Prevalence of tuberculosis in household contacts of sputum smears positive cases and associated demographic risk factors

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ABSTRACT

Pulmonary tuberculosis (PTB) is transmitted by aerosolized droplets nuclei. Home is the vulnerable place for transmission of this disease to its contacts. Risk factors associated with this contact transmission may differ according to locality. This study aims to determine the prevalence of household contact (HC) PTB and examine the risk factors contributing to it. A cross-sectional study was conducted to determine the prevalence of HC TB among HCs aged >5 years in Dharan. During the study period (June 2009 - May 2010), 184 index cases with sputum smear positive for AFB and their 802 HCs were included. Three sputum specimens were collected from each HCs and examined microscopically for AFB detection. The prevalence of HC TB was found to be 1.6%. The result was statistically associated (P<0.05) with illiterate HCs (OR= 5.77, 95%CI=1.52-21.81), close proximity with ICs (OR=3.07, 95%CI= 1.02-9.25), primary relatives to ICs (OR= 4.85, 95%CI=1.07-22.05) and slum dweller (OR = 4.56, 95%CI = 1.25-16.71). Similarly, AFB positivity was associated (P<0.05) with household crowding (OR = 7.46, 95%CI = 2.36-23.49), room size ≤10x10feet (OR=4.05, 95%CI =1.23-13.25), firewood user while cooking (OR=5.96, 95%CI=1.92-18.45). The prevalence of HCs tuberculosis is found to be 1.6%. Poverty, illiteracy, overcrowding, close proximity, close relation with ICs, firewood while cooking, slum dweller, are major factors highlighted by this study as risk factors of contact TB. Our results recommend a much better contact tracing and treatment program.

Keywords: Tuberculosis; epidemiology, health status.

INTRODUCTION

Tuberculosis (TB) is one of the leading causes of disease and death worldwide. The World Health Organization (WHO) report (2011) has estimated 8.8 million incident cases of TB and 1.1 million deaths among HIV negative cases of TB.[1] It is a serious threat to public health in Nepal too.[2] It is commonly transmitted from an infectious person to others by droplet nuclei, which are aerosolized while coughing, sneezing and speaking. The tiny droplets dry rapidly; the smallest (<5–10 μm in diameter) may remain suspended in the air for several hours and may reach the terminal air passages when inhaled. There may be as many as 3000 infectious nuclei per cough.[3] If a single bacterium can initiate an infection leading to TB, then even the briefest exposure entails a theoretical risk. In which case, home is the most vulnerable place for contact. Many studies have reported HC as a risk factor for TB disease.[4-6] Although, it's impact on epidemiology of TB has been known for a century, there are few documented studies showing its prevalence in Nepal. So, we aimed to determine the prevalence of pulmonary tuberculosis among household contacts of sputum smear positive cases and determine the demographic and environmental risk factors associated with contact cases. Early tracing and treatment of hidden cases may limit the further geometrical transmission of the disease.

MATERIALS AND METHODS

During the period of one year (June-2009 to May-2010), a cross-sectional study was carried out in Dharan Municipality, Nepal to determine the prevalence of TB in HCs. All pulmonary TB cases diagnosed by sputum smear microscopy at tuberculosis laboratory, B P Koirala Institute of Health Sciences; a referral centre of Eastern Nepal, were included in this study as Index Cases (ICs). The family members aged above 5 years, living under the same roof and sharing same kitchen with ICs were included in this study as HCs. The study population profile was calculated on the basis of local prevalence with 15% allowance error in 95% of confidence interval (CI). The numerically calculated sample size was 800 HCs. This study was ethically approved by the ethical committee of B.P.K.I.H.S. A total of 196 patients diagnosed during the study period were asked to enroll voluntarily as the ICs in this study. Then full home address was taken to make visits later. Only 184 ICs gave consent for the study. HCs of 184 ICs were contacted in their dwellings. A structured questionnaire was filled which included socio-demographic variables: age, gender, residence, occupation, educational status; activity variables: biological relationship with ICs, proximity with ICs, and day activity with ICs. Proximity

was defined as the sleeping manner with ICs either in the same bed room or not. Similarly, activity with ICs was defined as the frequency of time duration spent with ICs. Besides these, other environmental information like room size and number of family members was noted. The term crowding in this study was defined as number of persons per room and overcrowding as index >2. Purpose of the study was also clarified and informed consent taken from the head of the family or the participants themselves. Finally, they were properly instructed to collect three sputum specimens in provided standard wide mouthed sputum containers.

Three sputum specimens were collected over 2 days. The first and the third specimen were collected on the spot when we visited their residence. Similarly, they were instructed to collect second one on next day early morning at their residence. Some follow up visits were made for those HCs who were unable to provide sample in the first visit. Finally, 802 HCs of 184 ICs were included. All collected samples were transported to the laboratory.

A total number of 2406 (802 x 3) sputum specimens were processed for staining with fluorescent technique using Auramine-O for screening, confirmed by Ziehl-Neelsen (Z-N) method. At least 100 microscopic oil immersion fields in microscope were examined to declare a slide negative. Grading system recommended by International Union against Tuberculosis and Lungs Diseases (IUATLD)[7] was considered for the quantification of bacilli. The AFB positive contacts were referred to Department of medicine for the treatment.

