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Prevalence rate and factors associated with *Mycobacterium tuberculosis* infection among healthcare workers in King Chulalongkorn Memorial Hospital

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Background : *Healthcare workers (HCWs) are exposed to an increased risk for Mycobacterium tuberculosis infection due to increased number of tuberculosis from HIV pandemic and multidrug - resistant strain of Mycobacterium tuberculosis in Thailand.*

Objective : *To determine the prevalence rate of M.tuberculosis infection and its associated factors among healthcare workers in King Chulalongkorn Memorial Hospital.*

Design : *A cross-sectional descriptive study.*

Setting : *King Chulalongkorn Memorial Hospital*

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Materials and Methods : *A self-administered questionnaire survey for demographic data and factors associated M. tuberculosis infection and tuberculin skin test (TST) among healthcare workers during June-July 2004.*

Results : *Of 1,015 participants tested, 704 (69.4 percent) had indurations of ≥ 10 mm and 396 (39 percent) had indurations of ≥ 15 mm. In multiple logistic regression analysis, factors associated with TST positivity, using either cut-off, were male, older than 30 years old, and working in emergency room and radiological areas.*

Conclusion : *Healthcare workers in King Chulalongkorn Memorial Hospital may have an increased risk for M. tuberculosis infection, which are associated with workplace. The executive board of the hospital should be urgently concerned with implementing effective and affordable control measures for tuberculosis infection.*

Keywords : *Tuberculosis, Healthcare workers, Nosocomial infection.*

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จารุณี ทิพย์พญาชัย, วิโรจน์ เจียมจรัสรังษี, นรินทร์ หิรัญสุทธิกุล, ฉัตรชัย เอกปัญญาสกุล, วิศิษฏ์ อุดมพาณิชย์, ฉันชาย สิทธิพันธุ์. อัตราความชุกและปัจจัยที่เกี่ยวข้องกับการติดเชื้อวัณโรคในบุคลากรที่ปฏิบัติงานในโรงพยาบาลจุฬาลงกรณ์. จุฬาลงกรณ์เวชสาร 2549 พ.ค; 50(5): 303 – 18

ความเป็นมา : *ประเทศไทยมีจำนวนผู้ป่วยวัณโรคที่เพิ่มมากขึ้น เนื่องจากการระบาดของโรคเอดส์ ประกอบกับมีปัญหาเชื้อวัณโรคดื้อยา ส่งผลให้บุคลากรของโรงพยาบาลมีความเสี่ยงต่อการติดเชื้อวัณโรคเพิ่มมากขึ้น*

วัตถุประสงค์ : *เพื่อศึกษาอัตราความชุกและปัจจัยที่เกี่ยวข้องกับการติดเชื้อวัณโรคในบุคลากรที่ปฏิบัติงานในโรงพยาบาลจุฬาลงกรณ์*

รูปแบบการวิจัย : *การศึกษาเชิงพรรณนาแบบตัดขวาง*

สถานที่ทำการศึกษา : *โรงพยาบาลจุฬาลงกรณ์*

วิธีการศึกษา : *โดยใช้แบบสอบถามชนิดตอบด้วยตนเองเกี่ยวกับข้อมูลด้านประชากรศาสตร์ และปัจจัยเสี่ยงต่อการติดเชื้อร่วมกับการตรวจหาการติดเชื้อวัณโรคโดยการทดสอบทูเบอร์คูลิน ระหว่างเดือนมิถุนายนถึงกรกฎาคม 2547*

ผลการศึกษา : *อาสาสมัครที่ยินยอมเข้าร่วมการวิจัยที่มีคุณสมบัติตามเกณฑ์เข้าร่วมการวิจัยรวม 1,015 คน มีผู้ให้ผลบวกทูเบอร์คูลินรวม 704 คน (ร้อยละ 69.4) และ396 คน (ร้อยละ 39) เมื่อพิจารณาตุ่มนูนจากการทดสอบทูเบอร์คูลินเป็นบวกที่ ≥ 10 มม. และ ≥ 15 มม.ตามลำดับ หลังจากปรับปัจจัยรบกวนโดยใช้ความถดถอยพหุลอจิสติก พบว่าปัจจัยที่มีผลต่อการติดเชื้อวัณโรค ได้แก่ เพศชาย กลุ่มอายุที่มากกว่า 30 ปี และสถานที่ปฏิบัติงานโดยผู้ที่ปฏิบัติงานในห้องฉุกเฉินและหน่วยรังสีวิทยาจะมีโอกาสติดเชื้อวัณโรคสูงกว่ากลุ่มอื่น ๆ*

