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Original Article

Screening of tuberculosis among nurse clinicians: An analytical observational study at a tertiary care hospital in western Rajasthan

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ABSTRACT

Introduction: Healthcare workers (HCWs) face a significant risk of contracting tuberculosis (TB), especially in regions with a high incidence of the disease. In India, routine screening and surveillance data are scarce for TB among HCWs. Our objective was to conduct TB screening among nurse clinicians to address guidelines and policies in the health sector.

Methods: An analytical observational study was done in a tertiary care teaching hospital in western Rajasthan, India. Four hundred twenty-two nurse clinicians were recruited and screened for tuberculosis. The tuberculin skin test was conducted according to the latest recommendations and standards to obtain the results. Informed consent was obtained before the procedure was performed.

Results: 12.3% showed positive tuberculin test results, while 87.7% tested negative. Past positive history of tuberculosis and current signs and symptoms of tuberculosis are inversely correlated with the likelihood of having tuberculosis. In contrast, past contact with a tuberculosis patient is slightly positively associated with an increased risk of tuberculosis.

Conclusion: This study supports the prioritization of clinical nurses as a high-risk group for TB infection, underscoring the importance of considering demographic factors in TB screening and prevention efforts.

Keywords: Nurses, Screening test, Tuberculosis, Tuberculin test

Introduction

Tuberculosis (TB) is a common infectious disease and ranks among the top 10 causes of death globally.[1] It is caused by Mycobacterium tuberculosis and spreads easily through the air, often after prolonged exposure to an infected person.[2] In 2019, around 10 million people were diagnosed with TB, and 1.4 million deaths were reported worldwide. The incidence rate in India is approximately 193 cases per 100,000 people annually.[3] A study at Christian Medical College (CMC), Vellore, found 125 TB cases among healthcare workers (HCWs) over a 10-year period (1992–2001).[4] Additionally, the German Social Accident Insurance recorded 4,653 occupational TB cases between 2002 and 2017.[5] Health care workers are more vulnerable to getting hospital-associated transmission of tuberculosis because of deprived or non-existent infection control preventive measures. It's mainly the causes of transmission in low-resource settings.[6,7,8] Health care workers are closely working with patients who have active tuberculosis. They are at high risk

of contracting an infection due to ill-ventilated spaces and performing contaminated aerosol-generating procedures. For many years, health care workers have been at high risk of getting health hazard disorders, where tuberculosis is more common. The risk of exposure increased when they were exposed to a large number of (smear-positive) patients with TB. The risk of infection or its transmission can be minimized through effective infection control practices. HCWs who are working with an active case of a tuberculosis patient are recommended for screening of TB.[9]

Studies on infection risk show that many TB cases among staff nurses are work-related. For example, the Hamburg fingerprinting study revealed that 80% of TB cases in healthcare workers with known infection chains were linked to their occupation. A similar Dutch study reported this figure at 43%.10In Bengaluru, a descriptive longitudinal study conducted over 16 months among 600 healthcare workers in a tertiary care hospital showed that 120 (20.1%) initially had a positive Tuberculin Skin Test reaction. After one year, 345 of the 478 participants who initially tested negative were retested, and 67 (19.4%) showed a positive TST reaction.[11]

A cross-sectional study conducted in China reported a 33.6% prevalence of latent tuberculosis infection (LTBI) among healthcare workers (HCWs) using T-cell SPOTTB, highlighting the importance of strong infection control measures.[12] Globally, HCWs face a higher risk of both latent and active TB, even as overall TB prevalence declines.[13] In high-income countries, the annual incidence of TB among HCWs is below 10 per 100,000, with native-born HCWs at less than 25 per 100,000.[14] A review by Joshi et al. found that in low- and middle-income countries, 55% of HCWs have LTBI, with an annual LTBI risk of 0.5% to 14.3% and an annual TB incidence of 69 to 5,780 per 100,000.[15]

