Comparison of tuberculosis infection control programs in Canadian hospitals categorized by size and risk of exposure to tuberculosis patients, 1989 to 1993 – Part 2

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OBJECTIVE: To analyze tuberculosis (TB) programs in acute care hospitals (hospitals) categorized by size and risk of exposure to TB patients from 1989 to 1993.
DESIGN: Retrospective survey.
PARTICIPANTS: Members of the Community and Hospital Infection Control Association-Canada and l'Association des professionnels pour la prévention des infections who worked in Canadian hospitals received questionnaires. One questionnaire per hospital was completed.
OUTCOME: Hospitals reported the number of respiratory TB and human immunodeficiency virus (HIV) cases admitted, the engineering and environmental controls available, and the type of occupational TB screening programs available. Data were stratified by hospital size and risk of exposure to TB patients.
RESULTS: Thirty-four (10.9%) hospitals with at least 500 beds admitted more than 50% of the TB cases, more than 40% of the multidrug-resistant TB (MDR-TB) cases and more than 65% of the HIV cases. Thirty-six (11.6%) facilities classified as high risk hospitals reported more than 70% of the TB cases, more than 58% of the MDR-TB cases and more than 75% of the HIV cases. A significantly higher pooled average tuberculin test conversion rate was found in individuals working in high risk (4.4%) than in low risk hospitals (1.5%). Significantly more high risk than low risk hospitals had an isolation room with air exhausted outside, negative air pressure and at least six air changes per hour. Only 13 high risk hospitals had all three engineering characteristics. Surgical masks were used for respiratory protection in 18 (50%) high risk and 186 (77.8%) low risk hospitals.
CONCLUSIONS: Nosocomial transmission of *Mycobacterium tuberculosis* may have occurred because TB programs available in many Canadian hospitals were inadequate.

Key Words: *Nosocomial infection, Occupational health, Tuberculosis*

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Comparaison des programmes de lutte contre la tuberculose dans les hôpitaux canadiens classés selon leur taille et les populations à risque d'exposition à la tuberculose, 1989 à 1993

OBJECTIF : Analyser les programmes de lutte contre la tuberculose dans les hôpitaux de soins aigus classés selon leur taille et les populations à risque d'exposition à la TB entre 1989 et 1993.
MODÈLE : Sondage rétrospectif.
PARTICIPANTS : On a distribué des questionnaires aux membres de la *Community and Hospital Infection Control Association-Canada* et de l'Association des professionnels pour la prévention des infections. Un questionnaire par hôpital a été rempli.
RÉPONSE : Les hôpitaux ont signalé le nombre de TB respiratoires et de VIH admis, les contrôles techniques et environnementaux disponibles et le type de programmes de dépistage de la TB en milieu de travail disponibles. Les données ont été stratifiées selon la taille de l'hôpital et selon le risque que les patients soient exposés à la TB.
RÉSULTATS : Trente-quatre hôpitaux (10,9 %) d'au moins 500 lits ont admis 50 % des cas de TB, 40 % des cas multirésistants et 65 % des cas de VIH. Trente-six établissements (11,6 %) classés comme hôpitaux à haut risque ont signalé 70 % des cas de TB, 58 % des cas de TB multirésistants et 75 % des cas de VIH. Un taux de conversion de la réaction à la tuberculine en moyenne beaucoup plus élevé a été observé chez les sujets qui travaillaient dans les hôpitaux à haut risque (4,4 %) en comparaison avec les hôpitaux à faible risque (1,5 %). Un nombre significativement plus grand d'hôpitaux à haut risque étaient dotés de chambres d'isolement munies d'une bouche d'aération vers l'extérieur, d'un système de pression négative et d'au moins six changements d'air par heure. Seulement 13 hôpitaux à haut risque présentaient ces trois caractéristiques techniques. Les masques chirurgicaux ont été utilisés pour la protection respiratoire dans 18 hôpitaux à haut risque (50 %) et dans 186 hôpitaux à faible risque (77,8 %).
CONCLUSIONS : La transmission nosocomiale de *Mycobacterium tuberculosis* peut s'être produite parce que les programmes anti-TB de nombreux hôpitaux canadiens sont inadéquats.

