FOREIGN BORN TUBERCULOSIS IN CANADA: ARE CURRENT SCREENING AND CONTROL PRACTICES WORKING?

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ABSTRACT

Western countries including Canada have seen a steady decline in the incidence rates of tuberculosis (TB) since the advent of anti-tuberculosis drugs in the 1940s. However, less developed nations continue to struggle with high incidence rates as a result of inadequate prevention and treatment programs. The relatively high influx of immigrants from high-incidence countries poses a public health risk for individuals in low-incidence countries, such as Canada.

This paper seeks to determine if TB prevention and control programs in Canada are adequately equipped to handle foreign-born TB (FB TB) cases and what improvements, if any, can be made to the current reporting and surveillance system. An overview of screening and surveillance procedures from a range of other countries is used to provide a basis for comparison and recommendations, as is an analysis of data from the Canadian Tuberculosis Reporting System (CTBRS).

Keywords: Screening, Surveillance, Tuberculosis

Subject terms: Tuberculosis – Control; Tuberculosis – Diagnostic Tools; Tuberculosis – Immigration; Tuberculosis – Prevention; Epidemiology – Tuberculosis; Health Planning and Prevention

DEDICATION

This paper is dedicated to the family and friends who encouraged me throughout the research and writing process. Special thanks go to my parents, Douglas and Christine, and fiancé Mark, for their unwavering support and "tough love". I couldn't have done this without your encouragement! Thanks to my siblings, Stephen and Elizabeth, for keeping my spirits up when things were tough. Lastly, to my peers and friends in the M.Sc.PPH program, thank you for sharing your academic (and non-academic!) experiences with me.

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GLOSSARY

CIC	Citizenship and Immigration Canada
CTBRS	Canadian Tuberculosis Reporting System
CXR	Chest x-ray
Disease	A pathological condition of a part, organ, or system of an organism resulting from various causes, such as infection, genetic defect, or environmental stress, and characterized by an identifiable group of signs or symptoms
DOT	Direct observed therapy
EMB	Ethambutol; first-line drug used in combination with others to treat active TB
Infection	Invasion by and multiplication of pathogenic microorganisms in a bodily part or tissue, which may produce subsequent tissue injury and progress to over disease through a variety of cellular or toxic mechanisms
INH	Isoniazid; first-line drug used in combination with others to treat active TB; also used as prophylactic treatment for LTBI
IME	Immigration Medical Exam
MSP	Medical Surveillance Program
PZA	Pyrazinamide; first-line drug used in combination with others to treat active TB
RMP	Rifampin; first-line drug used in combination with others to treat active TB
Screening	A process that attempts to uncover conditions suitable for early prevention and intervention

Surveillance	An ongoing process involving the systematic collection, consolidation, evaluation, and dissemination of pertinent data
TST	Tuberculin skin test

1.0 Overview

This paper seeks to determine if TB prevention and control programs in Canada are adequately equipped to handle foreign-born TB (FB TB) cases and what improvements, if any, can be made to the current reporting and surveillance system. After conducting an analysis of case reporting forms in the Canadian Tuberculosis Reporting System from 1995-2003, a literature review was conducted to compare screening practices in Canada, Australia, selected European countries, and the United States. The results of the data analysis and literature review were then used to make recommendations for improvements to current national TB screening and control guidelines in Canada.

1.1 Etiology and Pathogenicity of Tuberculosis

Tuberculosis (TB) is a communicable infection caused by the bacterium *Mycobacterium tuberculosis*. Pulmonary TB, in which the bacterium manifests in the lungs, is the most common type of TB infection, but it is important to note that the bacteria can infect other parts of the body, including the lymph nodes, kidneys, bones, stomach, brain, and spinal cord, in what is referred to as extra-pulmonary TB (PHAC, 2004a). The transmission of TB disease is airborne via droplet nuclei expelled from an infected individual through coughing, sneezing, or similar forceful expirations. It is believed that inhalation of only a single droplet nucleus containing the TB bacilli is needed to become infected. TB droplets

have an extremely slow settling pace (0.5mm per second), which allows them to be carried long distances via air currents, duct systems, and elevator shafts (Long and Ellis, 2007). However, transmission of TB from an infected individual to others is most often limited to close contacts (CDC, 2005a), as the probability of one becoming infected depends on the duration and proximity of contact with an infected individual (i.e. prolonged close contact with an infected individual results in an increased risk of transmission). TB bacteria cannot survive in the environment for extended periods, as exposure to heat and sunlight causes them to dry out rapidly; therefore, TB is rarely indirectly transmitted (Long and Ellis, 2007).

1.2 Epidemiology of TB

TB is considered by many to be a social disease – that is, one in which certain individuals are rendered more susceptible to TB than others because of factors known as social determinants of health. For example, TB has been historically linked to poverty; therefore, individuals of lower socioeconomic status are at a greater risk of contracting TB. Other individuals who may find themselves more susceptible to acquiring a TB infection include those who are immunocompromised as a results of HIV/AIDS, substance abuse, diabetes mellitus, cancer of the head or neck, leukaemia, Hodgkin's disease, severe kidney disease, low body weight, organ transplants, or prolonged treatment of conditions with corticosteroids (CDC, 2005). People who reside in poor living conditions (overcrowded rooms with inadequate air circulation and ventilation;

homeless individuals) are also at a higher risk of contracting TB. Individuals who were born or lived in a country where TB is endemic are at an increased risk of TB, not only because of the higher rates of TB associated with their countries of origin but because recent immigrants to Canada are more likely to live in poorer housing conditions, be improperly nourished, and find themselves in social situations with active TB cases than Canadian-born individuals (PHAC, 2004c).

1.3 Diagnosis of Active TB

Active TB disease can be difficult to diagnose because individuals with active TB disease suffer from a variety of non-specific symptoms, including fatigue, fever, cough, and chest pain (PHAC, 2001a). Key indicators that TB disease is present are a persistent cough lasting longer than three weeks, coughing up blood, weight loss, loss of appetite, and night sweats. Active TB is often diagnosed using chest x-rays (CXR), though sputum smear microscopy is also used to diagnose active pulmonary TB disease. Sputum (phlegm from deep inside the lungs) is collected from a suspected case, smeared on a microscope slide, and stained using a special dye that enables a lab technician to visibly identify any TB bacteria present in the sputum. The results of this test are usually available within a day, which reduces any delay in treating patients (PHAC, 2004c; CDC, 2005b). Microbiological culture of a minimum of three sputum samples is highly sensitive for the detection of active pulmonary TB, and is considered by many to be the "gold standard" for diagnosing active pulmonary

TB (Dasgupta and Menzies, 2005).

