Risks of Tuberculosis Prevention and Control

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Caihong Xu and Hui Zhang

Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium tuberculosis*, which is seriously harmful to human health. *Mycobacterium tuberculosis* mainly affects the human lungs, resulting in pulmonary tuberculosis and even extrapulmonary tuberculosis. *Mycobacterium tuberculosis* can be transmitted by air, and people are mainly infected via droplets produced by patients who discharge the bacteria while speaking loudly or coughing. People are generally susceptible to infection.

5.1 Epidemic Situation of Tuberculosis

Since the beginning of the twentieth century, the prevalence of TB has been effectively controlled in many countries. In the late 1980s, however, many developed and developing countries witnessed the return of the TB epidemic. As a result, the WHO had to declare "a global TB emergency" in 1993. So far, the incidence of TB in many countries remains high, and outbreaks occur in some areas from time to time. The problem of drug resistance and the transmission of *Mycobacterium tuberculosis* is also a serious challenge worldwide.

5.1.1 General Situation of Global TB

In 2016, WHO announced the list of 30 countries with high burden of TB, TB/HIV coinfection, and MDR-TB in 2016–2020, including (bold county names mean high burden of TB, MDR-TB, and TB/HIV coinfection) **Angola**, Bangladesh, Brazil,

C. Xu · H. Zhang (✉)
Chinese Center for Disease Control and Prevention, Beijing, People's Republic of China
e-mail: zhanghui@chinacdc.cn

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Cambodia, **China**, Congo, Central Africa, Democratic People's Republic of Korea, the **Democratic Republic of the Congo**, **Ethiopia, India, Indonesia, Kenya**, Lesotho, Liberia, **Mozambique, Burma**, Namibia, **Nigeria**, Pakistan, Papua New Guinea, Philippines, Russia, Sierra Leone, South Africa, Thailand, **Tanzania**, Vietnam, Zambia, and **Zimbabwe**.

1. New TB cases: Globally, it was estimated that around 10 million people developed TB disease in 2017, with an incidence of 133/100,000, including 6.36 million men, 3.68 million women, and 1.01 million children [1]. In 2017, it was estimated that most of the cases occurred in the WHO Southeast Asian region (44%), African region (25%), and the Western Pacific region (18%), while a small number occurred in the eastern Mediterranean region (7.7%), the American region (2.8%), and the European region (2.7%). Thirty high TB burden countries accounted for 87.2% of the world's cases, and two-thirds were in eight countries: India (27%), China (9%), Indonesia (8%), the Philippines (6%), Pakistan (5%), Nigeria (4%), Bangladesh (4%), and South Africa (3%).
2. New MDR/RR-TB cases: It was estimated that worldwide in 2017, 560,000 people developed TB that was resistant to multiple drugs/rifampicin (MDR/RR), and of these, around 82% had multidrug-resistant TB (MDR-TB). 3.6% of new TB cases and 17.0% of previously treated cases had RR-TB. The number of new RR-TB cases in these 30 countries was about 507,000, accounting for 90.5% of the global total. Three countries accounted for about 47% of the world's cases of MDR/RR-TB: India, China, and the Russian Federation (10%).
3. New TB/HIV coinfections: In 2017, 920,000 of the estimated 10 million TB patients in the world were HIV positive, accounting for about 9%, and the incidence was 9.2/100,000. Among them, 766,000 TB/HIV coinfections were in high burden countries, accounting for 83% of the global total.
4. TB deaths and mortality: It was estimated that in 2017, about 1.57 million people died of TB in the world, with a mortality rate of 17/100,000. The ranking of TB as the leading causes of death has changed from the 9th to the 10th, but it is still one of the top 10 causes of death in the world. Among the 30 countries, the largest number of TB deaths is in India (410,000) and the lowest is in Namibia (8000), while the highest TB mortality is in Mozambique (73/100,000) and the lowest is in Brazil (2.4/100,000).