In 1994, the Laboratory Centre for Disease Control (LCDC), Health Canada and the Community and Hospital Infection Control Association-Canada (CHICA-Canada) initiated a study to determine the type of engineering and environmental controls available and occupational tuberculosis (TB) screening programs offered in Canadian acute care hospitals from 1989 to 1993. This study documented that 68% of the hospitals participating in the study admitted at least one TB case during the study period (1). The study also showed that many hospitals did not meet published recommendations for tuberculin skin test (TST) screening programs for health care workers (HCWs) or recommendations for TB engineering and environmental controls (2-4).

Analysis was performed to determine whether hospital size or the number of TB patients admitted influenced the engineering or environmental controls available in the hospitals. Analysis was also performed to evaluate the type of occupational TB screening program offered in high and low risk hospitals. Information is also presented about the presence of multidrug-resistant TB (MDR-TB) and the potential risk of individuals infected with the human immunodeficiency virus (HIV) to be exposed to individuals with TB.

MATERIALS AND METHODS

The study steering committee developed a questionnaire, based in part on a questionnaire used in a study performed by the Society of Healthcare Epidemiology of America and the Centers for Disease Control and Prevention, Atlanta, Georgia (CDC) to document, retrospectively, the number of respiratory TB cases admitted, the type of engineering and environmental facilities available, and the type of occupational TB screening programs offered in Canadian hospitals from 1989 through 1993. In 1994, each member of CHICA-Canada and l'Association des professionnels pour la prévention des infections (APPI) who indicated on CHICA or APPI membership list that they lived in Canada and worked in an acute care hospital received a questionnaire. Instructions were provided requesting that only one questionnaire be completed per hospital. Nonresponders were sent a follow-up letter that included a copy of the questionnaire. If two or more questionnaires were received from the same facility, the respondents were contacted and the duplicate questionnaire was discarded.

Respondents answered questions regarding the number of hospital beds, annual number of admissions (total admissions, admissions for respiratory TB and MDR-TB, number of admissions of individuals infected with human immunodeficiency virus [HIV]), number of personnel (medical, nursing, respiratory and laboratory staff), the type and frequency of occupational TST screening program, results of the screening program, type of personal respiratory protection devices used, isolation facilities and engineering controls available, and whether or not a protocol was in place to triage individuals at high risk of having TB. No data verification was performed.

The study categorized hospitals as small (fewer than 100 beds), medium (100 to 499 beds) or large (500 beds or more). Criteria published in the *Guidelines for preventing the transmission of tuberculosis in Canadian health care facilities and other institutional settings* (5) were used to classify the facility as a high or low risk hospital. The average number of TB admissions per hospital was calculated by adding the number of TB cases reported for each year of the study by each hospital and dividing by the number of years that data were provided. A hospital that averaged six or more TB cases a year was classified as a high risk hospital (5). Hospitals that reported treating at least one TB case but averaged fewer than six cases of TB per year were also classified as high risk hospitals if the ratio of HCWs to TB cases was less than or equal to 100 (5). Hospitals that did not meet these criteria were classified as low risk hospitals (5).

A hospital was identified as having a TST screening policy if the facility screened HCWs on hiring or postexposure or had any other type of regular TST screening policy (eg, every six

TABLE 1
Number of tuberculosis (TB) and human immunodeficiency virus (HIV) cases admitted to small, medium and large acute care hospitals

