What Is Tuberculosis Surveillance in the European Union Telling Us?

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(See the editorial commentary by Castro on pages 1268–70)

Background. Today’s European Union (EU) encompasses countries with diverse patterns of tuberculosis epidemiology.

Methods. We explored national tuberculosis data for 1999–2003 reported to the EuroTB surveillance network. We analyzed only complete, representative data for drug resistance (from 15 countries) and treatment outcomes (from 19 countries).

Results. Between 1999 and 2003, overall tuberculosis notification rates in the 25 EU countries decreased by 4% each year, down to 14 cases per 100,000 population in 2003, but Italy and the United Kingdom registered increases because of tuberculosis in immigrants. In 2003, EU countries reported 62,743 tuberculosis cases; of these, 76% were in persons who were previously untreated, 22% were in persons ≥64 years old, and 30% were in foreigners (the percentage in individual countries ranged from 2% to 75%). In Estonia, Latvia, and Lithuania, resistance to isoniazid and rifampicin occurred in 15%–23% of cases in which resistance testing was performed, but it was uncommon elsewhere (median resistance, 1%). Among previously untreated culture–positive patients with pulmonary tuberculosis, 76% had successful outcome (the percentage in individual countries ranged from 54% to 100%); among these patients, the probability of successful outcome diminished with advancing age. Of 9414 patients with AIDS reported in the EU, 2207 (23%) had tuberculosis as the initial defining illness, representing 3% of all tuberculosis cases notified that year (the percentage in individual countries ranged from 0% to 10%). The prevalence of HIV infection among patients with tuberculosis was highest in Portugal (16.1%) and Spain (9.6%), but it increased in Estonia (from 0.1% to 2.9%) and in Latvia (from 0.5% to 2.3%) between 1999 and 2003.

Conclusions. Surveillance data would be more comparable if more countries reported exhaustive and representative data. Drug resistance is low in most EU countries other than former Soviet states. HIV infection and tuberculosis comorbidity is important in certain countries. Prevention and control of tuberculosis in the EU should target groups at higher risk of infection or death, including foreigners and the elderly population.

Toward the end of the 20th century, the incidence of tuberculosis in Western Europe, which had been steadily decreasing for several decades, stopped decreasing, and some countries even experienced a modest increase [1]. In Eastern Europe, meanwhile, economic adversities in the newly independent countries of the former socialist bloc had profound repercussions on public health [2], as reflected in the increase in tuberculosis notification rates [3, 4]. An added feature of the epidemic in the countries of the former Soviet Union has been the high frequency of cases caused by drug-resistant organisms, partly as a result of the erratic use of antibiotic treatment [5–7]. Here, we analyze trends in notified tuberculosis cases between 1999 and 2003 in the 25 countries that, at that time, composed the European Union (EU; table 1).

METHODS

Data sources and collection. The surveillance data used herein are those reported to EuroTB, a European network for surveillance of tuberculosis established by the European Commission in 1996 [9]. The network collects data annually from national surveillance authorities in all 53 countries in the World Health Organization (WHO) European Region, including the
Table 1. Selected tuberculosis (TB) surveillance indicators in the European Union.

