Post-migration screening for active tuberculosis in Victoria, Australia

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**SUMMARY**

SETTING: Tuberculosis (TB) screening clinic.

OBJECTIVE: To determine TB prevalence at entry, screening yield and incidence in immigrants on a TB health undertaking (TBU) who were selected for post-migration screening due to an abnormal chest radiograph (CXR) in Victoria, Australia, in the years 1996–2006.

METHOD: Rates of notified TB calculated from linkage of a screening programme database with the Victorian TB database.

RESULTS: Prevalence at entry (cases notified between arrival in Australia and 6 months after the screening registration date) was 505 per 100 000 population; yield at entry (prevalent cases detected by the screening programme) was 420/100 000, and incidence (cases notified between 6 and 12 months after screening registration date) was 160/100 000 person-years. Persons issued a TBU after applying from within Australia (on-shore) had a prevalence of 1876/100 000, seven-fold higher than those issued a TBU outside Australia (off-shore, 254/100 000). The combination of an abnormal CXR and a tuberculin skin test ⩾ 15 mm carried a prevalence of notified TB of 2907/100 000.

CONCLUSION: Selective post-migration screening can achieve a high yield of notified TB.

KEY WORDS: tuberculosis; immigration; screening

THE INCIDENCE of notified tuberculosis (TB) in Australia is 5.4 per 100 000 persons per year; 86% of notified cases occur in persons born overseas. Notification of active TB is mandatory.1 In 2009, Australia issued 186 421 permanent visas and 4.0 million temporary entry visas, of which 3.3 million were visitors and 320 368 were overseas students. The State of Victoria received 24.5% permanent visa applications, 18.3% visitors and 33.1% students. The top three countries of birth for permanent additions to the Victorian population were India, the Peoples’ Republic of China and the United Kingdom. Overseas students in Victoria have increased from 46 401 in 2004 to 117 711 in 2009.2

People who want to migrate permanently or stay in Australia temporarily must satisfy the health requirement specified in the Migration Regulations of the Australian Government. Applicants for permanent entry are asked to undergo a medical examination and chest X-ray (CXR) if aged ⩾ 11 years. Where CXRs show possible evidence of TB, the applicant is asked to provide sputum for smear and culture, and may be asked to provide serial CXRs over 3–6 months. If active TB is found, Australian migration law does not allow a visa to be granted until the person has undergone treatment and is declared free of active TB. This is documented by repeat CXR and sputum examination. If CXRs show evidence of previous but now inactive TB, the applicant may be asked to sign a TB health undertaking (TBU) at the time the visa is granted. By signing the TBU, the applicant agrees to contact the Health Undertaking Service on a free call number on arrival in Australia. The applicant also agrees to report to a State or Territory health authority for follow-up, as directed by the Health Undertaking Service.3,4 Applicants for temporary entry may be asked to undergo a CXR, medical examination and possibly further tests, including sputum examination and repeat CXR, depending on the length of intended stay in Australia and the TB risk rating of the applicant’s country.5 Most TBUs originate from visa applications lodged outside Australia (off-shore TBU), with a smaller number from inside Australia (on-shore TBU). Both off-shore and on-shore TBUs include permanent and temporary residency immigrants, refugees and other humanitarian entrants.6

Under arrangements with the Department of Health Victoria (DH), the Department of Respiratory and Sleep Disorders Medicine at Western Hospital (WH) has provided post-migration screening for TB...
in Victoria since 1996. Since 2001, all TBU appointments in Victoria have been arranged by the WH. Urgent appointments are available for the small proportion of on-shore TBUs where the CXR report suggests active TB (urgent on-shore TBU). Migrants are seen in the Migrant Screening Clinic for clinical review with their previous migration medical papers and CXR. The CXR is repeated at the clinic if a previous one is considered abnormal or of poor quality. Clinic doctors use a coded worksheet to record clinical information, which is entered into a clinic database. Selected migrants aged <35 years\(^7\) are offered tuberculin skin testing (TST), including those with abnormal CXR, refugees\(^8\) and those born in the high-burden countries whose migrants have the highest TB incidence in Victoria.\(^9,10\) TST is performed with 10 international units (IU) of tuberculoprotein derivative (human) 100 IU/ml (Commonwealth Serum Laboratories, Parkville, VIC, Australia). Most TSTs are read at 72 h; however, some are read at 96 h to provide TST at all clinics.\(^11\)

