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Original Research Article

Latent tuberculosis infection in employees with long-Term exposure to hospital environment

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Abstract

Background: Hospital employees catering for Tuberculosis (TB) patients are scared of catching TB. We therefore evaluated the prevalence of latent tuberculosis infection (LTBI) among individuals with varying degrees of job-related exposure to hospital environment to assess if the risk is significant.
Materials and Methods: This cross-sectional comparative study included 200 participants, categorized into three groups: hospital employees with long-term direct exposure to patients (Group-1, n=88), hospital employees with long-term indirect exposure to patients (Group-2, n=59) and individuals with no exposure to hospital environment (Group-3, n=53). LTBI was detected using Tuberculin Skin Test (TST) and Interferon-Gamma Release Assay (IGRA) and results were correlated with duration of exposure and use of masks.
Results: The LTBI prevalence was significantly higher in Group-1 (21.59%) compared to Group-2 (5.08%) and Group-3 (5.6%). Pulmonology nursing staff (46.7%) and ICU staff (35.7%) demonstrated the highest positivity rates. Consistent use of N95 masks was associated with a 58% reduction in the infection risk. LTBI prevalence increased with years of hospital employment, with rates of 0% for 1-5 years, 25.4% for 5-10 years, and 83.3% for those employed for >10 years. Extended working hours were associated with higher positivity rates of 36.9% vs 4.7%.
Conclusion: Healthcare workers with direct patient contact have significantly higher prevalence of LTBI. Duration of employment and extended working hours substantially increase this risk. Consistent use of N95 masks provides significant protection. Targeted screening and preventive interventions are recommended for high-risk departments.

Keywords: Latent tuberculosis infection (LTBI), Healthcare workers (HCWs), N95 masks, Tuberculin Skin Test, IGRA

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1. Introduction

Tuberculosis (TB) remains one of the most significant infectious diseases, causing high morbidity and mortality globally. Despite advances in preventive and treatment strategies, the World Health Organization (WHO) reported approximately 10.8 million new cases of TB in 2023, with 1.25 million deaths.[1] While active TB disease receives considerable attention, latent tuberculosis infection (LTBI) represents a substantial reservoir of potential future cases, affecting approximately one-quarter of the world's population.[2] Latent tuberculosis infection represents a complex interaction between the host immune system and Mycobacterium Tuberculosis (MTB). Unlike active TB disease, LTBI is characterized by the presence of viable bacteria in a dormant state, controlled by the host's immune response. This state can persist for years or decades, with approximately 5-10% of infected individuals developing active disease during their lifetime.[3] Reactivation commonly occurs within the first 2 to 5 years following initial infection.[4]

Understanding LTBI prevalence among different population groups is crucial for effective TB control strategies. Early detection of active disease and preventive therapy for LTBI are vital pillars in TB control**.** According to WHO guidelines, systematic testing and treatment of LTBI should be prioritized in high-risk populations, including healthcare workers, people living with HIV, close contacts of TB cases, and individuals with immunosuppressive

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conditions such as diabetes or those on tumour necrosis factor (TNF) inhibitors.[5] Chemoprophylaxis regimens such as isoniazid monotherapy for 6–9 months or rifapentine-based short-course regimens have been shown to significantly reduce the risk of progression to active TB when adherence is ensured.[6]

Healthcare workers and other individuals with prolonged exposure to hospital environments face a unique set of challenges regarding TB exposure. The risk of acquiring tuberculosis infection in healthcare settings has been well documented since the early days of medicine, but the advent of modern infection control measures has significantly altered this landscape. Nevertheless, healthcare-associated transmission remains a concern, particularly in regions with high TB burden. Studies have shown that healthcare workers have a higher annual risk of TB infection compared to the general population, with estimates ranging from 3.8% to 8.4% in various settings.[7] The risk may extend beyond direct patient care personnel such as doctors and paramedical staff, to include administrative staff, maintenance workers, security personnel, lab workers and others who spend significant time in the healthcare facilities.

