

## Tuberculosis: 3. Epidemiology of the disease in Canada

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### The case

An 8-year-old grade 3 student comes to her family physician's office with her mother because the school has asked that she be tested for tuberculosis. The testing will be done at the school, but the mother wants to know if it is really necessary. The child is well and has no symptoms of tuberculosis. She was born in the Philippines, and the family immigrated to Canada 2 years previously.

Despite efforts to control tuberculosis (TB), this disease remains a major world health problem. In 1990 there were 7.5 million new cases and 2.5 million deaths.<sup>1</sup> An estimated 1 billion people worldwide are infected with the causative organism, making this the most common human infection known. In Canada approximately 2000 new cases and more than 100 deaths are reported each year.<sup>2</sup> The number of Canadians who are asymptotically infected with the tubercle bacillus is unknown.

Since the turn of the 19th century, when as many as 1 in 5 Canadians had TB in their lifetime, the combination of an improved standard of living, public health interventions to interrupt transmission, and effective treatment have reduced morbidity and mortality rates and have made the elimination of TB a possibility (Fig. 1). However, greater numbers of immigrants from countries with a high prevalence of TB, continuing high case rates among aboriginal people and the spread of HIV threaten this possibility for the immediate future. In this article we describe the epidemiology of TB in Canada, emphasizing the aspects most relevant to the practising physician.

### TB surveillance

From a public health perspective, surveillance is defined as the continuing, systematic collection, analysis and interpretation of health data, closely integrated with timely dissemination of this information both to those providing the data and to those who can apply them in control and prevention programs. The important role of physicians in surveillance is underscored by the fact that TB is a notifiable disease, and reporting of cases is obligatory under legislation in every Canadian province and territory. The information collected through surveillance is used for several purposes, including quantitative estimation of the magnitude of illness and death related to TB, assessment of control and prevention activities (e.g., contact



### Education

### Éducation

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### Standard definition of tuberculosis

Effective Jan. 1, 1990, the case definition for TB used by Health Canada is as follows:

- Cases with *Mycobacterium tuberculosis* complex (i.e., *M. tuberculosis*, *M. bovis* — excluding BCG [bacille Calmette-Guérin] strain — or *M. africanum*) demonstrated by culture, or
- Cases with significant evidence of activity and preferably a positive (significant) tuberculin reaction, even if there is no bacteriological proof; significant evidence of activity includes
  - change on chest radiograph compatible with active tuberculosis, including idiopathic pleurisy with effusion
  - clinically active nonrespiratory tuberculosis (e.g., meningeal, bone, kidney)
  - pathologic or postmortem evidence of active tuberculosis.

All cases are classified as either *new active* (no documented evidence or history of previously active TB) or *relapsed* (documented evidence or history of previously active TB that became inactive).<sup>3</sup> This classification applies whether the last episode was within or outside Canada.



tracing), and provision of a basis for developing public health programs.

Surveillance data initially collected at the local level are eventually forwarded to the Laboratory Centre for Disease Control at Health Canada, which subsequently analyses the national data and publishes an annual report. The first such report was prepared for 1936; the most recent available at the time of writing, for 1995,<sup>2</sup> is the source of much of the material presented in this paper.

The clinician plays an important role in establishing the diagnosis of TB. The typical patient has been symptomatic for several weeks or months, usually with systemic signs and symptoms and chronic cough. One indication that clinicians may not be considering the diagnosis or may not be considering it early enough to affect outcome is the number of patients whose TB is reported at death but who were not receiving antituberculous drugs before death (Table 1). From 1991 to 1995, a mean of 46 cases per year were reported at death; 60.7% of the patients were 65 years of age or older.<sup>2</sup> The proportion of cases reported at death increased with age, and 5.4% of TB patients 65 years of age and older died without being treated. Because the use of autopsies has declined markedly, it is impossible to assess what proportion of TB cases are missed antemortem.<sup>4</sup>

The clinician also plays an important role in the rapidity with which TB is suspected and diagnosed and in the reporting of confirmed and suspected cases of the disease. Any patient with pulmonary abnormalities on chest radiographs and a positive sputum smear for acid-fast bacilli should be reported to the local public health department immediately, so that treatment of the patient and investiga-

tion of his or her contacts can begin promptly. Similarly, positive culture results should be reported promptly by the laboratory to the public health department.

