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Why the tuberculosis incidence rate is not falling in New Zealand

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Abstract

Aims To assess the role of migration from high-incidence countries, HIV/AIDS infection, and prevalence of multi-drug resistant organisms as contributors to tuberculosis (TB) incidence in New Zealand (NZ) relative to ongoing local transmission and reactivation of disease.

Methods TB notification data and laboratory data for the period 1995 to 2004 and population data from the 1996 and 2001 Census were used to calculate incidence rates of TB by age and ethnicity, country of birth (distinguishing high and low -incidence countries), and interval between migration and onset of disease. Published reports of multi-drug-resistant TB for the period 1995 to 2004 were reviewed. Anonymous HIV surveillance data held by AIDS Epidemiology Group were matched with coded and anonymised TB surveillance data to measure the extent of HIV/AIDS coinfection in notified TB cases.

Results Migration of people from high-TB incidence countries is the main source of TB in NZ. Of those who develop TB, a quarter does so within a year of migration, and a quarter of this group (mainly refugees) probably enter the country with pre-existing disease. Rates of local TB transmission and reactivation of old disease are declining steadily for NZ-born populations, except for NZ-born Māori and Pacific people under 40. HIV/AIDS and multi-drug-resistant organisms are not significant contributors to TB incidence in NZ and there is no indication that their role is increasing.

Conclusion TB incidence is not decreasing in NZ mainly due to migration of TB infected people from high-incidence countries and subsequent development of active disease in some of them in NZ. This finding emphasises the importance of regional and global TB control initiatives. Refugees and migrants are not acting as an important source of TB for most NZ-born populations. Those caring for them should have a high level of clinical suspicion for TB.

It is well documented that tuberculosis (TB) incidence rates in the developed world rapidly declined after the Second World War. However, in the mid to late 1980s, the decline was halted and many countries experienced an increase in TB incidence rates.[1]

Occurrence of human immunodeficiency virus (HIV) infection and acquired immune deficiency syndrome (AIDS),[1,2] emergence of multi-drug-resistant (MDR) organisms,[1] and increased migration from high-incidence countries,[1] have been implicated as causes for the TB increase.

New Zealand (NZ) also followed this declining trend in TB incidence up to the mid-1980s. Since then, the incidence rate has plateaued.[3] TB in people who have emigrated from high-incidence countries has been thought to be one factor preventing

a further decline in TB incidence in NZ. Specifically, inadequate screening of migrants who are subsequently shown to have active disease soon after arriving has been suspected to be one factor contributing to this pattern.[4,5] However, it is important to assess the relative importance of other potential factors, notably the role of HIV/AIDS infection, increasing drug resistance (particularly MDR), and the potential decline in the effectiveness of local TB-control programmes. This paper uses data from several surveillance sources to analyse the relative importance of these factors in preventing the further fall in the TB incidence rate in NZ.

Methods

This paper is largely based on analysis of TB surveillance data for the years 1995–2004 and 1996 and 2001 Census data (see the preceding article for a description of these data sources).[6]

Migration—The TB surveillance system records country of birth and, for migrants, their date of arrival in NZ. These data allow cases born in low TB incidence countries to be distinguished from those born in high-TB incidence countries (defined as all countries except Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Holland, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, NZ, Norway, Slovakia, Sweden, Switzerland, the UK, and USA).[7]

We calculated the crude incidence rate by migrant region and country (for countries contributing on average more than one TB case a year) using census data on country of birth to provide the denominator. We also examined the TB notifications of people born in low- and high-incidence countries according to the interval between time of arrival in NZ and the date of notification.

Transmission and reactivation in NZ—TB cases were divided into categories based on probable transmission setting and timing of infection.

This classification used a combination of:

- NZ-born versus overseas-born;
- Ethnic group; and
- Age group.

The age group classification split the population into those <40 years where infection is likely to be due to relatively recent transmission and those ≥40 where TB is more likely to be due to reactivation of infection acquired many years previously. In the older group, however, some recent transmission cannot be ruled out as evidenced by studies using genetic fingerprinting.[8]

HIV/AIDS coinfection—Medical practitioners diagnosing a case of AIDS are required to notify this in a coded form to the local Medical Officer of Health (MOH). Nationally, AIDS notifications are compiled by the AIDS Epidemiology Group at the University of Otago, Dunedin. HIV infection is under laboratory-based surveillance. Two laboratories—one in Auckland Hospital and the other at the Institute of Environmental Science and Research Limited (ESR)—do the confirmatory 'Western Blot' test for HIV and report positive results in a coded form to the AIDS Epidemiology Group.