1.4 Treatment of Active TB

TB disease is treated with an array of anti-tuberculosis drugs, and length of treatment depends on the number and combination of drugs prescribed. Individuals may be asked to take their medication either daily or twice weekly, depending on the treatment regime. A standard treatment regime for uncomplicated TB in Canada consists of two months of intensive dosing with isoniazid (INH), rifampin (RMP), pyrazinamide (PZA), and in some cases, ethambutol (EMB); followed by four months of lower dose levels of the same drugs for a total of six months of treatment, or 95 doses.

Patient compliance is essential to successfully treating TB disease, as treatment failure and relapse are commonly cited as the result of poor patient adherence to treatment guidelines (Long and Ellis, 2007). Direct observed therapy, or DOT, has proven itself to be a highly effective way of ensuring patients adhere to their treatment regime. A trained individual (often a caregiver or health care worker) observes as a patient takes their medication and records it; this not only ensures the patient takes their medication as prescribed, but the health care worker can watch for side effects from the drugs and ensure they are working effectively (PHAC, 2004).

If treated with a strict regime of antibiotics in a timely manner, TB can be curable (Health Canada, 2006). Incomplete or partial adherence to a prescribed

treatment regime has several negative implications, including prolonged illness, increased risk of developing drug resistant TB, and increased risk of transmission to other individuals. Furthermore, individuals who have not been adequately treated (i.e. those who remained undiagnosed and therefore untreated for a long period of time; those who were treated with a single drug rather than several; and those who did not complete treatment) are more susceptible suffering relapses in the future (Long and Ellis, 2007).

2.1 Latent Tuberculosis Infection

TB also exists in a non-communicable form known as latent tuberculosis infection (LBTI). Individuals with LTBI experience no symptoms and feel no less healthy than they are generally accustomed to feeling (PHAC, 2004b). It is estimated that approximately one third of the current world population is infected with the TB bacterium (CIHI, 2001).

2.2 Diagnosis of LTBI

LTBI is most commonly diagnosed through tuberculin skin testing (TST), which involves an intradermal injection of 0.1mL of tuberculin purified protein derivative (PPD) material into the forearm. Patients must return to their health care provider 72 hours later to have their reaction interpreted. Individuals who develop localized swelling (induration of five to fifteen millimetres, depending on

their health status) at the site of the injection are deemed to have had a positive reaction (CDC, 2007). A true positive reaction means TB infection is present. However, both false positives and false negatives can occur as a result of both technical (i.e. poor injection technique) and biological (i.e. individual is malnourished or has experienced a major viral illness in the previous four weeks) reasons (Long and Ellis, 2007; Yuan, 2007). Furthermore, individuals may have a false positive result if they have previously received the Bacille Calmette-Guerin (BCG) vaccination (Long and Ellis, 2007). Negative skin tests can appear in individuals who have been recently infected, as it takes two to twelve weeks after infection for a TST to become positive. To address this issue, individuals who have been in contact with a known case of TB disease often undergo two skin tests, usually eight weeks apart (PHAC, 2004c; Long and Ellis, 2007).

A newer alternative to the TST is an in-vitro T-cell based assay (interferon-gamma release assay or IGRA). This test uses mycobacterial antigens to stimulate T-cells, as T-cells that have been previously sensitized to TB antigen will produce high levels of interferon-gamma upon re-exposure. Despite the availability of these tests, the TST remains the recommended method of screening for LTBI in Canada (CTC, 2007).

2.3 Treatment of LTBI

LTBI progresses into active TB disease in approximately 10% of infected

but otherwise healthy adults. It is therefore important to treat individuals with LTBI, especially those who suffer from other immunocompromising conditions that increase the risk of progression from LTBI to active TB. Current Canadian standards recommend that healthy individuals diagnosed with LTBI adhere to a nine-month regime of the anti-tuberculosis drug INH, though some experts recommend treating patients for shorter or longer periods, depending on the situation. The results of one randomized control trial show that over 90% of individuals who adhere to a 12-month regime (with a compliance of 80% or higher) benefit from protection against TB disease five years later (Long and Ellis, 2007).

Individuals who arrive in Canada with LTBI may later progress to active TB as a result of reactivation. Reactivation can occur when the immune system becomes stressed – a common occurrence in immigrants populations as they struggle to establish their lives in a new country (Lillebaek et al, 2002). It is important to distinguish between reactivation and reinfection; both of which are suspected to contribute to higher rates of TB in FB individuals. Reinfection of the TB bacteria in immigrants to Canada also contributes to high FB TB rates. Reinfection can occur when immigrants return to their country of origin to visit relatives or friends following their settlement in Canada. As these individuals are not re-screened for TB upon their return to Canada, the opportunity exists for these individuals to become re-exposed and re-infected during these trips and return to Canada with active TB. In fact, one study estimated that 20-30% of all FB TB cases in England could be attributed to recent immigrants to England who

became re-infected during a return visit to their country of origin following their settlement (Dasgupta and Menzies, 2005).

3.1 Incidence and Prevalence of TB Worldwide

In 1993, the World Health Organization (WHO) declared TB to be a "global emergency". Researchers for the WHO report that approximately one-third of the world's current population has been infected by the mycobacterium tuberculosis, resulting in about eight million cases and two to three million deaths per year (CIHI, 2001). In 2004, almost nine million new cases were reported worldwide and nearly two million deaths were attributed to TB (WHO, 2006a). The worldwide prevalence rate for the same year was 229 cases per 100,000 population, which means there 14.6 million cases worldwide (WHO, 2006b).

3.2 Geographic Distribution of TB Worldwide

More than 80% of all current TB patients reside in either sub-Saharan Africa or Asia (WHO, 2006a). The global incidence of TB is increasing at a rate of 1% a year, with half of all new cases reported in Bangladesh, China, India, Indonesia, Pakistan, and the Philippines, and nearly one third occurring in Africa (WHO, 2006c). Africa's burden is prominent on the global scene, as 11 of the 15 countries with the highest estimated incidence rates are African nations (WHO,

2006d). For example, the World Health Organization (WHO) reports that the estimated sputum smear positive pulmonary TB rate is 469 per 100,000 population in Swaziland, 282 per 100,000 population in Lesotho, and 268 per 100,000 population in Kenya (WHO, 2007). Zimbabwe, Zambia, South Africa, Namibia, Botswana, and Sierra Leone all display similarly alarming rates. A full compilation of international incidence rates can be seen in Appendix 1.

