Tuberculosis among resident doctors and nurses in a tertiary care hospital: A case-control study

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ABSTRACT

Background: Tuberculosis (TB) is one of the widely rampant infectious diseases worldwide. Healthcare workers (HCWs) such as Medical students and nurses are continuously exposed to this air-borne infection in hospitals and are vulnerable to the infection. Overcrowding at workplace, inadequate ventilation, lack of personal protective measures, improper eating habits, etc., further make the HCWs more susceptible to TB. Objectives: Study of sociodemographic profile of resident doctors and nurses; study of factors for occurrence of TB among HCWs in a tertiary care hospital. Materials and Methods: Case-control study conducted. Questionnaire used to collect data. Comparison was made between the TB cases and controls among HCWs to identify the epidemiological determinants of TB and derive preventive measures for the same. Results: By Chi-Square test, regularity of breakfast \(P < 0.001\); BMI \(P = 0.001\); total duration of exposure to TB patients \(P = 0.013\); screening for TB \(P = 0.014\); adequacy of sleep \(P = 0.029\); adequacy of protein intake \(P = 0.035\) were found to have a significant association with the occurrence of TB. Conclusion: Having regular meals at appropriate times, nutritional status, duration of exposure to TB patients, history of screening being done or not were found to have a significant association with the occurrence of TB.

Keywords: BMI, nurses, regularity of breakfast, resident doctors (PG students), screening, tuberculosis (TB)

Introduction

India accounts for one-fourth of the global tuberculosis (TB) burden. In 2015, an estimated 28 lakh cases occurred and 4.8 lakh people died due to TB.\(^{[1]}\)

With such a high incidence of TB in India, the transmission occurs easily from person to person. Being a chronic disease which is insidious in onset, TB is not suspected soon after the patient presents with its symptoms. During this, the patients can be infectious and the healthcare staff are vulnerable to infection, seldom taking protective measures. Interpersonal transmission of TB is of concern in hospitals in India.\(^{[2]}\) The risk is more during 1) the post graduation due to long duration of working hours in Out-Patient Departments (OPDs) and wards; 2) the nurses who have fixed working hours during which they should mandatorily be in or around the wards; and 3) primary care physicians as they serve as first point of contact for the patients. Respiratory symptoms and airborne diseases, including TB, are one of the commonest reasons for patients to consult primary care physician. In a clinic setup, personal protective equipment (PPE) is seldom used making the physician more susceptible to infection.

This study aims at identifying the determinants of TB among health care workers (HCWs). The objectives of the study were to determine the factors that could have influenced the occurrence of TB among HCWs and to compare them with controls. By this, we could determine the measures that can be adopted as protective measures against TB and thereby prevent the disease.

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Materials and Methods

A case-control study was conducted in a tertiary care hospital to determine the epidemiological determinants of TB among HCWs. Study was conducted for a total duration of 8 months, from September 2018 to April 2019. The study involved only answering a set of questions and no intervention as such, hence posed minimal ethical issues. Ethical approval was obtained from Institutional Ethics’ Committee and ethical practices followed throughout the study.

Cases were defined as HCWs who had contracted microbiologically confirmed TB, secondary to exposure at workplace. Controls were defined as colleagues of the TB case who had never contracted TB during their residency or work tenure. Matching was done for some confounding factors such as age and branch of post graduation for PG student; for nurses, a control was chosen among the nurses working in same ward in hospital.

A list of TB cases among HCWs for the past 5 years was collected from Revised National Tuberculosis Control Program (RNTCP) cell at the hospital. Study participants were limited to past 5 years to reduce recall bias. HCWs included resident doctors, nursing students, and staff nurses. Since the study population—TB cases among HCWs in a hospital—is limited, complete enumeration technique was used for deriving the sample size. The contacts available in the list were approached, informed consent was taken, and questionnaire was filled. The questionnaire included questions about sociodemographic profile, personal history, working conditions, and housing conditions of the participant. Questions regarding factors that can be risk for/protective against TB and the use of PPE were also asked.

