Prevalence of Tuberculin Skin Test Reactions Among Prison Workers

Klaus Jochem, MD, MPH,[1] Terry Nan Tannenbaum, MD, MPH, FRCPC,[2] Dick Menzies, MD, MSc, FRCPC[3]

ABSTRACT

Objective: To determine the prevalence of positive tuberculin skin test (TST) reactions (10 mm or greater) among full-time employees of a provincial prison for women in Montreal.

Methods: Participants underwent tuberculin skin testing and completed a self-administered questionnaire.

Results: Among 129 employees identified, 118 (91%) underwent tuberculin testing. Among 102 born in Quebec who completed the questionnaire, 33 (32%) had positive TST reactions, including 12 (23%) of 52 subjects who had never been vaccinated. Positive TST reactions were significantly associated in multivariate analysis with BCG vaccination after infancy (OR = 4.5, 95% CI = 1.5-13.5), years of work at other provincial prisons (OR = 2.5 for each 5 years of work, 95% CI = 1.2-5.2), travel to tuberculosis endemic countries (OR = 7.7, 95% CI = 1.4- 43), although not with work in the prison for women (OR = 1.3, 95% CI = 0.9-1.9)

Conclusion: The prevalence of positive TST reactions was greater among workers at a provincial prison for women than among a sample of students, suggesting increased occupational risk of tuberculosis infection.

ABRÉGÉ

Objectif : Déterminer la prévalence des cuti-réactions positives à la tuberculine (10 mm ou plus) parmi les employés à temps plein d'une prison provinciale pour les femmes à Montréal.

Méthodologie : Les participants ont passé un test cutané à la tuberculine et ont répondu eux-mêmes à un questionnaire.

Résultats : Sur 129 employés identifiés, 118 (91 %) ont subi un test cutané à la tuberculine. Sur les 102 d'entre eux nés au Québec qui ont rempli le questionnaire, 33 (32 %) ont eu une cuti-réaction positive, dont 12 parmi les 52 individus qui n'avaient jamais été vaccinés. Dans l'analyse multivariable, les cuti-réactions positives sont apparues nettement associées à la vaccination au BCG après l'enfance (risque relatif [RR] = 4.5, 95 % intervalle de confiance [IC] = 1.5-13.5), à des années de travail dans d'autres prisons provinciales (RR = 2.5 pour 5 années de travail, 95 % IC = 1.2-5.2), à des voyages dans des pays où la tuberculose est endémique (RR = 7.7, 95 % IC = 1.4-43), mais pas avec le travail dans la prison pour femmes (RR = 1.3, 95 % IC = 0.9-1.9).

Conclusions : La prévalence des cuti-réactions positives est plus importante parmi les employés d'une prison provinciale pour femmes que parmi un échantillon d'étudiants, ce qui tend à indiquer une augmentation du risque professionnel de contraction de la tuberculose.

Tuberculosis in Canadian prisons and detention centres is a growing concern. Although the overall annual incidence in Canada is 7.5 cases per 100,000 population,[1] tuberculosis is increasingly concentrated in high risk groups, including immigrants from countries with a high incidence of the disease,[2,3] Aboriginal people,[4] the urban poor[5] and injection drug users.[6] Some of these groups are also at increased risk of HIV infection, the most important determinant of active tuberculosis following infection.[6,7] Because persons with risk factors for tuberculosis and HIV infection are overrepresented among offenders, the risk of active tuberculosis among inmates of North American prisons is higher than that in the general population.[8-10] The risk of transmission may be increased by overcrowding, poor ventilation, and delayed diagnosis resulting in longer duration of exposure. Recent increases in the incidence of tuberculosis in prisons have been reported in Europe[8,9] as well as in the United States,[11,12] where several states have reported an annual incidence in excess of 100 per 100,000 population among prisoners, more than 10 times the national average.[12] In addition, the Centers for Disease Control documented 11 tuberculosis outbreaks in prisons in eight states between 1985 and 1989,[12] and outbreaks of multidrug resistant (MDR) tuberculosis have been documented in penitentiaries in New York State[13] and California.[14]

In 1994, an offender was admitted to a provincial multilevel security prison for women in Montreal with short-stay and long-stay inmates (hereafter referred to as the study prison). After three days, tuberculosis was suspected, and she was transferred to an acute care hospital. On admission, direct sputum smears were positive for acid-fast bacilli and multiple cavities were seen on chest radiography. Subsequently, *Mycobacterium tuberculosis*, sensitive to all antibiotics, was isolated from the sputum. Within 10 days of hospitalization 18 workers who had been in contact with the offender were initially tuberculin tested. An unexpectedly high proportion were positive, although in no other inmate or worker had active tuberculosis been diagnosed during the preceding two years. This prompted the decision to screen all workers, to determine the prevalence of and risk factors for tuberculin reactions among staff of a provincial prison in Canada.