In addition to close contact with infectious patients thus increasing risk of transmission; healthcare workers face challenges such as long working hours, job-related stress, irregular sleep etc, all of which may impair immunity and make them more vulnerable to new infection or reactivation. Managing Multidrug resistant tuberculosis (MDR TB) cases poses a further risk of acquiring this difficult to treat illness as more and more such cases are getting hospitalized.[8] Comorbidities like diabetes or chronic respiratory illness, often present in HCWs, further increase this risk.[9] On a brighter side, healthcare workers also have better access to personal protective equipments (PPEs) such as N95 masks, may have UV disinfection available at workplace and have easy availability of diagnostic, treatment and chemoprophylaxis facilities. These measures can significantly lower the risk of catching new infection and progression to active disease when consistently applied.[10] The actual benefits of these on ground level however need to be seen as literature suggests a significant risk of TB transmission to HCWs.[11]

There is fear of TB in the society. Medical, paramedical and non-medical employees of hospitals are often scared to work for TB patients. Although it is generally believed that a close and prolonged contact with TB patients is essential for TB transmission, it remains to be seen whether a distant or indirect contact with TB patients, such as that for employees working in hospital environment for prolonged period but not involved in direct patient care, also increases the risk of LTBI.

2. Materials and Methods

This observational study was therefore conducted to evaluate the prevalence of LTBI among individuals with varying degrees and duration of hospital environment exposure. A prior approval was obtained from the Institutional Ethics Committee (Reference Number: I.E.S.C./258/2023, Dated: 22/12/2023). The enrolled participants were categorized into three groups: individuals with long-term direct exposure to patients for extended periods of time, mainly consisting of doctors and nursing staff working in the hospital treating TB patients (Group-1), individuals with long-term indirect exposure to patients during the work hours, mainly consisting of administrative, maintenance and security personnel working in hospital treating TB patients (Group-2) and individuals with minimal to no exposure to hospital environment, consisting mainly of relatives of non-TB OPD patients (Group-3).

A total of 270 eligible candidates were screened for participation in the study. Out of these, 63 were excluded based on predetermined exclusion criteria. These included persons with active TB, past history of TB, having contact with a family member with active TB, uncontrolled diabetes, chronic kidney disease, systemic steroid therapy and those with any other immunocompromised status. Those with recent BCG vaccination were also excluded. After obtaining informed consent, demographic information, contact details, and relevant medical history were gathered from each study participant using a comprehensive case proforma. For participants with hospital exposure (Group-1 and Group-2), additional details regarding their professional roles and duration of working hours were documented. Use of PPEs was also enquired in to.

For the detection of latent tuberculosis infection, we did both TST and IGRA for initial 20 study participants (10% proposed sample size). During an initial interim analysis, we confirmed that the results were similar for both TST and IGRA and there was no statistically significant difference in results. Thereafter, participants were subjected to either a Tuberculin Skin Test (TST) or an Interferon-Gamma Release Assay (IGRA) based on the participant's individual preference. TST was performed by administering 0.1 ml (5 tuberculin units) of Purified Protein Derivative of Tuberculin intradermally on the inner forearm, with results evaluated after 72 hours. An induration of more than 10 mm in the transverse diameter was considered positive. The QuantiFERON-TB Gold In-Tube (QFT-GIT) assay was conducted following manufacturer specifications, with a positive response defined as an antigen-nil IFN-γ concentration greater than or equal to 0.35 IU/mL. Data was entered in Excel and analysed using SPSS version 21, with qualitative data expressed in terms of frequency and percentages.

Out of the 207 enrolled participants, seven participants did not follow up for reading the TST after 72 hours and had to be excluded from the analysis.

Data of remaining 200 participants was analysed. These included 88 participants in group-1, 59 participants in group-2 and 53 participants in group-3 [**Figure 1**].