The clinic acts as a triage service, seeing each person once and referring those who need further assessment to other health services. Persons with symptoms suggestive of TB, or one or more CXRs suggestive of active TB, are defined as suspected active TB and referred to other specialist clinics. Those without such features, but with a history of TB diagnosis, positive TST or one or more CXRs thought likely to represent previous TB, are defined as inactive TB. Migrants with a positive TST are referred for treatment of latent TB infection at the discretion of the clinic physician. Those aged >35 years thought to have inactive TB are either discharged or referred for further radiographic surveillance, depending on the extent of the radiographic abnormality and the period of radiographic observation already undertaken. Any person with CXR suggestive of TB and less than 6 months’ radiographic abnormality is also referred. The remaining persons are defined as either normal or an abnormal CXR due to a non-TB problem. Persons who do not attend an appointment are notified to the Australian Government to check for a change of address. The Victorian Government TB programme is advised of non-attendees with CXRs suggestive of active TB; TB programme nurses are asked to contact the person, and may make a home visit.

Improved data are needed to guide the screening of migrants for TB.\(^{12}\) The objectives of this report are to determine screening yield and prevalence at entry of notified TB in migrants on a TBU.

**STUDY POPULATION AND METHODS**

**Study population**

The study includes all persons referred to the Migrant Screening Clinic at WH during the period from November 1996 to June 2006.

**Matching of notified cases**

Cases of notified TB in subjects referred to WH on a TBU were identified by linking the Migrant Screening Database at the WH with the DH database of notified TB. For the period from November 1996 to May 2003, a computer-generated search was used to identify records with an identical date of birth in the two databases. These pairs of records were then manually checked for similar names, sex, country of origin and date of arrival. A further search, using the initial characters of family and given names combined with year of birth, was used to identify additional matching records with differing dates of birth. From June 2003 until June 2007, the DH manually searched the WH Migrant Screening Clinic database on a weekly basis to match newly notified cases of active TB.

**Review of case records**

For each matched case, the medical record of the Migrant Screening Clinic, including correspondence received from specialist clinics to which the migrant had been referred, was reviewed to determine whether the diagnosis of notified TB was related to the activities of the TBU program. Cases diagnosed as a result of referral by the Migrant Screening Clinic were regarded as being found by the TBU program (Group A). Cases diagnosed after discharge from the Migrant Screening Clinic (Group B) or while on a TBU but not as a result of a screening referral (Group C), were regarded as not being found as a result of the TBU program.

**Exclusions**

Cases of notified TB were excluded (Group D) if the diagnosis was made in Australia before a TBU was issued, or if the case had been transferred to WH from another provider of screening services. Cases diagnosed and treated before arrival in Australia do not appear in the DH database.

**Definitions**

Prevalence at entry was defined as the number of cases of TB notified between arrival in Australia and 6 months after registration at WH per 100,000 persons. Screening yield at entry was defined as the number of notified cases found by the screening programme (Group A) between arrival and 6 months after registration per 100,000 persons. Incidence was calculated as the number of cases notified between 6 and 12 months after registration per 100,000 person-years.

**Statistical analysis**

Time between registration date and notification date was computed using Epi Info v3.5 (Centers for Disease Control and Prevention, Atlanta, GA, USA). Where a migrant had applied for entry and a TBU was issued on more than one occasion, only the first TBU referred to WH was used in the analysis. Rates are expressed with 95% confidence intervals (CIs).\(^{13}\)
The study was approved by the Ethics Committee of the Department of Health Victoria, and by the Human Research Ethics Committee of the Royal Melbourne Hospital Research Foundation.