<table>
<thead>
<tr>
<th>Country</th>
<th>TB notifications in 2003 (no. of cases per 100,000 population)</th>
<th>TB mortality 2002/2003 (no. of deaths per 100,000 population)</th>
<th>Mean annual change in notification rate during 1999–2003, %</th>
<th>Percentage of TB cases occurring among children and elderly individuals in 2003, by age</th>
<th>Percentage of TB cases caused by multidrug-resistant organisms in 2003, by infection type</th>
<th>Percentage of TB cases occurring in individuals of foreign origin, 2003</th>
<th>Treatment outcome among previously untreated patients with culture-confirmed pulmonary TB, 2003</th>
<th>HIV infection among TB cases notified in 2003, no. of cases (% of all TB cases with HIV infection)</th>
<th>AIDS cases with TB as initial AIDS identifying illness in 2003, no. of cases (% of all TB cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>980 (12.0)</td>
<td>45 (0.6)</td>
<td>0.5</td>
<td>421 35</td>
<td>1.4 2.0</td>
<td>506 68</td>
<td>10</td>
<td>4 (0.4)</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>1117 (10.8)</td>
<td>...</td>
<td>...</td>
<td>21 54</td>
<td>0.6 1.1</td>
<td>437 72</td>
<td>7 10 (6.3)</td>
<td>58 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>35 (4.3)</td>
<td>...</td>
<td>...</td>
<td>17 63</td>
<td>...</td>
<td>21 81</td>
<td>0 ...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1162 (11.4)</td>
<td>81 (0.8)</td>
<td>-7.9</td>
<td>1 34</td>
<td>0.2 0.3</td>
<td>619 75</td>
<td>5 2 (0.2)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>393 (7.3)</td>
<td>23 (0.4)</td>
<td>-9.5</td>
<td>11 60</td>
<td>0.0 0.0</td>
<td>213 84</td>
<td>9 11 (2.8)</td>
<td>13 (3.3)</td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>623 (46.5)</td>
<td>91 (6.7)</td>
<td>-3.7</td>
<td>1 21</td>
<td>14.1 22.8</td>
<td>332 70</td>
<td>11 18 (2.9)</td>
<td>8 (1.3)</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>412 (7.9)</td>
<td>48 (0.8)</td>
<td>-7.8</td>
<td>1 52</td>
<td>0.7 0.9</td>
<td>...</td>
<td>...</td>
<td>...</td>
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</tr>
<tr>
<td>France</td>
<td>6088 (9.8)</td>
<td>467 (0.8)</td>
<td>-2.6</td>
<td>5 42</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>31 (4.5)</td>
</tr>
<tr>
<td>Germany</td>
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<td>396 (0.5)</td>
<td>-7.8</td>
<td>4 42</td>
<td>1.2 2.1</td>
<td>2624 73</td>
<td>73 11</td>
<td>...</td>
<td>65 (9.0)</td>
</tr>
<tr>
<td>Greece</td>
<td>620 (0.6)</td>
<td>107 (1.0)</td>
<td>-9.7</td>
<td>3 25</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>22 (3.5)</td>
</tr>
<tr>
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<td>-9.6</td>
<td>6 22</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>3 (0.1)</td>
</tr>
<tr>
<td>Ireland</td>
<td>407 (10.2)</td>
<td>27 (0.7)</td>
<td>-4.9</td>
<td>6 22</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>152 (70)</td>
</tr>
<tr>
<td>Italy</td>
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<td>413 (0.7)</td>
<td>0.6</td>
<td>4 32</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>170 (3.8)</td>
</tr>
<tr>
<td>Latvia</td>
<td>1726 (74.1)</td>
<td>202 (8.8)</td>
<td>-2.4</td>
<td>6 5</td>
<td>8.3 14.6</td>
<td>963 78</td>
<td>9 40 (2.3)</td>
<td>21 (1.2)</td>
<td></td>
</tr>
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<td>Lithuania</td>
<td>2821 (81.7)</td>
<td>331 (9.6)</td>
<td>-0.2</td>
<td>5 5</td>
<td>9.0 22.3</td>
<td>1099 76</td>
<td>8 1 (6.0)</td>
<td>2 (0.1)</td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td>54 (11.9)</td>
<td>3 (0.7)</td>
<td>...</td>
<td>2 67</td>
<td>1.9 1.9</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Malta</td>
<td>7 (1.8)</td>
<td>1 (0.3)</td>
<td>...</td>
<td>14 57</td>
<td>...</td>
<td>2 100</td>
<td>0 1 (14.3)</td>
<td>0 (0.0)</td>
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<td>Netherlands</td>
<td>1321 (8.2)</td>
<td>33 (0.2)</td>
<td>-4.1</td>
<td>4 57</td>
<td>1.2 2.5</td>
<td>439 86</td>
<td>7 65 (4.9)</td>
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<td></td>
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<tr>
<td>Poland</td>
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<td>909 (2.4)</td>
<td>-4.4</td>
<td>1 28</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
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</tr>
<tr>
<td>Portugal</td>
<td>4148 (39.9)</td>
<td>211 (2.0)</td>
<td>-5.6</td>
<td>2 12</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Slovakia</td>
<td>983 (19.2)</td>
<td>64 (1.2)</td>
<td>-5.2</td>
<td>2 2</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Slovenia</td>
<td>200 (14.9)</td>
<td>221 (1.1)</td>
<td>-9.4</td>
<td>3 15</td>
<td>0.4 0.4</td>
<td>205 84</td>
<td>11 1 (3.3)</td>
<td>2 (1.0)</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>7467 (17.7)</td>
<td>360 (0.9)</td>
<td>-3.7</td>
<td>6 17</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>714 (9.6)</td>
</tr>
<tr>
<td>Sweden</td>
<td>408 (4.5)</td>
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<td>4 75</td>
<td>1.9 2.0</td>
<td>208 84</td>
<td>7 ...</td>
<td>10 (2.5)</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
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<td>430 (0.7)</td>
<td>3.4</td>
<td>5 59</td>
<td>1.0 1.3</td>
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<tr>
<td>European Union</td>
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<td>... (0.8)</td>
<td>...</td>
<td>4 30</td>
<td>1.2 2.0</td>
<td>17,253 76</td>
<td>... (2.8)</td>
<td>220 (7.2)</td>
<td></td>
</tr>
</tbody>
</table>

