by tuberculosis physicians in designated hospitals, policy makers in the cities which are preparing for transition can be aware of the potential issues that may occur during and after their transition, and make a plan to cope with these challenges to improve the efficiency of tuberculosis control.

The mixed-method design is strong in revealing the issues from qualitative analysis supported by quantitative data through method triangulation. By surveying tuberculosis physicians, quantitative data were collected and statistically analyzed. The interview with physicians, department directors, and CDC officials provided detailed

reasons behind each option in the questionnaire. By method triangulation, the findings of this research are relatively solid and reliable.

In addition, through the interviews with physicians, department directors and CDC officials, a data source triangulation was performed through presenting and comparison the opinions from different stakeholders. The attitudes and opinions of these interviewees reflected their beliefs and presented viewpoints from different agencies.

#### **4.2.2. Limitations**

This study faced several limitations during the fieldwork and data analysis.

The small sample size for quantitative analysis limited the use of complex statistical analysis. Based on the quantitative data collected, analysis for the inter-variables associations was not feasible due to the small sample size. This was largely due to the sampling strategy.

This research was facing biases during data collection. As opportunity sampling strategy was used, the healthy worker bias exists for both quantitative and qualitative data collection. The ill physicians were not included in the research. In addition, the social disability bias appeared in the interview. As this research was about occupation and involved some questions about the attitudes towards hospital administration and governments, physicians might give more socially positive answers. Some of the

interviewees appeared to be cautious about the audio recording and their answers seem to be conservative.

A small number of research sites limited the generalizability of research findings. As only two prefecture cities in two provinces were visited, the research findings may not be able to reflect the situation in economically developed eastern China.

This research only touched the physicians at county and prefecture-city level tuberculosis designated hospitals. However, two important group of physicians were missing from the research. Physicians in non-designated hospitals were also diagnosing and treating tuberculosis, even their hospitals were not listed as tuberculosis designated hospitals. Physicians at grassroots health facilities, who do not diagnose but will refer suspect patients, were also not included in the research. Their performance was also affecting the tuberculosis control in China.

## **5. Conclusions and recommendations**

### ***5.1. Implications***

Human resources is one of the key building blocks in tuberculosis control. As the implementer of disease control policies and medical practices, physicians are at a core position for the health of tuberculosis patients. Unfortunately, while all tuberculosis is under the transition to the Trinity Model, little attention was paid to this particular population. This study filled the gap of little information about the challenges of tuberculosis physicians.

This study found that the health workforce does not meet all the needs of a sustainable TB care and control. Currently, the shortage of physicians, difficulty in recruitment, insufficient protective equipment, unfair compensation, and short of training opportunities are found as major challenges of tuberculosis physicians.

These challenges are caused by multiple reasons, such as the shortage of workforce and insufficient financial resources. Yet, these reasons and challenges are mutually connected and eventually lead to today's situation.

## **5.2. Recommendations**

To fill the gaps and cope with the challenges of human resources for tuberculosis care in China, several measures can be taken by all levels of governments, CDC, and hospitals. Based on the interview with physicians, department leaders, and CDC officials and the analysis of quantitative data collected from physicians, several policy recommendations were proposed to address current challenges in the tuberculosis facilities. The ultimate goal of these recommendations is to increase the quantity and improve the quality and performance of tuberculosis physicians.

**Increase Competence.** More training opportunity is needed for tuberculosis epidemic and increasing drug-resistant tuberculosis. The content of training should be adjusted to meet the physicians' need. Mobile APPs, especially WeChat, could be used for sharing knowledge about tuberculosis diagnosis and treatment for physicians' self-learning.

**Ensure safety.** Sufficient protective supplies and equipment should be ensured to tuberculosis physicians. Training of the correct use of protective equipment should also be delivered to tuberculosis physicians. In addition, The government should modify the publicity of tuberculosis control and provide clearer instruction of “free treatment” policy to avoid potential conflicts.

**Fair compensation.** The government should subsidize the physicians working for public health. The performance evaluation mechanism should properly consider the social benefits produced by tuberculosis physicians and the risk of infection. The epidemic subsidy should be properly adjusted to fully compensate the risk of infection.

**Increase productivity.** Reduce unnecessary workload for physicians by simplifying case reporting process and fully utilize existing hospital information system for information collection. Meanwhile, lab ability should be improved to provide more tools and evidence for physicians’ diagnosis, and therefore generate more health outcomes.

**Strengthen supportive supervision.** Under the Trinity Model, the structure should be reformed to strengthen the supervision of tuberculosis physicians in hospitals. The supervision on clinical practice can be performed by higher level tuberculosis facilities, if the CDC is not sufficient in clinical expertise. A supportive supervision, rather than an administrative event, should be promoted so as to supervise but also help the tuberculosis physicians to conduct the quality practice.

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