สรุป : *บุคลากรที่ปฏิบัติงานในโรงพยาบาลจุฬาลงกรณ์ อาจมีความเสี่ยงต่อการติดเชื้อวัณโรคสูงกว่าประชากรทั่วไป ซึ่งสัมพันธ์กับสถานที่ทำงาน ทางโรงพยาบาลควรมีมาตรการในการป้องกันบุคลากรจากการติดเชื้อวัณโรคอย่างเร่งด่วน มีประสิทธิภาพ และค่าใช้จ่ายไม่สูงเกินไปนัก*

คำสำคัญ : *วัณโรค, บุคลากรทางการแพทย์, การติดเชื้อในโรงพยาบาล*

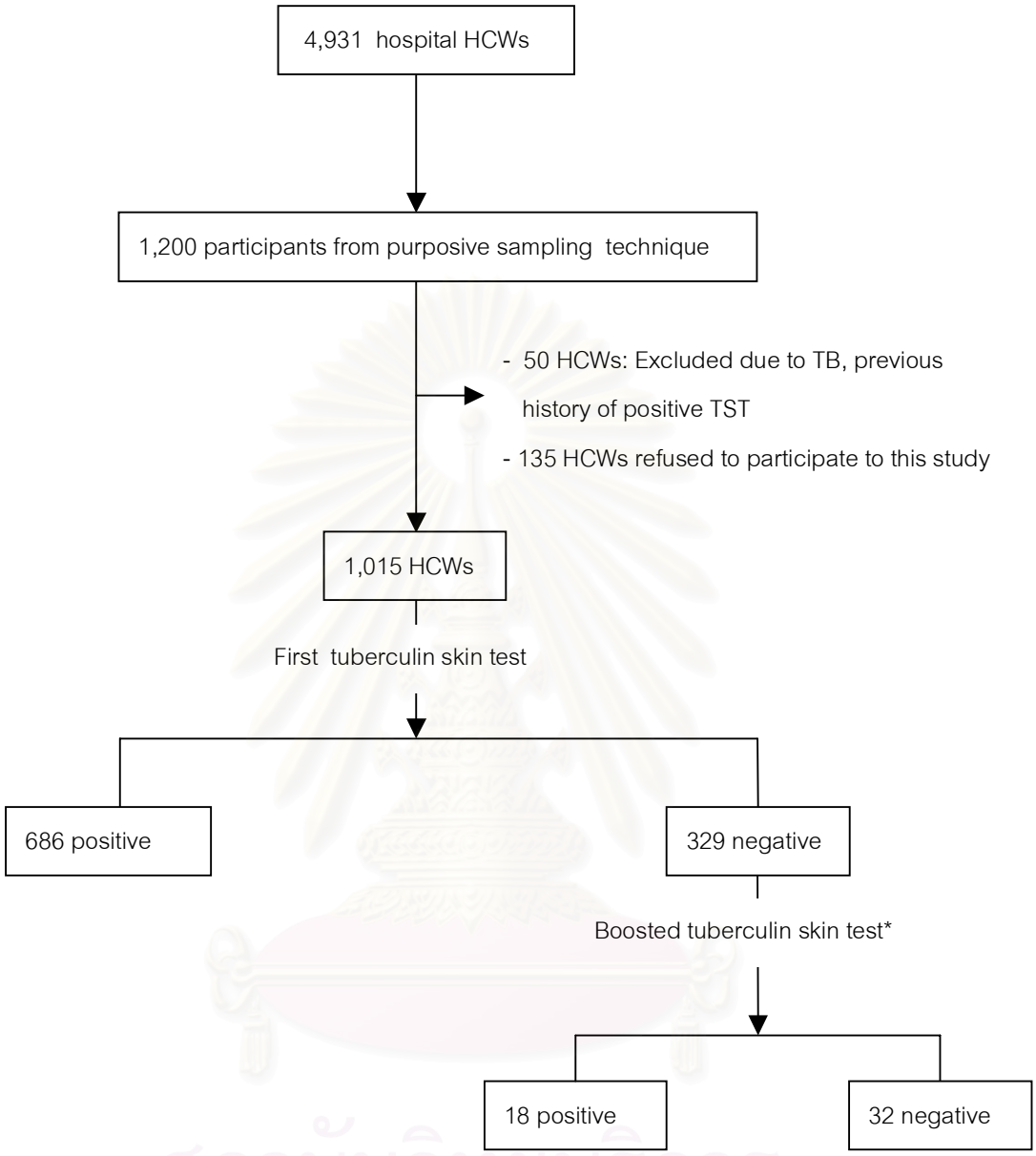
The resurgence of tuberculosis (TB) in Thailand, in accompanying with the human immunodeficiency virus (HIV) pandemic, socioeconomic change, and general failure of TB control, [1-3] healthcare workers (HCWs) are vital resources in the fight against TB and they are at increased risk of *Mycobacterium tuberculosis* infection.[4-7] The outbreak of TB in health care setting (nosocomial transmission) hightened concern about transmission to both patients and HCWs.[7-11] Some of these outbreaks involved multidrug-resistant *M. tuberculosis*[8-10] that cause the risk more severe. While HCWs are valuable and often scarce resource and their expertise cannot be easily replaced, occupationally acquired TB among them may result in either temporary or permanent loss of workforce. Commitment to reducing the risk of nosocomial *M. tuberculosis* transmission to HCWs is necessary to protect them from undue exposure, infection, disease, disability, and death.

