

Prevalence of Tuberculosis among Health Care Workers in Tertiary Care Hospitals - A Review

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Abstract: Tuberculosis (TB) infection represents a global health problem and a great risk to Health Care Workers (HCWs). Identifying individuals, particularly HCWs with latent tuberculosis infection (LTBI) will support TB control through chemoprophylaxis and prevent cross infection. Though many countries boost up the low incidence of tuberculosis, other are not so fortunate. Eradicating them simply doesn't mean by simply providing clean water and food, its about setting up an organised system and reducing the transmission.

Keywords: Tuberculosis, health, workers, nosocomial transmission, sputum, infection, public, airborne.

INTRODUCTION:

Tuberculosis is a global health problem and The World Health Organisation (WHO) in 2010 reported that someone in the world is newly infected with TB bacilli every second. One-third of the world's population is currently infected with the TB bacillus. Also, 5-10% of people who are infected with TB bacilli (but who are not infected with HIV) become sick or infectious at some time during their life.^[1]

Tuberculosis is a public health problem in India. The patients of Tuberculosis hide their disease from family, relatives, and community due to the presence of stigma.

Tuberculosis is a public health problem in India, accounting for one fifth or 21% of the global incidence. It was estimated that almost 2 million incident cases were from India in 2009, among which 0.87 million cases were infectious. Moreover, in India, the estimate of MDR TB among new cases was 2-3% and among re-treatment cases, it was 14-17%. In 2009, TB patients with known HIV status was 17% and tested TB patients with HIV positive was 12%. Revised National Tuberculosis Control Program (RNTCP) based on the internationally recommended Directly Observed Therapy Short-course (DOTS) strategy was started as pilot in Oct 1993, launched in 1997, expanded across the country in a phased manner with support from World Bank. Full nationwide coverage was achieved in 24th March 2006. By December 2009, more than 11 million patients have been initiated on treatment – largest cohort in the world. In 2007, the global target of case detection rate (CDR) of 70% had been achieved while maintaining the treatment success rate of more than 85%. RNTCP has been revised to provide “universal access to quality TB care to all patients” by 2015, which was marked by the launch of a new DOTS logo from 24th March of World TB day 2011.

Risk appears particularly high when there is increased exposure like working at infectious diseases hospitals, emergency rooms and laboratory settings, combined with inadequate infection control measures.

Identifying positive Latent TB among HCWs helps in reducing the risk of later development of open TB among them.^[2]

General history of tuberculosis:

Tuberculosis (TB) is one of the worst killers in the world, from the time immemorial. It is communicable by the inhalation of airborne particles. When patients with TB visit health care facilities (HCF), they are likely to transmit the disease to the health care workers (HCW). This aspect of occupational risk is largely understudied and preventive measures are frequently not in place. This problem is more in the low- to middle-income countries (LMIC), due to increased prevalence of TB and lack of effective control

programmes.

With increasing incidence of multi-drug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) this problem has been further compounded, with the risk of HCW contracting more severe forms of the disease, which are difficult or sometimes impossible to treat successfully. These patients with MDR-TB and XDR-TB have relatively higher morbidity and visit the HCF more frequently. We had reported the first health care worker death in India due to XDR-TB. The subject was a nurse in the respiratory ward and had received the best medical and surgical treatments possible, and yet succumbed to the illness. The grim reality is that we live and practice medicine in an era of potentially incurable TB, where palliative and end-of-life-care are being considered. It is necessary that drastic steps are taken to protect the health of HCW to win the battle against TB.

Another aspect of transmission is that which occurs from HCW to patients. Centers for Disease Control and Prevention (CDC) recently reported the transmission of *Mycobacterium tuberculosis* from a health care worker to patients in New York City.⁽³⁾

DATA FROM LOW- AND MIDDLE-INCOME COUNTRIES

Approximately one-third of the world population harbors latent TB infection (LTBI), based on tuberculin skin testing (TST). In a systematic review assessing the incidence of LTBI among HCW in LMIC, based on 51 studies, the estimated annual risk of LTBI ranged from 0.5% to 14.3% and the annual risk of TB disease ranged from 69 to 5,780 per 100,000. Attributable risk for TB disease in HCW, compared to the risk in the general population ranged from 25 to 5,361 per 100,000 per year. India alone accounts for an estimated one quarter (26%) of all TB cases worldwide with China and India combined accounting for 38%.⁵ HCF in LMIC had a median of 36 HCW per 100 TB patients treated at the facility, which is much lower than facilities in high-income countries, which have a median of ,450 HCW per 100 TB patients. Thus, HCWs in low-income countries are likely to have significantly higher TB exposure.