TB is an AIDS defining condition in HIV-positive persons. So, by definition, an HIV-positive person with TB also has AIDS. The AIDS Epidemiology Group matched the coded list of people with AIDS and HIV infections with the similarly coded list of TB notifications to detect people coinfected with HIV and TB.

AIDS is notified anonymously with a code using the first two letters of surname, first initial of given name, sex, day, month, and year of birth.[9] We calculated the proportion of TB patients coinfected with HIV each year and examined the trend.

Multi-drug resistance—Three mycobacteriology laboratories (in Auckland, Wellington, and Waikato hospitals) test antimicrobial susceptibility of all *Mycobacterium tuberculosis* and *Mycobacterium bovis* isolated from human specimens in NZ. ESR matches these with TB case notifications and analyses the data to describe the distribution of TB-drug resistance in NZ. We reviewed reports for the period 1995 to 2001,[10] and annual reports of anti-TB-drug resistance for subsequent years (2002-2004),[11] to assess the role of multi drug resistance in local transmission of the disease.

Results

Migration—For the 10-year period 1995–2004, country of birth status (NZ or overseas) was reported for 89.3% (3367/3772) of notified cases. Of those for whom country of birth status was known, 35.4% (1193) were born in NZ and 64.6% (2174) were born overseas.

Table 1 presents numbers and crude incidence rates of TB by region and selected countries (those with an average of more than one case per year). Most of the overseas-born cases were from three regions of the world—Asia, Africa, and Pacific Islands.

Countries (in descending order) contributing an average of more than 5 cases a year were India, China, Somalia, Samoa, Philippines, Tonga, Korea, Cook Islands, Vietnam, and Cambodia. Tuvalu contributed more than 5 cases per year for the period 2000–2004. Very high rates were observed in people born in Ethiopia (3209.9 per 100,000) and Somalia (1924.4 per 100,000) in the 1995–1999 period.

Among people born in high-incidence countries, the numbers of TB notifications was highest within the first year of arrival, and then decreased substantially in subsequent years (Figure 1). About a quarter (28.3% or 144 / 508) of people who were notified with TB within 1 year of migration from a high-incidence country were identified as having active TB within 2 months of arrival in NZ.

In contrast, very few people from lower-incidence countries were notified with TB within 1 year of arrival in NZ (Figure 2). Most of those who developed the disease did so 20 years or more after arrival (Figure 2).

Table 2 shows TB numbers and rates in NZ- and overseas-born populations according to broad age and ethnic groups. Compared to NZ-born people of Pacific and Other ethnicity, TB rates were much higher in their overseas-born counterparts. This difference indicates that exposure to TB overseas rather than local transmission is the predominant mode of acquiring TB in people of these ethnic groups.

Rates of TB in overseas born populations generally declined over the 10-year period, with the exception of Pacific people <40 years, where there was a slight increase.