5.1.2 TB Epidemic in the "Belt and Road" Countries

Among the "Belt and Road" countries, 12 countries (India, Indonesia, Bangladesh, Pakistan, Cambodia, Burma, Philippines, Thailand, Vietnam, Ethiopia, Kenya, and Russia) were among those with high burden of TB in 2016–2020 announced by WHO, while 13 countries or province (India, Russia, Ukraine, Pakistan, Philippines, Burma, Uzbekistan, Indonesia, Vietnam, Kazakhstan, Bangladesh, Kenya, and Thailand) were among those with high burden of MDR-TB in 2016–2020 announced by WHO (Table 5.1).

Table 5.1 TB epidemic in countries along the "Belt and Road"

	TB cases (10,000)	Incidence (/100,000)	TB/HIV coinfections (10,000)	MDR/RR cases (10,000)	Deaths (10,000)	Mortality rate (/100,000)
India	274	204/10	8.6	13.5	41	31/10
Indonesia	84.2	319/10	3.6	2.3	10.7	40/10
Bangladesh	36.4	221/10	0.055	0.84	5.9	36/10
Pakistan	52.5	267/10	0.73	2.7	5.4	27/10
Cambodia	5.2	326/10	0.13	0.12	0.31	19/10
Burma	19.1	358/10	1.7	1.4	2.7	51/10
Philippines	58.1	554/10	0.71	2.7	2.6	25/10
Thailand	10.8	156/10	1.1	0.39	0.93	13/10
Vietnam	12.4	129/10	0.45	0.71	1.2	12/10
Ethiopia	17.2	164/10	1.2	0.55	2.5	24/10
Kenya	15.8	319/10	4.5	0.28	2.5	50/10
Russia	8.6	60/10	1.8	5.6	1	7.3/10

5.1.3 TB Epidemic in China

The number of reported TB patients in China in 2017 was 835,000, ranking the second in category A and B infectious diseases in China. The reported incidence of TB is decreasing year by year, from 74.3/100,000 in 2010 to 60.5/100,000 in 2017, or an annual decline rate of 3.2% higher than that globally (1.5%).

Globally, China's TB burden is second only to India. WHO estimated that in 2017, new TB cases in China totaled 889,000, or 8.9% of the global total, and 49.4% that of the Western Pacific region. The estimated TB incidence in 2017 was 63/100,000, ranking 28th among the 30 countries with high TB burden.

In 2017, 12,000 TB/HIV coinfections were estimated in China, ranking 14th among the 30 countries, and the incidence, 0.8/100,000, or 27th among the 30 countries.

The RR-TB rates of new cases and retreated cases in China were 7.1% and 24.0%, respectively. According to the estimated cases of TB, the number of RR-TB cases was 73,000 (13% of, or second in the global total); the number of RR-TB cases calculated according to the number of identified TB patients was 58,000; the number of RR-TB cases calculated according to the number of identified smear-positive TB patients was 21,000.

TB deaths in China was 37,000, and the death rate, 2.6/100,000, ranking the 29th among the 30 countries [2].

5.2 TB Risks and Principles for Prevention and Control

5.2.1 TB Prevention and Control Strategy in "Belt and Road" Countries

The strategy of Directly Observed Therapy (DOTS) was developed by Karel Styblo from the International Union against TB and Lung Disease in the 1970s and 1980s. It consists of five elements: government commitment, case detection by sputum smear microscopy, standardized treatment regimens directly observed for smear-positive TB patients, regular and uninterrupted supply of free anti-TB drugs, and standardized recording, reporting, surveillance, and assessment system for TB patients. According to years of experience in piloting and replication around the world, the DOTS strategy can identify the source of infection to the greatest extent and can cure almost all newly identified TB patients. Patients do not need to be hospitalized, and the cost of treatment is low. In 1994, WHO announced that the DOTS strategy is the most cost-effective way to stop the spread of TB and recommended it as a global TB control strategy.

In March 2006, WHO and the Stop TB Partnership proposed a new TB control strategy in order to actively respond to the MDR-TB and TB/HIV coinfection and achieve the Millennium Development Goals of the United Nations. The core of the strategy is DOTS, and it also complements and improves the implementation of the DOTS strategy, its fairness and quality, so as to ensure that all TB patients can obtain diagnosis and treatment. Its six components include to (1) expand and enhance quality DOTS; (2) focus on challenges of TB/HIV comorbidity and multidrug-resistant TB (MDR-TB, for instance); (3) strengthen primary health care; (4) engage all care providers; (5) encourage people with TB; (6) strengthen and promote scientific research.