METHODS

In the spring of 1995, all full-time permanent employees of the study prison were invited to participate in the study, irrespective of the degree of contact with inmates in their current job. Participants were asked to complete a self-administered questionnaire regarding demographic data, BCG vaccination, employment and travel history, and known occupational and non-occupational exposure to tuberculosis. For the 18 workers who had tuberculin skin tests

1. Nuffield Institute for Health, University of Leeds (on leave from the Infectious Disease Unit, Direction de la santé publique de Montréal-Centre)
2. Tuberculosis Control Program at the Infectious Disease Unit, Direction de la santé publique de Montréal-Centre; Department of Family Medicine and Department of Epidemiology and Biostatistics, McGill University
3. Montreal Chest Institute; Department of Medicine and Department of Epidemiology and Biostatistics, McGill University

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Correspondence and reprint requests: Dr. Dick Menzies, Montreal Chest Institute, 3650 St. Urbain Street, Montreal, QC, H2X 2P4, Tel: 514-398-8122, Fax: 514-398-8981.

(TST) in 1994 following contact, the interval between exposure and testing of less than 2 weeks meant that these initial TST reactions could not be attributed to the exposure. Therefore, these workers were also asked to complete questionnaires, and the results of their initial TST were included as prevalent reactions in the analysis.

Tuberculin skin testing was conducted using the Mantoux technique: 0.1 mL of 5 tuberculin units of PPD-T, bioequivalent to PPD-S (Connaught Laboratories, Toronto), was injected intradermally into the volar aspect of the forearm. The transverse diameter of induration was measured using the "ball-point method"[15] 48-72 hours later and recorded in millimetres. TST reactions of 10 mm or greater were defined as positive;[16] subjects with positive reactions were referred for further evaluation, including chest radiography and medical consultation.

Between 1948 and 1980, more than 100,000 vaccinations with bacille Calmette-Guérin (BCG) were given annually in Quebec,[17,18] resulting in vaccination of more than 50% of persons born during that period. The vaccine manufacturer, the Institut Armand Frappier (Laval, Quebec), maintained a registry of persons vaccinated in the province, which is readily accessible, has been demonstrated to be reasonably accurate,[19] and was used to verify BCG vaccination for all Quebec-born subjects.

Associations of tuberculin test reactions and independent variables were tested for significance with independent t-tests for continuous variables and Chi-square tests for categorical variables using SAS (SAS Institute, Cary, North Carolina).[20] Population attributable risk (PAR) percentages were calculated using the formula PAR = 100 $[P_e(I_e-I_u)/(P_tI_t)]$, where P = persons, I = incidence rate, e = exposed, u = unexposed and t = total population.[21] Logistic regression was performed using BMDP (BMDP Statistical Software, Los Angeles, California) to estimate an adjusted effect of employment in correctional facilities. Two models were tried. The first (shown in Table IV) included age, sex, and factors that appeared to be associated with tuberculin reactions in bivariate analysis. The second model included all characteristics shown in Tables II and III. The parameter estimates from logistic regression were used to calculate odds ratios (OR) and 95% confidence intervals (CI).[22]

TABLE I
Characteristics of Study Population

Continuous Characteristics	Quebec-Born Participants n=102 Mean	(SD)	Non-Participants or not Quebec-born* n=12 Mean	(SD)	p-Value
Age, yr	38.7	(9.8)	36.3	(11.1)	NS
Age first employed in prisons, yr	28.7	(8.0)	31.8	(8.5)	NS
Years of work at study prison	8.3	(7.0)	2.7	(6.0)	0.001
Years of work at other prisons	1.8	(4.3)	0.1	(0.2)	0.001
Categorical Characteristics	**n**	**(%)**	**n**	**(%)**	
Sex					
Female	78	(91%)	8	(9%)	NS
Male	24	(86%)	4	(14%)	
BCG vaccination					
Never	52	(90%)	6	(10%)	NS
Before age 2	11	(79%)	3	(21%)	
Age 2 or older	39	(93%)	3	(7%)	
Work at other prisons					
At least 1 year	24	(100%)	0	(0%)	NS
0-11 months	78	(91%)	8	(9%)	
Contact with inmates					
None/Some (<10 hr/week)	28	(97%)	1	(3%)	NS
Moderate (10-30 hr/week)	27	(82%)	6	(18%)	
Frequent (>30 hr/week)	47	(90%)	5	(10%)	
Job title - Prison Guard	70	(91%)	7	(9%)	NS
Extensive travel	8	(89%)	1	(11%)	NS
Worked in health institutions	21	(91%)	2	(9%)	NS
Initial TST					
Done†	102		16		
Negative (0-9 mm)	69	(87%)	10	(13%)	NS
Positive (10+ mm)	33	(85%)	6	(15%)	NS

* Of the 27 non participants or non-Quebec born, 12 completed a questionnaire.
† 16 persons had initial TST but did not complete a questionnaire or were not born in Quebec.