STATISTICAL ANALYSIS

To assess association between all categorical risk factors and AFB positivity, univariate analysis was performed using χ^2test. Odds ratio and their 95% confidence intervals (CI) were derived using SPSS version 16.0 software.

RESULTS

During the study period, 184 Index Cases (ICs) and their 802 Household Contacts (HCs) were studied. The median household size was 5.0. AFB were detected in sputum of 13 (1.6%) HCs. The median age of HCs was 29; 59.1% were females.

The univariate analysis of risk factors for AFB positivity in household contacts is presented in Table-1 and 2. There was no statistical association (P>0.05) of AFB result with gender, age group and religion. The risk of TB transmission revealed to be 5 times higher in illiterate HCs (OR= 5.77, 95%CI=1.52-21.81) as compared to that among literates HCs. Statistical association was seen between sputum smear positivity and contacts sharing the bed room (OR=3.07, 95%CI= 1.02-9.25, P<0.05) but no association could be seen among those who spent most of time with ICs during day time (P>0.05). Statistical association was found with biological relationship (P<0.05). The risk of TB transmission was high in primary relatives (parents, spouse, son/daughter) to ICs, (OR= 4.85, 95% CI=1.07-22.05). The prevalence of AFB positivity was inversely associated with house hold size (P>0.05). HCs living in slum areas were about 5 times more at risk of acquiring TB (OR = 4.56, 95%CI = 1.25-16.71, P<0.05). Similarly, the risk was found to be increased with household crowding. People living in a household of > 2 people per room were 7 times more likely to have TB (OR = 7.46, 95%CI = 2.36-23.49, P<0.05). The risk was greater in HCs living in a house with ≤2 rooms (OR=10.41, 95%CI=3.39-31.97, P<0.05) and room size ≤10 x10feet (OR=4.05, 95% CI =1.23-13.25, P<0.05). The prevalence of a positive AFB was significantly associated with the HCs who were using firewood for their cooking arrangement (OR=5.96, 95%CI=1.92-18.45, P <0.05).

DISCUSSION

Tuberculosis is a major public health problem in the world. Most of the cases are household contacts. Our

Table-1: Demographic factors associated with tuberculosis disease among household contacts.

Variables	Categories	Positive/ total (%)	OR	95% CI	P value
Gender	Male	7/328 (2.1)	1.70	0.56 -5.11	NS
	Female	6/474 (1.3)			
Age	5-14 Children)	1/151 (0.7)	-	-	NS
	15-59 (Young)	9/547 (1.6)			
	>60 (Elderly)	3/104 (2.9)			
Religion	Other than Hindu	3/174 (1.7)	1.08	0.29-3.98	NS
	Hindu	10/628 (1.6)			
Education	Illiterate	3/42 (7.1)	5.77	1.52-21.81	0.022
	Literate	10/760 (1.3)			
Relative	Primary relatives	11/430 (2.6)	4.85	1.07-22.05	0.048
	Secondary relatives	2/372 (0.5)			
Occupation	Employed	4/288 (1.4)	0.79	0.24-2.59	NS
	Unemployed	9/514 (1.7)			

OR= Odds ratio; CI: Confidence interval; NS= Non Significant

Table-2: Activity and environmental factors associated with tuberculosis disease among household contacts.

Variables	Categories	Positive/total (%)	OR	95% CI	P value
Proximity to case	Same bed room	7/224 (3.1)	3.07	1.02- 9.25	0.036
	Separate bed room	6/578 (1.0)			
Activity with case	Mostly (>12hrs)	3/162 (1.9)	1.19	0.32-4.37	NS
	Partly	10/640 (1.6)			
Household size	<4	6/125 (4.8)	4.82	1.59 -14.61	0.002
	>4	7/677 (1.0)			
Crowding	2.1-3	5/66 (7.6)	7.46	2.36-23.49	0.001
	≤2	8/736 (1.1)			
Size of rooms	≤10x10	9/291 (3.1)	4.05	1.23-13.25	0.028
	>10x10	4/511 (0.8)			
Residence	Slum	10/343 (2.9)	4.56	1.25-16.71	0.020
	City	3/459 (0.7)			
Cooking fuel	Firewood	8/175 (4.6)	5.96	1.92-18.45	0.001
	Petroleum product	5/627 (0.8)			

OR= Odds ratio; CI: Confidence interval; NS= Non Significant

study showed 13/802 (1.6%) prevalence of TB among HCs. This result is higher than the prevalence (0.61%) reported in previous study from Eastern Nepal.[8] This difference can be explained by the difference in the design of the two studies where retrospective cohorts of contacts of smear-positive, smear-negative and extra-pulmonary tuberculosis patients were taken. Studies based on similar setting from Kenya in 1978, Malawi in 2002 and India in1996 reported the similar rate of prevalence; 1.67%, 2.02% and 2.22% respectively.[9-11] However, prevalence rate again compares lower with the 3%–14.5% figures quoted in studies of contact tracing.[12-14] The differences can be partly explained by different criteria for selection of contacts, the scope of examinations performed on the contact, epidemiology within study area and the type of TB diagnosed.