Despite the increasing concerns, risk assessment data are insufficient for the development of preventive interventions for the healthcare setting in developing countries. In addition to resource limitations, a lack of awareness on the occupational TB risk and an assumption that most HCWs are already infected when they began employment may also have deterred the initiation of such assessments. Tuberculin skin testing (TST) of HCWs, a risk assessment tool integral to TB infection control program,[12] is not routinely practiced in most developing countries. It is believed that prior to the vaccination with Bacille Calmette-Guerin (BCG), which is widely used in developing countries, may complicate interpretation of TST results.[13] Wang L, et al performed the meta-analysis and found that the effect of BCG vaccination on TST measurements[14] was less after 15 years, and positive TST with indurations of >15 mm are more likely to be the result of TB infection than of BCG vaccination. So the TST is the only method available for demonstrating infection with *M. tuberculosis* in Thailand. Although the currently available TST is less than 100 percent sensitive and specific for the detection of infection with *M. tuberculosis*. Our main objectives were to determine the prevalence rate of *M. tuberculosis* infection and its associated factors among HCWs in King Chulalongkorn Memorial Hospital. The result of this study will use in the implementation of a TB infection control plan for reducing the risk of TB transmission in King Chulalongkorn Memorial Hospital.

Materials and Methods

Subjects

This cross sectional study was conducted among HCWs in King Chulalongkorn Memorial Hospital during June to July 2004. The TST and self-administered questionnaires were distributed to 1,014 HCWs who were selected by purposive sampling from all HCWs in King Chulalongkorn Memorial Hospital.(sampling units were wards/sections) The purposive sampling was considered by the risk from TB infection, assessed by the risk of exposure to *M. tuberculosis* in a given area depending on the prevalence of TB in the population, occupational group, degree of exposure and based on the data from the 15-year retrospective cohort study about TB among nursing personnel at King Chulalongkorn Memorial Hospital during 1988-2002.[15]



* Only 50 HCWs participated in boosted TST.

Figure 1. Characteristics of TST survey participants.

Prior to the data collection, all research assistants attended a training session in which they were shown a standardized approach for completing data collection forms, looking for BCG scars, and administering and reading TST results. The self-administered questionnaire included information on demographics (such as sex, age, education level), occupational information (such as working duration, workplace, occupation category, position), symptoms suggestive of tuberculosis, possible household exposes to *M. tuberculosis*, BCG vaccination, underlying disease and current immunosuppressive medication. Subjects who had a history of positive TST and TB were excluded from this study.

The TST was administered by Mantoux intradermal injection method. All participants received a TST with 0.1 ml of 10 tuberculin units from PPD-TRC (there is no statistically significant differences of reaction sizes from PPD-TRC and PPD-S in both groups[16]) on the volar surface of right forearm. The participants were asked to return in 48-72 hours for the TST reading.[17] For the purpose of our analyses, two induration size cut-offs were used to define a positive TST: $\geq$ 10 and $\geq$ 15 mm.