The rate of TB in developing nations is a stark contrast to the current situation in highly developed countries. Nations such as Canada, Norway, Sweden, and the United States, boast estimated sputum smear positive pulmonary TB rates as low as 2 per 100,000 population (WHO, 2007).

4.1 Incidence and Prevalence of TB in Canada

The incidence of TB in Canada is relatively low compared to many other countries. Typically, 1,600 new and relapsed cases of TB are reported in Canada annually (Health Canada, 2006).

Following a decline in rates after the discovery of effective antibiotics in the late 1940s, the annual reported incidence reached a plateau in the late 1980s, leading to concern that the rate of TB in Canada could be on the rise once again (Canadian Lung Association, n.d.). This resurgence in incidence may be due in part to increased rates of international travel and immigration, the interaction of TB with HIV and other immune deficiencies, and the emergence of drug resistant

and multi-drug resistant TB (CIHI, 2001; Tortora and Grabowski, 2003).

Recent Canadian data shows that the total number of all reported cases in 2005 (both new and relapsed) was 1,616. This translates to 5.0 cases per 100,000 population. Of these cases, 63% were attributed to foreign born individuals, and Canadian-born Aboriginals accounted for an additional 19% (PHAC, 2006). The burden of foreign born cases (referred to herein as FB TB) will be examined in greater detail in subsequent chapters.

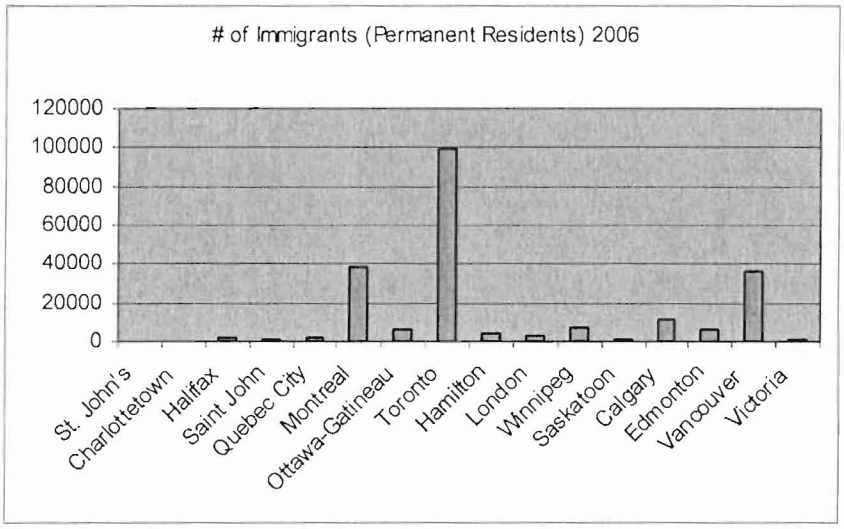
4.2 Geographic Distribution of TB Cases in Canada

Nova Scotia boasted the lowest rate of all reported cases in 2005 with 0.6 reported cases per 100,000 population; New Brunswick and Prince Edward Island were close behind with 0.7 cases per 100,000 population (PHAC, 2006). On the opposite end of the scale, Nunavut displayed the highest rate at 150.0 cases per 100,000 population, which is the result of high incidence rates in the Inuit population (PHAC, 2006; Long and Ellis, 2007).

Ontario reported the largest number of cases (n=623) and Ontario, British Columbia, and Quebec collaboratively accounted for 71% of all Canadian cases reported during 2005 (PHAC, 2006). This is because the geographic distribution of FB TB cases in Canada is not uniform (Gushulak, 2006). Immigrants tend to settle in large metropolitan areas (especially those that are ports of entry) as opposed to rural regions, and certain provinces, such as Ontario and British

Columbia, see a higher annual influx of immigrants than others for this reason (Walter et al, 2008). Figure 1 below displays the distribution of immigrant arrivals by metropolitan region in 2002.

Figure 1: Distribution of Immigrants by Metropolitan Area, 2006



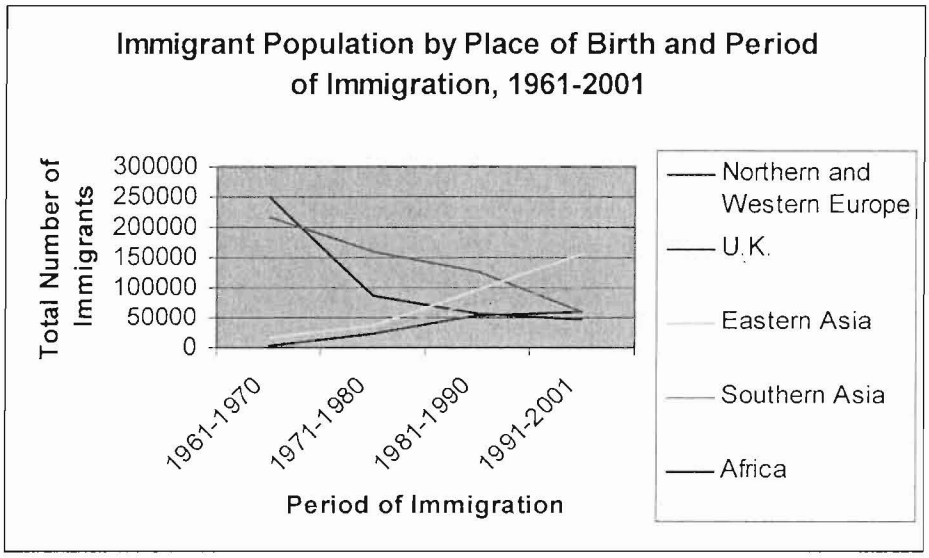
5.1 FB TB in Canada

Canada boasts one of the largest per capita immigration programs in the developed world (Gushulak, 2007). In fact, when expressed as a percentage of the total national population, the annual influx of immigrants into Canada is higher than that of the United States (Gushulak, 2006).

Until the 1960s, most immigrants to Canada originated in Western and Central Europe and the United States - all relatively low-incidence TB countries

(Gushulak, 2006). At present, the majority of all immigrants to Canada arrive from high incidence countries in the Western Pacific, Eastern Asian, and African regions (see Figure 2). The use of domestic measures alone to control TB would be both expensive and complex given the high numbers of immigrants who arrive in Canada from TB endemic countries, whereas investing in international TB control is not only more cost-effective but may be cost-saving in the long run (Gushulak, 2007; Cain and MacKenzie, 2008). Analyses have shown that FB TB rates in low incidence countries correlate with rates in immigrants' countries of origin (Menzies, 2003); therefore some researchers suggest that domestic TB control in low incidence countries such as Canada be guided by the global epidemiology of TB (Cain and MacKenzie, 2008). The prevalence of FB TB in Canada could be reduced if migration is treated as a major component in TB prevention and control practices. However, in spite of the perceived effectiveness of international prevention and control strategies, the majority of current Canadian TB control policies continue to focus on domestic disease elimination (MacPherson and Gushulak, 2006).