Some studies have established the grim reality of nosocomial transmission of TB in India. The annual risk of TB infection is about 5% per year in HCW in comparison to the national average of 1.5%. The excess of 3.5% can be attributed to nosocomial transmission. In a prospective study conducted in our institution among nursing students, the annual risk of TB infection as measured by TST conversion was 7.8%, which was 5-folds higher than the national average. In the same cohort, using interferon-gamma release assays (IGRAs), the annual risk of TB infection was even higher (11%).

In a study from North India, TB developed in 2% of the resident doctors already working in the hospitals, giving an incidence of 11.2 new cases per 1000 person-years of exposure. The estimated incidence of TB among resident doctors was 10-fold higher than the incidence for the country. Extra-pulmonary TB was more common and accounted for two-thirds of the cases.

In a retrospective review of HCW who underwent anti-TB treatment in a referral hospital in southern India, 125 HCW who had active TB were identified between 1992 and 2001. The annual incidence of pulmonary TB was 0.35 to 1.80 per 1000 HCW. The annual incidence of extra-pulmonary TB was 0.34 to 1.57 per 1000 HCW.

Molecular epidemiological study at a TB hospital in Delhi by deoxyribonucleic acid fingerprinting in mycobacterial isolates from patients showed that nosocomial transmission of mycobacteria was likely to have occurred. The predominance of mostly pleural disease among HCW indicates that the disease was from newly acquired primary infection, rather than reactivation of previous LTBI. Molecular epidemiological studies have shown that pleural TB is associated with the highest fingerprint-clustering rate of all forms of TB, suggesting that pleural TB is an early manifestation of recent infection.

Levels of training and age were associated with the prevalence of LTBI in most studies. Studies from Brazil have proved that the prevalence of LTBI in senior years was two to three times higher compared with junior years. A study from India has shown a 4-fold higher prevalence in medical students who were more than 23 years of age than in medical students aged 18-20 years, which could be attributed to additional 3-5 years spent in training, and thus patient contact.¹¹ This could also reflect the increasing patient contact in the clinical years; compared to the initial years of training as pre-clinical students, where patient contact is minimal.

Each additional year of occupation increased the prevalence of LTBI in HCW. The risk increased by 1.5 [95% confidence intervals (CI) 1.0 to 2.2] 26 to 2.4 (95% CI 1.1 to 5.0) times with employment duration of more than one year.⁽⁴⁾ There was a 3-fold higher prevalence of LTBI with more than 10 years of employment. In a prospective study conducted in our institution among nursing students, TST positivity was strongly associated with time spent in health care after adjusting for age at entry into healthcare. In our institution, HCW with frequent patient contact and those with a body mass index (BMI; kg/m²) less than were at increased risk of acquiring active TB. Nosocomial transmission of TB was prominent in locations, such as medical wards and microbiology laboratories.

Procedures like sputum collection, sputum induction, nebulisation, sputum processing, bronchoscopy, endotracheal intubation are deemed high risk for exposure to bacteria laden aerosols. In our cohort, involvement with sputum collection and caring for pulmonary TB patients were both associated with TST conversions among nursing students.

RISK GROUPS AMONG HEALTH SCREENING OF STAFF CARE WORKERS

It is logical to assume that the risk of LTBI and TB disease are proportionate to the level of patient contact and exposure to contact with infectious TB cases.⁽⁵⁾ The prevalence of LTBI in nurses has been found to be 1.3% to 35.6% times higher than other HCW. Higher level of clinical training, nursing occupation and recent exposure to TB have been found to be the independent risk factors for TST conversion.

There is a considerable heterogeneity regarding the risk of developing TB disease. The risk as compared with general population is highest among workers in TB in-patient facilities, laboratories, general medicine wards, and emergency rooms. Workers in out-patient medical facilities have an intermediate risk, while workers in surgery, obstetrics, administration and operating theaters have

the lowest risk.