RESULTS

Screening programme evaluation

Matching of DH and WH databases yielded 131 notified prevalent cases, shown by diagnostic group in Table 1. Thirty-six cases were excluded (26 on-shore, 10 off-shore). After exclusions, there were 95 persons with notified TB among 18 801 persons registered, giving a prevalence at entry of 505/100 000 (95% CI 413–618). Of the 95 cases, 79 (83%) were notified as a result of the screening programme, giving a yield at entry of 420/100 000 (337–524). The screening programme detected 89% (667/74) of cases of pulmonary TB compared to 62% (13/21) of cases with extrapulmonary disease (χ² = 10.2, P = 0.006). Of the 95 cases, 68 (71.6%) were diagnosed on culture, 4 (4.2%) on microscopy (culture-negative), 2 (2.1%) on histology, 2 (2.1%) on polymerase chain reaction and 19 (20.0%) on radiology. Persons with notified TB among 18 801 persons registered, 65% (12 062/18 801) were entered for 14 873 (Tables 4 and 5). Of those attending the clinic, 3022 (19.7%) were referred to specialist clinics for further assessment. Only 65% (9668/14 866) of CXRs were considered abnormal when reviewed or repeated in the clinic. The proportion considered abnormal was higher among on-shore TBUs (76%) than off-shore TBUs (41.0%).

Clinic assessment

Following initial registration, 18 359 persons were given appointments at WH, 340 with regional physicians and 102 at the Royal Children’s Hospital. Of the 18 359 persons issued an appointment at the WH, 15 352 (83.6%) attended. CXR findings were entered into the database for 14 866 persons, 3689 also had TST results entered and a clinic assessment was entered for 14 873 (Tables 4 and 5). Of those attending the clinic, 3022 (19.7%) were referred to specialist clinics for further assessment. Only 65% (9668/14 866) of CXRs were considered abnormal when reviewed or repeated in the clinic. The proportion considered abnormal was higher among on-shore TBUs (1636/2168, 76%) than off-shore TBUs (5309/7948, 67%).

Table 1  Notified prevalent cases by diagnostic group

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis by screening while on TBU</td>
<td>79</td>
</tr>
<tr>
<td>Diagnosis after discharge from TBU screening</td>
<td>1</td>
</tr>
<tr>
<td>Diagnosis while on TBU but not a result of screening</td>
<td>15</td>
</tr>
<tr>
<td>Exclusions</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>131</td>
</tr>
</tbody>
</table>

TBU = tuberculosis health undertaking.

Table 2  Prevalence in off-shore and on-shore TBUs

<table>
<thead>
<tr>
<th>Persons</th>
<th>Notified cases</th>
<th>Prevalence /100 000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-shore</td>
<td>10 253</td>
<td>26</td>
</tr>
<tr>
<td>On-shore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-urgent</td>
<td>2437</td>
<td>10</td>
</tr>
<tr>
<td>Urgent</td>
<td>335</td>
<td>42</td>
</tr>
<tr>
<td>All</td>
<td>2 772</td>
<td>52</td>
</tr>
</tbody>
</table>

TBU = tuberculosis health undertaking; CI = confidence interval.

Table 3  Top five countries of birth, 1996–2006

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>China</td>
<td>17.7</td>
<td>21.9</td>
<td>20.2</td>
</tr>
<tr>
<td>India</td>
<td>8.1</td>
<td>12.0</td>
<td>10.4</td>
</tr>
<tr>
<td>Indones</td>
<td>4.8</td>
<td>4.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Philippines</td>
<td>5.1</td>
<td>4.4</td>
<td>4.7</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>13.7</td>
<td>5.5</td>
<td>8.9</td>
</tr>
</tbody>
</table>

CI = confidence interval; TB = tuberculosis.

Table 4  Prevalence by radiograph and TST

<table>
<thead>
<tr>
<th>CXR finding</th>
<th>Persons</th>
<th>Notified cases</th>
<th>Prevalence /100 000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>5 198</td>
<td>2</td>
<td>38 (10–154)</td>
</tr>
<tr>
<td>TST 0–4 mm</td>
<td>453</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>TST 5–9 mm</td>
<td>121</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>TST 10–14 mm</td>
<td>128</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>TST &gt;15 mm</td>
<td>264</td>
<td>1</td>
<td>379 (53–2689)</td>
</tr>
<tr>
<td>Abnormal</td>
<td>9 668</td>
<td>75</td>
<td>776 (619–973)</td>
</tr>
<tr>
<td>TST 0–4 mm</td>
<td>1 073</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>TST 5–9 mm</td>
<td>305</td>
<td>1</td>
<td>328 (46–2328)</td>
</tr>
<tr>
<td>TST 10–14 mm</td>
<td>313</td>
<td>2</td>
<td>639 (160–2555)</td>
</tr>
<tr>
<td>TST &gt;15 mm</td>
<td>1 032</td>
<td>30</td>
<td>2 907 (2033–4158)</td>
</tr>
</tbody>
</table>

TST = tuberculin skin testing; CI = confidence interval; CXR = chest X-ray.