Figure 2: Immigrants to Canada by Country of Origin



5.2 Current Screening and Control Practices in Canada

Certain individuals are required to undergo an Immigration Medical Exam (IME) in their country of origin by a designated physician prior to being granted entry to Canada. These individuals include those applying for permanent residency from abroad, individuals claiming refugee status within Canada, and students, workers, and visitors intending to stay longer than six months and who have spent six or more consecutive months in a high TB incidence country or territory in the year preceding the date of application (CIC, 2008). A complete list of entrants who are required to undergo an IME can be found in Appendix 2.

The IME consists of a medical-taking history, physical examination, and CXR for individuals over eleven years of age. CXRs are one of the best methods currently available for screening, as both active TB and previous inactive TB can

be detected from them (Menzies, 2003). Individuals with CXRs indicative of active pulmonary TB are denied entry to Canada until they have successfully completed a course of treatment. Individuals whose CXRs show evidence of past or inactive TB and who are determined to be at an increased risk for progression to active TB are not denied entry. Instead, they are instructed to report to a local health authority for medical surveillance within thirty days of arrival at their destination city in Canada (Heywood et al, 2003). TSTs for LTBI are not currently included as part of the routine screening program for immigration to Canada (Levesque et al, 2004).

The Medical Surveillance Program (MSP) acts as a means for follow up of individuals with suspected TB infection. It provides an opportunity for individuals to undergo a complete medical evaluation in Canada with a health care practitioner who is experienced with the diagnosis and management of TB in order to confirm or refute the presence of any type of TB infection. Based on the results of the evaluation, the individual may receive treatment for active TB or LTBI, or be referred for ongoing medical surveillance (PHAC, 2001b). However, while individuals suspected of having LTBI following the IME must sign their written consent for referral to the MSP upon entry into Canada, this does not ensure their adherence to MSP protocols (Richard et al, 2005).

While national screening and control guidelines for active TB are published in the Canadian Tuberculosis Standards, actual strategies employed may vary between provinces and territories. In British Columbia, for example, the British Columbia Centre for Disease Control (BC CDC) has adapted national guidelines

to suit the needs and resources of the province. Screening of new arrivals to the province includes a review of the individual's relevant medical history, results of the TST (if available), a recent CXR, and results of any bacteriological specimen testing (BC CDC, 1999).

5.3 Are Current Canadian Screening and Control Strategies Working?

One of the most pressing issues associated with FB TB in low incidence countries is missed opportunities for the early diagnosis and prevention of TB. Several studies have suggested that opportunities to prevent future TB cases are lost as a result of low referral rates to the MSP, poor patient adherence to the MSP guidelines, and the few individuals that have been referred to the program who receive adequate preventive therapy (Wobeser et al, 2000). A review of the literature available on FB TB in Canada, as well as an analysis of data from the Canadian Tuberculosis Reporting System (CTBRS), showed mixed results regarding the effectiveness of Canada's current system.

Current immigrant screening practices were developed over fifty years ago, and do not ensure that all immigrants to Canada are evaluated for TB; that is, they do not receive an IME (Gushulak, 2006; Beiser, 2005). For example, some persons with non-resident visas are not required to provide a CXR, and illegal immigrants forgo the medical screening process completely (MacPherson et al, 2007).

Interpretation of IME results, especially CXRs, is another potential hindrance in the screening of TB in immigrants to Canada. Most immigration medical cases are reviewed by contracted medical staff abroad, for whom there is no standard training program - each contracted staff member is expected to follow the instructions of the medical officer at their respective location (Gushulak, 2006). This may impact the quality assurance of the IME, as inadequately trained medical officials may not know how to recognize signs and symptoms of TB and/or LBTI. This can also be applied to physicians conducted follow-up medical evaluations in Canada. A Montreal based study found that high-volume clinicians were more likely to recommend treatment of LTBI than their low-volume counterparts (86% versus 71%), suggesting that doctors familiar with TB are more likely to prescribe treatment (Richard et al, 2005). Furthermore, the results of the IME are considered valid for a period of 12 months, giving future immigrants to Canada who provide a clean CXR as part of the IME a lengthy period of time to develop active TB disease (Gushulak, 2006).

The current screening program was not designed to deal with LTBI in immigrants, but rather infectious active disease, which is no longer the driving force behind high FB TB rates (Gushulak, 2006). Only a small proportion of individuals applying for permanent residency are found to have active TB at the time of their medical evaluation; much of the FB TB burden in Canada is the result of progression from LTBI to active TB disease after arrival in Canada (Dasgupta and Menzies, 2005). In fact, one study reported that 60-90% of active FB TB cases occur in patients who immigrated with LTBI (Levesque et al, 2004).

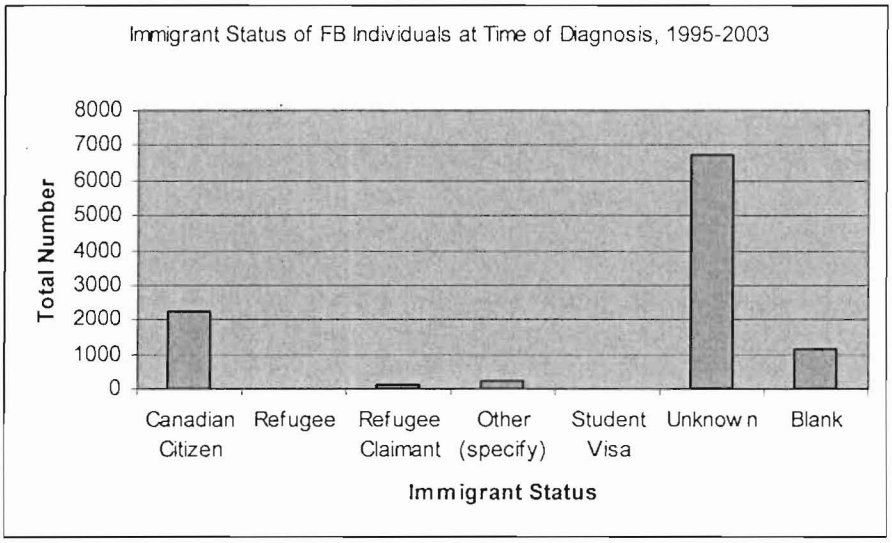
Large scale efforts to screen and treat new immigrants for LTBI would require extensive planning, pilot testing, enhanced information sharing, further practitioner training, and ongoing program evaluation. The increases in cost and complexity that would accompany in implementation of such a system would be substantial (Richard et al, 2005; Dasgupta and Menzies, 2005).