The "End TB Strategy" was adopted at the 67th World Health Assembly in 2014 [3]. The VISION of the Strategy is a world free of TB—zero deaths, disease, and sufferings due to TB. The GOAL is to end the global TB epidemic by 2035 (TB incidence <10/100,000), a 95% reduction in TB deaths (compared with 2015), and no affected families facing catastrophic costs due to TB. Meanwhile, in order to better achieve the goal of ending TB by 2035, the strategy also sets the interim goals for 2020 and 2025: 20% reduction in TB incidence rate and 35% reduction in TB deaths (compared with 2015) globally, or incidence rate <85/100,000 by 2020, and 50% reduction in TB incidence rate and 75% reduction in TB deaths (compared with 2015) globally, or incidence rate <50/100,000 by 2025. At its core, there are three pillars: integrated, patient-centered care and prevention; bold policies and supportive systems; and intensified research and innovation. To actively respond to the "End TB Strategy," the Chinese government issued the "13th Five-Year Plan for Tuberculosis Prevention and Control" in 2017, which clearly states that "By 2020, the incidence of pulmonary TB throughout China shall be reduced to 58/100,000." The "Outline of 'Healthy China 2030' Program" (hereinafter referred to as the

Outline) puts forward an explicit plan for the TB control system, that is, "to establish a model for integrated TB prevention and care services, to strengthen the screening and surveillance of MDR-TB, to standardize TB diagnosis, treatment and management, and to ensure the continued reduction in TB epidemic throughout the country." The Outline also points out that by 2030, the proportion of personal health expenses in total health expenditure shall be reduced to less than 25%, and the universal health coverage shall be achieved. Based on this goal, public financing is expected to increase to raise the level of medical insurance, and in turn, to reduce the economic burden for patients.

5.2.2 Risk of the Spread of TB Epidemic from Other "Belt and Road" Countries to China, and Recommendations on Its Prevention and Control

India, Indonesia, Bangladesh, Pakistan, Cambodia, Burma, Philippines, Thailand, Vietnam, Ethiopia, Kenya, Russia, Ukraine, Uzbekistan, and Kazakhstan are among the 30 countries with high burden of TB and/or MDR-TB in 2016–2020 announced by WHO. There is a risk of the import of TB, particularly MDR-TB, from these countries to China. If foreign TB patients, particularly MDR-TB patients, stay in China for a long period of time, the transmission risk will increase. If they stay in hospitals, prisons, schools, and other congregation settings for a long period of time, and adequate infection control measures are not taken, it may cause local transmission.

China needs to establish a joint prevention and control mechanism for infectious diseases with the above countries. According to recommendations in "Tuberculosis and Air Travel" published by WHO, the "Belt and Road" countries are required to restrict TB patients, especially those with MDR-TB, to make international travel during the infectious period. It prohibits patients with known infectious TB to take public aircraft before they are adequately treated for at least 2 weeks or MDR-TB patients to travel before they are fully tested (i.e., culture) and proved noninfectious. To avoid local spread caused by the import of TB into China, relevant provisions of the Law of the People's Republic of China on the Administration of Exit and Entry provide that no visa shall be issued to patients with infectious TB. If patients with infectious TB or MDR-TB are found to travel internationally, the countries concerned shall inform each other so that the target country can take preventive and control measures in time and reduce the risk of local transmission.

Once there are TB cases imported from abroad, the CDC shall actively strengthen the surveillance, track cases, assist designated health facilities to carry out appropriate TB treatment and management, take the initiative to contact the close contacts of the infectious TB patients for testing according to relevant provisions, and take effective follow-up actions.

5.2.3 Risk for Travelling to and Working in "Belt and Road" Countries, and Recommendations on Travel

Although travel and work-related risks of TB infection are lower in most "Belt and Road" countries than in China, it is recommended that travelers stay away from high-risk settings, such as crowded hospitals, prisons, and homeless shelters. If they need to visit such places, they are recommended to wear masks.