Table 1. Incidence of tuberculosis by country of birth, New Zealand, 1995–2004

Country of birth	1995–1999			2000–2004			Total
	Cases	Population[1]	Rate[3]	Cases	Population [2]	Rate[3]	
High TB incidence countries							
Ethiopia	26	162	3209.9	14	654	428.1	40
Somalia	84	873	1924.4	81	1770	915.3	165
South Africa	9	11334	15.9	20	26061	15.3	29
Zimbabwe	–	–	–	16	2827	113.2	16
Other African countries	22	6114	72.0	20	6794	58.9	42
Total Africa	**141**	**18483**	**152.6**	**151**	**38106**	**79.3**	**292**
Afghanistan	9	210	857.1	8	735	217.7	17
Cambodia	28	3675	152.4	34	4773	142.5	62
China	75	19518	76.9	119	38949	61.1	194
Hong Kong	19	11763	32.3	19	11301	33.6	38
India	149	12807	232.7	269	20892	257.5	418
Indonesia	20	2718	147.2	18	3792	94.9	38
Iraq	19	2649	143.5	10	4848	41.3	29
Korea	38	12183	62.4	55	17931	61.3	93
Laos	6	1008	119.0	9	1017	177.0	15
Malaysia	14	11889	23.6	9	11463	15.7	23
Pakistan	6	837	143.4	13	1317	197.4	19
Philippines	46	7002	131.4	58	10137	114.4	104
Sri Lanka	14	4020	69.7	7	6186	22.6	21
Taiwan	12	10932	22.0	4	12486	6.4	16
Thailand	22	3348	131.4	20	5154	77.6	42
Vietnam	40	3462	231.1	25	3948	126.7	65
Other Asian countries	22	9897	44.5	30	10848	55.3	52
Total Asia	**539**	**117918**	**91.4**	**707**	**165777**	**85.3**	**1246**
Cook Islands	40	13755	58.2	26	15222	34.2	66
Fiji	17	18774	18.1	21	25725	16.3	38
Niue	9	5277	34.1	18	5328	67.6	27
Samoa	73	42174	34.6	74	47118	31.4	147
Tokelau	10	1509	132.5	4	1662	48.1	14
Tonga	53	14040	75.5	51	18054	56.5	104
Tuvalu	9	378	476.2	32	1017	629.3	41
Other Pacific Islands	11	3351	65.6	23	3861	119.1	34
Total Pacific Islands	**222**	**99258**	**44.7**	**249**	**117987**	**42.2**	**471**
Europe (high incidence)	8	13533	11.8	9	15939	11.3	17
South and Central America	6	2676	44.8	5	3519	28.4	11
Total for high incidence countries	**916**	**251859**	**72.7**	**1121**	**341328**	**65.7**	**2037**
Low TB incidence countries							
Europe (low incidence)	68	272322	5.0	33	268731	2.5	101
North America	4	19230	4.2	3	21279	2.8	7
Australia	3	54711	1.1	3	56259	1.1	6
New Zealand	643	2848206	4.5	562	2890869	3.9	1205
Total for low incidence countries	**718**	**3194469**	**4.5**	**601**	**3237138**	**3.7**	**1319**
Birth country unknown	240			176			416
Overall Total	**1874**	**3618300**	**10.4**	**1898**	**3737277**	**10.2**	**3772**

[1] Census 1996, [2] Census 2001, [3] Annual incidence rate per 100,000.

Figure 1. Interval between migration and notification of tuberculosis in cases born in high-incidence countries, New Zealand, 1995-2004

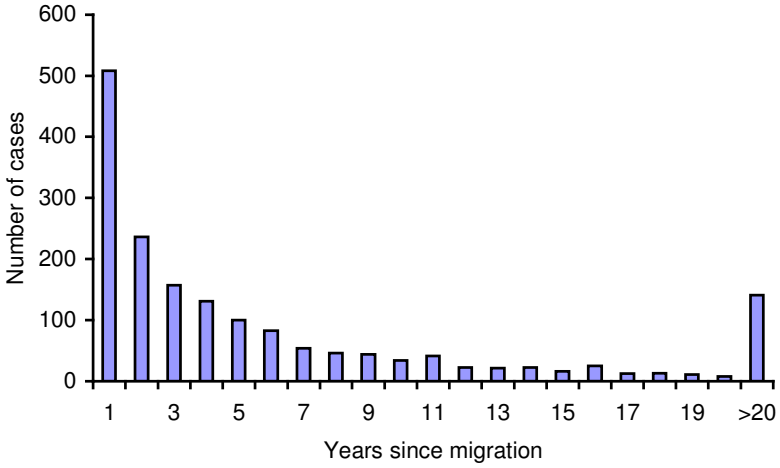


Figure 2. Interval between migration and notification of tuberculosis in cases born in low-incidence countries, New Zealand, 1995-2004

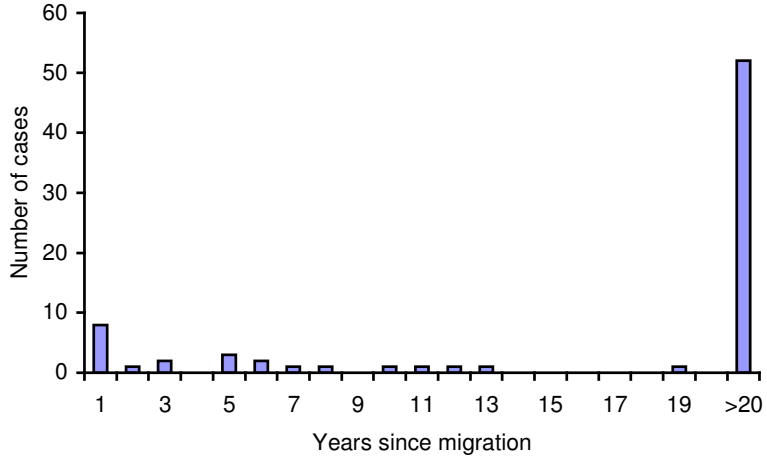


Table 2. Incidence of tuberculosis in New Zealand-born and overseas-born populations by ethnicity and age group, New Zealand, 1995-2004