a TB mortality data are according to the latest country data from 2002 or 2003 (or 2001 for Denmark) available from the World Health Organization Statistical Information System mortality database (updated March 2006) [8]. All countries are estimated to have >90% coverage and 100% reporting of mortality.

b Percentage of all TB notifications in which TB was reported as the initial AIDS-defining disease (excluding TB episodes in patients with AIDS whose initial defining condition was not TB).

c Data are from 2002.

d Data from Poland refer to a countrywide survey conducted in 2001.

e Only aggregate data on new and recurrent respiratory and meningeval cases was reported; therefore, the percentage of TB notifications in which TB was reported as the initial AIDS-defining disease was not calculated.

f Data from the United Kingdom excludes Scotland.

g Median value.
countries currently forming the EU. In addition to aggregated data, 24 EU countries were also reporting anonymous, individual records for notified cases by 2003. Data used were received and validated by 28 February 2006 without adjustment for underreporting. Tuberculosis notification data preceding 1995 were derived from the WHO [10]. Data regarding tuberculosis as the initial AIDS-indicative disease were obtained from the European Non-Aggregate AIDS Dataset [11], maintained by EuroHIV, which is a network that is similar to EuroTB and is dedicated to HIV and AIDS surveillance in Europe [12].

WHO publications were the source for the total number of deaths due to tuberculosis in 2002 and 2003 [8]. Population estimates used for calculating notification and mortality rates were from the United Nations Population Division [13]. The population of all EU countries combined was 459 million in 2003. Population statistics used to derive rates by geographic origin were provided by the countries themselves.

**Definitions.** The definitions and methodology used for tuberculosis surveillance in Europe have been documented elsewhere [14, 15]. Previously treated cases were those occurring in patients who had previously received curative combination therapy with antituberculosis antibiotics for \( \geq 1 \) month. The geographic origin of tuberculosis cases was classified as national or foreign on the basis of patients' place of birth or on the basis of citizenship in relation to the country of report. Multidrug resistance was defined as resistance to both isoniazid and rifampicin [16]. Treatment success was defined as completion of treatment within 12 months after detection of tuberculosis or after start of treatment, with or without bacteriologic confirmation of cure [17]. Death was defined to include all patients with tuberculosis who died of any cause while undergoing treatment.