RESULTS

Among 129 full-time employees identified by the prison administration, four were on leave at the time of the study and two did not participate. Five completed the questionnaire but did not undergo tuberculin testing, while nine had tuberculin testing but did not complete the questionnaire. Of the 109 persons who completed skin testing and questionnaires, seven were born outside Quebec, and BCG vaccination could not be verified. As shown in Table I, the characteristics and tuberculin test results of the 27 nonparticipants or non-Quebec born participants were virtually identical to the 102 Quebec-born participants, with the exception that the Quebec-born participants had worked significantly more years in correctional facilities, particularly at the study prison.

The remainder of this article describes the results of initial tuberculin tests and factors associated with positive reactions among the 102 Quebec-born subjects who completed tuberculin tests and questionnaires. As shown in Table II, workers with positive tuberculin reactions had worked significantly more years in other prisons, but there was no difference in duration of employment at the study prison. Of the 24 workers who reported more than one year of work at other correctional facilities, half were tuberculin positive compared with only 27% of those who had worked exclusively at the study prison ($p<0.005$). The population attributable risk was 17% for work more than one year in another correctional facility. Within the Montreal region the study prison was the only provincial correctional facility for women. Therefore work in other prisons likely represented work in male prisons. There was no association between TST results and current job title or hours of contact with inmates reported on the questionnaire.

Eight subjects reported travel of more than three months to countries with a high incidence of tuberculosis (endemic), and of these, five (63%) had significant initial

TABLE II
Factors Associated with a Positive Tuberculin Test

	TST Negative n=69		TST Positive n=33		p-Value*
Continuous Characteristics	**Mean**	**(SD)**	**Mean**	**(SD)**	
Age, yr	37.8	(10.1)	40.8	(8.9)	NS
Age first employed in prisons, yr	28.6	(8.4)	28.8	(7.1)	NS
Years of work at study prison	8.3	7.1	8.1	(7.0)	NS
Years of work at other prisons	0.8	(2.0)	3.8	(6.6)	0.015
	TST Negative		**TST Positive**		**p-Value**
Categorical Characteristics	**n**	**(%)**	**n**	**(%)**	
Sex					
Female	56	(72%)	22	(28%)	NS
Male	13	(54%)	11	(46%)	
Worked at other prisons					
At least 1 year	12	(50%)	12	(50%)	0.05
0-11 months	57	(73%)	21	(27%)	
Contact with inmates					
None/Some (<10 hr/week)	19	(68%)	9	(32%)	NS
Moderate (10-30 hr/week)	16	(59%)	11	(41%)	
Frequent (>30 hr/week)	34	(72%)	13	(28%)	
Job title					
Prison Guard	52	(74%)	18	(26%)	0.03
Others	17	(53%)	15	(47%)	
Travel to TB endemic countries					
Yes	3	(37%)	5	(63%)	0.06
No	66	(70%)	28	(30%)	
Worked in health care institutions					
Yes	14	(67%)	7	(33%)	NS
No	55	(68%)	26	(32%)	

* p value from independent 2-tailed t-tests for continuous variables, and Chi square tests for categorical variables.

TABLE III
Initial Tuberculin Reactions — Effect of BCG Vaccination

	TST Negative		TST Positive		Young Adult Students* TST Positive
	n	**(%)**	**n**	**(%)**	**%**
BCG Vaccination Status					
No vaccination	40	(77%)	12	(23%)	2%
Vaccination before age 2	8	(73%)	3	(27%)	7%
Vaccination at age 2 or older	21	(54%)	18	(46%)	30%

* Results from initial TST of 1544 Canadian-born college/university students.[23]

TABLE IV
Adjusted Odds Ratios for Positive Tuberculin Reactions

Risk Factor	Odds Ratio	95% Confidence Interval
Sex		
Male vs female	1.96	0.50 - 7.5
BCG vaccination		
Before age 2 vs never	1.75	0.3 - 11.2
Age of 2 or older vs never	4.53	1.5 - 13.5
Travel to TB endemic countries		
Yes vs No	7.68	1.4 - 43.3
Age first employed in prison system for each 5 years	1.12	0.80 - 1.6
Years of work at study prison for each 5 years	1.30	0.90 - 1.9
Years of work in other prisons for each 5 years	2.53	1.2 - 5.2

tuberculin reactions. This compares with 30% among subjects who did not report such travel. The population attributable risk was at most 8%.