Country of birth & Ethnicity	Age group	1995–1999					2000–2004				
		Cases	Population[1]	Rate[3]	Rate Ratio (RR)	95% CI of RR	Cases	Population[2]	Rate[3]	Rate Ratio (RR)	95% CI of RR
New Zealand-born											
European	< 40 years	49	1290987	0.76	Reference[4]		29	1214124	0.48	0.63	0.39-0.99
	40 years or more	173	903696	3.83	5.04	3.67-6.92	97	997290	1.95	2.56	1.81-3.61
	All age groups	222	2194686	2.02			126	2211420	1.14		
Māori	< 40 years	142	403881	7.03	9.26	6.69-12.81	152	395331	7.69	10.12	7.33-13.97
	40 years or more	149	102969	28.94	38.07	27.57-52.57	129	117792	21.90	28.82	20.74-40.04
	All age groups	291	506847	11.48			281	513126	10.95		
Pacific people	< 40 years	79	84984	18.59	24.46	17.13-34.94	118	98997	23.84	31.36	22.48-43.76
	40 years or more	2	2838	14.09	18.55	4.51-76.25	2	4365	9.16	12.06	2.93-49.60
	All age groups	81	87816	18.45			120	103362	23.22		
Other ethnicity	< 40 years	16	32901	9.73	12.8	7.28-22.51	18	42120	8.55	11.25	6.55-19.31
	40 years or more	6	3906	30.72	40.41	17.32-94.27	3	4923	12.19	16.04	5.00-51.46
	All age groups	22	36801	11.96			21	47034	8.93		
Overseas born											
European	< 40 years	16	136068	2.35	3.09	1.76-5.44	10	139542	1.43	1.88	0.95-3.72
	40 years or more	62	236169	5.25	6.91	4.75-10.05	42	244194	3.44	4.53	3.00-6.84
	All age groups	78	372243	4.19			52	383742	2.71		
Māori	< 40 years	3	6504	9.23	12.14	3.78-38.96	0	6765	0.00	--	--
	40 years or more	2	915	43.72	57.46	13.99-235.94	1	663	30.17	39.68	5.48-286.93
	All age groups	5	7422	13.47			1	7425	2.69		
Pacific people	< 40 years	90	49392	36.44	47.92	33.84-67.85	106	53103	39.92	52.48	37.41-73.63
	40 years or more	115	33363	68.94	90.50	64.79-126.42	126	42159	59.77	78.51	56.45-109.18
	All age groups	205	82755	49.54			232	95262	48.71		
Other ethnicity	< 40 years	454	96621	93.98	123.22	91.77-165.44	573	132372	86.57	113.55	84.83-152.01
	40 years or more	246	40149	122.54	160.45	118.10-217.99	310	68985	89.87	117.86	87.21-159.30
	All age groups	700	136767	102.36			883	201357	87.70		

[1] Census 1996, [2] Census 2001, [3] Annual incidence rate per 100,000, CI= Confidence interval. There were 270 and 182 TB cases, respectively, for the 1995–99 and 2000–04 periods that had missing values for either country of birth, ethnicity, or age. These cases were excluded. [4] This rate is used as the reference value for all rate ratios presented in this table.