**Indicators and analysis.** Notification and mortality rates are expressed as number of cases per 100,000 population and stratified by age group, sex, and geographic origin, when indicated. The overall trend in notification rates was expressed as the mean of the annual percentage difference in rates between each year between 1999 and 2003. It was not calculated for countries reporting <60 cases in 2003.

In addition to the proportion of patients with AIDS for whom tuberculosis was the initial AIDS-defining illness, the contribution of HIV infection to tuberculosis morbidity was also expressed as the proportion of patients with tuberculosis who had test results positive for HIV and as the proportion of patients with both AIDS and tuberculosis (as reported to EuroHIV) divided by the total number of patients with tuberculosis cases (as reported to EuroTB) within the same year.

To enhance comparability between countries, drug-resistance data shown were limited to data from countries with \( \geq 50\% \) of cases confirmed by culture and with initial drug susceptibility test results available for at least 80% of culture-positive cases. Results for Poland were derived from a nationwide drug susceptibility survey conducted in 2001. Multidrug-resistant (MDR) tuberculosis percentage was expressed either as the percentage of patients with MDR tuberculosis among all patients with tuberculosis who had drug-susceptibility test results for isoniazid and rifampicin (combined MDR tuberculosis) or as the percentage of patients with MDR tuberculosis among patients who had not had previous tuberculosis treatment (primary MDR tuberculosis).

Analysis of treatment outcome was restricted to patients with pulmonary cultures positive for tuberculosis. Results presented were generally limited to countries that provided individual outcome data, but they also included results for the United Kingdom, which reported aggregate outcome data for all initially notified cases in patients with pulmonary cultures positive for tuberculosis.

**RESULTS**

In 2003, EU countries reported a total of 62,743 tuberculosis cases (table 1). Of these, at least 76% were in patients who were previously untreated (percentages for individual countries ranged from 62% to 97%), whereas 9% of patients had been treated in the past (percentages for individual countries ranged from 0% to 20%). Pediatric tuberculosis (i.e., tuberculosis occurring in children <15 years old) represented only 4% of tuberculosis notifications overall, and the disease was most common in patients >64 years old (who accounted for 22% of tuberculosis notifications).

The tuberculosis notification rate in the EU was 13.7 cases per 100,000 population in 2003. Rates were highest in the Baltic States of Estonia (47 cases per 100,000 population), Latvia (74 cases per 100,000 population), and Lithuania (82 cases per 100,000 population), and in marked contrast, they were much lower in the neighboring Nordic countries of Denmark (7 cases per 100,000 population), Finland (8 cases per 100,000 population), and Sweden (5 cases per 100,000 population) (figure 1). Mediterranean countries, including Cyprus (4 cases per 100,000 population), Greece (6 cases per 100,000 population), and Malta (2 cases per 100,000 population), had some of the lowest tuberculosis notification rates in the EU.

Total annual tuberculosis notifications in the EU decreased progressively between 1999 and 2003, reflecting a decreasing trend in most countries, with a mean annual rate of decrease exceeding that observed between 1989 and 1999 (3.9% vs. 1.7%) (figure 2). The Baltic States experienced a substantial increase in the 1990s, which started to abate only in recent years. Between 1999 and 2003, rates decreased across all age groups, except in younger adults of both sexes (figure 3), which is the peak age group for disease among patients of foreign origin. As the number of notified cases among nationals decreased or remained stable in countries with comparable data...
Figure 1. Tuberculosis notification rates in the 25 countries of the European Union (EU), 2003.