		Small hospitals (fewer than 100 beds)	Medium hospitals (100 to 499 beds)	Large hospitals (500 beds or more)	Hospitals with unknown bed number
Number of TB cases	1989 (n=724)	22 (3.0%)	298 (41.2%)	383 (52.9%)	21 (2.9%)
	1990 (n=763)	30 (3.9%)	319 (41.8%)	385 (50.5%)	29 (3.8%)
	1991 (n=812)	46 (5.7%)	303 (37.3%)	421 (51.8%)	42 (5.2%)
	1992 (n=872)	65 (7.5%)	299 (34.3%)	462 (53.0%)	46 (5.3%)
	1993 (n=829)	62 (7.5%)	297 (35.8%)	425 (51.3%)	45 (5.4%)
	Total (n=4000)	225 (5.6%)	1516 (37.9%)	2076 (51.9%)	183 (4.6%)
	MDR-TB (n=51)	4 (7.8%)	20 (39.2%)	21 (41.2%)	6 (11.8%)
Number of HIV cases	1989 to 1993 (n=15,333)	170 (1.1%)	4963 (32.4%)	10,075 (65.7%)	125 (0.8%)

MDR-TB Multiple-drug resistant tuberculosis

TABLE 2
Percentage of ward isolation room environmental and engineering controls in small, medium and large acute care hospitals

	Small (fewer than 100 beds) n=113		Medium (100 to 499 beds) n=145		Large (500 beds or more) n=34		χ^2
Characteristic	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**P***
A) Air exhausted directly outside building	45.1%	47.0%	55.2%	31.7%	55.9%	35.3%	NS
B) Negative air pressure	19.5%	75.2%	35.2%	55.2%	52.9%	47.1%	15.6 (0.0004)
C) Six or more air changes per hour	31.9%	55.7%	40.7%	43.4%	52.9%	32.4%	6.9 (0.03)
D) Ultraviolet light	0.0%	100.0%	1.4%	86.9%	2.9%	97.0%	Not done
E) High efficiency particulate air filter	8.0%	84.1%	6.9%	81.4%	8.8%	91.2%	NS
F) Anteroom present	34.5%	54.5%	39.3%	51.0%	38.2%	61.8%	NS
A) + B) + C)	10.6%	72.6%	20.7%	59.3%	35.3%	47.1%	12.4 (0.002)
A) + B)	15.0%	75.2%	29.0%	71.0%	44.1%	47.1%	14.6 (0.0007)

**Excludes hospitals that did not provide usable information in answer to question. NS Not significant*

months, every year, every two years). Only hospitals reporting that TST screening was performed every six months or once a year were considered to have a routine screening program.

TB was defined as respiratory TB where there was involvement of the lung tissue, respiratory airways or larynx, pleura, cervical and intrathoracic nodes or when there was disseminated disease (ICD9 codes 010 to 012.8 and 018). MDR-TB was defined as presence of an organism resistant to at least isoniazid (INH) and rifampin; the definition of MDR-TB was included in the questionnaire. Individuals with a positive TST documented within two years of a documented negative TST were classified as converters (4-6).

The average number of HIV admissions per hospital was calculated by adding the number of HIV cases reported for each year of the study for each hospital and dividing by the number of years that data were provided.

Data were entered and analyzed using EPI INFO 6.02 (CDC). Categoric data were analyzed using a ^{2} test. Significance was determined using either Yates correction coefficient or, when the cell sizes were small, a Fisher's exact test. ORs were reported using the exact confidence intervals (95% CI). A ^{2} test for linear trends was used to assess trends over time. Means were analyzed using a Krushal-Wallis H test because the data were not normally distributed. $P<0.05$ was considered significant.

RESULTS

Data were received from CHICA-Canada and APPI members working in 319 hospitals. Only one questionnaire was included from each hospital. Eight hospitals were removed from the analysis because they failed to state whether persons with TB had been admitted to their facility during the study period.

Comparison of small, medium and large hospitals: One hundred and thirteen (36.3%) hospitals were classified as small, 145 (46.6%) as medium, and 34 (10.9%) as large. Nineteen (6.1%) hospitals could not be classified because the total number of beds was not reported. Forty-four per cent of the small hospitals, 80.7% of the medium hospitals and 91.2% of the large hospitals admitted at least one TB patient from 1989 to 1993. Table 1 indicates the number of TB and HIV cases admitted to small, medium and large hospitals reported during the study. The environmental and engineering controls present in small, medium and large hospitals are presented in Table 2.