Given the increased risk, there is no doubt that there needs to be effective screening of HCW for LTBI and active TB. However, there is no consensus on the “gold standard” test for diagnosing LTBI. Conversion in test regardless of the testing method used is usually considered as presumptive evidence of new *Mycobacterium tuberculosis* infection, which is associated with an increased risk for progression to TB disease. The TST has been in use for a very long time. TST conversion is defined as an increase in the size of the induration of 10mm or more during a 2-year period in a HCW with a documented negative (<10mm) baseline two-step TST result. But it has many drawbacks, including low specificity due to cross-reactivity to environmental mycobacteria and previous vaccination with bacille Calmette-Guerin (BCG). Also there is controversy regarding the optimum dose of the reagent and the cut-off value for positive test in various risk groups. The test itself is highly operator dependent. There is a potential booster effect by repeated testing.

IGRAs were introduced about a decade ago with great enthusiasm to overcome the problems associated with TST. IGRAs measure interferon- γ released by sensitised T-cells after stimulation with *Mycobacterium tuberculosis* antigens. IGRAs have been found to have higher specificity and positive predictive value in comparison to TST in high income and low TB burden diseases. Serial testing with IGRAs has the advantage of avoiding subjective measurement and eliminates multiple visits. According to Centers for Disease Control and Prevention (CDC) guidelines published in the year 2005, IGRAs were expected to replace TST in all instances, where TSTs are currently used, including serial testing.

However, the initial enthusiasm has died down. The recent 2010 CDC guidelines suggested more caution and called for more research regarding serial testing with IGRAs. The measurement values of IGRAs are highly dynamic, with changes over time from biologic variability and an inherent tendency for conversions (negative to positive test) and reversions (positive to negative test). This has been our experience also, when we evaluated serial IGRAs responses over a 2-year period in nursing students at a tertiary care hospital in South India.³⁷ We found IGRAs results to be negatively associated with successive visits suggesting responses may decrease over time within individuals independent of exposure, although this effect was small. We also identified a small random effect for student (variance=1.76), after accounting for known LTBI risk factors and TB exposure, suggesting that there may be unknown factors contributing to differences in baseline interferon -gamma response across students. Salient differences between TST and IGRAs are given in table 1.

Once LTBI is suspected, a general screening needs to be done to rule out active TB disease. There is no consensus regarding optimal drugs used and the duration of treatment of LTBI in LMIC.

INFECTION CONTROL METHODS

Multi-pronged strategy needs to be taken to reduce the nosocomial transmission of TB (Table 2). World Health Organization (WHO) and Government of India have published guidelines regarding detailed technical and operational measures that can be implemented to reduce the transmission of TB in HCF. Education of the HCW as well as the patients is of paramount importance in controlling the spread of TB. ⁶There are large gaps in the knowledge and attitudes of HCW on TB. In a survey in Delhi, only 12% of the private practitioners request sputum investigations for suspected TB, thereby increasing the probability of missing infectious TB patients. In another study⁴³ among nurses, only 67% reported *Mycobacterium tuberculosis* as the causative organism of TB, and only 22% reported sputum microscopy as the most appropriate way to diagnose pulmonary TB. The patients need to be educated on cough etiquette to minimise the generation of infectious droplet nuclei.

Early detection of patients with infectious TB and segregating them can help in preventing the hospital spread. All TB suspects should be provided separate waiting area and consideration should be given to provide expedited priority service to decrease exposure for other patients and HCW. In a pilot study at our hospital, all new patients who registered at the hospital were screened using a TB screening questionnaire at the new patient triage area over a one-month period. For all those who had cough with sputum for more than two weeks, a sputum smear test for microscopy for detecting acid-fast bacilli was done and the results were obtained the same day. Out of 81 patients who fulfilled the entry criteria, 19 patients (23.4%) were found to have a positive sputum smear. Five of them ultimately were found to have MDR-TB. All those diagnosed were taught cough etiquette and their appointment with other departments was fast tracked. Such fast tracking of TB suspects effectively reduces the duration and the risk of exposure to other patients and other HCW.

Once detected, the patients should be isolated and effective anti-TB treatment should be started with measures to improve compliance. Polymerase chain reaction (PCR) based nucleic acid amplification (NAA) tests for *Mycobacterium tuberculosis* can decrease diagnostic delay and reduce the duration of infectiousness. The Xpert MTB-Rif, which is an automated assay employing automated nucleic acid amplification to detect *Mycobacterium tuberculosis* appears to be a promising tool. This test facilitates confirmation of the diagnosis of TB in a couple of hours and also helps in detecting mutations causing rifampicin resistance, which are surrogate markers for MDR-TB.