As shown in Table III, BCG vaccination had an important effect on TST reactions, although the prevalence of positive TST reactions was considerably higher in all three of these groups of prison workers compared with students (of mean age 21) entering health professional training programs in Montreal in 1989-91.[23] The population attributable risk for a positive TST related to BCG vaccination after infancy was 29%.

In the first multiple logistic regression model, only BCG vaccination, history of travel to tuberculosis endemic countries and years of work in other correctional facilities were significantly associated with positive TST reactions (Table IV). In a second model, which included all of the factors shown in Table IV plus job description, weekly hours of contact with inmates, and prior work in health care institutions, these additional three factors were not significantly associated with positive TST reactions (results not shown in tabular form).

DISCUSSION

This is the first report of the prevalence of tuberculin skin test (TST) reactions among staff of a Canadian prison. Although the small study sample limits conclusions, BCG vaccination status was verified and other risk factors for tuberculosis infection were ascertained for the participants, allowing adjustment for these factors in the analysis. The prevalence of TST reactions of 10 mm or more was 32% overall, and 23% in nonvaccinated Quebec born workers, compared with 2.4% in a previous survey of Quebec-born students in health professional training programs in Montreal.[23] These students were younger, however, and may have been from higher socioeconomic backgrounds.

At most 29% of positive tuberculin reactions could be accounted for by BCG vaccination, 8% by travel to TB endemic areas, and 17% by work in other prisons. This meant that for 46%, the risk factor was unknown. The effect of work in the study prison, a relatively small prison for women, was less than the effect of work in other prisons. Since all other provincial prisons in the Montreal area are for men only, our findings imply that the occupational risk of tuberculosis infection may be greater in male prisons. This may be explained by the higher incidence of tuber-

culosis among men in the Montreal region[24] and in the rest of Canada.[1]

In the United States, the increased incidence of tuberculosis among inmates[11,25] has been largely attributed to HIV infection. In New York State the incidence of tuberculosis in prisons increased ten-fold between 1976-78 and 1985-86.[11] Among the inmates with active tuberculosis diagnosed between 1984 and 1986, all inmates whose HIV status was known were HIV infected; of those with unknown HIV status, two thirds were users of street drugs.[11]

In Canada, the relationship between tuberculosis and HIV infection in prisons is not known. However, a survey of inmates in Quebec provincial prisons detected a prevalence of HIV infection of 3% among males,[26] and 7% among females.[27] A recent finding that 25% of inmates of federal penitentiaries for men and women were sero-positive for hepatitis C[28,29] indicates that persons incarcerated in Canadian prisons frequently have HIV risk behaviours. Among intravenous drug users, who tend to be over-represented in prison populations, the prevalence of HIV infection has risen rapidly in Montreal[30,31] and in Canada's other large cities.[32] In view of the impact of HIV on the incidence of tuberculosis that has been documented in many other countries, the recently observed increase in the prevalence of HIV infection among inmates could result in a rapid increase of tuberculosis in Canadian prisons.

In this study, the increased prevalence of positive TST reactions was not associated with known or recognized prior exposure to tuberculosis. However, unrecognized exposure to inmates with active tuberculosis is likely to occur, given the large numbers of inmates and rapid turnover in provincial prisons, such as the study prison. Undiagnosed cases of tuberculosis among inmates pose a risk for other inmates and prison staff, but also to the community if these inmates are released before their disease is diagnosed or adequately treated.[33]

This survey was carried out among a relatively small number of employees of a single prison in the Montreal area. The findings are consistent with studies in the United States and other countries that have demonstrated an increased risk of tuberculosis transmission from inmates to prison workers as well as to other inmates.[33-37] Although the study prison has both long- and short-term inmates and multiple security levels, it is unclear whether these results can be generalized to other Canadian prisons. It is important that further studies be conducted to examine the prevalence and incidence of tuberculosis infection among staff as well as inmates of federal and provincial prisons elsewhere in Canada.

Tuberculosis prevention and control in correctional facilities must address the issues of the screening of inmates at entry, the adequate supervision of tuberculosis treatment and preventive therapy, and mechanisms for appropriate discharge planning. Specific interventions aimed at staff protection must be seen in this larger context. These issues have been addressed in recently published guidelines for the control of tuberculosis in correctional facilities.[38] Rapid implementation of these guidelines, in addition to continued monitoring of infection, could prevent dramatic outbreaks like those documented in correctional facilities in the United States.

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