Comparison of hospitals classified as high or low risk hos-

TABLE 3
Tuberculin skin test (TST) policies by tuberculosis risk category and occupational group

Occupational group	High risk hospitals			Low risk hospitals		
	Answered staff category question	With TST policies		Answered staff category question	With TST policies	
		Yes*	No*		Yes**	No***
Medical staff	36	55.6%	16.7%	275	46.9%	20.0%
Nursing staff	36	77.8%	5.6%	275	70.5%	7.6%
Respiratory staff	23	73.9%	4.3%	142	71.8%	7.7%
Laboratory staff	29	72.4%	10.3%	232	69.4%	8.2%

No significant difference between staffing categories; **χ^2=46.2, P>10^{-8} between staff categories; *χ^2=28.1, P>0.000004 between staff categories*

TABLE 4
Tuberculin skin test (TST) screening policies in hospitals by occupational group

Occupational group	TST screening	High risk hospitals	Low risk hospitals		Comparison of high risk with low risk hospitals
			Reported TB cases	No TB cases reported	
Medical staff (n=149)	Pre-employment	13/20 (65.0%)	47/91 (51.6%)	26/38 (68.4%)	NS
	Postexposure	19/20 (95.0%)	80/91 (87.9%)	20/38 (58.6%)	NS
	Routine program	9/20 (45.0%)	12/91 (13.2%)	3/38 (7.9%)	OR 6.22, 95% CI 1.91<OR<19.5, P=0.0009*
Nursing staff (n=222)	Pre-employment	21/28 (75.0%)	116/131 (88.5%)	58/63 (92.1%)	NS
	Postexposure	26/28 (92.9%)	119/131 (90.8%)	38/63 (60.3%)	NS
	Routine program	17/28 (60.7%)	32/131 (24.4%)	11/63 (17.5%)	OR 5.43, 95% CI 2.19<OR<13.74, P=0.00005
Respiratory staff (n=119)	Pre-employment	14/17 (82.4%)	76/91 (83.5%)	7/11 (63.6%)	NS
	Postexposure	15/17 (88.2%)	84/91 (92.3%)	7/11 (63.6%)	NS
	Routine program	11/17 (64.7%)	16/91 (17.6%)	1/11 (9.1%)	OR 9.17, 95% CI 2.62<OR<33.8, P=0.00001*
Laboratory staff (n=182)	Pre-employment	15/21 (71.4%)	99/116 (85.3%)	39/45 (86.7%)	NS
	Postexposure	19/21 (90.5%)	99/116 (85.3%)	27/45 (60.0%)	NS
	Routine program	14/21 (66.7%)	28/116 (24.1%)	10/45 (22.2%)	OR 6.47, 95% CI 2.2<OR<20.2, P=0.0001

**Fisher's exact text. n Hospitals with TST policy; NS Not significant; TB Tuberculosis*

pitals: Using the definition of high and low risk hospitals published in the Canadian TB guidelines (5), 36 (11.6%) hospitals were classified as high risk hospitals. Eight high risk hospitals were in British Columbia or Alberta (11.8% of participating hospitals from these two provinces); seven high risk hospitals were in Saskatchewan, Manitoba and the Territories (18.9% of the participating hospitals from this region); 14 were in Ontario (11.9% of participating hospitals from Ontario); five were in Quebec (10.0% of participating hospitals from Quebec); and two were in Atlantic Canada (5.3% of participating hospitals from Atlantic Canada). The 36 high risk hospitals reported 70.9% (2837 of 4000) of the TB cases documented in the study.

Ten of 34 (29.4%) large hospitals were classified as high risk hospitals compared with 15 of 145 (10.3%) medium hospitals and seven of 113 (6.2%) small hospitals (^{2}=14.55; P=0.0007). Significantly more large hospitals were classified as high risk than medium or small hospitals (large and small OR 6.31, 95% CI 1.91<OR<21.36, P=0.0008, two tailed Fisher's exact test); large and medium hospitals (OR 3.61, 95% CI 1.28<OR<9.74, P=0.01, two tailed Fisher's exact test). No significant difference was found between small and medium hospitals. Of the 275 hospitals classified as low risk hospitals, 176 (64.0%) reported at least one TB case. Ninety-nine hospitals (36%) did not report any TB cases.