Two-step testing was performed on all HCWs who have an initial negative PPD test result and have not had a documented negative PPD test result during the 12 months preceding the initial test. A second test should be performed 1-3 weeks after the first test. If the second test result is positive, this is most likely a boosted reaction, and the HCWs should be classified as previously infected. If the second test result remains negative, the HCWs is classified as uninfected, and a positive reaction to a subsequent test is likely to represent a new infection with *M. tuberculosis*.

Risk by work location

The HCW risk of *M. tuberculosis* exposure in different hospital locations was assessed by considering whether or not each location is primarily used as a patient care area and the frequency of reports of patients with acid-fast bacillus (AFB) positive smears from each location. For the purpose of our analysis, each hospital location was classified as having high, intermediate, or low risk for *M. tuberculosis* exposure. Hospital locations used primarily for patient care and with a high number of patients reported with AFB-positive smears (e.g. medical wards, emergency department) were considered high-risk areas with occasional patients reported with AFB-positive smears (e.g. surgical wards, pediatric wards) were considered intermediate-risk areas, and locations not used for patient care (e.g. kitchen, storage area, pharmacy, administrative office) or with rare or no patients reported with AFB-positive smears (e.g. obstetrics ward, orthopedics ward) were considered low-risk areas.

Risk by occupational category

The risk for exposure to *M. tuberculosis* was also estimated by considering the amount of direct patient contact with HCW who was on duty. For the purposes of this analysis, three categories were developed: 'frequent' for those HCWs who routinely came into direct contact with patients (e.g. nurses, physicians), 'occasional' for HCWs who sometimes had patient contact (e.g. maintenance personnel), and 'rare' for those with no direct contact with patients (e.g. office clerks).

In this study, only 2 physicians were participated in this study, so we decided to exclude physician from this study, because of it's too few to analyse in this study.

Statistical analysis

Data were entered and analyzed by statistical software program. To examine the effects of different factors on the TST results, the data were analyzed using two minimum cut-off points for a positive TST result : $\geq$ 10 mm and $\geq$ 15 mm indurations. A univariate analysis was first performed to examine all possible predictive factors for TST positivity. Multicollinearity was checked before multivariate analysis. A multiple logistic regression model was utilized selecting all variables with p-value < 0.2) in the univariate analysis

and those with known biologic importance. In each independent variable comparison, the HCWs in the lowest risk category were used as a reference group. Forward regression procedure was used in statistical modeling : in the final model odds ratio with 95 % confidence interval were calculated and checked by Hosmer-Lemeshon goodness-of-fit tests.[18]

Results

Characteristics of TST survey participants

Of all 4,931 HCWs in the hospital, 1,200 HCWs were selected into the study (Figure 1). Among these HCWs, 50 HCWs were excluded due to their underlying tuberculosis or previous history of positive TST or TB. 135 HCWs refused to participate in this study maybe caused by not so much concern about occupational TB infection and afraid of the adverse reaction from TST such as scar and pain. Off-peak shift workers reported that testing schedules were inconvenient, eventhough we provided flexible schedule for them. 1,015 HCWs participated in our study. Most of participants are woman (86.8 percent), aged between 31-40 years old (34 percent). More than half (52.3 percent) of the participants have been working in the hospital for more than 10 years. Almost all participants did not smoke (94 percent).

M. tuberculosis exposure risk, by work location and occupation

Of 1,015 participants, 381 (37.5 percent) were employed in hospital areas where the risk of *M. tuberculosis* exposure was high; 538 (53 percent) worked in intermediate risk areas, and 96 (9.5 percent) in low-risk areas. A total of 631 (62.2 percent) were involved in direct patient care; 246 (24.2 percent) had occasional contact with patients; and the remaining 138 (13.6 percent) rarely contacted the patients.

The prevalence rate of TST positivity

Of 1,015 participants, 704 (69.4 percent) had $\geq$ 10 mm induration, and 396 (39 percent) $\geq$ 15 mm induration. In fact, the prevalence rate might be higher than this because of 279 HCWs who had negative TST results on the first tests did not have the boosted TST. The data from the boosted TST results showed that of 50 negative TST results in the first TST were changed into 18 positive TST results (36 percent). So if all 279 HCWs who had negative results in the first TST might have 100 positive boosted TST results. The estimated prevalence rate of tuberculosis infection among HCWs is about 79.2 percent.