### Anatomic disease site

Cases of TB reported in 1995 are listed by anatomic site in Table 2. Although the number of reported cases of respiratory TB in Canada decreased by 2.2% on average each year from 1980 to 1995, the number of nonrespiratory cases did not change significantly (503 in 1980 and 476 in 1995). As a result, the proportion of total cases that were nonrespiratory rose from 18% in 1980 to 25% in 1995.

### Infectiousness

TB is a disease of public health concern because TB of the respiratory tract is transmissible from one person to another by the airborne route. Transmission of tubercle bacilli from source case to susceptible host is more likely if there are greater concentrations of bacilli in the sputum, if the infected person has a greater frequency of cough, if ventilation is poor or if the susceptible host is exposed for longer periods to contaminated air.

Of the 1448 cases of respiratory TB reported in Canada in 1995, 1116 (77.1%) were reported as smear-positive, culture-positive or both. Of these bacillus-positive cases, 572 (51.2%) were smear-positive. Because the chance of transmitting the organism is much higher for patients with positive smear test results than for those with negative smear test results, only about 40% (572/1448) of the patients with respiratory TB reported in Canada in 1995 would be considered highly infectious. These patients are also more likely to be symptomatic than those with negative smear test results.<sup>5</sup>

### National trends

For many years Canada experienced a substantial decrease in TB incidence and mortality rate; for example, from 1965 to 1995 the annual incidence dropped from 29.0 to 6.5 per 100 000 population and the mortality rate from 3.6 to 0.4 per 100 000 population (Fig. 1). However, between 1987 and 1992, a period when the number of

**Table 1: Cases of tuberculosis (TB) reported in Canada for various age groups, 1991-1995**

| Age group, yr | No. (and %) reported at death* | Total no. reported |
|---------------|--------------------------------|--------------------|
| ≤ 24          | 6 (0.3)                        | 2 147              |
| 25-44         | 32 (1.0)                       | 3 339              |
| 45-64         | 52 (2.5)                       | 2 095              |
| ≥ 65          | 139 (5.4)                      | 2 557              |
| Total         | 229 (2.3)                      | 10 142†            |

\*Percentages relate to the number of cases for each age group.  
†Includes 4 cases that were not reported at death but for which the patient's age was unknown.

**Table 2: Anatomic site of disease and ethnic origin of patients for cases of TB reported in Canada in 1995**

| Anatomic site  | Ethnic origin; no. (and %) of cases |              |                 |          |            |
|----------------|-------------------------------------|--------------|-----------------|----------|------------|
|                | Status Indian                       | Foreign-born | Other Canadian* | Unknown  | Total      |
| Respiratory†   | 230 (87)                            | 743 (67)     | 444 (87)        | 31 (79)  | 1448 (75)  |
| Nonrespiratory | 34 (13)                             | 370 (33)     | 66 (13)         | 6 (15)   | 476 (25)   |
| Unknown        | 0 (0)                               | 3 (<1)       | 1 (<1)          | 2 (5)    | 6 (<1)     |
| Total          | 264 (100)                           | 1116 (100)   | 511 (100)       | 39 (100) | 1930 (100) |

\*Includes non-status Indians, Métis and Inuit.  
†Includes pulmonary, miliary, pleural, primary and "other" respiratory TB. Patients with both respiratory and nonrespiratory disease (65 patients [3.4%]) were counted as having respiratory disease.



cases increased in the United States, the annual decrease in Canada levelled off (Fig. 1). The increased case load in the US was attributed to increased immigration from countries with a high prevalence of TB,<sup>6</sup> the spread of HIV<sup>7</sup> and reduced federal funding of the public health infrastructure so critical to the containment of TB.<sup>7</sup> In Canada, immigration, continuing high case rates among aboriginal people and pockets of HIV infection are thought to explain the levelling off of case rates in the late 1980s and early 1990s.

Over the past several years, TB in Canada has increasingly become a disease of foreign-born people<sup>8</sup> and aboriginal people<sup>9</sup> (status and non-status Indians, Métis and Inuit), whereas the proportion of cases in Canadian-born non-aboriginal people has decreased.\*

### Geographic distribution

In 1995 just over 75% of TB cases in Canada occurred in Ontario, Quebec and British Columbia (Fig. 2). In these provinces a disproportionate number of the cases were reported from large urban areas — Toronto, Montreal and Vancouver. Within these cities, people in lower socioeconomic groups are at highest risk for TB.<sup>10</sup> In contrast, TB has almost been eliminated from the Atlantic provinces, where there were only 13 smear-positive cases of TB in 1995 (5 per million population) (Fig. 2) (elimination of the disease is defined as one infectious case per million population per year).