TST screening policies and conversion rates: Hospitals reported TST screening policies according to four staffing categories: medical, nursing, respiratory and laboratory staff. Some high and low risk hospitals indicated they did not employ respiratory and/or laboratory staff. Some hospitals did not de-

TABLE 5
Results of tuberculosis screening programs in high and low risk hospitals

Occupation	Conversion rate (number of converters/number screened) High risk hospitals	Low risk hospitals	Test	Percentage given INH prophylaxis (number given INH/number of converters) High risk hospitals	Low risk hospitals	Test
Medical staff	3.4% (5/149)	3.5% (48/1384)	NS	80% (4/5)	22.9% (11/48)	OR 13.5, 95% CI 1.11<OR<680, P=0.02*
Nursing staff	4.5% (104/2308)	1.4% (536/38,015)	OR 3.3, 95% CI 2.65<OR<9.92, $P<10^{-7}$	83.6% (87/104)	24.8% (133/536)	OR 15.5, 95% CI 8.73<OR<28.7 P=0.0006
Respiratory staff	2.4% (5/209)	2.0% (19/953)	NS	80% (4/5)	47.4% (9/19)	NS
Laboratory staff	6.4% (12/187)	1.4% (34/2472)	OR 4.92, 95% CI 2.27<OR<9.92 P=0.00005*	66.7% (8/12)	20.8% (7/34)	OR 7.7, 95% CI 1.46<OR<43.9, P=0.0006*
All health care workers	4.4% (126/2853)	1.5% (637/42,824)	OR 3.06, 95% CI 2.51<OR<3.73 $P<10^{-7}$	81.7% (103/126)	25.1% (160/637)	OR 13.4, 95% CI 8.1<OR<22.7, $P<10^{-7}$

**Fisher's exact test. INH Isoniazid; NS Not significant*

scribe their TST screening policies. Tables 3 and 4 document the type of screening policies reported in high and low risk hospitals.

During the study, 763 of 45,677 (1.7%) HCWs were reported as TST converters. Occupational TST conversion rates and the percentage of convertors who were prescribed INH prophylaxis in high risk and low risk hospitals are presented in Table 5.

Forty-three hospitals reported TST screening results for each year of the study. Four of these 43 hospitals were classified as high risk. The pooled average conversion rate in the high risk hospitals was 2.7% (21 converters in 782 HCWs screened). The pooled average conversion rate in the low risk hospitals was 1.4% (408 converters in 29,022 HCWs screened). This difference was statistically significant (OR 1.94, 95% CI 1.21<OR<3.07, P=0.005). The median conversion rate reported in each year of the study in the four high risk hospitals varied from zero to 7.9%, while the median conversion rate reported in each year of the study by the 39 low risk hospitals was zero (no significant difference). In 1989, 1991 and 1993, two of four high risk hospitals reported converters, while one hospital reported converters in 1990 and three hospitals reported converters in 1992. The percentage of the low risk hospitals that reported converters increased over the study period, although the increase was not significant (28.2% in 1989, 35.9% in 1990 and 1991, 38.5% in 1992 and 41.0% in 1993). Clusters of conversions were reported in five of 36 (13.9%) of the high risk hospitals and 20 of 265 (7.5%) low risk hospitals (no significant difference).

Isolation facilities: The type of environmental and engineering controls present in high and low risk hospitals are reported in Table 6. Protocols to identify patients at increased risk of having TB were reported in 10 of 36 (27.8%) high risk hospitals and 70 of 275 (25.5%) low risk hospitals (no significant difference).

Thirty-six hospitals did not indicate the type of mask or personal respirator used by HCWs. All of these hospitals were low risk. One high risk hospital (2.8%) and two (0.8%) low risk hospitals reported that no masks or respirators were used for HCW respiratory protection. Among the hospitals reporting that HCWs used some form of personal respiratory protection, respiratory protection was provided by a device other than a surgical mask in 17 of 35 (48.6%) high risk and 51 of 237 (21.5%) low risk hospitals (OR 3.44, 95% CI 1.54<OR<7.62, P=0.001).