Predictive factors for TST positivity

In the univariate analysis, the factors most predictive of a positive TST, using either 10 or 15 cut-off were : male, older than 30 years old, low education, smoking, numbers of TB patients in hospital working area during the preceding year (person), known contact with TB patient outside hospital, HCWs who worked in emergency room, and who were the transportation worker (Table 2). When using 15 mm cut-off, the additional predictive factors of positive TST were employment duration and working in radiological areas. The presence of BCG scar, and prior BCG vaccination were not predictive factors for positive TST result.

After adjust confounder and covariate, the result in the multivariate analysis, (Table 3) the male gender, the older age group (more than 30 years old), and HCWs who worked in emergency room or radiological areas were independently predictive for a positive TST result, using either cut-off.

Table 1. Characteristics of survey participants, King Chulolongkorn Memorial Hospital, Thailand, June 2004.

Charcateristics*	n (%)
Sex (n= 1,015)	
Female	881 (86.8)
Male	134 (13.2)
Age group (years) (n=980)	
20-30	315 (32.2)
31-40	333 (34.0)
41-50	214 (21.8)
51-60	118 (12.0)
Duration of employment (years) (n=907)	
≤ 1	83 (9.2)
2-5	131 (14.4)
6-10	219 (24.1)
>10	474 (52.3)
Education (n=988)	
Elementary school	134 (13.6)
Secondary school	307 (31.0)
Vocational school	80 (8.1)
Associated degree	53 (5.3)
Bachelor's degree and higher	414 (42.0)
Underlying disease (n=1,015)	
No	820 (80.8)
Yes	195 (19.2)
Smoking habit (n=1,011)	
Non-smokers	950 (94.0)
Ex-smokers	23 (2.2)
smokers	38 (3.8)
History of BCG vaccination (n=1,002)	
No	118 (11.8)
Yes	644 (64.2)
Unknown	240 (24.0)
BCG scar (n=985)	
Absent	370 (37.6)
Present	615 (62.4)
M.tuberculosis exposure risk by workarea (n= 1,015)	
High	381 (37.5)
Intermediate	538 (53.0)
Low	96 (9.5)
Direct patient contact in job (n=1,015)	
Frequent	631 (62.2)
Occasional	246 (24.3)
Rare	138 (13.5)

* Numbers of subjects were unequal due to missing data.

Table 2. Predictive factors for tuberculin skin test positivity by univariate analysis, King Chulalongkorn Memorial Hospital, Thailand, June 2004.

	N	Positive tuberculin skin test cut-off (induration size)					
		≥ 10 mm			≥ 15 mm		
		n (%)	Odds ratio (95% CI)	P value	n (%)	Odds ratio (95%CI)	P value
Sex							
Female	881	574 (65.1)	1		330 (37.5)	1	
Male	134	112 (83.5)	2.7 (1.7-4.4)	< 0.001	66 (49.3)	2.8 (1.7-4.6)	<0.001
Age group (years)							
20-30	315	187 (59.2)	1		97 (43.1)	1	
31-40	333	229 (68.8)	1.5 (1.1-2.1)	<0.05	142 (57.7)	1.8 (1.2-2.6)	<0.005
41-50	214	161 (75.2)	2.1 (1.4-3.0)	<0.001	94 (63.9)	2.3 (1.5-3.5)	<0.001
51-60	118	83 (70.9)	1.7 (1.1-2.6)	<0.05	48 (58.5)	1.8 (1.1-3.0)	<0.05
Working duration (years)							
≤1	83	55 (66.3)	1		23 (45.1)	1	
2-5	131	76 (58.0)	0.7 (0.4-1.2)	NS	40 (42.1)	0.9 (0.5-1.8)	NS
6-9	219	138 (63.0)	0.9 (0.5-1.5)	NS	83 (50.6)	1.2 (0.7-2.3)	NS
≥10	474	340 (71.7)	1.3 (0.8-2.1)	NS	206 (60.6)	1.8 (1.1-3.4)	<0.05
Education							
Bachelor's degree and higher	414	253 (61.1)	1		140 (46.5)	1	
Elementary school	134	103 (76.9)	2.1 (1.4-3.3)	<0.005	63 (67)	2.4 (1.5-3.8)	<0.001
Secondary school	307	220 (71.7)	1.6 (1.2-2.2)	<0.005	132 (60.3)	1.8 (1.2-2.5)	<0.005
Vocational school	80	54 (67.5)	1.3 (0.8-2.2)	NS	29 (52.7)	1.3 (0.7-2.3)	NS
Associated degree	53	40 (75.5)	1.9 (1.1-3.8)	<0.05	24 (64.9)	2.1 (1.1-4.4)	<0.05
Underlying disease							
No	820	540 (65.9)	1		325 (53.7)	1	
Yes	195	146 (74.9)	1.6 (1.1-2.2)	<0.05	71 (59.2)	1.2 (0.8-1.9)	NS