Patients with proven TB should not be admitted in hospital, unless otherwise clinically indicated; like, for management of complications or drug intolerance. If they need to be hospitalised, they should be admitted in isolation rooms; which should be separate for TB suspects, drug-sensitive and drug-resistant TB patients. Efforts should be taken to reduce the concentration of

droplet nuclei in the air by increasing natural ventilation or mechanical ventilation by exhaust fans. WHO recommends more than 12 air changes per hour (ACH) in areas where infectious patients are kept. In resource-limited settings, natural ventilation may be the only measure that can be implemented. But such rooms should have openings in opposite sides of the room that can be left open on all climates. The openings should constitute more than 20% of floor area. If assisted ventilation is being used (e.g., exhaust fans) to maintain the adequate ACH it should be ensured that these are kept switched on at all times. Additional air-cleaning methods to prevent airborne spread include room- air recirculation units containing HEPA filters or ultraviolet germicidal irradiation. The disadvantage of these air-cleaning methods is their high cost and the need for meticulous maintenance.

Patients need to wear surgical mask, which may reduce the spread of droplet nuclei. Infectious patients should be provided with sputum container with lids containing 5% phenol. HCW need to wear N-95 respirator masks, while entering the room to attend to these patients. By rotating the staff who are posted in the high risk areas, the risk of exposure can be reduced.

TRANSMISSION:

The risk of transmission of Mycobacterium tuberculosis from patients to health-care workers (HCWs) is a neglected problem in many countries including Iran.⁽⁷⁾ The aim of this study was to estimate the prevalence of latent tuberculosis infection (LTBI), and related risk factors among TB laboratory staff in Iran. Methods: All TB laboratory staff (689 individual) who were working in TB laboratories of 50 Iranian Universities of Medical Sciences and a random sample consisted of 317 participants from low risk HCWs, were included in this cross sectional study. Participants with TST indurations 10 mm or more were considered as positive for LTBI. Results: The prevalence of LTBI among TB laboratory staff and low risk HCWS staff was 24.83% and 14.82% respectively. No active TB case was found in both groups. After adjusting for potential confounders, TB laboratory staff had higher odds of LTBI than low risk HCWs. Conclusions: This study demonstrated that latent tuberculosis is an occupational health problem among TB Laboratory staff in Iran. This study reinforces the need to design and implement simple, effective, and affordable TB infection-control programs in TB laboratories in Iran.

TUBERCULIN SKIN:

From 350 participants, 71 (20.28%) had indurations between 10-15mm and 96 (27.42%) had indurations more than 15mm. Most of HCWs with indurations more than 15mm were in age of 20-30 years. From 75 HCWs with employment duration of more than 10 years, 45(47%) had indurations of more than 15mm. Conclusion: PPD reaction in HCWs was higher comparison with control group, meaning this group are at high risk for Acquired TB.

TB An Occupational disease:

TB is considered an occupational disease among health care workers (HCWs). Physicians, nurses in hospitals, and other HCWs, particularly TB laboratory staff, are at high risk for TB.⁽⁸⁾ The relative risk of TB infection in HCWs has been reported to be approximately 3 times higher than other groups in the community. The prevalence of latent TB among HCWs was reported between 2% and 47% in Iran. Considering that HCWs, especially staff in TB laboratories, are at higher risk of latent and active TB compared with the general population, they should have appropriate knowledge, attitude, and practice (KAP) regarding, transmission, prevention, and treatment of the disease. Previous studies conducted in Iran indicate poor knowledge about TB among general physicians in the public and private health sectors, but no study to our knowledge has been conducted to evaluate KAP about TB in laboratory personnel. Lack of knowledge of TB among HCWs may contribute to an increased risk of developing TB. Available evidence suggests that relatively simple interventions (eg, education and training of HCWs) might be effective in the prevention of TB among HCWs. Evaluating the KAP of TB in laboratory staff is essential to plan educational programs for HCWs, including TB laboratory staff, in Iran. The aim of this study was to assess the level of KAP of this group in Iran. ⁽⁹⁾