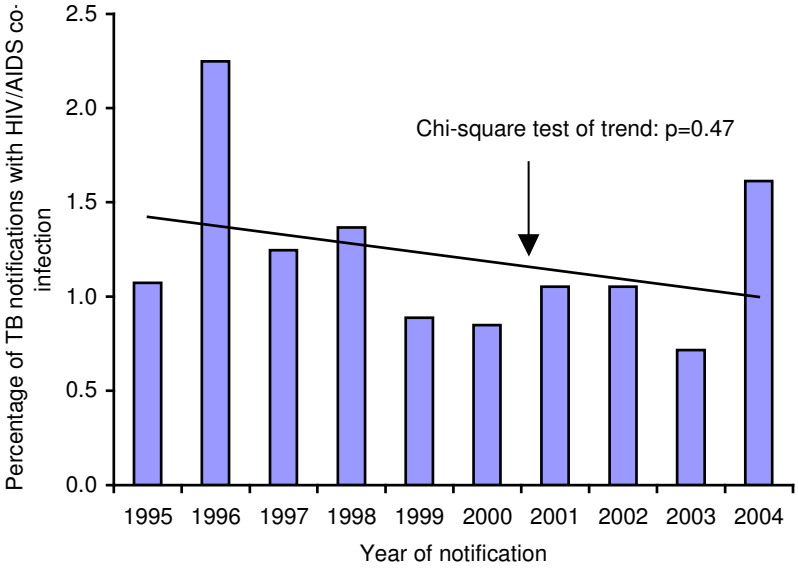
Transmission and reactivation in NZ—In the NZ-born population (Table 2), TB incidence varied markedly by age group and ethnicity. In 2000–2004, rates ranged from <0.5 per 100 000 (in Europeans <40 years) up to 23.8 per 100,000 (in Pacific people <40 years). TB rates in NZ-born populations were generally higher in older age groups (≥40 years) except for Pacific people (where these rates were based on very small numbers of cases).

TB rates declined in most NZ-born populations except for Māori and Pacific people <40 years, in whom there were statistically non-significant increases between 1995–1999 and 2000–2004. Of particular note was the statistically significant decline in the TB rate for NZ born Europeans <40 years, which is the largest single sub-population identified in Table 2.

Multi-drug-resistant TB (MDR-TB)—MDR-TB is defined as TB resistant to at least isoniazid and rifampicin. Published reports on anti-TB drug resistance showed that MDR-TB is rare in NZ, with a total of 19 cases recorded in 10 years since national surveillance of anti-TB drug resistance began in 1995.[10,11] Eighteen of the 19 MDR-TB cases identified were people born overseas and presumed to have acquired the MDR-TB overseas. The remaining MDR-TB case was also born overseas, but multi drug resistance appeared to have developed during treatment in NZ. There is no documented evidence that MDR-TB has been transmitted within NZ up to 2004.

HIV/AIDS coinfection—In the 10-year period (1995-2004), out of 3,772 notified TB cases, 45 (1.2%) were diagnosed with HIV infection. The annual proportion of TB cases with HIV showed a non-significant declining trend over this 10-year period (Figure 3).

Figure 3. Percentage and trend of tuberculosis cases coinfected with HIV, New Zealand, 1995–2004



Discussion

This analysis has shown that migration of TB-infected people from higher incidence countries is the dominant factor driving the incidence of this disease in NZ. By comparison, rates in most NZ-born populations are static or declining, indicating that local transmission is being effectively controlled for most population groups. This analysis has also shown that HIV/AIDS and TB drug resistance are not making a significant contribution to the burden of TB in NZ.

Amongst people migrating from countries classified as 'high-TB incident', rates of disease vary enormously. Large contributors (more than 5 cases per year) with particularly high rates include India, China, Somalia, Philippines, Vietnam, Cambodia and Korea (Table 1).[12] A similar pattern has also been seen in Australia.[13] However, this observation has some limitations. Denominators used to calculate the rates in Table 1 are from 1996 and 2001 Census data. They do not represent the actual number of people with specific country of birth in other years (other than 1996 and 2001). As the numbers of people born in some of the countries are small, a change in their number could have a large effect on the rates.

A quarter (508 out of 2036) of TB cases born in high-incidence countries were notified within 1 year of migration. This population of 508 included 144 cases (28.3%), who developed TB within 2 months of arrival. Most of these people are likely to be refugees who had active TB on their arrival in NZ. This assumption is supported by the findings of TB screening for quota refugees at Mangere Refugee Resettlement Centre.[14] Screening, within 6 weeks of arrival, of 1405 refugees from July 1995 to July 1998 found that 2% of them had active disease.

If 2% is taken as the prevalence rate of TB in newly arrived refugees, then NZ can expect to see 15 TB cases per year in the quota refugee population (750 refugees per year). Other groups that are not screened for TB before entry include short-term visitors, who may in a few instances have active TB on arrival in NZ.