(excluding Cyprus, Greece, Luxembourg, Malta, Poland, and Spain), cases in patients of foreign origin increased or underwent a modest decrease between 1999 and 2003 (overall annual percentage change, −5.8% in nationals vs. +3.0% in patients of foreign origin). As a result, the proportion of patients of foreign origin among patients with notified cases of tuberculosis increased from 24% in 1999 to 31% in 2003. The increase in total tuberculosis cases observed in Italy and the United Kingdom reflected increases in the number of cases in foreign-born patients over time, whereas the number of cases in nationals remained stable in both countries.

Rates were higher among patients of foreign origin (59 cases per 100,000 population for all cases pooled across countries) than among nationals (5 cases per 100,000 population), and this discrepancy ranged widely between countries, reflecting different migration patterns and disease frequencies in the countries of origin. Approximately one-third of tuberculosis cases occurring in individuals of foreign origin in the EU occurred in individuals from Africa; 31% occurred in individuals from a country of the WHO European Region, 21% occurred in individuals from the Indian subcontinent, and 10% occurred in individuals from another Asian country (data not shown). Approximately one-half of the foreign cases originated from only 11 countries.

In 2003, tuberculosis was the initial AIDS-indicative disease in 2207 (23%) of 9414 cases of AIDS reported in the EU, with the highest percentages occurring in Estonia (73%), Portugal (44%), Belgium (38%), Latvia (36%), and Denmark (33%). AIDS-defining tuberculosis cases represented 2.7% of all tuberculosis cases reported. The prevalence of HIV infection among patients with tuberculosis cases in 13 countries having data ranged from 16.1% in Portugal to 0.1% in Poland and Slovakia (median prevalence, 2.8%). Between 1999 and 2003, the prevalence of HIV infection among patients with tuberculosis increased steadily in Estonia (from 0.1% to 2.9%) and in Latvia (from 0.5% to 2.3%). Compared with other countries, the Baltic States had a very high prevalence of MDR tuberculosis (prevalence range, 15%–23%). In 11 countries providing drug-resistance data for 2003 (i.e., the countries listed in table 1, excluding the Baltic States and Poland), the prevalence of both primary and combined MDR tuberculosis was higher among patients of foreign origin (1.5% and 2.4%, respectively) than among nationals (0.4% and 0.5%, respectively). In these countries, MDR tuberculosis was observed in 14.6% of cases from countries of the former Soviet Union, in 2.6% of cases from Asia, in 1.6% of cases from Africa, and in 0.5% of cases from other EU countries.

Nineteen countries reported nationwide data on treatment outcomes for previously untreated patients with pulmonary cultures positive for tuberculosis in 2003 (table 1). The percentage of treatment success ranged from 54% in Hungary to 100% in Malta (mean percentage of treatment success, 76%), whereas 7% of all patients died. The risk of dying increased with advancing age (data not shown). The mean percentage of cases without reported outcomes or lost to follow-up was 13% and varied widely by country, from 0% to 25%.

The mortality rate attributable to tuberculosis during the period 2002–2003 (including combined data for pulmonary and extrapulmonary tuberculosis) was ≈1 death per 100,000 population in most countries, but it was 2 deaths per 100,000 population in Hungary, Poland, and Portugal and was still higher (7–10 deaths per 100,000 population) in the Baltic States. Mortality rates tended to be much higher among persons >64 years old; however, in the Baltic States, there was a marked
increase in mortality in middle age, with a plateau thereafter (data not shown).

DISCUSSION

The increase in tuberculosis notification rates observed in the early 1990s in the Western world led to refreshed interest in the surveillance and control of tuberculosis in Europe [1]. The incremental trend persisted for only a few years, however, and most EU countries have since experienced a steady decrease in incidence, which is now reaching very low levels. A similar trend was observed in tuberculosis notification rates in the United States, which reached a peak in 1992 (10.5 cases per 100,000 population) but decreased progressively thereafter (to 4.9 cases per 100,000 population in 2004) [18].