A study conducted in Montreal in 1999 and 2000 showed high patient adherence to the MSP (83% of patients who received an invitation for follow up from the Montreal Public Health Department (MPHD) attended an initial visit; and 80% of those prescribed treatment for LTBI following the initial visit completed their treatment regime) but poorer performance from health service providers. Only 792 of the 1,444 new adult permanent residents referred to the MSP in Montreal (55%) received invitations for follow up from the MPHD. Main reasons cited for letters not being sent included invalid permanent address data, or receipt of documentation of previous adequate treatment for TB in files forwarded by Citizenship and Immigration Canada (CIC) (Richards et al, 2005). The results of this study demonstrate that if high treatment rates are to be achieved, both public health authorities and immigrants must comply with MSP protocols.

Completed case reporting forms obtained from the CTBRS indicate that the current screening programs are ill-adapted to Canada's current TB situation. From 1995 to 2003, approximately two thirds (n=6,742) of all reported FB TB cases provided no information with respect to immigrant status (see Figure 3, below). We cannot draw conclusions about whether or not screening programs should be expanded to include more entrant categories based on the information

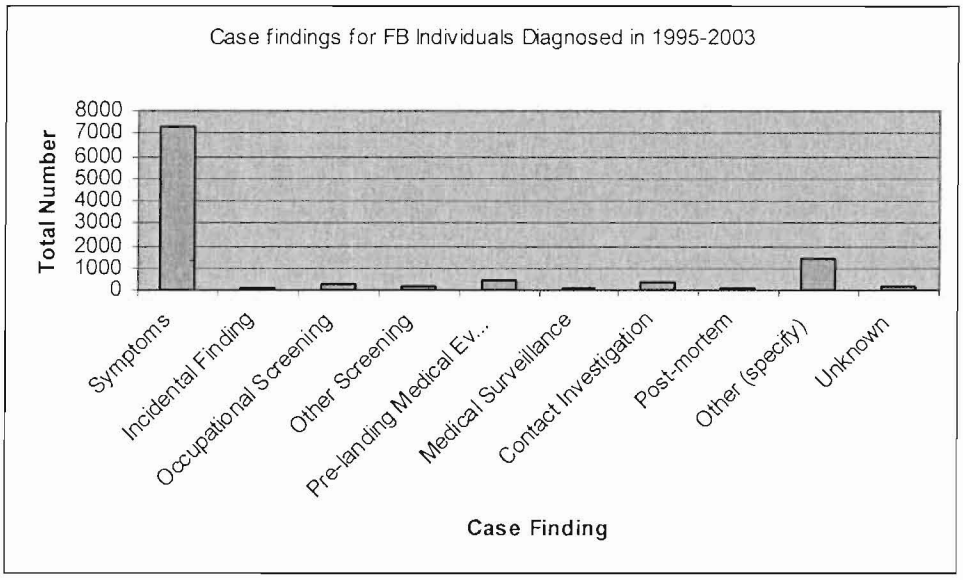
available.

Figure 3: Immigrant Status of FB Individuals at Time of Diagnosis, 1995-2003



Results of the CTBRS analysis also show that only a small number of FB TB cases are uncovered annually through the medical surveillance program (see Figure 4, below).

Figure 4: Case Findings for FB Individuals Diagnosed in 1995-2003



Overall, it appears the current Canadian system has the potential to reduce the burden of FB TB on public health services, but only if IME and MSP guidelines are closely followed by both new entrants and public health officials/practitioners. Because of the relative lack of incentive and enforcement, it becomes easy for immigrants with LTBI to be lost to follow up and progress to active TB in the years following their resettlement.

5.4 FB TB Screening and Control Strategies in the United States

The United States employs similar, though not identical, screening strategies to Canada's. Individuals seeking citizenship in the U.S. are required to undergo a medical examination conducted by a physician who has been designated as a civil surgeon by the United States Citizen and Immigration

Services (USCIS). All individuals over the age of two must have a TST conducted during their medical exam. If a positive reaction is noted, individuals are then required to have a CXR. Individuals diagnosed with active TB are not granted medical clearance until a course of treatment (usually nine months in length) is completed. Individuals with suspected LTBI are referred to a physician for further evaluation and will receive medical clearance upon provision of documentation of their evaluation to the civil surgeon, as surveillance of patients with LTBI does not regularly occur following arrival in the U.S. (USCIS, 2005). Under certain circumstances, individuals with active TB may file for a medical waiver, which permits immigration despite the presence of a condition which would normally render them medically inadmissible (USCIS, n.d.).

Despite the slightly more rigorous medical requirements, the immigration process in the U.S. is comparable to that in Canada and, as a result, similar difficulties with the screening of FB TB cases have been reported. Like Canada, the U.S. *Immigration and Nationality Act* designates immigration officials as the authority for immigration medical exams rather than public health officials and no federal regulations prescribing or enforcing medical surveillance recommendations exist (Gushulak, 2006).

Disparities in physician awareness of TB varies in the U.S. For example, a survey of civil surgeons in California, Massachusetts, and New York found that of 5,739 immigrants, 1,449 (25%) received non-standard screening. This indicates a need to develop guidance documents, training manuals, and diagnosis/treatment guidelines for physicians who screen immigrants for TB

infection and disease (CDC, 2005c).

Patient non-adherence to treatment for both LTBI and TB represents a major barrier to FB TB control in the U.S. Reasons for this may include cultural and linguistic barriers that affect both access to health care and health-seeking behaviours; a lack of understanding about patient responsibilities for follow up; and a lack of understanding about treatment completion (CDC, 2005c). While patient non-compliance appears to be less of a problem in Canada, based on the results of the Montreal study, both countries would benefit from reducing cultural and linguistic barriers to treatment and care.

Another barrier for TB control within the United States is that of illegal immigrants. The U.S. must attempt to deal with large influxes of undocumented, irregular, or illegal immigrants who manage to bypass the immigration medical screening process. As a national strategy for TB control in illegal immigrants does not currently exist, this quickly escalates into a large problem: there are an estimated 7 to 8 million illegal immigrants residing in the U.S., with most individuals hailing from Latin America, a region with elevated TB rates (Gushulak, 2006).