Table 2. Continuous.

	N	Positive tuberculin skin test cut-off (induration size)					
		≥ 10 mm			≥ 15 mm		
		n (%)	Odds ratio (95% CI)	P value	n (%)	Odds ratio (95%CI)	P value
Smoking habit							
Non-smokers	950	630 (66.3)	1		361 (53)	1	
Ex-smokers	23	20 (87.0)	3.4 (0.9-11.5)	NS	21 (77.8)	3.1 (1.2-7.8)	<0.05
smokers	38	32 (84.2)	2.7 (1.1-6.6)	<0.05	12 (80)	3.5 (0.9-12.7)	NS
History of BCG vaccination							
No	118	82 (69.5)	1			47 (56.6)	1
Yes	644	434 (67.4)	0.9 (0.6-1.4)	NS	255 (54.8)	0.9 (0.6-1.5)	NS
Unknown	240	158 (65.8)	0.8 (0.5-1.4)	NS	86 (51.2)	0.8 (0.5-1.4)	NS
BCG scar							
Absent	370	244 (65.9)	1		140 (52.6)	1	
present	615	416 (67.6)	1.1 (0.8-1.4)	NS	240 (54.7)	1.09 (0.8-1.5)	NS
Number of TB patient in hospital working area during the preceding year (person)							
0	197	130 (66.0)	1		68 (50.4)	1	
1-5	208	115 (55.3)	0.6 (0.4-0.9)	<0.05	66 (41.5)	0.7 (0.4-1.1)	NS
≥ 6	569	411 (72.2)	1.3 (0.9-1.9)	NS	247 (61.0)	1.5 (1.0-2.3)	<0.05
Had known contact with TB patient outside hospital area							
No	530	341 (64.3)	1		192 (50.4)	1	
Yes	462	331 (71.6)	1.4 (1.1-1.8)	<0.05	198 (60.2)	1.5 (1.1-2.0)	<0.05
Had TB-infected family members lived in the house							
No	903	611 (89.1)	1		352 (54.7)	1	
Yes	112	75 (67.0)	0.9 (0.6-1.5)	NS	44 (54.3)	0.9 (0.6-1.6)	NS
M. tuberculosis exposure risk by work area							
Low	96	62 (64.6)	1		32 (48.5)	1	
Intermediate	538	360 (66.9)	1.1 (0.7-1.8)	NS	194 (52.2)	1.2 (0.7-1.9)	NS
High	381	264 (69.3)	1.2 (0.8-1.9)	NS	170 (59.2)	1.5 (0.9-2.6)	NS

Table 2. Continuous.