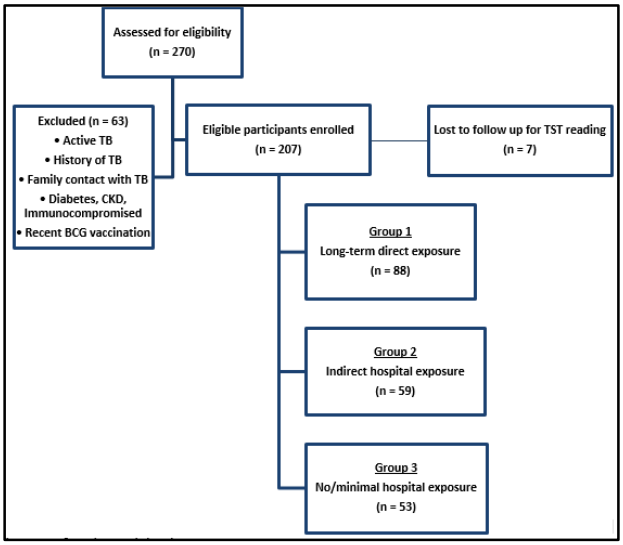

Figure 1: Flow diagram of study participation

3. Results

3.1. Demographic characteristics

The study encompassed 200 participants across three exposure groups: long-term direct exposure to patients (Group-1, n=88) during hospital work hours, individuals with long-term indirect exposure to patients during the work hours (Group-2, n=59) and individuals with minimal or no exposure to hospital environment (Group-3, n=53). Majority of the study participants were young to middle-aged adults (21-40 years). There was a predominance of males (77.4%) in the minimal exposed group, while the long-term exposed groups had a more balanced gender ratio. There was a balanced distribution between rural (42%) and urban (58%) participants. 196/200 participants had BCG vaccination in the first year of their life and 4/200 were unvaccinated.

3.2. LTBI prevalence by exposure groups

Table 1 summarizes the prevalence data of LTBI across the three exposure categories. The long-term direct exposure group exhibited the highest positivity rate of 21.59% (19/88), significantly exceeding rates in both long-term indirect exposure group (5.08%, 3/59) and no exposure group (5.6%, 3/53). This fourfold difference highlights the substantial occupational risk faced by healthcare workers with direct patient contact. Group-2 participants with indirect exposure to patients did not show any significant increase in risk of LTBI as compared to non-exposed participants (group-3).

3.3. Occupational risk analysis

Table 2 summarizes LTBI positivity rates across different hospital role categories within the long-term direct exposure group (Group-1). Pulmonology nursing staff showed the highest prevalence (46.7%), followed by ICU staff (35.7%), junior doctors (7.4%), and interns (0%). General nursing staff had 0% positivity rate. This distribution highlights the heightened risk in departments handling respiratory cases and performing aerosol-generating procedures.

3.4. Protective effect of N95 masks

Among directly exposed healthcare workers (Group-1 participants), those who regularly used N95 masks had a positivity rate of 11.11% as compared to 26.22% among non-users as depicted in **Figure 2**. This is a huge 58% reduction in infection risk. This finding supports the effectiveness of personal protective equipment in high-exposure settings.

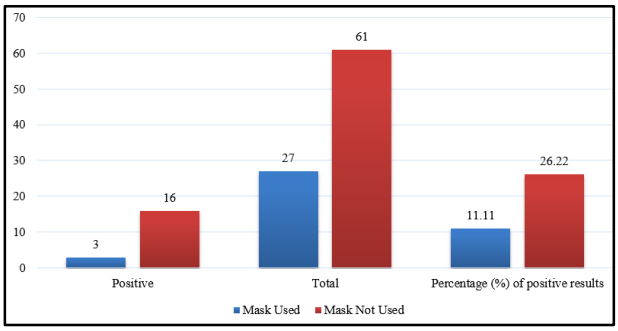

Figure 2: Effect of consistent use of N95 mask on LTBI prevalence in Group-1

3.5. Influence of duration of work

Table 3 illustrates the cumulative risk associated with duration of hospital employment and extended working hours. For group-1 participants, LTBI prevalence increased dramatically with years of service: 0% for those with 1-5 years of employment, 25.4% for 5-10 years, and 83.3% for more than 10 years, as shown in Figure-3. Individuals working in 12-hour shifts had substantially higher positivity rates (36.9%) compared to those working 8-hour shifts (4.7%), suggesting that both duration and intensity of exposure significantly impact infection risk (**Table 3**).

3.6. Logistic regression analysis

Unadjusted analysis revealed that long-term direct exposure to TB patients was significantly associated with higher odds of latent TB infection (LTBI) compared to those with long-term indirect exposure (OR: 5.14; 95% CI: 1.45–18.3; $p = 0.005$). Similarly, individuals working 12-hour hospital shifts had significantly increased odds of LTBI compared to those working 8-hour shifts (OR: 7.56; 95% CI: 2.13–26.8; $p < 0.001$). A logistic regression analysis for the possible confounding factors such as age, gender, area of residence, prior BCG vaccination and work duration is depicted in **Table 4**. These did not show any statistically significant association with LTBI status.