Based on the literature review conducted, screening practices and policies in the U.S. are no more beneficial than those used in Canada. Minor differences in screening protocols of immigrants do exist between Canada and the U.S., but the result is essentially the same: FB TB screening and control practices are not working as effectively as possible.

5.5 FB TB Screening and Control Strategies in Australia

Australia has one of the lowest incidence rates of TB in the world (about 5 cases per 100,000 population) despite the fact that approximately 60% of the 8.8 million cases reported worldwide in 2002 occurred in nearby the Southeast Asian and the Western Pacific regions. In 2003, 982 cases of TB were reported; 812 were attributed to FB TB (DHA, 2004).

Individuals applying for permanent residency, as well as some individuals applying for temporary visas, are required to have a medical exam performed by a panel physician (equivalent of the U.S. civil surgeon), which includes a CXR for individuals eleven years of age and older. If active TB is present, the individual must undergo a course of treatment and test negatively before they can be considered eligible for admission to Australia. Furthermore, they must provide written agreement to contact the Health Undertaking Service (TBU) upon their arrival in Australia and be willing to report to a state or territory health authority for follow up (DIC, 2008).

Once an individual is referred to the Migrant Screening Clinic, he or she is assessed for signs and symptoms of active TB, his or her CXR is reviewed, and, if necessary, a TST is given. Patients may be referred for further evaluation if there is any indication of active TB or there is cause for considering treatment of LTBI (DIC, 2008).

Treatment outcomes for 2003 show that 86.4% of FB TB cases resulted in cure or completion (DHA, 2004), while treatment outcomes for 2004 indicate that

96% of FB TB cases were reported as cured or completed (DHA, 2005). The FB TB cure/completion outcomes for both years were slightly lower than those of the native-born population (96.6% and 97%), however they are still quite high. This may be due in part to the fact that Australian TB services support pre-migration screening for active TB and participate in post-migration follow up programs co-led by the Department of Immigration, Multicultural, and Indigenous Affairs (DIMIA). Furthermore, TB clinics routinely produce educational materials in a number of languages and are currently working to adapt their programs to meet the specific cultural and social needs of various migrant populations (DHA, 2004).

In 1999, the Communicable Disease Network Australia (CDNA) approved the formation of a National TB Advisory Council (NTAC) with the objective of providing advice of the development of a coordinated national and international plan to control TB, and to develop and review nationally agreed-upon strategies and implementation plans for TB control within Australia. A key component of this program, and one that appears to be lacking in other countries, is the establishment of transparent performance indicators, including the annual incidence of TB in FB persons, and the number of case outcomes reported yearly (CDNA, 2002).

The Australian government has clearly worked to create a unified national strategy to prevent the importation of FB TB into their country. Making resources available to FB persons in a culturally sensitive manner has no doubt contributed to the success of their program. Though the rate of FB TB continues to be

elevated above that of the native-born populations, public health officials have developed measures that will likely help lessen the burden of FB TB in years to come.

5.6 FB TB Screening and Control in European Countries

Approaches to screening immigrants to European countries vary widely, depending on each country's own policies. Enlargement of the European Union (EU) in recent years facilitated migration between certain nations, which in turn has dramatically changed FB TB rates across its expanse (EuroTB, 2007). The lack of a standardized policy across the EU and other countries belonging to the WHO's European Region makes the control of TB within the region especially problematic.

A study of screening policies in 26 countries belonging to the European Region conducted in 2003 found that 13 countries (Albania, Austria, Bulgaria, Croatia, Hungary, Italy, Kyrgyzstan, Moldova, Poland, Romania, Spain, Turkey, and the former Yugoslavia) had no specific screening policies for new entrants to their country. The remaining 13 countries surveyed had policies that targeted refugees and asylum seekers, while six of these countries also held additional policies targeting foreign workers and students (ECDC, 2004). Ten of the countries that had TB screening programs for individuals had written national guidelines, and eight had national laws regarding the screening of new entrants

for TB (Coker et al, 2004). Interestingly, none of these countries screened new entrants prior to arrival in the country and only three (the UK, Belgium, and Switzerland) screened at ports of entry. Another nine screened new arrivals at designated migrant centres and one (Malta) screened at a specialized TB clinic (ECDC, 2004; Coker et al, 2004). All countries except Denmark, the Netherlands, and France routinely used CXRs and TSTs as screening tools (ECDC, 2004).

The authors of this study suggest that the lack of similarities in TB screening policies across Europe reflects the uncertainty surrounding the systematic screening of new entrants. Because overall rates of TB are higher in Eastern and Central Europe than in Western Europe, public health policy makers in Eastern and Central Europe may not view FB TB as a public health challenge and would rather focus their prevention and control efforts on health issues of greater political priority (Coker et al, 2004).

Another study focused on screening processes in Norway determined that high initial rates of TB detection were partly explained by the obligatory screening of individuals from high incidence countries upon their arrival. However, researchers also found that despite compulsory notification and personal reminders, only 50% of new arrivals from high incidence countries attended screening in 1999 (Farah et al, 2005). This clearly demonstrates that though a country may have strict screening policies in place, they are not routinely adhered to.

The screening practices employed in the Netherlands provide a worthy

example for other countries. All immigrants arriving in the Netherlands from highly endemic countries undergo obligatory screening by CXR within one week of arrival, followed by voluntary follow up every six months for two years (Dasgupta and Menzies, 2005). Residence permits are only issued to temporary visa applicants from countries of high TB incidence if the condition of screening upon arrival has been met (Coker et al, 2006). A study found that coverage of entry screening is nearly 100%, but declines with time: coverage at first follow up is 50%, and only 30% at second follow up. Nonetheless, an evaluation of these screening practices found that cases were detected earlier, a lower proportion of patients were sputum-positive, there were fewer hospital admissions, patients experiences shorter durations of symptoms, there were fewer outcomes of death, and transmission of TB was reduced (Verver et al, 2002). The benefits of screening both at entry and at regular intervals thereafter are detection of TB at an earlier stage of disease progression, and a smaller number of cases go undetected.

In the UK, screening (brief medical examination and CXR) is conducted at ports of entry despite the widespread attitude that this type of screening only identifies a small number of cases and that resources are better spent on TB control strategies (HPA, 2007). The Consultant for Communicable Disease Control (CCDC) is informed of the arrival of all new entrants to the UK who intend to stay for a period of more than six months and who hail from a country where the incidence rate of TB is greater than 40 cases per 100,000 population. A new entrant is referred to TB services in their destination city by the CCDC so that he

or she may be offered follow up treatment should it be deemed necessary; however only one in six individuals invited to attend further screening actually do so (Coker et al, 2006). Furthermore, no guidelines exist on the extent to which individuals should be screened (Van den Bosch and Roberts, 2000).