Special issues – MDR-TB and HIV: Fifty-one cases of MDR-TB were reported by 30 different hospitals. MDR-TB was identified in 1.8% of TB cases reported in participating small hospitals, 1.3% of TB cases reported in medium hospitals and 1.0% of TB cases reported in large hospitals (Table 1). This difference was not significant. Cases of MDR-TB were reported in 15 of 33 (45.5%) high risk hospitals and in 15 of 244 (6.1%) of low risk hospitals (OR 12.8, 95% CI 4.87<OR<32.7, $P<10^{-8}$). Thirty of 51 (58.8%) cases of MDR-TB were reported in high risk hospitals while 21 cases (41.2%) were reported in low risk hospitals. The descriptions written about the clusters of TST conversions did not suggest that any of the index cases had MDR-TB.

During the study, 209 hospitals reported 15,333 admissions of HIV-infected individuals (Table 1). HIV admissions were reported in 50.4% of the small hospitals, 78.9% of the medium hospitals and 79.4% of the large hospitals; 57.9% of hospitals that did not indicate bed size (^{2}=26.02, P=0.000009). High risk hospitals reported 75.5% (11,577) of the HIV cases while the low risk hospitals reported 24.5% (3756) of the HIV cases. The mean of the average number of HIV cases reported per year in the 32 high risk hospitals reporting HIV data was 88.3 (median 9.7); the mean of the average number of HIV cases reported in the 256 low risk hospitals was 3.2 (median 0.4). This difference was statistically significant (Krushal-

TABLE 6
Percentage of ward isolation room environmental and engineering controls available in high and low risk hospitals

Characteristic	High risk hospitals (n=36)		Low risk hospitals (n=275)				Comparison of high risk with low risk hospitals
			Reported TB cases (n=176)		No TB cases reported (n=99)		
	Yes	No	Yes	No	Yes	No	
A) Air exhausted outside	63.9%	25.0%	55.1%	36.9%	37.4%	45.5%	NS
B) Negative air pressure	25.0%	44.4%	36.9%	59.7%	14.1%	72.7%	OR 2.6, 95% CI 1.19<OR<5.79, P=0.013
C) Six or more air changes per hour	55.6%	33.3%	48.5%	44.9%	23.2%	56.6%	OR 2.3, 95% CI 1.02<OR<5.45, P=0.04
D) Ultraviolet light	0%	100%	1.2%	94.3%	1.0%	81.8%	Not done
E) High efficiency particulate air filter	8.3%	86.1%	7.4%	86.4%	6.1%	78.9%	NS
F) Anteroom	63.9%	33.3%	40.3%	56.3%	19.2%	62.6%	OR 3.43, 95% CI 1.54<OR<7.91 P=0.001
A) + B) + C)	36.1%	44.4%	21.0%	63.1%	5.1%	70.0%	OR 3.48, 95% CI 1.41<OR<8.36, P=0.003
A) + B)	41.7%	44.4%	29.0%	62.0%	10.1%	71.7%	OR 2.77, 95% CI 1.19<OR<6.35, P=0.01

NS Not significant; TB Tuberculosis

Wallis H test 28.5, $P<10^{-6}$). The descriptions written about the clusters of TST conversions did not indicate that any converters were HIV-positive.

DISCUSSION

Hospitals were asked to outline the TB control program in their institution from 1989 to 1993 by answering questions about TB surveillance activities, occupational TST screening programs and type of engineering and environmental controls. The survey questions were based on recommendations for TB control programs that were available in the public domain during the study period (2-4). Part 1 of this study's results (1) discusses the study's representativeness and potential biases.

Relatively few hospitals treated most of the TB cases reported in this study. This finding is consistent with reports from other authors and from national surveillance reports that TB is a focal disease in Canada (7,8). However, this study also documented that facilities classified as either small or low risk hospitals not only reported cases of TB, they also reported cases of MDR-TB. This finding emphasizes the need for all hospitals to have a TB control plan (5).