	N	Positive tuberculin skin test cut-off (induration size)					
		≥ 10 mm			≥ 15 mm		
		n (%)	Odds ratio (95% CI)	P value	n (%)	Odds ratio (95%CI)	P value
Workarea							
Office & support	96	62 (64.6)	1		32 (48.5)	1	
ER	100	86 (86.0)	3.4 (1.7-6.8)	<0.005	66 (82.5)	5.0 (2.4-10.6)	<0.001
OR	55	35 (63.6)	0.9 (0.5-1.9)	NS	22 (52.4)	1.2 (0.5-2.5)	NS
Radiological area	76	59 (77.6)	1.9 (0.9-3.8)	NS	39 (69.6)	2.4 (1.2-5.1)	<0.05
Clinical laboratory	10	7 (70.0)	1.3 (0.3-5.3)	NS	4 (57.1)	1.4 (0.3-6.8)	NS
Pharmacy store	57	38 (66.7)	1.1 (0.5-2.2)	NS	13 (40.6)	0.7 (0.3-1.7)	NS
OPD	96	67 (69.8)	1.3 (0.7-2.3)	NS	35 (54.7)	1.3 (0.6-2.6)	NS
IPD	379	262 (69.1)	1.2 (0.8-1.9)	NS	148 (55.8)	1.3 (0.8-2.3)	NS
ICU	146	70 (47.9)	0.5 (0.3-0.9)	<0.05	37 (32.7)	0.5 (0.3-0.9)	<0.05
Direct patient contact in job							
Rare	138	95 (68.8)	1		56 (56.6)	1	
Occasional	246	182 (73.9)	1.3 (0.8-2.0)	NS	103 (61.7)	1.2 (0.8-2.1)	NS
Frequent	631	409 (64.8)	0.8 (0.6-1.2)	NS	237 (51.6)	0.8 (0.5-1.3)	NS
Position							
Administrative, clerical worker	59	40 (67.8)	1		22 (53.7)	1	
Nurse	305	179 (58.7)	0.7 (0.4-1.2)	NS	104 (45.2)	0.7 (0.4-1.4)	NS
Nurse aid	326	230 (70.6)	1.1 (0.6-2.4)	NS	133 (58.1)	1.2 (0.6-2.3)	NS
Ward worker	105	75 (71.4)	1.2 (0.6-2.4)	NS	46 (60.5)	1.3 (0.6-2.9)	NS
Clinical laboratory technician	17	13 (76.5)	1.5 (0.4-5.4)	NS	7 (63.6)	1.5 (0.4-5.9)	NS
Radiologic technician	42	31 (73.8)	1.3 (0.5-3.2)	NS	19 (63.3)	1.5 (0.6-3.9)	NS
Transportation worker	30	28 (93.3)	6.7 (1.4-30.9)	<0.05	19 (90.5)	8.2 (1.7-39.9)	<0.01
Ordinary worker	79	55 (69.6)	1.1 (0.5-2.3)	NS	34 (58.6)	1.2 (0.5-2.7)	NS
Pharmacist	52	35 (67.3)	0.9 (0.4-2.2)	NS	12 (41.4)	0.6 (0.2-1.6)	NS

Table 3. Predictive factors for tuberculin skin test positivity by multivariate analysis, King Chulalongkorn Memorial Hospital, June 2004

	N	Positive tuberculin skin test cut-off (induration size)					
		≥ 10 mm			≥ 15 mm		
		n (%)	Adjusted odds ratio (95% CI)	P value	n (%)	Adjusted odds ratio (95%CI)	P value
Sex							
Female	881	574 (65.1)	1		330 (37.5)	1	
Male	134	112 (83.5)	2.3 (1.3-3.8)	<0.005	66 (49.3)	2.4 (1.3-4.3)	<0.005
Age group(years)							
20-30	315	187 (59.2)	1		97 (43.1)	1	
31-40	333	229 (68.8)	1.4 (1.0-2.0)	NS	142 (57.7)	1.6 (1.1-2.5)	<0.05
41-50	214	161 (75.2)	2.0 (1.3-3.1)	<0.005	94 (63.9)	2.2 (1.4-3.7)	<0.005
51-60	118	83 (70.9)	1.7 (1.1-2.8)	<0.05	48 (58.5)	1.8 (0.9-3.1)	NS
Workarea							
Office & support	96	62 (64.6)	1		32 (48.5)	1	
ER	100	86 (86.0)	3.9 (1.7-8.9)	<0.005	66 (82.5)	5.9 (2.4-14.6)	<0.001
OR	55	35 (63.6)	1.1 (0.5-2.6)	NS	22 (52.4)	1.3 (0.5-3.3)	NS
Radiological area	76	59 (77.6)	2.3 (1.1-5.1)	<0.05	39 (69.6)	3.1 (1.3-7.4)	<0.01
Clinical laboratory	10	7 (70.0)	1.5 (0.3-8.4)	NS	4 (57.1)	1.8 (0.3-11.2)	NS
Pharmacy store	57	38 (66.7)	1.3 (0.6-3.1)	NS	13 (40.6)	0.7 (0.2-1.9)	NS
OPD	96	67 (69.8)	1.5 (0.7-3.1)	NS	35 (54.7)	1.6 (0.7-3.6)	NS
IPD	379	262 (69.1)	1.5 (0.8-2.7)	NS	148 (55.8)	1.7 (0.8-3.2)	NS
ICU	146	70 (47.9)	0.8 (0.4-1.5)	NS	37 (32.7)	0.8 (0.3-1.7)	NS
Number of TB patient in hospital working area during the preceding year (person)							
0	197	130 (66.0)	1		68 (50.4)	1	
1-5	208	115 (55.3)	0.8 (0.5-1.3)	NS	66 (41.5)	0.9 (0.5-1.5)	NS
≥6	569	411 (72.2)	1.3 (0.8-1.9)	NS	247 (61.0)	1.5 (0.9-2.4)	NS