As industrialized countries gradually approach elimination of tuberculosis in the indigenous population, the burden of disease is increasingly concentrated among immigrants from countries with a high prevalence of tuberculosis [19, 20] and other high-risk groups, such as prisoners and the homeless. Immigration from areas with a high prevalence of tuberculosis represents the major development in tuberculosis in recent years in much of the western EU and other neighboring countries, such as Norway and Switzerland [15]. Nationwide statistics, such as those presented in this article, may mask important intracountry variations in tuberculosis [21–24]. Rates of tuberculosis in capital cities and big towns are often substantially higher than the national average as the result of an abnormal concentration of at-risk populations in urban environments.

Patients from countries with a high prevalence of tuberculosis may also be at higher risk of being HIV infected [25], leading to an increased concentration of both conditions in the same populations. Most countries have a low proportion of patients with tuberculosis who are HIV positive; therefore, no significant impact of HIV infection on tuberculosis epidemiology is expected in the short term. However, the steady increase in HIV infection observed among patients with tuberculosis in Estonia and Latvia in the past few years may herald the onset of a more important trend in the future. Portugal and Spain report the highest numbers and frequency of HIV-infected persons among patients with tuberculosis. Studies in Spain estimated that, in the 1990s, HIV infection significantly influenced the progression of tuberculosis, and in some regions, up to 27% of patients with tuberculosis were seropositive for HIV infection [26, 27]. In a representative sample of patients with pulmonary tuberculosis with acid-fast bacilli detected by microscopy of sputum smear in Portugal between 1995 and 1998, the prevalence of HIV infection was highest in the capital, Lisbon. However, the prevalence of HIV infection among patients with tuberculosis in Portugal (8.3%) was lower than that reported in recent years [28]. Among patients with MDR tuberculosis, HIV prevalence was much higher (29.2%), although MDR tuberculosis was more common among intravenous drug users and prisoners, who may also be more predisposed to HIV infection.

Although more than one-fifth of cases of tuberculosis in the EU today occur in the elderly population, tuberculosis rates in older age groups are decreasing over time. Despite a decrease in the overall number of reported tuberculosis cases, the elderly population still accounts for a disproportionate share. A similar trend has been observed in the United States [29]. This probably reflects a higher frequency of infection in the first half of the 20th century. Moreover, residence in long-term care facilities may predispose elderly individuals to new infection with tuberculosis. The elderly population is a group at higher risk for lethal outcome or missed diagnosis, in part because elderly individuals with tuberculosis often present with atypical clinical features [30, 31].

The higher rates of tuberculosis and drug resistance in the Baltic States are indicative of a widespread problem that is inherent to much of the former Soviet Union. Even if they represent a small proportion of all patients with tuberculosis in the EU, patients originating from the former Soviet Union
have the highest levels of MDR tuberculosis [32]. In the former Soviet Union, the spread of tuberculosis is diffuse in the population at large, with prisons forming disease reservoirs with a high potential for the transmission of tuberculosis and its drug-resistant forms in the community [5, 33].

The large majority of EU countries have implemented surveillance of outcome of tuberculosis treatment and regularly report the results of nationwide surveillance to the European network. Although monitoring of treatment outcome is increasingly implemented at national levels, international comparability of results is still limited by insufficient standardization (e.g., of outcome categories and period of observation). Differences in outcome categories also affect comparability of data, and changes in definitions proposed in recent years may not have been unanimously adopted by all countries [34]. The WHO target of 85% treatment success for previously untreated, definite cases of pulmonary tuberculosis is not met in most countries of the EU. This is partly explained by the higher mean age of patients with tuberculosis, which means that patients in the EU have a greater independent risk of dying, compared with patients elsewhere in the world. In addition, the frequency of treatment interruption is higher among foreigners, who account for a substantial proportion of cases in the EU. In certain countries, overall success would be expected to improve if retrieval of outcome information were more exhaustive. The frequencies of success and death presented here were comparable to those estimated by a review pooling tuberculosis cases (mostly cases of pulmonary tuberculosis) from 26 European studies conducted between 1996 and 2004 (success, 74.4%; death, 6.8%) [35]. In a separate analysis of 10,303 cases reported by 9 European countries for the period 2000–2001, success was most strongly associated with younger age, female sex, and no resistance to any 2 of isoniazid, rifampicin, or ethambutol [36].