Table 1: LTBI prevalence by exposure group

Exposure Group	Total Participants	LTBI	Prevalence (%)	95% CI
Long-term direct exposure (Group-1)	88	19	21.59%	13.9-31.1
Long-term indirect exposure (Group-2)	59	3	5.08%	1.3-13.2
Newly exposed (Group-3)	53	3	5.6%	1.5-14.6
Total Participants	200	25	12.0%	8.4-17.6

Table 2: LTBI prevalence according to hospital role in long-term direct exposure group

Occupation	Total Participants	LTBI	Percentage (%)
ICU staff	28	10	35.7%
Junior doctors	27	2	7.4%
Pulmonology nursing staff	15	7	46.7%
Interns	15	0	0%
General nursing staff	3	0	0%

Table 3: LTBI Prevalence by years of employment and working hours (Group-1)

Variable	Category	Total participants	LTBI	Percentage (%)
Years of Employment	1-5	27	0	0%
	5-10	55	14	25.4%
	>10	6	5	83.3%
Working Hours	8 hours	42	2	4.7%
	12 hours	46	17	36.9%

Table 4: Regression analysis of confounding factors

Confounder	LTBI Negative		LTBI Positive		Total	Un adjusted OR (95% CI)	P value
	n	%	n	%			
Age group (years) (n=200)							
0-30	95	85.6	16	14.4	111	1.56 (0.63-3.84)	0.34
31-60	74	90.2	8	9.8	82	1	
>60	6	85.7	1	14.3	7	1.54 (0.16-14.47)	0.68
Gender(n=200)							
Male	97	88.2	13	11.8	110	1.15 (0.5-2.66)	0.75
Female	78	86.7	12	13.3	90	1	
Residence(n=200)							
Rural	72	85.7	12	14.3	84	0.76 (0.33-1.75)	0.52
Urban	103	88.8	13	11.2	116	1	
Study groups(n=200)							
Long term direct exposure	69	78.4	19	21.6	88	5.14 (1.45-18.3)	0.005
Long term indirect exposure	56	94.9	3	5.1	59	1	
Newly exposed	50	94.3	3	5.7	53	1.12 (0.22-5.8)	0.89
BCG vaccination status (n=200)							
No	4	100	0	0	4	-	0.58
Yes	171	87.2	25	12.8	196		
Hospital working hours (n=147)							
12 hours	57	75	19	25.0	76	7.56 (2.13-26.8)	<0.001
8 hours	68	95.8	3	4.2	71	1	

4. Discussion

Based on WHO recommendations, either TST or IGRA can be used to detect LTBI.[12] We did both TST and IGRA for initial 20 study participants (10% of proposed enrolments). We realized that doing both tests was not needed as the objective was to detect LTBI. Also, even in case of discrepancy (TST positive and IGRA negative, or vice versa),

positivity of either test would be considered as LTBI. During an initial interim analysis, we also confirmed that the results were similar for TST and IGRA. Doing both tests was not cost effective as the diagnostic variability was negligible and doing either test would not interfere with the study objective. There have been some debates on which test is superior to detect recent infection or predict likelihood of progression to active disease.[13] This however was immaterial as the current study was cross sectional and the objective was just to detect the overall prevalence of LTBI.

The findings of this study reveal a clear association between occupational exposure to hospital environments and risk of latent tuberculosis infection. The significantly higher prevalence of LTBI among healthcare workers with direct patient contact (21.59%) compared to newly exposed individuals (5.6%) and those with indirect exposure (5.08%) aligns with available medical literature on this subject. This pattern is consistent with a systematic review by Apriani et al., which reported LTBI prevalence ranging from 8.4% to 50.2% among healthcare workers in low and middle-income countries.[14] The risk stratification observed across different hospital departments, with pulmonology nursing staff (46.7%) and ICU staff (35.7%) showing the highest rates of infection, aligns with findings from multiple studies which showed health care settings as high-risk areas for nosocomial TB transmission due to delayed diagnosis, aerosol-generating procedures, and the immunosuppressed status of many ICU patients.[15] In a recent regional cross-sectional study conducted in a tertiary care hospital in India, the overall LTBI prevalence among healthcare workers with long-term direct exposure to patients was found to be 20.1%.[16] The substantial LTBI burden among pulmonary medicine staff is expected, given their specialized role in TB management and frequent exposure to infectious patients.