In 1995, 90% of cases of TB in foreign-born people occurred in the same provinces accounting for most cases of TB in general: Ontario, Quebec and BC. These provinces have attracted the vast majority of new immigrants to

\*Status Indians are those registered with Indian and Northern Affairs Canada, according to the *Indian Act of Canada*. Data on status Indians are presented later in this paper. Data on non-status Indians, Métis and Inuit are included with those for Canadian-born non-aboriginal people (as “other” Canadians).

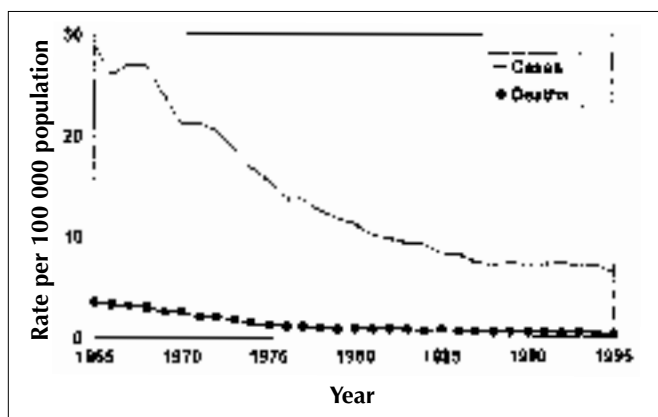


Fig. 1: Incidence and mortality rate for tuberculosis (TB) in Canada, 1965–1995.

Canada in recent years. Of all cases of TB reported in these provinces in 1995, 81%, 48% and 60% respectively occurred in foreign-born people. Clearly, immigration from countries with a high prevalence of TB has contributed significantly to the total burden of TB in Canada.

Cases of TB in status Indians have been largely confined (72% of all cases in 1995) to 3 other provinces or territories: Manitoba, Saskatchewan and the Northwest Territories. In 1995 status Indians accounted for 46%, 65% and 80% respectively of all cases of TB in those jurisdictions. Although the proportion of status Indians in the population is highest in those 3 jurisdictions, most (67%) status Indians live in the other provinces or territories (Statistics Canada census data). Thus, there are regional differences in incidence rates of TB among status Indians<sup>11,12</sup> (Fig. 3).

Cases of TB in “other” Canadians, including non-status Indians, Métis and Inuit, were dispersed across the provinces and territories. Of the few cases of TB reported in the Atlantic provinces in 1995, 75% occurred in “other” Canadians.

These data indicate that TB in Canada is becoming fo-

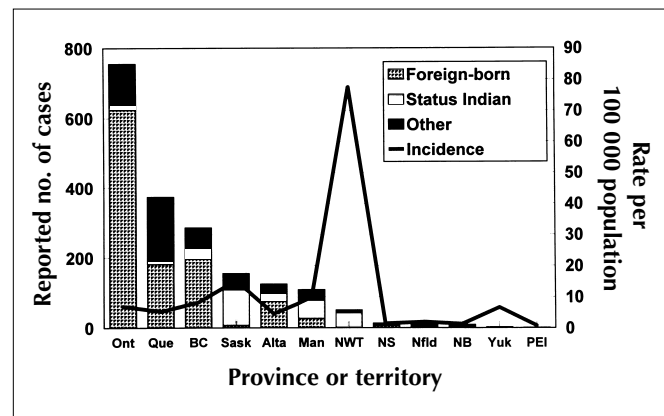


Fig. 2: Number of cases of TB reported and incidence rate in Canada by ethnic origin for 1995. “Other” includes non-status Indians, Métis and Inuit.