Table 5  Prevalence by clinic assessment

<table>
<thead>
<tr>
<th>Clinic assessment</th>
<th>Persons</th>
<th>Notified cases</th>
<th>Prevalence /100 000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>4 638</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>Possible active TB</td>
<td>2 817</td>
<td>57</td>
<td>20 285 (15 647–26 298)</td>
</tr>
<tr>
<td>Inactive TB</td>
<td>8 490</td>
<td>21</td>
<td>247 (161–379)</td>
</tr>
<tr>
<td>Non-TB abnormality</td>
<td>1 464</td>
<td>1</td>
<td>68 (10–485)</td>
</tr>
</tbody>
</table>

CI = confidence interval; TB = tuberculosis.
**Incidence**

There were 15 cases notified between 6 and 12 months after registration, giving an incidence of 160/100 000 (97–266) person-years.

**DISCUSSION**

Service models for screening new immigrants for TB appear to vary in Western Europe: few output data are routinely and systematically collected,15 and identifying best practice in screening migrants for TB is difficult.16

As this study examines those migrants arriving in Victoria who have been selected for community post-migration screening through the Health Undertaking System, it is not surprising that the yield of notified TB is considerably higher than the estimated yield of 80/100 000 for the Australian migration screening programme as a whole.17 The prevalence of notified TB in this study (505/100 000) is similar to that reported in a study of migrants on TBU in Western Australia,18 which found four cases among 1344 migrants in the first 6 months (298/100 000).

The striking finding in this study is that the prevalence of notified TB in on-shore TBUs is seven-fold higher than in off-shore TBUs. We consider several possible factors. A likely explanation is that cases of active TB prevalent at off-shore CXR complete treatment before arrival in Australia, are not notified in Victoria, and are therefore not counted as active cases in this study, whereas active cases prevalent at on-shore CXR are included as notified cases in our data. Among on-shore applicants for visa renewal, >2 years may have elapsed since the previous off-shore or on-shore CXR, during which time new prevalent cases might accumulate. As the proportion of CXRs considered abnormal on clinical review was not greatly different in on-shore (76%) and off-shore (67%) TBUs, it seems unlikely that the seven-fold difference in the rate of notified TB is due to a difference in image quality or reporting of CXRs, although we cannot exclude this as a contributory factor. TB incidence in the country of birth is known to predict TB risk in migrants,19–21 but this is an unlikely explanation, as the proportion of on-shore TBUs born in a high-burden country was slightly lower than the proportion of off-shore TBUs. The high prevalence in on-shore TBUs is not explained by the excluded cases, most of which were on-shore TBUs. On-shore applicants include asylum seekers, who have not had a pre-migration CXR. Visa class was not recorded in the database, but in 2008–2009, on-shore asylum seekers accounted for only 1.0% (564/54 810) of permanent additions to the Victorian population.2

Orr et al. reported a much higher yield of active TB (2797/100 000 at first visit) in a study of Canadian immigrants placed on post-migration surveil-lance after pre-migration health assessment.22 The Canadian study included humanitarian entrants with a ministerial permit, which provides exemption from pre-migration health requirements. When humanitarian entrants on a permit are excluded, the yield is 1185/100 000. In the Canadian study, 98% of CXRs were abnormal; the Canadian yield can thus be compared with prevalence in this study among migrants with an abnormal CXR (776/100 000).

A recent national study of community post-migration screening from the Netherlands reported an overall prevalence of 131/100 000.23 The prevalence among immigrants with abnormal CXRs was much higher (5185/100 000) than seen in this study, perhaps due to the absence of pre-migration screening. A study of applicants for migration to Australia at pre-migration screening found a yield of bacteriologically confirmed TB of 489/100 000 in Viet Nam and 1209/100 000 in Cambodia.24 Arshad et al. reported a yield of 349 active cases per 100 000 immigrants screened at entry in a meta-analysis that excluded studies only of immigrants who had undergone pre-migration screening.25