Those who were not accessible, due to jobs in far off places, or due to some other reasons were contacted through a phone call and were mailed the questionnaire and informed consent. They were guided to mail back the filled questionnaire and consent form. If a reply was not soon received, they were called and reminded regarding the same.

Snowball sampling was done to enroll more cases. For this, the cases thus contacted were enquired if they knew of other HCWs who had contracted TB. Cases were approached till a reference of no new case was obtained. The list obtained from the RNTCP had details of 37 HCWs who had contracted TB in the past 5 years. After contacting, 32 HCWs were accessible and 29 of them consented to participate in the study. By snowball technique further 7 cases were enrolled, thus taking the total number of participants to 36 TB cases.

Contacts of colleagues who had not contracted TB were taken and approached for participating in the study as controls. Cases and controls were taken in the ratio of 1:2, so a total of 72 matched controls were enrolled. Matching was done for confounding factors such as age, branch of specialization, and place of duty. Individuals who were not willing or had issue in accessibility were excluded from the study.

The outcome of the study was the occurrence of TB; this was taken as a dependent factor. The variables that were evaluated for association included regularity of having breakfast (irregular if they missed breakfast most of the times), nutritional status assessed by BMI, adequate duration of sleep, history of smoking, usage of N-95 mask consistently, history of immunosuppressant medication, etc.

The data thus collected were entered in SPSS 22 for analysis. Details of 36 TB cases and 72 matched controls were entered. The level of significance was at 5%. Association between each of the factor and occurrence of TB was analyzed using Chi-Square test. All factors with P value <0.05 on univariate analysis were tested using multivariate logistic regression analysis. Stepwise backward logistic regression analysis was applied to determine the strength of association. Thus, the factors responsible for the occurrence of TB among HCWs were determined.

Results

Among the total cases enrolled, 16 (44.4%) were males and 20 (55.6%) were females. Among controls, 34 (47.9%) were males and 38 (52.1%) were females. Of the 36 cases, 25 (69.44%) were resident doctors and 11 (30.55) were staff nurses or nursing students.

Among TB cases, 12 (33.33%) were underweight, whereas among controls, only 6 (8.33%) were underweight [Figure 1]. Among TB cases, only 11 (30.5%) were having breakfast regularly at appropriate time and among controls, 54 (75%) were regular in having breakfast [Figure 2]. On applying Chi-Square test, the following factors were found to have significant association: regularity of breakfast (irregular if they missed breakfast most of the times), nutritional status were regular [Figure 2]; BMI, Chi-square value - 10.8, P = 0.001 [Figure 1]; total duration of exposure to TB patients, Chi-square value - 6.171, P = 0.013; screening for TB, Chi-square value – 6.019, P = 0.014; adequacy of sleep, Chi-square value – 4.767, P = 0.029; adequacy of protein intake, Chi-square value – 4.434, P = 0.035 [Table 1].

On the factors that were found to have a significant association, stepwise backward logistic regression analysis was applied, and the
strength of association of each factor was determined: regularity of breakfast, Odds’ ratio (OR) - 6.219; 2.314 to 16.716 at 95% CI; BMI, OR - 0.132; 0.032 to 0.542 at 95% CI; total duration of exposure to TB patients, OR - 2.45; 0.915 to 6.56 at 95% CI; screening for TB, OR - 0.289; 0.103 to 0.807 at 95% CI [Table 2].

Discussion

TB is one of the leading causes of morbidity and mortality worldwide. According to Global TB Report 2017, incidence of TB in India was approximately 28,00,000 of which 1,47,000 was MDR-TB.[3] There are risk factors for each of the four distinct steps in the pathogenesis of TB, namely, exposure, infection, disease, and death,[5] of which first three steps can be controlled/ are preventable well beforehand by precautionary measures.