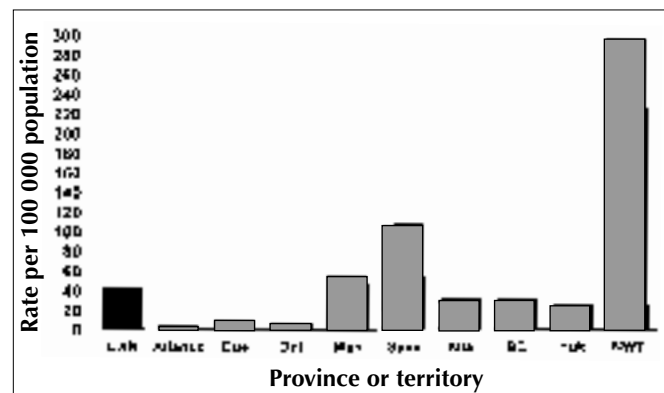


Fig. 3: Incidence rate of TB among status Indians in Canada by province or territory for 1995. Status Indian census data are based on population projections for 1991–2015 (1995 medium growth projection).<sup>12</sup>



cused in geographically and demographically distinct groups, toward which intensified efforts at control and elimination can be directed.

### Age distribution

TB case rates in Canada are highest for those 65 years of age and older (Table 3), a finding that is attributed to the higher incidence of remote TB infection in this group, which creates a larger pool in which there is potential for active disease.<sup>13</sup> However, the case rates for 1987 and 1995 (Table 3) indicate that the rates among older Canadians are falling, whereas the rates among younger Canadians (except those aged 25–34 years) are increasing. In addition, it may be inferred from the increase in case rates among children under 5 years of age that there has been an increase in recent transmission of tuberculous infection in all age groups. Most of the cases in children under 5 years of age (52% in 1987 and 53% in 1995) occurred in status Indians, the only ethnic group in which case rates for this age group increased between 1987 and 1995 (data not shown).

For both status Indians and foreign-born people, the case rates were highest among those up to 44 years of age, whereas for “other” Canadians, the rates were highest among those older than 44 years.

Among status Indians and foreign-born people, the tendency of TB to be concentrated in young age groups is an

ominous sign. Unless preventive measures can be more effectively targeted to these groups, infectious cases will continue to emerge in these populations and perpetuate transmission to young people.

Fortunately, there is a positive side to the current age characteristics and trends: 60% of cases among status Indians and approximately 40% of cases among foreign-born people occurred in people under 35 years of age — the age group for which isoniazid preventive therapy is routinely recommended to treat TB infection.<sup>14</sup> Had these people been identified when they were infected but before the disease became active, a substantial proportion of cases could have been prevented.

### Sex distribution

In Canada, TB is more common among males. In 1995 case numbers and rates were higher for males than for females (Table 3). From 1987 to 1995 the number of reported cases in males decreased by 7.8% (88 cases), whereas the number of reported cases in females increased by 5.4% (45 cases).

### Ethnic origin

Of the 1930 cases of TB reported in 1995, foreign-born people (1116 cases [57.8%]) and status Indians (264 cases

**Table 3: Reported cases and rates of TB in Canada for 1987 and 1995**

| Patient characteristic | Year; no. of cases<br>(and rate per 100 000<br>population)* |                   | Change in no. of<br>cases from 1987<br>to 1995 (and %<br>change in rate<br>per 100 000) |
|------------------------|---|-------------------|---|
|                        | 1987  | 1995              |   |
| <b>Age, yr</b>         |   |                   |   |
| ≤ 4                    | 69 (3.7)  | 91 (4.6)          | +22 (+24.3)   |
| 5–14                   | 71 (1.9)  | 85 (2.1)          | +14 (+10.5)   |
| 15–24                  | 215 (4.9)   | 229 (5.7)         | +14 (+16.5)   |
| 25–34                  | 368 (7.5)   | 325 (6.6)         | –43 (–12.0)   |
| 35–44                  | 246 (6.3)   | 314 (6.4)         | +68 (+1.6)  |
| 45–54                  | 198 (7.5)   | 200 (5.4)         | +2 (–28.0)  |
| 55–64                  | 265 (11.1)  | 209 (8.3)         | –56 (–25.2)   |
| 65–74                  | 283 (16.3)  | 251 (12.0)        | –32 (–26.4)   |
| ≥ 75                   | 257 (23.1)  | 225 (15.3)        | –32 (–33.8)   |
| <b>Sex</b>             |   |                   |   |
| Male                   | 1131 (8.6)  | 1043 (7.1)        | –88 (–17.4)   |
| Female                 | 841 (6.3)   | 886 (5.9)         | +45 (–6.3)  |
| <b>Ethnic origin</b>   |   |                   |   |
| Status Indian†         | 283 (51.6)  | 264 (43.8)        | –19 (–15.1)   |
| Foreign-born           | 686 (22.2)  | 1116 (20.4)       | +248 (–8.1)   |
| Other Canadian         | 809 (3.2)   | 511 (1.7)         | –298 (–46.9)  |
| <b>Total</b>           | <b>1972 (7.4)</b>   | <b>1930 (6.5)</b> | <b>–42 (–12.2)</b>  |

\*Age and sex were unknown for 1 patient in 1995; ethnic origin was unknown for 12 patients in 1987 and for 39 patients in 1995.