Nurses play vital roles in the care, management, and support of tuberculosis patients throughout treatment, despite facing various barriers. Makhado et al. highlight the challenges nurses face due to resource shortages, with limited investigation into their experiences and patient perspectives during treatment.[16] Healthcare workers, including nurses, are about three times more likely to contract TB compared to the general population, though this risk varies across studies. For example, in China and Taiwan, two studies reported active TB incidence rates of 78.3% and 61.1%, respectively.[17,18] There are no such criteria for tuberculosis screening before joining the institute. Therefore, this study will investigate the incidence of tuberculosis among staff nurses working in western Rajasthan, and it will also aid in the exploration of various clinical and demographic correlates associated with its causation. It is anticipated that the findings from this study will inform the development of necessary guidelines and policies related to occupational infections and preventive measures for staff nurses. We hope that the findings of this study can help to develop scientific infection control guidelines for nurses, contributing to a safer work environment and practices, ultimately reducing the risk of infectious diseases among staff nurses.

Methods

The analytical observational study was conducted in May-July 2023 in a tertiary care teaching hospital in western Rajasthan, India. Researchers used a simple random sampling technique to recruit the clinical nurses in this study. The nurses were provided with a consent form and questionnaires to participate in the study. Nursing

personnel working in a health care setting, i.e, clinical, for more than one year and who are willing to participate and share their clinical and health-related information related to this research study were included in the study.

Nursing professionals who have been previously diagnosed and treated for tuberculosis, pregnant or lactating female nursing personnel, individuals under care for HIV/AIDS, organ transplant recipients, and those who are immunosuppressed due to cytotoxic immunosuppressive agents such as cyclophosphamide or methotrexate are excluded from participation. Additionally, nurses undergoing long-term systemic corticosteroid therapy, individuals suffering from end-stage renal disease, and those diagnosed with leukemia are also excluded from the study.

The calculation of the sample size for the study was based on established statistical principles, using the formula Sample Size (n) = $(Z\ 1\text{-}\alpha/2)^2 * (p) * (q) / d^2$. Here, 'n' represents the desired sample size, 'Z 1-α/2' denotes the critical value corresponding to the level of confidence (1.96 for a 95% confidence interval), 'p' signifies the expected prevalence (considered as 0.5), 'q' represents the complementary probability of 'p', and 'd' indicates the margin of error or precision (set at 0.05). Drawing from a study by Christopher DJ et al[18]., where 'P' was considered as 0.5, 'q' as 0.5, and 'd' as 0.05, the calculated sample size was determined as $(1.96)^2 * 0.5 * 0.5 / (0.05)^2$, resulting in 384. To account for potential participant attrition, a 10% dropout rate was added, resulting in a final sample size of 422 nursing professionals. This rigorous calculation ensures adequate statistical power to detect meaningful associations and draw reliable conclusions from the study's findings.

Personal information consists of age in years, Gender, Educational qualification, Designation, Total working experience (Clinical), Area of living, and family history of tuberculosis. Clinical variables datasheet included the BCG scar, past history of tuberculin test, history of HIV testing, current signs and symptoms of tuberculosis, and previous contact with a tuberculosis patient.

A trained healthcare professional administered a tuberculin skin test, which was carried out according to the latest recommendations and standards of the Central TB Division, Ministry of Health and Family Welfare, Government of India. TST was performed on all nursing professionals who fulfilled the inclusion criteria.

The TB skin test involved injecting 0.1 ml of a solution containing 5 TU (tuberculin units) of purified protein derivative (PPD) into the intradermal skin on the lower arm. After 48–72 hours, the diameter of the raised area (induration) on the skin was measured to evaluate the result. The test was considered positive if the induration was 10 mm or more. Positive or active cases of tuberculosis was given further treatment as per hospital policy and protocols and proper follow-up was carried out for them till complete recovery.

Ethical clearance was granted by the Institutional Ethics Committee, as per letter number: /IEC/22/147 on dated 20 March 2023. All procedures adhered to pertinent ethical guidelines and regulations. Before obtaining informed consent, participants were provided with information about the research objectives and their involvement in the study. Privacy and confidentiality were maintained throughout all stages of the study. Each participant received a self-administered questionnaire to provide the necessary information on the study variables.

The information gathered through online surveys was exported as Excel data and imported into SPSS 26.0. Descriptive and inferential statistics were used for analysis. Statistical analysis was

conducted using SPSS Statistics 26.0. Quantitative data were presented as the mean with standard deviation. The relationship between demographic variables was analyzed using logistic regression.