Multiple factors act, predisposing HCWs to TB infection. Delay in diagnosis and treatment of TB in hospitalized patients,[5] large number of TB patients being handled in crowded and poorly ventilated wards,[5] lack of recommended PPE,[2,6] extensive duty hours with inadequate rest, and improper eating habits at inappropriate times increase the chances of TB infection among HCWs. Poor knowledge and attitude, with perceived lack of vulnerability to TB among HCWs[2] and poor compliance with routine screening for TB among HCWs[7] also need to be addressed.

The risk of TB transmission in hospital personnel is 2–10 times higher than among the general population.[8] However, control of nosocomial transmission of TB is still neglected in hospitals in India.[9]

In a study by Mathew et al.,[2] it was found that HCWs with frequent direct patient contact were at an increased risk of acquiring TB, especially in settings where patients with active TB

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Table 1: Factors showing significant association with occurrence of TB at 95% CI

| Factor                                      | Tb cases | Controls | Chi-square value | P     |
|---------------------------------------------|----------|----------|------------------|-------|
| #h/o Steroid or immunosuppressant drugs    | 5        | 5        | 1.378            | 0.241 |
| Screening for TB done                       | 11       | 40       | 6.019            | 0.014*|
| #h/o Smoking                                | 1        | 2        | 0                | 1     |
| N-95 mask used                              | 3        | 10       | 0.7              | 0.403 |
| Protein intake adequate                     | 21       | 56       | 4.434            | 0.035*|
| Had regular breakfast                       | 11       | 54       | 19.784           | 0.000*|
| Had adequate sleep                          | 14       | 44       | 4.767            | 0.029*|
| Did regular exercise                        | 2        | 5        | 0.076            | 0.782 |
| Total duration of exposure to TB patients   | 15       | 48       | 6.171            | 0.013*|
| Underweight or normal weight                | 12       | 6        | 10.8             | 0.001*|

#h/o implies history of

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Table 2: Stepwise backward logistic regression analysis applied on factors with significant association for occurrence of TB

| B     | S.E.  | Wald | df | Sig. | Exp (B) | 95% C.I. for EXP (B) |
|-------|-------|------|----|------|---------|---------------------|
|       |       |      |    |      |         | Lower              |
|       |       |      |    |      |         | Upper              |

**Step 1**

| Protein intake adequate or not | 0.630 | 0.536 | 13.82 | 1 | 0.240 | 1.877 | 0.657 | 5.366 |
|---------------------------------|--------|-------|-------|----|-------|-------|-------|-------|
| Regularity of breakfast         | 1.607  | 0.552 | 8.488 | 1 | 0.004 | 4.988 | 1.692 | 14.709 |
| BMI category before TB          | −2.127 | 0.754 | 7.951 | 1 | 0.005 | 0.119 | 0.027 | 0.523 |
| Total duration of exposure to TB patients | 0.846 | 0.535 | 2.501 | 1 | 0.114 | 2.330 | 0.817 | 6.649 |
| Adequacy of sleep               | 0.387  | 0.609 | 0.405 | 1 | 0.525 | 1.473 | 0.446 | 4.862 |
| Screening for TB done or not    | −1.218 | 0.527 | 5.338 | 1 | 0.021 | 0.296 | 0.105 | 0.831 |
| Constant                        | 1.049  | 0.990 | 1.124 | 1 | 0.289 | 2.856 |

**Step 3**

| Regularity of breakfast         | 1.828  | 0.504 | 13.123 | 1 | 0    | 6.219 | 2.314 | 16.716 |
|---------------------------------|--------|-------|--------|----|------|-------|-------|--------|
| BMI category before TB          | −2.022 | 0.720 | 7.896  | 1 | 0.005 | 0.132 | 0.032 | 0.542 |
| Total duration of exposure to TB patients | 0.896 | 0.503 | 3.179  | 1 | 0.075 | 2.450 | 0.915 | 6.560 |
| Screening for TB done or not    | −1.241 | 0.524 | 5.607  | 1 | 0.018 | 0.289 | 0.103 | 0.807 |
| Constant                        | 1.535  | 0.926 | 2.745  | 1 | 0.098 | 4.641 |
are treated, as in the medical wards of a tertiary care center. In a study by Jian Du et al., the prevalence of TB among HCWs was found to be higher than that in general population. The study by Sousa et al. threw light on the deficiencies, making the HCWs more prone to TB.