†Based on population projections for status Indians, 1991–2015 (1995 medium growth projection).<sup>12</sup>

**Table 4: Top 10 countries of origin of foreign-born patients with TB, for cases reported in Canada, 1990–1995**

| Country of origin | No. (and %) of cases |
|-------------------|----------------------|
| Vietnam           | 868 (13.5)           |
| China             | 725 (11.3)           |
| Philippines       | 651 (10.1)           |
| India             | 599 (9.3)            |
| Hong Kong         | 421 (6.6)            |
| Somalia           | 405 (6.3)            |
| Haiti             | 260 (4.0)            |
| Ethiopia          | 187 (2.9)            |
| Poland            | 137 (2.1)            |
| United Kingdom    | 108 (1.7)            |
| <b>Total</b>      | <b>4361 (67.8)</b>   |

\*Percentages relate to the total number (6421) of foreign-born patients with TB in Canada over the period 1990–1995.

**Table 5: Cases of TB among foreign-born patients, reported in Canada in 1995**

| Age, yr              | No. (and %) of cases |
|----------------------|----------------------|
| < 35 at diagnosis    | 431 (38.6)           |
| ≥ 35 at diagnosis    |                      |
| < 35 at entry        | 241 (21.6)           |
| ≥ 35 at entry        | 421 (37.7)           |
| Age at entry unknown | 23 (2.1)             |
| <b>Total</b>         | <b>1116 (100.0)</b>  |



[13.7%]) accounted for 71.5% (Table 3). The overall risk of TB was 12.0 times (20.4/1.7) higher for people born outside of Canada and 25.8 times (43.8/1.7) higher for status Indians than for "other" Canadians (Table 3).

Between 1987 and 1995 the case rates in all ethnic groups declined; however, there were notable differences in the rates of decline for the different groups. Whereas the case rate for "other" Canadians decreased by nearly 50%, the rates for foreign-born people and for status Indians decreased only minimally, by 8.1% and 15.1% respectively.

Since the late 1980s the number of cases reported in people from Asia and, to a lesser extent, Africa has increased. Between 1990 and 1995, 10 countries of origin accounted for 4361 (67.9%) of the 6421 cases reported in foreign-born people in those years (Table 4). An increasing proportion of new immigrants to Canada are from Asian countries, most of which have a high prevalence of TB, and fewer immigrants are from Western Europe and the United States, which have a lower prevalence of TB.

Among TB cases reported in foreign-born people, most occurred in young people (Table 5). Of the 1116 foreign-born TB patients in Canada in 1995, 431 (38.6%) were less than 35 years of age at the time of diagnosis, and another 241 (21.6%) who were 35 years of age or older at the time of diagnosis were less than 35 when they arrived in Canada. Thus 60.2% of cases in foreign-born patients were potentially preventable, had these people been identified as infected and given preventive therapy.

In 1995 most foreign-born TB patients were recent arrivals: 45% had been in Canada for less than 5 years, and an additional 29% had been in Canada for 5 to 15 years. Because disease rates among foreign-born people are highest in the first few years after arrival, screening and preventive efforts should be targeted to those who have recently arrived.<sup>15,16</sup> TB may be a problem among others from high-prevalence countries who come to Canada for extended periods, such as visitors and students.

Not only are disease rates high among people born outside of Canada, but the infecting organisms are frequently resistant to common antituberculosis drugs, especially isoniazid and streptomycin.<sup>17</sup> If not recognized and managed appropriately, drug-resistant disease and infection may lead to failure of treatment or prophylaxis.

## Risk factors

The risk factors for TB may be conveniently divided into factors associated with a higher risk of infection with tubercle bacilli and those associated with a higher risk of progression from tuberculous infection to disease (Table 6).