LACK OF FACILITY

The risk of transmission of Mycobacterium tuberculosis from patients to health-care workers (HCWs) is a neglected problem in many low- and middle-income countries (LMICs). Most health-care facilities in these countries lack resources to prevent nosocomial transmission of tuberculosis (TB).⁽¹⁰⁾

In many people, the bug causes no health problems—it remains latent. But about 10% of infected people develop active, potentially fatal TB, often in their lungs. People with active pulmonary TB readily spread the infection to other people, including health-care workers (HCWs), in small airborne droplets produced when they cough or sneeze. In high-income countries such as the US, guidelines are in place to minimize the transmission of TB in health-care facilities. Administrative controls (for example, standard treatment plans for people with suspected or confirmed TB) aim to reduce the exposure of HCWs to people with TB. Environmental controls (for example, the use of special isolation rooms) aim to prevent the spread and to reduce the concentration of infectious droplets in the air. Finally, respiratory-protection controls (for example, personal respirators for nursing staff) aim to reduce the risk of infection when exposure to *M. tuberculosis* is unavoidably high. Together, these three layers of control have reduced the incidence of TB in HCWs (the number who catch TB annually) in high-income countries.

Most authors reported that no specific TB infection-control programs were being used in the health-care facilities where the studies were carried out. Only three studies evaluated the impact of multiple infection-control strategies on the risk of TB infection or disease. Another two studies analyzed whether a lack of personal-protection measures was associated with a risk of TB infection. One study evaluated the knowledge, attitudes, and use of TB infection-control measures by HCWs.

Harries at al. evaluated the impact of multiple administrative control measures which were implemented in 40 district and mission

hospitals in Malawi, following adoption of infection-control guidelines. The data were collected by interviewing HCWs and by screening the TB registers at these facilities. The study revealed that the infection-control guidelines were not uniformly implemented, and the median compliance with various measures was 76% (range 3% to 100%). There was a non-significant decrease in TB disease incidence after 1 y of implementing these measures.⁽¹¹⁾

The introduction of multiple administrative, personal, and engineering controls in a single hospital in Thailand resulted in a significant drop in the annual incidence of LTBI in HCWs from 9.3% to 2.2%. However, the incidence of TB disease in HCWs showed a non-significant increase (from 179 to 252 per 100,000) 1–2 y after initiation of these control measures. During the course of this study, the proportion of HIV-positive TB patients treated at this facility increased from 3% to 57%; if there was a similar increase in HIV among HCWs, the incidence could have increased despite a fall in new infections. In another study from Brazil, a cross-sectional tuberculin survey determined the baseline LTBI prevalence in four hospitals. Hospital A initiated administrative controls and provided N95 respirators for all HCWs required to enter a TB-isolation room⁽¹²⁾ Hospital B had initiated administrative controls 3 mo before the baseline TST testing and, at the onset of the study, had introduced N95 respirators and had begun construction of negative-pressure isolation rooms. Hospitals C and D had no TB-control measures in place throughout the study.⁽¹³⁾ Baseline TST positivity was significantly different in the four hospitals (46.7%, 69.6%, 65.8%, and 62.2% in hospitals A, B, C, and D, respectively). After 1 y, the incidence of LTBI (in initially tuberculin-negative workers) was significantly lower in hospitals A and B, which had implemented multiple infection-control measures, compared with the other two hospitals.

In a case-control study by Jelip et al., HCWs with TB disease were 5.9 times (95% CI 0.76 to 46.4) more likely to have poor knowledge about TB transmission, and 4.3 times (95% CI 0.95 to 19.8) more likely to be unaware of the need for respiratory protection. In a study among medical students, although 90% were aware of the risk of TB transmission, only 46% reported the use of personal-protection measures⁽¹⁴⁾. In a study from Northern part of India, although 97% of HCWs were aware of TB infection-control policies, only 52% used personal-protection measures (e.g., respirators), and only 72% implemented respiratory isolation for TB cases. Failure to use personal protection was associated with a 2.6-fold (95% CI 1.06 to 6.64) increased risk of TB disease in HCWs.⁽¹⁵⁾

Persons infected by Tubercle bacilli have about a 10% chance of developing tuberculosis during the remainder of their lives

Conclusion

In the fight against TB, protecting the health of HCW is important. TB control programmes should highlight this important need. Efforts should be taken to implement control strategies to prevent nosocomial transmission of TB and make the health care centers safer for both patients and HCW.

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