There was no statistically significant difference in the prevalence of infection found in Group-2 and Group-3 participants. The administrative or security staff working in hospital premises with only indirect exposure to patients (Group-2) had similar infection prevalence as compared to that in general population (Group-3). They don't seem to have an additional risk of catching TB infection even after further risk evaluation adjusted to age and duration of service.

The protective effect of N95 masks observed in our study, with a 58% reduction in infection risk among consistent users, corroborates the efficacy of PPEs in preventing tuberculosis transmission. Other studies have similarly concluded that the use of N95 respirators and ultraviolet germicidal radiation significantly reduce transmission of TB.[17,18] The relatively low overall rate of mask compliance in both the hospital groups (20.3% in Group-2 and 30.6% in Group-1) was alarming and suggest significant gaps in infection control practices that need to be addressed. The cumulative nature of TB exposure risk is highlighted by the strong correlation between years of employment and LTBI positivity (83.3% for >10 years, 25.4% for 5-10 years and 0% for 1-5 years), indicating that prolonged occupational exposure substantially increases infection probability over time. Similarly, the higher positivity rates among those working for extended hours (36.9% for 12-hour shifts vs. 4.7% for 8-hour shifts) suggest that both duration and intensity of exposure are critical risk determinants, possibly related to fatigue-induced immune suppression and cumulative exposure to infectious particles. In addition to being at higher risk due to close working with infectious patients, healthcare workers (HCWs) also experience professional pressures that may make them even more susceptible to tuberculosis. Long workdays, job stress and unpredictable sleep schedules; can all impair immune function and make a person more vulnerable to TB infection as well as reactivation. Furthermore, healthcare workers (HCWs) frequently deal with multidrug-resistant (MDR) TB cases,[8] which significantly increases their physical and mental stress not only due to the challenges in managing active MDR-TB but also because of the fear of acquiring latent MDR-TB infection. Unlike drug-sensitive latent TB, which has well-established and effective chemoprophylaxis options, treatment options for latent MDR-TB are limited, poorly defined, and often associated with serious adverse effects.[19] This uncertainty regarding prevention and the looming threat of reactivation into a difficult-to-treat active disease contribute substantially to the emotional burden faced by HCWs in high-risk settings. The likelihood of reactivation of LTBI in this population may be further increased by the existence of underlying comorbidities including diabetes, chronic respiratory disease, or other immunosuppressive disorders which are not uncommon in medical professionals.[9]

On the other hand, despite their elevated risk, healthcare workers can hugely benefit from regular use of protective measures such as N95 masks, as demonstrated in our study. Environmental control measures such as UV germicidal lights when properly implemented, can also significantly reduce the risk of infection transmission.[10]

These findings have important implications for infection control policies in healthcare settings, especially in high TB burden countries. Healthcare workers (HCWs) are at a significantly increased risk of acquiring TB infection, particularly those working in high-risk departments such as pulmonology and intensive care units. Based on our findings, we recommend implementing risk-based LTBI screening schedules tailored to departmental exposure levels and length of service, to enable early LTBI detection. Chemoprophylaxis should be freely available to these high-risk groups. The observed protective effect of N95 mask usage highlights the need to reinforce routine use of appropriate PPE, especially during aerosol-generating procedures. PPE distribution prioritization plans should ensure adequate supply in high-risk departments. Additionally, ultraviolet (UV) germicidal irradiation may be considered as an adjunct engineering control in high-

exposure zones. Good ventilation strategies in pulmonology wards, OPDs and ICU settings can also help reduce the risk of TB transmission. The increased risk linked to extended working hours calls for reviewing shift schedules or adopting supplementary protective measures for long-shift workers. There is a need for developing clear guidelines for preventing MDR LTBI among HCWs, given the limited treatment options and significant anxiety associated with such infections. Above proposed measures can be made mandatory for hospital areas where MDR-TB patients are treated.

Future research should include longitudinal studies to assess conversion rates over time, more detailed investigation into department-specific risk factors, evaluation of efficacy of infection control interventions, and exploration of factors influencing compliance with protective measures.