HIV infection is the most potent risk factor yet identified for the development of TB in people with prior tuberculous infection.<sup>18</sup> Because the risk of TB among people with both HIV and tuberculous infection is extraordinarily high, all TB patients should routinely undergo counselling and testing for HIV antibodies. Furthermore, it is impor-

tant to identify and prescribe preventive treatment for people who have both HIV and tuberculous infection.

Other factors have been reported to increase the risk of progression to disease in infected people. Some are relatively rare, such that only a small fraction of TB morbidity in Canada can be attributed to them. Nevertheless, because they appear to increase the risk of disease by many times, the clinician should screen for tuberculous infection in people with these risk factors and, if the results are positive, prescribe preventive therapy.

Those who have been in contact with people with active TB and have been recently infected are at an especially high risk of the disease: the risk is 5% during the first 1 to 2 years after infection, and there is an additional 5% risk for the rest of their lives.

Immunosuppression by cancer chemotherapeutic agents or high-dose corticosteroids can increase the risk of TB among people infected with *Mycobacterium tuberculosis*, as can certain tumours, in particular T-cell lymphomas. Patients with diabetes, especially the insulin-dependent form, and those with renal failure requiring dialysis are also at higher risk. Pulmonary silicosis (simple or progressive massive fibrosis) increases the risk of disease substantially, but only the pulmonary forms. In people who react to tuberculin and whose weight is less than 90% of ideal body weight (body mass index of less than 20), the risk of disease is twice that of reactors whose weight is in the ideal range,

**Table 6: Risk factors for TB**

### Characteristics associated with higher risk of infection with tubercle bacilli

Country of origin with high prevalence of TB  
Aboriginal background  
Homelessness  
Substance abuse  
Time spent in a correctional facility  
Contact with a person who has TB  
Older age  
Travel to a high-prevalence country  
Health care occupation  
Other occupational contact with a high-prevalence group (e.g., foreign-born people, aboriginal people)

### Characteristics associated with higher risk of progression from tuberculous infection to disease

HIV seropositivity  
Diabetes (especially poorly controlled insulin-dependent diabetes)  
Alcohol abuse  
Other immunosuppressive illnesses  
Long-term corticosteroid use (at least 15 mg prednisone per day for longer than 2 weeks)  
Gastrectomy  
Intravenous drug abuse  
Malnutrition  
End-stage renal disease, particularly if dependent on dialysis  
Silicosis  
Radiotherapy  
Pregnancy or immediate postpartum period  
Recent tuberculin conversion  
Old, healed but untreated TB



and 4 times that of reactors whose weight is more than 110% of the ideal.<sup>19</sup>

People with previously untreated TB, including those with a positive skin test result and those with fibrotic pulmonary parenchymal lesions, are also at higher risk.

## Conclusion

Foreign-born people, particularly recently arrived Asian immigrants, and, to a lesser extent, status Indians bear a disproportionately large burden of TB morbidity in Canada. Although TB occurring in "other" Canadians is predominantly a disease of elderly people, TB in the foreign-born and status Indian populations is concentrated in much younger age groups. Increasing case rates among children are of particular concern. Over recent years TB has not declined in Canada as expected, mainly because of the increased numbers of cases in the foreign-born population and the persistently high rates among aboriginal people. Available data also support the hypothesis that HIV infection may have contributed to this resurgence.

The epidemiologic data demonstrate that TB in Canada is retreating into focal geographic areas and demographically well-defined populations that can be targeted for intensified control and elimination efforts. A substantial proportion of TB in Canada is potentially preventable through the administration of preventive therapy to high-risk groups. The cost-effectiveness of such programs will be determined by, among other things, the degree of risk (i.e., the rate ratio, whereby the incidence rate for the group of interest is compared with the incidence rate for "other" Canadians) and the proportion of cases occurring in each risk group.<sup>20</sup>

## Case resolution

The child described in the case was born in a country with a high prevalence of TB. She is therefore at higher risk of being infected with tubercle bacilli. A positive tuberculin test may confirm that she is indeed infected. Given her age, she would be a suitable candidate for prophylaxis. The absence of symptoms would argue against her having active disease.

Although many children from high-prevalence countries have been vaccinated with the BCG (bacille Calmette-Guérin) vaccine, one cannot be certain that a positive tuberculin test in a child her age results from vaccination. Thus, this interpretation of a positive tuberculin test is a cautious one that tends to ignore the BCG history and places more emphasis on the high prevalence of TB in her country of origin.

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