Mortality rates for tuberculosis roughly follow the same geographic gradient as tuberculosis notification. Tuberculosis may be a more important cause of death in countries in which the proportion of HIV-attributable tuberculosis is higher; however, tuberculosis deaths in patients with HIV-attributable tuberculosis may be reported as AIDS deaths, and the tuberculosis mortality rates that we cite may therefore be underestimated.

If EU countries are to progress toward the goal of tuberculosis elimination, control strategies should address the changing pattern of disease. Improvements in national surveillance and international reporting would enable a more factual study of the evolution of tuberculosis epidemiology and of the effectiveness of tuberculosis-control measures.

Persons at increased risk of tuberculosis should be targeted for early detection and treatment [37]. These measures include the active screening of immigrants upon and shortly after arrival in host countries and maintaining an increased index of suspicion for tuberculosis in congregate institutions, such as correctional facilities, long-term care facilities for elderly individuals, and shelters for the homeless. Evidence from European data showing a higher likelihood of unfavorable outcome in certain patient subgroups, such as treatment interruption among immigrants and death among the elderly population and patients with drug-resistant infection, should be used to direct early preemptive action. Testing for HIV infection among patients with tuberculosis and for tuberculosis among HIV-positive persons should be intensified, because early diagnosis of either condition can limit transmission and decrease morbidity and mortality [38].

As a result of the increasing mobility of populations and the contribution of imported tuberculosis to tuberculosis notifications in many EU countries, tuberculosis-control efforts need to extend beyond national borders and have a direct impact in countries of origin, where a high incidence of tuberculosis is commonly matched by inadequate resources. Initiatives to control tuberculosis and HIV infection in less developed countries, as exemplified by the European Parliament’s engagement in achieving the United Nations Millennium Development Goals, could, in the long term, reduce the burden of imported tuberculosis [39]. The high levels of MDR tuberculosis encountered in the former Soviet Union, which are associated with a high frequency of treatment failure, suggest that current treatment programs are insufficient and that tuberculosis-control activities in these countries, some of which border the EU, should be a priority for international and European funding [2, 40].

Acknowledgments

Tuberculosis surveillance data were provided by EuroTB National Contact Points in the European Union, and the current incumbents had the opportunity to comment on a draft of this article: J. P. Klein (Austria); M. Wanlin and G. Vankerschaeveer (Belgium); P. Constantinou (Cyprus); J. Wallenfels (Czech Republic); P. Andersen (Denmark); V. Hollo (Estonia); P. Ruutu (Finland); D. Che (France); W. Haas and B. Brodtkun (Germany); G. Spala (Greece); J. Jonas (Hungary); J. O’Donnell (Ireland); M. G. Pompa (Italy); J. Leimans (Latvia); E. Davidaviciene (Lithuania); P. Huberty-Krau (Luxembourg); A. Pace Asciak (Malta); C. Erkens (The Netherlands); M. Korzeniewska-Kosela (Poland); A. Fonseca Antunes (Portugal); I. Solovic (Slovakia); D. Erzen (Slovenia); P. Ruutu (Finland); V. Kuyvenhoven, and R. Zaleskis. J. Scholten, previously of the World Health Organization Regional Office for Europe, in Denmark, assisted in the collection of aggregate tuberculosis data. A special tribute is due to Andrea Infuso, who coordinated the EuroTB network from 2000 until his death, in office, in 2005.

Financial support. The EuroTB network is funded by the European Commission’s Health and Consumer Protection Directorate General (DG SANCO) and the Institut de Veille Sanitaire, France.

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