Results

The demographic details of the 422 participants are presented in Table 1. Approximately 201 (47.7%) of the participants were aged between 26 and 30 years, while 15 (3.6%) were over 35 years old. Among the participants, 249 (59%) were male and 173 (41%) were female. Regarding educational qualifications, the majority, 323 (76.5%), held a B.Sc. in Nursing, and 6 (1.4%) held an M.Sc. in Nursing. A greater number of participants, 321 (76.1%), were nursing officers, followed by Senior Nursing Officers, 82(19.4%), and ANS, 19 (4.5%). Urban areas host the majority of the group 335(79.4%) compared to rural areas 87 (20.6%). Concerning clinical experience, a notable 177 (41.9%) possess over 5 years of experience, with 1-3 years and 3-5 years constituting 122 (28.9%) and 123 (29.14%), respectively.

A family history of tuberculosis is present in a small fraction, 5.9%, of the group. Overall, 43.1% of participants were working in emergencies with a smaller representation in IPD, 16.58%

Table 1: Frequency and percentage distribution of demographic variables (N=422)

Variables	Frequency (%)
Age in completed years	
18-25	93 (22)
26-30	201(47.6)
31-35	113 (26.8)
More than 35	15 (3.6)
Mean	28.80
Median	29
Range	21-42
Standard deviation	3.613
Gender	
Male	249 (59)
Female	173 (41)
Education qualification	
GNM	38 (9)
PB B.Sc.	55 (13)
B.Sc. Nursing	323 (76.5)
M. Sc. Nursing	6 (1.4)
Designation	
Nursing officer	321 (76.1)
Senior Nursing officer	82 (19.4)
ANS	19 (4.5)
Place of Living	
Rural	87 (20.6)
Urban	335 (79.4)
Working experience (Clinical)	
1-3 years	
3-5 years	122 (28.9)
More than 5 years	123 (29.14)
	177 (41.9)
Family history of tuberculosis (Yes)	
	25 (5.9)

Area of working	
IPD	7016.58)
Critical care	170 (40.3)
Emergency	182 (43.1)

Table 2 shows the clinical profile of the participant, where all 100% have a BCG scar on the upper part of the arm. Only a few participants, 5% had a past history of tuberculin test, among whom 23.7% tested positive. Similarly, past HIV testing history reveals that 35.3% have been tested, and among those tested, 35.3% have tested negative. Presently, a small fraction (2.6%) exhibits signs and symptoms suggestive of tuberculosis. Notably, a substantial proportion (43.1%) reports previous contact with tuberculosis patients

Table 2: Clinical Information of study participants **(N=422)**

Variables	Frequency (%)
BCG scar	
Present	422 (100)
Past history of tuberculin test	
Yes	21 (5)
No	401 (95)
If yes, then the result (n=21)	
Positive	5 (23.8)
Negative	16 (76.2)
Past history of HIV testing	
Yes	149 (35.3)
No	273 (64.7)
If Yes, then the result (n=149)	
Negative	149 (100)
Current signs and symptoms of tuberculosis	
Yes	11 (2.6)
No	411 (97.4)
Previous contact with a tuberculosis patient	
Yes	182 (43.1)
No	240 (56.9)

Table 3: Result of Tuberculosis among health professionals

Variables	Frequency (%)
Result of tuberculosis	52 (12.3)

Table 3 depicts the results of tuberculosis among participants, 12.3% showed positive tuberculin test results, while 87.7% tested negative. Table 4 suggests that past positive history of tuberculosis and current signs and symptoms of tuberculosis are inversely correlated with the likelihood of having tuberculosis, while past contact with a tuberculosis patient is very weakly positively correlated with tuberculosis. It is essential to note that correlation does not imply causation; further analysis is required to establish causal relationships.

Table 4 suggests that past positive history of tuberculosis and current signs and symptoms of tuberculosis are inversely correlated with the likelihood of having tuberculosis. In contrast, past

contact with a tuberculosis patient is very weakly positively correlated with tuberculosis. It is important to note that correlation does not imply causation, and further analysis would be needed to determine causal relationships.