A prospective study to estimate TB infection chances in village doctors in China showed that there was 5% seroconversion detected by QuantiFERON® TB Gold In‑Tube (QFT) and 6.1% seroconversion detected by Quantiferon®‑TB Gold Plus (QFT‑Plus). In a study done on Polish Health Care Workers, prevalence of LTBI was found to be more in HCW than general population.

With the high occurrence of TB and repeated encounter with active TB cases, health care professionals have now emerged as a high-risk group for the occurrence of TB. A study by Anita Basavaraj et al. found a 15-fold higher estimated incidence of TB among medical trainees at BJGM‑SGH (3279 cases/100,000 person‑years) than among that reported for the community (167 cases/100,000 person-years) in the study state of Maharashtra, India. Health care professionals will include family physicians, resident doctors, nurses, etc.

Here, a case‑control study was conducted with HCWs who had suffered from TB as cases; controls who were matched for age and branch of medical field/hospital ward were chosen. Various factors found to be associated with the occurrence of TB were analyzed using a questionnaire. Chi‑square test was applied and the following factors were found to be associated with the occurrence of TB among HCWs at 5% level of significance: regularity of breakfast, BMI, total duration of exposure to TB patients, screening for TB, adequacy of sleep, and adequacy of protein intake.

Among the factors found to have a significant association, logistic regression analysis was applied and the following was inferred:

HCW who had irregular breakfast (skipped/had late most of the time) were found to be 6.21 times at more risk than those having breakfast regularly. OR varies between 2.314 and 16.716 at 95% CI [Table 2]. On review of literature, the role of meals or breakfast in increasing susceptibility to TB was not found, indicating this being a novel finding. HCW who were underweight were 5.848 times more at risk of suffering TB disease [Table 2]. In a study by Anoop Mathew et al. also, BMI was found to be significantly associated (OR‑2.96; varies between 1.49 and 5.87 at 95% CI). HCW who had more exposure to TB had 2.45 times more risk of developing TB (OR varies from 0.915 to 6.560 at 95% CI) [Table 2]. In a study by Guang Xue He et al. also, it was found that with increased exposure to TB patients, the risk of LTBI was higher. In a study by Anoop Mathew et al. (OR – 2.83; 1.47 to 5.45 at 95% CI), it was found that risk of TB increases with an increase in duration of exposure to TB cases. In our study, HCW who were not screened for TB were at 3.46 times more at risk for developing TB compared to those who were screened [Table 2]. In a study by Naidoo et al., pre and post employment screening was found to have a significant association with the occurrence of TB. The risk factors evaluated by the study – irregularity of having meals, low BMI, not undergoing screening at regular intervals are risk factors among primary care physicians and family physicians as well.

The strength of the study is that analytical study design was used, which gave better scope for comparison between study groups. Probable epidemiological determinants were evaluated. The limitation was that since it is a retrospective study involving the affected and unaffected groups, recall bias is likely. To reduce bias, study participants were taken from past 5 years only.

This study gives a perspective of protective factors against TB in HCWs. This can be further researched and protective measures can be formulated to protect the health care manpower from getting TB disease.

**Conclusion**

Healthcare workers are at higher risk of TB than general population. Irregularity in meals, low BMI, lack of screening for TB, and prolonged exposure to TB patients are found to be risk factors in our study. Therefore, having regular meals at appropriate times, adequate nutritional status/normal BMI, screening for TB, and minimizing the exposure to TB patients were found to have a protective role against suffering from TB. All health care workers should be trained time to time and made aware of the risk of TB at their workplace and adopt practices to protect themselves against TB.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate participant consent forms. In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The participants understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.
Chavan and Shenoy: Tuberculosis among health care workers

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