Discussion

In our study, we documented a high rate of TB infection among HCWs in King Chulalongkorn Memorial Hospital. From the 3rd Thailand TST survey during 1991-1992,[19] the prevalence rate of TB infection among Thai people was about 29.8 percent. From 1993, There are many published reports about occupational TB transmission among HCWs in Thailand and the prevalence rate of TB infection was about 32-98 %[20-27] (mostly more than 60 %). This increased risk is related to the work area, especially in emergency room, radiological area, the older age group and the male gender.

Increased TB risk in the mergency room and radiological area were consitent with previous knowledge.[15,20,28-29] TB risk for ER personnel was the most obvious. The emergency room, as the entry point of many patients into the medical service system, is one area where patients with TB are provided care before diagnosis and initiation of TB treatment and isolation precaution. Furthermore, emergency procedures such as intubation and suctioning, which promote droplet formation, pose a particular risk to the staff serving high TB risk populations.[29] HCWs in the radiological area also had higher prevalence of TB infection. It is usually a closed air-conditioned room where patients with TB undergoing their radiological investigation before diagnosis and treatment.

High prevalence of TB infection among the older age group observed in this study has also been observed in other areas of the world.[20-22,28-30] This may reflect the increased opportunities for *M. tuberculosis* exposure and infection with time among them. In addition to the predictors related to occupational exposure to *M. tuberculosis*, we observed an association between the male gender and TST positivity (Table 3). This association has been previously reported, although the reasons are not entirely clear.[20-21] Possible hypotheses include socio-economic and cultural factors, such as greater mobility and more TB contacts outside the household among the male compared with the female.[31] Some underlying health-related factors including HIV infection, impaired immunologic function and high-risk behaviors (e.g. cigarette smoking) that may influence TST reactivity may be more prevalence among male HCWs.[32]

Some limitations needed to be mentioned in our investigation. First, TST cannot exclude other nontuberculous mycobacterium from *M. tuberculosis*.[33] In this study we define positive TST result as *M. tuberculosis* infection. Second, the participants were chosen by purposive sampling, which may produce selection bias, although we systemically tried to recruit from all hospital work areas. Third, in the boosted TST process, only 50 out of 329 HCWs (15 percent) with negative TST results in the first tests were participated. The reason for this poor co-operation was the fear of adverse effects of from TST such as bleb and severe skin reactions which were observed in some HCWs. TB is an increasing public health threat, especially in developing countries, where resources are limited and there are numerous infectious TB patients. Nosocomial transmission of *M. tuberculosis* is of particular concern to HCWs. In hospitals, implementation of well-organized TB surveillance and infection control programs is mandatory.[34] Even in the absence of costly engineering controls, these programs should

emphasize the importance of administrative controls to ensure early identification and isolation of potentially infectious TB patients, prompt evaluation of symptomatic HCWs, and compliance with the World Health Organization's infection control and directly observed therapy recommendations.[35]

Conclusions

HCWs in King Chulalongkorn Memorial Hospital had a high prevalence of *M. tuberculosis* infection, which was statistical significantly associated with occupational exposure. The emergency room and radiological areas had highest risk of tuberculosis infection that need urgent, effective, and affordable infection control measures.

Implications

This study supports that HCWs are exposed to increased risk of occupational *M.tuberculosis* transmission, and the result can be used in implementation of TB infection control programs. Further studies should focus on the efficacy and cost-effectiveness of nosocomial TB prevention program.

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