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Table 4: Association between clinical profile and active case of tuberculosis

VARIABLES	CORRELATION COEFFICIENT	INFERENCE
Past positive history of tuberculosis	-0.061	Very weak negative
Current signs and symptoms of tuberculosis	-0.016	Very weak negative
Past contact with a tuberculosis patient	0.008	Very weak positive

The analysis of demographic variables related to tuberculosis testing outcomes (Table 5) reveals significant associations between various factors and the likelihood of testing positive for TB. Among age groups, individuals aged 21-28 exhibit 2.19 times higher odds of testing positive for TB compared to those aged 37 and above (95% CI: 0.09-0.04), and this association remains significant even after adjusting for other variables, with an adjusted odds ratio (aOR) of 10.64 (95% CI: 6.47-17.50). Similarly, individuals aged 29-36 show 4.58 times higher odds of TB positivity compared to the reference group (aged 37 and above), with an aOR of 5.08 (95% CI: 3.54-7.30). Gender-wise, females demonstrate 5.55 times higher odds of TB positivity than males (95% CI: 3.93-7.84). Regarding educational qualifications, those with GNM, Post Basic BSc Nursing, and BSc Nursing qualifications exhibit significantly elevated odds of TB positivity compared to MSc Nursing, with adjusted odds ratios (aORs) ranging from 5.33 to 7.5. Additionally, individuals residing in urban areas have 13.3 times higher odds of TB positivity than rural residents (95% CI: 5.81-30.56). Various other factors such as total working experience, previous contact with TB patients, and current signs and symptoms of TB also exhibit significant associations with TB testing outcomes. These results underscore the importance of considering demographic factors when developing TB screening and prevention strategies.

Table 5: Logistic regression analysis on participants variable with TST results

Demographic variables	TST Positive % (n/N)	TST negative % (n/N)	OR* (95% CI*)	AOR* (95% CI*)
Age				
21-28	4.8 (17/198)	95.2 (181/198)	2.19 (0.09-0.04)	10.64 (6.47-17.50)
29-36	16.4 (35/213)	83.6 (178/213)	4.58 (0.197-0.043)	5.08 (3.54-7.30)
37 and above	0 (0/11)	100 (11/11)	Reference	-
Gender				
Male	15.3 (38/249)	84.7 (211/249)	Reference	-
Female	8.1 (14/173)	91.9 (159/173)	5.55 (3.93-7.84)	-

Education Qualification				
GNM	15.8 (6/38)	84.2 (32/38)	5.33 (2.23-12.75)	-
Post Basic BSc Nursing	14.5 (8/55)	85.5 (47/55)	5.87 (2.77-12.43)	-
BSc Nursing	11.8 (38/323)	88.2 (285/323)	7.5 (5.34-10.52)	-
MSc Nursing	0 (0/6)	100 (6.6)	Reference	-
Designation				
Nursing Officer	11.5 (37/321)	88.5 (284/321)	7.67 (5.44-10.81)	-
Senior Nursing Officer	15.9 (13/82)	84.1 (69/82)	5.30 (2.93-9.6)	-
ANS	10.5 (2/19)	89.5 (17/19)	Reference	-
Place of living				
Rural	7 (6/86)	93 (80/86)	Reference	-
Urban	13.7 (46/336)	86.3 (290/336)	13.3 (5.81-30.56)	-
Total working experience				
1-3 years	9.8 (12/122)	90.2 (110/122)	9.16 (5.05-16.63)	-
3-5 years	12.2 (15/123)	87.8 (108/123)	7.2 (4.19-12.35)	-
More than 5 years	14.1 (25/177)	85.9 (152/177)	Reference	-
Family history of Tuberculosis				
Yes	20.0 (5/25)	80.0 (20/25)	4 (1.50-10.65)	-
No	11.8 (47/397)	88.2 (350/397)	Reference	-
Area of working				**-**
IPD	5.9 (4/68)	94.1 (64/68)	16.0 (5.82-43.93)	
OPD	0 (0/2)	100 (2/2)	-	-
Critical Care	21.2 (36/170)	78.8 (134/170)	3.72 (2.57-5.37)	
Emergency	6.6 (12/182)	93.4 (170/182)	Reference	
BCG Scar				
Present	12.3 (52/422)	87.7 (370/422)	2.66 (2.30-3.08)	
Past history of Tuberculin test				
Yes	4.8 (1/21)	95.2 (20/21)	20 (2.68-149.02)	
No	12.7 (51/401)	87.3 (350/401)	Reference	-
If yes, what was the result				
Positive	0 (0/11)	100 (11/11)	Reference	
Negative	2.7 (11/411)	97.3 (400/411)	2.67 (2.30-3.09)	
Past history of HIV testing				
Yes	13.4 (20/149)	86.6 (129/149)	Reference	