There was no statistical association of AFB positivity with age group (P>0.05). However, various studies in different setting have shown the middle aged to be infected most with TB[15,16] whereas, a recent study (review) conducted in South Africa has described the elderly as being more vulnerable to TB due to immune senescence.[17]

There was no statistical association between religion and sputum positivity (p>0.05) in this study. This result is not consistent with study conducted in UK (1991) as their study on the effect of origin, sex and religion for the transmission and progression of TB was found to be higher among vegetarian Hindus.[18] Vegetarian diet accounted as risk factor in their findings. In our study, participants were mostly non-vegetarian irrespective of their religious belief.

The prevalence of contact TB was higher among those HCs who were illiterate (71.4 per 1000). Strong relationship between health and education has always been known.[19] Lack of awareness and ignorance regarding TB transmission might have been the reason behind this finding.

This study reinforced the existing knowledge about TB transmission being associated with poor economic status.[6] Mostly, unemployed; mainly laborers were AFB positive. Poverty is directly proportional to poor education, nutrition and living space.

The degree of exposure to the individual with TB was evaluated by recording the geographic proximity of the HCs to the individual with TB within the household at nighttime and the extent of activities shared with the individual with TB during the day. The result revealed that the sputum smear positivity was in direct association with close proximity between ICs and HCs. The risk of TB transmission was 3 times more in contacts who shared the same bed room as compared to those using separate rooms; (OR=3.07, 95%CI= 1.02-9.25), while significant association could not be seen with day time activity (P>0.05). Earlier studies had also reported close proximity and activity as the risk factors for contact TB.[20,21]

The findings of this study also revealed that sputum smear positivity was associated with the biological relationship of HCs with ICs (P<0.05). The association was greatest if the HC was primary relatives (parents, spouse and children) of IC. The prevalence among parents was found to be 51.5 per 1000 followed by spouse, 26.5 per 1000. Similar results were seen in studies from Dominican

Republic in 2000[22] and Botswana, 2002.[23] Primary relatives generally spend more time with each other and have close proximity which facilitate the transmission of airborne infection like TB.

The risk of TB transmission was greatest in household contacts having their room size, 10x10feet (OR=4.05, 95% CI =1.23-13.25). Similarly, the result is associated with increased household crowding (P<0.05). The association between housing density and tuberculosis incidence has long been recognized.[20,24] Enclosed and confined spaces play a model for transmission of airborne infection. Overcrowded housing conditions have the potential to increase exposure of susceptible people to those with infectious respiratory droplets nuclei which are generated while talking, coughing and sneezing by family members infected with TB. Sneezing generates the most droplet nuclei by far, which can spread up to 10 feet away.[25]

Risk of getting infected with TB among HCs living in slum areas was five times more than in city area (OR = 4.56, 95%CI = 1.25-16.71) which concur with the study conducted in 2010, Nepal[26] showing poor, malnourished people living in under hygienic, overcrowded condition as facilitating factors for the transmission. Poor living areas have been associated with TB transmission in both industrialized and developing countries.[27]

Firewood for cooking purpose increases the incidence of TB, as shown in the present study. The prevalence of TB among HCs using firewood was 45.7 per 1000 while low rate of 8.0 per 1000 was found among them who were using petroleum products for cooking. Cooking arrangement with firewood is the good source for enormous amount of smoke which induces cough generating increased droplet nuclei in surrounding. Prolong exposure to smoke also deteriorate health system since it lowers immunity.[28]

Over the years, HCs TB remains the major public health problems. Early tracing could have the effect on limiting TB transmission and disease. If Anti-Tubercular Therapy (ATT) can be started to those identified TB cases, definitely it could add some efforts on TB control which we have done to our positive HCs.

The HCs evaluated in this study are subjected to a high risk for developing active tuberculosis. The prevalence of household contact tuberculosis found is 1.6%. Higher proportion of contact tuberculosis is found in male and elderly. Poverty, lack of awareness, overcrowding, rooms with small area, close proximity, close relation with ICs, use of firewood for cooking purpose and unhygienic family environment are some of the factors highlighted by this study as risk factors of contact TB. Our result warrants a better effort on contact tracing and treatment program. Contact investigation should be conducted for all family members of patients with infectious tuberculosis as a routine part of the tuberculosis control program. Those contacts identified as having been infected with tuberculosis can then be offered early preventive therapy. Appropriate health education should be given to people concerning disease transmission, personal hygiene and safe dealing with diseased family member. Both new sociobehavioral insights and technological innovations are needed to make this intervention most efficient and effective. Thus, this study emphasizes the need for a multisectorial approach to reduce the morbidity and mortality associated with tuberculosis.

LIMITATIONS

In this study, prevalence of contact TB among children below 5 years of age was not looked for as most of children fail to produce sputum and exposure to X-ray radiation is not strongly recommended unless emergency. Others diagnostic procedures like chest X-ray, culture and rapid tests were also not performed. If these diagnostic procedures were also included, the prevalence of household contact tuberculosis would be expected to be higher than the present figure.

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