5. Conclusion

This study shows that healthcare workers, especially those working in pulmonology and ICUs, have a higher risk of catching TB infection, which increases with longer service and extended work hours. Encouragingly, consistent use of N95 masks may significantly reduce this risk. Limiting exposure to TB patients with small work shifts, provision of protective measures, regular screening for LTBI and timely chemoprophylaxis will help to keep frontline medical staff safe while they care for others. Working in hospital premises without any direct patient contact does not seem to increase risk of TB transmission.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Global tuberculosis report 2024. Geneva: World Health Organization; 2024. Licence: CC BY-NC-SA 3.0 IGO. [2024 Sep 2] Available at https://www.who.int/teams/global-programme-on-tuberculosis-and-lung-health/tb-reports/global-tuberculosis-report-2024.
2. Cohen A, Mathiasen VD, Schön T, Wejse C. The global prevalence of latent tuberculosis: a systematic review and meta-analysis. *Eur Respir J*. 2019;54(3):1900655.
3. Behr MA, Edelstein PH, Ramakrishnan L. Revisiting the timetable of tuberculosis. *BMJ*. 2018;362:k2738.
4. Kiazyk S, Ball TB. Latent tuberculosis infection: An overview. *Can Communicable Dis Rep*. 2017;43(3-4):62–6.
5. WHO. Latent tuberculosis infection: updated and consolidated guidelines for programmatic management. World Health Organization. [2024 Sep 22]. Available at https://www.who.int/publications/i/item/9789241550239.
6. Huaman MA, Sterling TR. Treatment of latent tuberculosis infection–An Update. *Clin Chest Med*. 2019;40(4):839–48.
7. Baussano I, Nunn P, Williams B, Pivetta E, Bugiani M, Scano F. Tuberculosis among health care workers. *Emerg Infect Dis*. 2011;17(3):488–94.
8. O'Donnell MR, Jarand J, Loveday M, Padayatchi N, Zelnick J, Werner L et al. High incidence of hospital admissions with multidrug-resistant and extensively drug-resistant tuberculosis among South African health care workers. *Ann Intern Med*. 2010;153(8):516–22.
9. Hernández-Acevedo GN, González-Vázquez R, Reyes-Pavón D, Torres-Maravilla E. Tuberculosis Infection and Comorbidities: A Public Health Issue in Baja California, Mexico. *Bacteria*. 2024;3(3):194–208.
10. Jensen PA, Lambert LA, Iademarco MF, Ridzon R; CDC. Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings, 2005. *MMWR Recomm Rep*. 2005;54(RR-17):1–141.
11. Joshi R, Reingold AL, Menzies D, Pai M. Tuberculosis among health-care workers in low-and middle-income countries: a systematic review. *PLoS Med*. 2006;3(12):e494.
12. World Health Organization. WHO operational handbook on tuberculosis. Module 1: prevention-tuberculosis preventive treatment. World Health Organization; [2024 Sep 2]. Available at https://www.who.int/publications/i/item/9789240097773.
13. Carranza C, Pedraza-Sanchez S, de Oyarzabal-Mendez E, Torres M. Diagnosis for latent tuberculosis infection: new alternatives. *Front Immunol*. 2020;11:2006.
14. Apriani L, McAllister S, Sharples K, Alisjahbana B, Ruslami R, Hill PC, et al. Latent tuberculosis infection in healthcare workers in low-and middle-income countries: an updated systematic review. *Eur Respir J*. 2019;53(4):1801789.
15. Pai M, Kalantri S, Aggarwal AN, Menzies D, Blumberg HM. Nosocomial tuberculosis in India. *Emerging Infect Dis*. 2006;12(9):1311–8.
16. Kumar MG, Joseph B, Goud BR, Joseph M, Rajitha M. Risk of tuberculosis infection among healthcare workers in a tertiary care hospital in Bengaluru City. *Indian J Occup Environ Med*. 2019;23(2):83–9.
17. Xie Z, Zhou N, Chi Y, Huang G, Wang J, Gao H, et al. Nosocomial tuberculosis transmission from 2006 to 2018 in Beijing Chest Hospital, China. *Antimicrob Resist Infect Control*. 2020;9(1):165.
18. Willeke K, Qian Y. Tuberculosis control through respirator wear: performance of national Institute for occupational safety and health-regulated respirators. *Am J Infect Cont*. 1998;26(2):139-42.
19. Mishra G, Mulani J. Latent multi-drug resistant tuberculosis: an unaddressed problem. *Arch Pulmonology Respir Care*. 2020;6(1):84–6.

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