No	11.7 (32/273)	88.3 (241/273)	6.45 (4.02-10.33)	
If yes, what was the result				
Negative	12.3 (52/422)	87.7 (370/422)	2.66 (2.30-3.08)	
Current signs and symptoms of TB				
Yes	0.2 (1/52)	12.4 (51/370)	Reference	
No	2.4 (10/411)	87.6 (360/411)	10 (1.28-78.11)	
Previous contact with tuberculosis patient				
Yes	12.6 (23/182)	87.4 (159/182)	Reference	
No	12.1 (29/240)	87.9 (211/420)	6.91 (4.46-10.7)	

Discussion

The 422 nurse clinicians screened for tuberculosis who were working in a tertiary care centre in western Rajasthan. The majority of study participants were aged between 26 and 30 years, with a median age of 29 years. This age distribution is similar to the findings of a study that was conducted among nursing professionals in a hospital setting.[18]

The current study found that only 59% of males and 41% of females participated in screening. These findings contrast with prior work by Mogan et al., who found that 78.7% of males and 21.3% of females were screened for tuberculosis.[19] Interestingly, the present study discovered that 35.3% of participants had a history of HIV testing. These results are comparable to a study by Mogan et al., which found that 30% of participants had previously undergone HIV testing.19The results are highly favourable and reassuring, as none of the patients tested positive.

The current study findings suggested that the majority of participants, 76.1% were nursing officers, which is in line with a previous study conducted by wang et. al, where subjects completed a bachelor's degree in the medical profession, 72.9%.[20] Our study found that 12.3% of participants tested positive for the tuberculin test, which is lower than the LTBI prevalence of 20% reported in public tertiary care hospitals in India and 40% in Pakistan.[21,22] Previous studies have shown a significant link between increasing age and TST positivity. In our study, we also observed a moderate positive association with previous contact tuberculosis patients.[22,23] A study by Main S highlighted a significant connection between TBI and factors such as being male, working in the hospital, and older age, which was unexpected.[24] Our analysis also revealed a statistically significant relationship between increasing age and TST positivity, aligning with findings from other studies.[23,24] In the hospitals included in the study, most healthcare workers began their careers between the ages of 26 and 30. Therefore, the increased risk of TST positivity with age is likely due to prolonged exposure from both work-related and non-work-related sources.[25] Specific work areas, such as inpatient TB services, general medicine wards, emergency rooms, and laboratories, have been associated with a higher risk of TB exposure compared to outpatient or surgical services, as well as the general population. This matches our study's findings. The study's key strength lies in its focus on nurse clinicians, a high-risk group for tuberculosis, providing valuable insights into occupational exposure in a real-world clinical setting. Conducted at a tertiary

care hospital using validated screening tools, the study ensures reliability and relevance to similar healthcare environments. A key limitation of the study is that it was conducted at a single center, which may limit the generalizability of the findings. Furthermore, issues like symptom underreporting and the potential impact of prior BCG vaccination on test outcomes could influence the accuracy of the results.

Conclusion

In conclusion, this study found a significant number of clinical nurses tested positive for the TST. This study marks an initial effort to assess the risk of TB exposure and TST outcomes among clinical nurses in public tertiary care hospitals in India. Our analysis also warrants the immediate implementation of an occupational infection preventive policy in tertiary care teaching hospitals. The findings of this study highlight the need for hospital authorities to develop scientific infection control guidelines for nurses, which would promote a safer work environment and practices, ultimately helping to prevent infectious diseases among staff nurses.

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Disclosure statement

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