FB TB screening guidelines in the UK dictate that TSTs should only be given to new immigrants who have not received the BCG vaccination. A study of two UK screening sites found that neither followed these guidelines: one site limited testing to individuals younger than 35 years of age on the basis that they would be offered preventive treatment if a positive test was obtained and active TB had been ruled out; the other site screened all individuals over the age of 25 by CXR and only used TSTs when deemed necessary (Coker et al, 2006). This clearly demonstrates a lack of adherence to national guidelines for FB TB control.

A study on the effectiveness of FB TB screening practices in the UK found that at periods of peak travel, immigration officers did not have sufficient time or staff so screen all recommended individuals; therefore CXRs were not routinely required for individuals who would have been detained for longer than 30 minutes. They also found that only an estimated 15-40% of individuals referred to the local health authority for further screening actually attended (Van den Bosch and Roberts, 2000).

It seems then that the priorities of the UK government do not align with their screening policies, and that the lack of uniformity in the execution of screening protocol results in poor adherence to surveillance guidelines by both officials and

immigrants.

6. Discussion

Clearly, screening practices vary widely from nation to nation, and no two of the countries examined in the previous section have identical screening practices. FB TB prevention and control strategies must be tailored to suit the needs of each individual country, so when comparing current Canadian guidelines with those of other countries in hopes of uncovering strategies that may improve screening of TB in immigrants to Canada, it is important to keep in mind that Canada's TB situation is unique to Canada. The table below presents a summary of selected countries' FB TB screening and control practices so that they may be compared with greater ease.

Table 1: Comparison of FB TB Screening Strategies for Permanent Resident Applicants in Selected Countries

Country	Location of Screening	Components of IME	If active TB is detected ...	If LTBI is detected ...
Canada	Abroad	Physical exam; CXR for those >11 years; review of medical history	Applicant is denied entry until 9 months of treatment has been completed	Applicant may enter Canada without being treated; may be referred to MSP upon arrival
Australia	Abroad or in Australia	Physical exam; CXR for those >11 years; review of medical history	Declared medically inadmissible until 9 months of treatment has been completed	Referred for further evaluation and surveillance
Netherlands	At local health authority	CXR within one week of arrival; voluntary surveillance of LTBI for 2 years	Applicant is referred to TB services for treatment	Applicant is encourage to attend follow up sessions every 6 months for 2 years
United Kingdom	At port of entry	Brief physical examination and CXR if resources are available	Applicant is referred to TB services for treatment	Applicant may be referred to TB services for follow up
United States	Abroad	Physical exam; TST for those >2 years; review of medical history; CXR only if deemed necessary	Applicant is denied entry until 9 months of treatment has been completed	Applicant is referred to a physician for further evaluation; surveillance following arrival not common

7. Recommendations for Improvements

1. One of the greatest limitations of screening immigrants is that, despite the

efforts made by public health officials to enroll new entrants in the MSP, individuals are often screened only once, prior to their initial entry to Canada. Because the results of the IME are valid for one year, a window of opportunity for the progression from LTBI to active disease exists, and individuals may unknowingly arrive in Canada with active TB and a clean bill of health. Therefore, the period of time for which the IME remains valid should be shortened to six or nine months. While individuals may still develop active TB during this period, the risk is greatly diminished.

However, one consequence of reducing the length of the validity of IME results is that there is a great deal of paperwork involved with immigration, and it can take quite some time to complete it all. If the period of validity for the IME is reduced to only 6 or 9 months, immigrant applicants may actually have to undergo the IME more than once if not all paperwork is completed by the time their IME results expire. This creates more stress for immigrant applicants, which can in turn result in progression from LTBI to TB disease should that individual be infected with the TB bacterium.

2. Furthermore, individuals who have been granted permanent residency often return to their country of origin to visit friends and family, re-exposing themselves to TB disease. These individuals are not screened upon re-entry to Canada and may therefore import TB with them at this point. Implementing a policy to reduce the importation of TB obtained on return visits to one's country of origin would be extremely controversial but should be considered nonetheless.

3. Another major obstacle of screening programs is the coordination and flow of information between jurisdictions. In the Canadian context, IMEs are performed overseas and reported to Canadian immigration authorities yet post-immigration surveillance programs are administered by local providers. Secondary migration between provinces or territories also poses a problem, as it increases the potential for losing a case to follow up. A solution to this would be to follow the lead of the state of California, which has developed a special case reporting form that is forwarded from one local health authority to another in the case an individual under medical surveillance relocates.

4. Low incidence countries such as Canada rely on the CXR, which has a sensitivity of 59-82% and a specificity of 52-63% for the detection of active pulmonary TB, as a key screening tool for new entrants to the country (Dasgupta and Menzies, 2005). Because of its low positive predictive value (PPV), in combination with the low prevalence of active TB at the time of screening (0.1-0.2% of immigrant populations), it has little impact on reducing the rates of FB TB in Canada and is not very cost effective. Replacing the CXR with sputum culture testing would offer a small improvement in cost effectiveness but would not detect any cases of LTBI, which is the driving force behind the high rates of FB TB in Canada. TSTs approximate the CXR in terms of sensitivity and specificity, and while they are more cost effective, false positives are common and the majority of infected persons will not develop active TB disease (Menzies, 2001). The table below compares the sensitivity, specificity, and PPV of four commonly

used diagnostic tests. The data presented in the table below (Dasgupta and Menzies, 2005) clearly demonstrates that improved diagnostic and therapeutic tools are desperately needed; until then, a combination of CXRs and TSTs should be used.

Table 2: Sensitivity, Specificity, and Positive Predictive Value of Commonly Used Diagnostic Tests for the Detection of Pulmonary TB

Test	Sensitivity (%)	Specificity (%)	PPV (%)
CXR	59-82	52-99	2.9
Single culture microscopy	80-85	98	29.3
Three culture microscopy	80-100	98	31.3
TST	53-90	5 (when distinguishing between active TB and LTBI)	<1

5. Expanded screening programs, especially for LTBI, would be useful in reducing the burden of LTBI; however, this would only be beneficial if all individuals suspected of having LTBI received preventive therapy for it. This is unlikely to happen on a national level, as adherence to medical surveillance guidelines is often poor, and preventive therapy is lengthy, costly, and potentially toxic. It would also result in a substantially increased administrative workload for public health departments. Instead, efforts should be focused on providing pertinent information, such as referrals to the MSP, in multiple languages. New entrants need to be made aware of how to access public health services and of

the importance of protecting themselves against TB disease without increasing fear of the disease. Individuals may need reassurance that attending post-immigration surveillance or evaluations will not result in the revocation of their visa or status as a permanent resident. Lastly, we need to improve upon the number of individuals referred to the MSP for follow up. Perhaps making this an enforceable condition, as it is in the Netherlands, would help increase the number of individuals who receive preventive treatment via the MSP.