The common symptoms of TB include discomfort or weakness, weight loss, fever, and night sweat. There may also be cough, chest pain, and hemoptysis. Other symptoms of extrapulmonary TB are related to the affected parts. Individuals with the above symptoms should stop their international travels, as are recommended in "Tuberculosis and Air Travel" published by WHO. Patients with known infectious TB shall not take public aircraft before they are adequately treated for at least 2 weeks. MDR-TB patients shall not travel until they have been fully tested (i.e., culture) and proved in a noninfectious status. If the patients have left the country, they should contact local physicians or health departments for active treatment, prevention, and control [4–7].

5.2.4 Recommendations on Public Health Cooperation Among "Belt and Road" Countries

In consideration of the development level of the public health and the epidemic patterns of TB in "Belt and Road" countries, China can cooperate with "Belt and Road" countries in joint prevention and control of TB, especially MDR-TB and TB/HIV coinfection, public health system strengthening, professional communication and training, scientific research, etc.

5.3 Case Studies on Prevention and Control

Case 1: A Typical Case of Investigation and Control of Tuberculosis Outbreak in School

1. Outbreak identification: On March 11, 2016, a student in a university was diagnosed as a sputum smear-positive pulmonary TB case and was notified in the National Disease Surveillance Information Management System. The local Center for Disease Control and Prevention (CDC) interviewed the student and discovered that he had been coughing since December 2015 and had already been diagnosed as a TB case in January 2016 in his hometown during his winter holiday. The student returned to the university after the holiday and purposely concealed his disease.

The CDC immediately organized a close contact investigation on March 11th and screened all 80 students who were in the same class and the same dormitory with this TB case. Two new TB cases were diagnosed, and 17 students strongly positive in tuberculin susceptibility test (TST) (indicated TB

infection) were identified. Since new cases were discovered, a series of screenings and outbreak surveys were carried out in this university on more students and teachers who might have contacted those TB cases closely or casually. Finally, from March 11th to 30th, 424 students and teachers were screened with chest X-ray examination and TST, and 12 pulmonary tuberculosis cases were diagnosed. Thus, based on the identified epidemiological linkage from a detailed analysis of investigation information, this outbreak was reported as a public health emergency to local health authorities.

2. Emergency responses: The local government took rapid actions to respond to this public health emergency, including (1) investigating and screening all related persons to figure out new cases and identify disease spreading route; (2) isolating all diagnosed TB cases, enhancing treatment supervision for 1 inpatient and 11 outpatients isolated at home or school; (3) The prescribing preventive therapy for 28 (of the 41) TST strongly positive students without TB) agreed to take preventive treatment; (4) enhancing ventilation in all classrooms and dormitories, conducting air sterilization in places where those TB cases stayed; (5) organizing health education activities among students and teachers to inform them of early symptoms of TB and how to protect themselves, hence dispelling their fears for TB; (6) intensifying TB symptom monitoring and reporting in schools for early detection and reference of students with suspected symptoms to TB designated hospitals; (7) soothing emotions of TB cases and their parents and making plans to help students catch up with their courses even if they had to leave school for 4–6 months for anti-TB treatment; (8) releasing newsletters about this emergency event and communicating with medias to inform the society promptly of the progress of the emergency response.

The investigation showed that 9 TB cases lived on the same floor of a dormitory building, two lived on the upper floor of this building, and one lived in another building but shared the classroom with one case. Thus, it was believed that the outbreak was mainly due to TB spreading in dormitories. Since the last case being detected through screening on March 24th, no new case was found. All diagnosed cases finished anti-TB treatment and were cured in 6 months. The local government ended emergency response 3 months after the last case was diagnosed.

3. Lessons learned: First, school TB prevention and control measures were not well implemented. Otherwise, the index case should have been found to be a suspected TB case and reported and referred to the local TB hospital to shorten the time of disease spreading in school. Second, the TB hospital in the index case's hometown should have verified the case's occupation and notified him as a student so that the information could be transferred to the CDC of the county where the university is located. Third, preventive therapy is an important measure for preventing infected students from developing into active TB cases. We should try to persuade as many as possible of those infected students to take preventive treatment. Finally, the excellent collaboration of health and education departments should always be the essential foundation for rapid response to public health emergencies.

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