Although guidelines in existence during the study period recommended TST screening of HCWs (3,4), 4% to 20% of participating high and low risk hospitals did not have a TST screening policy. In addition, many other participating hospitals did not respond to the three TST screening questions, leaving it unclear whether a TST screening policy could not be located or did not exist. Among high risk hospitals reporting TST testing policies, routine screening was reported for the nursing, respiratory and laboratory staff in about two-thirds of the hospitals. Less than 50% of these hospitals had routine policies to test the medical staff. The 1996 Canadian TB guidelines enhance and expand previous recommendations with respect to TST screening policies (5). The guidelines recommend that all individuals who perform paid or unpaid work in a hospital have a two-step baseline TST on record unless the individual has been treated for active TB in the past, been given preventive INH therapy, or is documented to be TST-positive (5). All individuals with significant exposure to an individual with infectious TB should have baseline and three-month follow-up TST tests (5). Routine TST screening should be performed on individuals who perform activities of high or intermediate risk and work in a high risk hospital (5).

Part 1 of this study discusses reasons why the interpretation of the TST conversion rate data must be done cautiously (1). However, to disregard the TST data collected in this study is not appropriate. The data strongly suggest that programs to protect HCWs from exposure to *Mycobacterium tuberculosis* were inadequate. The pooled average TST conversion rate calculated for high risk hospitals was significantly higher than the rate calculated for low risk hospitals. The high risk hospitals' conversion rates in the nursing (4.5%) and laboratory staff (6.4%) are of particular concern (Table 5). Among the 43 hospitals that reported the number of converters in each year of the study, higher rates of conversion were found in individuals employed in high risk hospitals.

INH preventive therapy should be offered to all individuals who develop a positive TST result within two years of having a negative TST (4-6). However, our results identified a striking

difference between the percentage of converters who were offered INH preventive therapy in high risk hospitals (81.7%) and low risk hospitals (25.1%) (Table 5).

Canadian recommendations for hospital engineering and environmental controls measures were available, but not widely circulated, during the study period (2). Less stringent recommendations from CDC were more widely available (3). At the time of the study, CDC recommended that individuals known or suspected to have TB be placed in a room where the air was exhausted outside the building, and which had six changes of air per hour and was under negative pressure. Only 13 (36.1%) high risk hospitals stated that these three engineering and environmental control measures were present in any ward isolation room; 42 (15.3%) low risk hospitals reported that all three control measures were present. The 1996 Canadian TB guidelines recommend that individuals known or suspected to have TB be placed in a room where the air flow is away from the door (often called negative pressure), where air is exhausted outside the building and where there is a minimum of nine changes of air per hour in new or remodelled ward isolation rooms, and six changes of air per hour in all existing ward isolation rooms (5).

Patients with suspected or known infectious TB should be cared for in isolation rooms with appropriate engineering and environmental controls. From 1989 to 1993, 74.3% of participating hospitals did not have protocols for early identification and triage of infectious TB cases. Hospitals with isolation rooms that meet current engineering and environmental control recommendations need an early TB identification protocol to enable rapid transfer of infectious patients to these rooms. Hospitals that do not have isolation rooms satisfying current recommendations need an early TB identification protocol to enable transfer of patient to facilities that have appropriate and available isolation rooms.

High risk hospitals admitted more than 75% of the HIV patients reported in the study. HIV infected individuals may be at greater risk of being infected with *M tuberculosis* and once infected are much more likely to develop active TB (5,6). Reports from the United States have documented outbreaks of TB in HIV patients (9-14). Although our study did not document outbreaks or clusters of TST conversions related to TB in HIV infected individuals, our results suggested that outbreaks could easily occur.

CONCLUSIONS

Many high and low risk hospitals did not have TST screening policies or engineering and environmental controls that met recommendations available during the study period (2-4). Hospitals should take urgent action, if they have not already done so, to prevent the nosocomial transmission of *M tuberculosis* to HCWs and patients by following the current recommendations to prevent the transmission of *M tuberculosis* (5,6).

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