Although almost all TBUs are issued because a CXR is thought to be abnormal, we found that only 65% of CXRs were considered abnormal when reviewed or repeated in the clinic, compared with 79% reported by Fang et al. in Western Australia,18 and 98% in a similar post-migration programme in Canada.22

We note three limitations of this study. The migrant screening data set is incomplete, we do not know what proportion of the persons registered remained in Victoria, and we are unable to calculate incidence beyond 12 months. Furthermore, the probability of a CXR abnormality representing TB was not recorded separately from the overall clinic assessment, which could be helpful in further risk stratification.26,27

**CONCLUSIONS**

Migrants entering Victoria on a TBU have a high prevalence of active TB, and the Migrant Screening Clinic has a high yield at entry. We recommend continued selective post-migration screening for TB. Only 65% of persons on a TBU were thought to have abnormal CXR. We recommend that consideration be given to more selective issue of TBUs, and that further study be made of the high prevalence of notified TB in on-shore TBUs.

**Acknowledgements**

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References

Post-migration screening for TB

CONTEXTE : Dispensaire de dépistage de la tuberculose (TB).

OBJECTIF : Déterminer dans l’État de Victoria, Australie, au cours des années 1996–2006, la prévalence de la TB lors de l’immigration, le rendement du dépistage et l’incidence chez les immigrants ayant signé un engagement de santé pour la tuberculose (TBU) qui avaient été sélectionnés pour un dépistage après immigration en raison d’un cliché thoracique anormal.

SCHÉMA : Cas de TB déclarés calculés à partir des liens créés entre une base de données du programme de dépistage et la base de données de TB de l’État de Victoria.

RÉSULTATS : La prévalence à l’immigration (cas déclarés entre l’arrivée en Australie et 6 mois après la date d’enregistrement du dépistage) a été de 505 pour 100 000 personnes. Le rendement à l’immigration (cas prévalents détectés par le programme de dépistage) a été de 420/100 000. L’incidence (cas déclarés entre 6 et 12 mois après la date d’enregistrement du dépistage) a été de 160/100 000 années-personne. Les personnes ayant signé un TBU après l’avoir sollicité à partir de l’Australie même (on-shore) connaissent une prévalence de 1876/100 000, soit sept fois plus élevée que celle de ceux sollicitant un TBU en dehors de l’Australie (off-shore, 254/100 000). La combinaison d’un cliché thoracique anormal et d’un texte cutané tuberculinique ⩾15 mm entraîne une prévalence de TB déclarée de 2907/100 000.

CONCLUSION : Un dépistage sélectif après immigration peut obtenir un rendement élevé de déclarations de TB.

MARCO DE REFERENCIA: Un consultorio de detección de la tuberculosis (TB).

OBJETIVO: Determinar la prevalencia de TB en el momento del ingreso al país, el rendimiento de la detección sistemática y la incidencia en los inmigrantes que se comprometieron a participar en una iniciativa sanitaria de detección de la TB (TBU) posterior a su entrada al país, tras haber presentado imágenes anormales en la radiografía de tórax (CXR) realizada durante el proceso de inmigración en el estado de Victoria, Australia, entre 1996 y el 2006.

MÉTODOS: Se calcularon las tasas de TB notificada mediante la correlación entre la base de datos de un programa de detección y la base de datos de TB del estado de Victoria.

RESULTADOS: La prevalencia de TB al ingreso al país fue 505 por 100 000 (casos notificados entre el momento de la llegada a Australia y 6 meses después de la fecha de registro de la detección sistemática). El rendimiento diagnóstico a la entrada fue 420/100 000 (casos prevalentes detectados por el programa de detección sistemática). La incidencia fue 160/100 000 años-persona (casos notificados entre 6 y 12 meses después de la fecha de registro de la detección). Las personas que acordaron participar en la iniciativa sanitaria sobre la TB después de solicitar un visado estando en Australia presentaron una prevalencia de 1876/100 000, la cual fue siete veces superior a la prevalencia de quienes solicitaron el visado y acordaron participar en la iniciativa estando fuera de Australia (254/100 000). La combinación de una CXR anormal y un resultado de la prueba tuberculinica ⩾15 mm aportó una notificación de la prevalencia de TB de 2907/100 000.

CONCLUSIÓN: Una detección selectiva de la TB posterior a la inmigración puede lograr un alto rendimiento en la notificación de casos de TB.