Prevalence of Tuberculin Skin Test Reactions Among Prison Workers

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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, tuberculosis is increasingly concentrated in high risk groups, including immigrants from countries with a high incidence of the disease, Aboriginal people, urban poor and injection drug users. Some of these groups are also at increased risk of HIV infection, the most important determinant of active tuberculosis following infection. 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. 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 as well as in the United States, 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. In addition, the Centers for Disease Control documented 11 tuberculosis outbreaks in prisons in eight states between 1985 and 1989, and outbreaks of multidrug resistant (MDR) tuberculosis have been documented in penitentiaries in New York State and California.

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 tuberculosis 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...
(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 $\text{PAR} = 100 \left( \frac{P(e-I_e)/(P(I_e-I_u))}{(P(I_e-I_u))} \right)$, where $P$ = persons, $I = \text{incidence rate}$, $e = \text{exposed}$, $u = \text{unexposed}$ and $t = \text{total population}$. 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

**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
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. 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. 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-
closis among men in the Montreal region and in the rest of Canada. In the United States, the increased incidence of tuberculosis among inmates 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. 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.

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 and 7% among females. A recent finding that 25% of inmates of federal penitentiaries for men and women were sero-positive for hepatitis C 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 and in Canada’s other large cities. 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. 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. 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. 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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REFERENCES

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1997 International Travel and Health
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This booklet is addressed to national health administrations and to the practising physicians, tourist agencies, shipping companies, airline operators, and other bodies who are called upon to give health advice to travellers. In addition to summarizing the vaccination requirements of individual countries, the booklet indicates the main areas where malaria transmission occurs and where Plasmodium falciparum is resistant to drugs. Other chapters cover certain health hazards to which the traveller may be exposed and indicate the areas in which these hazards are most likely to occur. The booklet also recommends a number of precautions that the wise traveller should take when visiting unfamiliar places.

1997 Voyages internationaux et santé
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La présente publication s’adresse aux administrations de la santé, au corps médical, aux agences de tourisme, aux compagnies maritimes et aériennes et aux autres organismes qui sont amenés à donner des conseils d’hygiène aux voyageurs. En plus du résumé des exigences des pays en matière de vaccinations, la publication indique les principales zones où il y a transmission du paludisme et résistance de Plasmodium falciparum aux médicaments. D’autres chapitres décrivent certains risques pour la santé des voyageurs et indiquent les régions où ces risques se rencontrent le plus souvent. La publication recommande aussi certaines précautions que le voyageur serait avisé de prendre lorsqu’il se rend dans des régions peu connues.

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