6. The control of LTBI in FB individuals following settlement currently poses a major issue for Canadian public health infrastructure. Follow up of individuals diagnosed with LTBI at the time of their IME is imperative. As an individual with LTBI is not considered under the Immigration Refugee and Protection Act to be a danger to public health or likely to place excessive demands on the Canadian health care system, they may be admitted to Canada with no requirement for treatment or follow up. Only high-risk individuals are referred to the MSP, despite the fact that over 100,000 tuberculin-positive immigrants arrive in Canada each year (Menzies, 2003); and it is a struggle to properly manage the much smaller number of individuals who are referred to the MSP given Canada's current health infrastructure and resources. Therefore, routine testing for LTBI should be added to the IME, and individuals who test positively and are estimated to be at an increased risk for progression to active TB should be required to report for medical surveillance. While this would require massive investments and alterations to the Canadian public health infrastructure, the

benefits to both public health and individual health of immigrants would be substantial. There is also a dire need to improve compliance rates for those individuals who are recommended for medical surveillance. Individuals who are treated for LTBI should not be released from follow up until they have satisfactorily completed their course of treatment, and should be instructed to seek medical attention from their primary health provider should any symptoms of active TB arise. Likewise, general practitioners need to be alert to the symptoms of TB and aware of treatment protocol. By improving our standards for screening and treating LTBI, we could drastically reduce the burden of FB TB.

7. The final recommendation that should be made is to make a global investment in the control of TB in high incidence countries. While an idealistic venture, reducing the rate of TB in high incidence countries will result in a global reduction in incidence and will in turn reduce the rates of FB TB in low incidence countries such as Canada. In the long run, this may prove to be the most cost-effective means for reducing the burden of FB TB and is certainly the most humanitarian way to achieve this goal.

8. Conclusions

The control of FB TB in Canada is not an unattainable goal. While the current prevention and control strategies are not perfect, they do provide a basis

for improvement. The examination of protocols and policies for FB TB control in other countries allows us to see which strategies are successful and which are not. From there, we can adapt our system, making modifications to suit the needs of both immigrants and native-born Canadians. Strengthening our national policies and providing additional resources for local health care providers will facilitate our efforts in reducing the FB TB burden. If we continue to follow the national guidelines with respect to the IME, train our health care professionals so that they are comfortable with diagnosing TB and LBTI, and ensure that individuals referred to the MSP meet their conditions, we should be able to alleviate some of the burden of FB TB in Canada.

APPENDICES

APPENDIX 1 – INTERNATIONAL TB RATES, 2003-2005

Country	WHO Estimated Sputum-Smear Positive Pulmonary TB Rate per 100,000 (3 year average)
Afghanistan	125
Angola	115
Armenia	33
Australia	3
Austria	6
Azerbaijan	34
Bangladesh	105
Bolivia	98
Botswana	259
Brazil	27
Burkina Faso	84
Burundi	147
Cambodia	226
Canada	2
Central African Republic	134
China	46
Congo	162
Croatia	19
Cyprus	2
Czech Republic	5
Djibouti	328
Dominican Republic	41
Democratic Republic of the Congo	158
Egypt	12
Estonia	20
Ethiopia	154
Finland	4
France	4
Germany	4
Grenada	2
Guinea	105
Haiti	136
Iceland	1
India	75
Indonesia	115
Iran	12
Iraq	54
Ireland	5
Israel	4
Italy	3

Japan	13
Kazakhstan	66
Kenya	268
Lesotho	282
Liberia	124
Lithuania	29
Luxembourg	5
Madagascar	99
Malawai	175
Malaysia	46
Malta	3
Mauritania	130
Mexico	13
Monaco	1
Mongolia	86
Montenegro	15
Morocco	47
Mozambique	189
Namibia	290
Nepal	86
Netherlands	3
New Zealand	5
Nigeria	125
Norway	2
Pakistan	82
Papua New Guinea	107
Peru	80
Philippines	132
Poland	13
Portugal	18
Republic of Korea	41
Romania	64
Russian Federation	51
Rwanda	160
Samoa	12
San Marino	3
Saudi Arabia	18
Senegal	111
Serbia	15
Sierra Leone	199
Singapore	16
Slovakia	9
South Africa	252
Spain	12
Sri Lanka	27
Sudan	98
Swaziland	469
Sweden	2

Switzerland	3
Tajikistan	82
Thailand	63
Timor-Leste	250
Togo	158
Trinidad & Tobago	4
Tunisia	10
Turkey	12
Uganda	171
Ukraine	43
United Arab Emirates	8
United Kingdom	5
USA	2
Uzbekistan	52
Venezuela	19
Viet Nam	79
Yemen	40
Zambia	265
Zimbabwe	260

APPENDIX 2 – LIST OF INDIVIDUALS RECOMMENDED FOR THE IMMIGRATION MEDICAL EXAM (IME)

Entrants to Canada	**Criteria**
Foreign nationals applying for permanent residency (immigrants and refugees selected abroad)	Mandatory for all
Foreign nationals claiming refugee status in Canada	Mandatory for all
Foreign nationals applying for temporary residency (including students, workers, and visitors)	Those who will stay in Canada for more than 6 months and who have spent 6 or more consecutive months in a high TB incidence country/territory, as designated by the Public Health Agency of Canada, during the 1 year immediately preceding the date of seeking entry (application) to Canada
Foreign nationals applying for temporary residency and seeking to work in certain occupations	Mandatory for all who are seeking to work in an occupation in which the protection of public health is essential regardless of length of stay and country of origin AND for agricultural workers from a high TB incidence country/territory, as designated by the Public Health Agency of Canada. The occupational list is available at: <http://www.cic.gc.ca/english/information/medical/medexams-temp.asp>
Seriously ill foreign nationals	May be requested to undergo an IME if a CIC or Canadian Border Services Agency officer has reasonable grounds to believe that the person is medically inadmissible to Canada, regardless of anticipated length of stay in Canada and country of origin

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