Results of this analysis provide considerable reassurance that migrant populations are not acting as an important source of TB transmission to most NZ-born populations. The largest NZ-born population considered in this analysis, those of European ethnicity aged <40 years, experienced a significant decline in TB incidence over these two time periods. This is despite the rise in absolute numbers of TB cases in migrant populations from high incidence countries that occurred over this time period. This observation is consistent with the experience of other countries such as Australia, that has also found that TB transmission tends to occur within defined population groups.[13]

The NZ-born populations that experienced modest, though non-significant, increases in TB rates were Māori and Pacific people <40 years. NZ-born Pacific people <40 have a significant burden of disease. There are several possible explanations for these observations, including: a potential decline in the effectiveness of local TB control measures; increased exposure to Pacific migrants with TB; increasing ease of transmission (from such factors as higher levels of household crowding); for Pacific people increased visiting to ancestral home countries; or a chance finding. These

possible contributing factors need further investigation to identify opportunities for improved prevention and control.

This study found that HIV is making only a small contribution to TB incidence in NZ. Woodhouse, by analysing the data from Auckland Hospital Infectious Disease Unit, reported an increasing incidence of HIV/TB coinfected cases from the 1985–95 period to 1996-2001 period.[15] However, our study based on national data for a 10 year period, did not find any increasing trend either in the number or in the proportion of coinfected cases. The findings of this study (and also of the previous reports)[16,17] indicate that HIV is an insignificant contributor to TB in NZ, unlike some other countries,[1,2] and there is no indication that its contribution is increasing.

Drug resistance also does not appear to be making a significant contribution to TB transmission in NZ. Multi-drug resistance among TB isolates in NZ (0.6%) is low compared to the global median (1.7%), Australia (2.0%), United States (1.4%), and England and Wales (1.5%).[18] Indeed, there is no indication that MDR-TB is increasing in NZ or is being transmitted.

One other potential source of TB infection in NZ is the large reservoir of *Mycobacterium bovis*-infected animals. A separate combined epidemiological and microbiological investigation has shown that these animal reservoirs are making only a small contribution to TB infection in humans (2.7% over the 1995 to 2002 period) and incidence from this source is not increasing.[19]

One limitation of this study is the possible numerator-denominator bias in calculating incidence rate by ethnicity. Though prioritised ethnicity was used both for the numerator and denominator, it is possible that these were not collected in the same way.[6] While ethnicity in the census (denominator) is self-reported, surveillance (numerator) data are more likely to contain health professional reported ethnicity. It is known that in comparison to census data, hospital records are more frequently coded with sole rather than multiple ethnicities.[20] The implication for this is underestimation of the Māori rates.[6]

In conclusion, the findings of this study clearly indicate that migration from high TB-incidence countries is the predominant source of TB in NZ, and this contribution is increasing over time. This source of TB is supplemented in a smaller way by transmission to young Pacific people,[17] local outbreaks,[6] and reactivation of latent infection in the NZ born population.

It is envisaged that (for economic, social, and humanitarian reasons) NZ will continue to accept immigrants (including refugees) from high-TB incidence countries in future. We therefore need to constantly identify approaches to improve the swift detection and treatment of TB in these populations.[12] One area where improvements could be made is the systematic screening of family reunification refugees. For quota refugees, there is an organised system of screening soon after their arrival. The system for family reunification is not as well organised.

In 2005 the NZ Immigration Service introduced stricter migrant health screening. These measures included full medical certificate (including chest X-ray) for people wishing to stay in NZ for more than 12 months, temporary entry chest X-ray certificate for people wishing to stay for more than 6 months (but less than 12

months), and chest X-ray for international students and working holiday makers.[21] The effects of these changes have yet to be seen.

At the time of entering NZ far greater numbers of immigrants have latent TB infection (LTBI) rather than active disease and LTBI is not detected by chest X-ray. So clinicians who are caring for immigrants and refugees (particularly from Asia, Africa and Pacific Islands) need to be very vigilant for features of TB. Early detection and treatment of cases improves clinical outcomes and minimises the further spread of disease.

Ultimately, TB needs to be seen as a regional and global health problem. Increasing aid and development assistance can contribute to preventing and controlling this health threat. Other countries, notably the United States, have also seen value in supporting TB control in neighbouring counties.[22] NZ is well placed to support regional TB control efforts, and at the same time help to protect NZ from this disease.

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