

# TUBERCULOSIS IN MALAYSIA: A CONTINUING SURGE

V Nissapatorn<sup>1</sup>, YAL Lim<sup>1</sup>, I Jamaiah<sup>1</sup>, H Man Chin<sup>1</sup>, MZ Ilyana<sup>1</sup>, MZ Nonaziah<sup>1</sup>, A Siti Hasifah<sup>1</sup> and I Kuppusamy<sup>2</sup>

<sup>1</sup>Department of Parasitology, University of Malaya Medical Center, Kuala Lumpur; <sup>2</sup>Assunta Hospital, Petaling Jaya, Selangor, Malaysia

**Abstract.** The substantial influx of foreign-born persons including immigrant population into the community becomes one of the postulated reasons to be elucidated relating to this so-called "a disease without border" in Malaysia. A total of 425 TB patients, including Malaysians and foreigners, were treated at the Institute of Respiratory Medicine from May to December 2003. TB was found relatively more often in foreign laborers and Malaysians with nonspecific occupations. Tuberculin skin test (TST) was used to screen for latent TB infection and a higher positive rate of TST was found in foreign compared to local patients. Chest X-ray findings showed a higher rate of abnormalities consistent with PTB, found in the majority of both groups. Lymph node biopsy and sputum culture were used significantly to detect the presence of *M. tuberculosis* and confirm the diagnosis of TB. EHRZ+B6 was significantly the most commonly used anti-tubercular drug regimen, found in both local and foreign patients. Foreign patients were more significantly associated with non-compliance to anti-tubercular therapy. Hepatitis was one of the most common adverse drug reactions found in local patients. The presence of a greater number of illegal migrants, who are highly mobile within the country as well as across borders, and who do not undergo any health screening, further complicates the national tuberculosis control program in the future.

## INTRODUCTION

Tuberculosis (TB) is one of the world's most important infectious causes of morbidity and mortality among adults. Between 8 to 9 million people develop the disease, and approximately 2 million die from TB each year (Pai *et al*, 2006). TB is mainly concentrated in developing countries, and global control efforts have been hampered by the limitations of diagnostic, prophylactic, and therapeutic tools (Freire, 2006). This resurgent disease has become a significant worldwide public health problem and is largely related to immigration from countries with a high prevalence of TB; infection with HIV; social problems, such as poverty, homelessness, and drug abuse; and dismantling of TB services (Raviglione and O'Brien, 2005). In Malaysia, about 10% of TB notified cases have been discovered among the immigrant population, particularly those from

high TB burden neighboring countries (Iyawoo, 2004). Immigrants contributed more than 24% of the newly detected TB cases in Sabah, East Malaysia (Dony *et al*, 2004). The substantial influx of foreign-born persons including the immigrant population into the community has become one of the reasons why TB could be called "a disease without borders" in Malaysia. We conducted this study in order to compare the course of tuberculosis in terms of epidemiology, clinical manifestations, investigation, and treatment outcomes between Malaysian (local) and foreign-born patients. This study certainly provided a picture of the current situation of TB in these patients, particularly in the latter group. It could also be useful for the host country to establish preventive measures and regional collaboration to curb the future incidence of TB among foreign-born persons.

## MATERIALS AND METHODS

A total of 425 patients including 297 (69.9%) Malaysian (local) and 128 (30.1%) foreigners who were confirmed as non-HIV infected patients and registered for tuberculosis treatment at the Institute of Respiratory Medicine (IRM) from May to December, 2003 were included in this

---

Correspondence: Dr Veeranoot Nissapatorn, Department of Parasitology, University of Malaya Medical Center, 50603 Kuala Lumpur, Malaysia.

Tel: 603-7967-6618; Fax: 603-7967-4754

E-mail: nissapat@hotmail.com

study. This institute is a tertiary level national referral center for respiratory diseases, situated in Kuala Lumpur, Malaysia. Any person with a respiratory problem can attend this center without a physician's referral. The majority of notified TB cases in Kuala Lumpur each year are treated there. The data was retrospectively reviewed from each patient's medical record. Socio-demographic profiles, clinical presentations, investigation results, treatment, patient compliance with therapy, and outcomes of therapy response were included in a standardized data collection sheet. A country like Malaysia still attracts more foreigners in each year to come in for different purposes, such as working and/or studying. These foreign patients were mainly from its neighboring countries: Indonesia (89), Myanmar (16), Philippines (3), Thailand (1), and Vietnam (2). Others were from Nepal (5), Bangladesh (4), India (3), Pakistan (2), and 1 each from Africa and Japan. Of these, 21 (17 Indonesian and 4 Burmese) patients resided in this country more than 10 years, while the remaining (107) had less than 10 years (range of 1 month to 9 years) residency. The group was comprised of job seekers or laborers (78; 63%), non-laborers (30; 24.2%), and others, such as housewives and students (16; 13%). The case definitions of tuberculosis were obtained from the World Health Organization (WHO, 2002).

### Statistical analysis

The data were analyzed employing the statistical software, SPSS version 11 (SPSS Inc, Chicago, Ill, USA). The data with quantitative variables were described as mean and range, while qualitative variables were described as frequency and percentage. Statistical analysis was estimated using chi-square test where appropriate. A p-value of <0.05 was regarded as statistically significant.

## RESULTS

Table 1 shows the demographic profiles of 425 TB patients comprising Malaysian (297, 70%) and foreigners (128, 30%) who attended the Institute of Respiratory Medicine (IRM) from May to December 2003. Overall, the incidence of

tuberculosis in this study was high in both local (270; 90.9%) and foreign (119; 93%) patients. The age range was found to be older in local than in foreign patients. Both groups had the significantly highest percentage in the age group of 21-40 years, and the occurrence of TB slowly declined in the locals when compared to that of foreign patients, which decreased markedly over the years ( $p = 0.000$ ). TB occurred more commonly in married-and-male than unmarried-and-female patients, in both groups. However, no statistical difference was found between both groups ( $p > 0.05$ ). TB was found relatively more often in foreign laborers and Malaysian with nonspecific occupations ( $p = 0.000$ ). A significant one-third of these patients, including 121 (40.7%) Malaysian and 12 (9.4%) foreigners, were given BCG vaccination ( $p = 0.000$ ). Smoking was the most common predisposing factor for the occurrence of TB, found in both groups ( $p > 0.05$ ). Both groups (39, 13.1% Malaysian vs 13, 10.2% foreigner) showed similar results with a previous history of contacting TB ( $p > 0.05$ ). Intravenous drug use was more significantly found in national (49, 16.8%) than foreign (3, 2.3%) patients ( $p = 0.000$ ).

Clinical manifestations and investigation of the 425 TB patients are presented in Table 2. A significant majority of patients in both groups had fever (Malaysian, 55% vs foreigner, 67.2%), loss of appetite (Malaysian, 55.2% vs foreigner, 67.2%), weight (Malaysian, 56.2% vs foreigner, 72.7%), and hemoptysis (Malaysian, 16.8% vs foreigner, 33.6%) ( $p < 0.05$ ). Cough (Malaysian, 73.1% vs foreigner, 79%) and sputum (Malaysian, 54% vs foreigner, 53.1%) were also more common in these patients. However, no statistical difference was found between these two groups ( $p > 0.05$ ). Lymphadenopathy occurred more commonly in local (59, 20%) than foreign (17, 13.3%) patients, and the cervical lymph nodes were the most common location found in both groups ( $p > 0.05$ ). Tuberculin skin test (TST) or Mantoux test was used to screen for latent TB infection, and an optimum cut-off point  $\geq 10$  mm ( $p = 0.07$ ) when compared to  $\geq 5$  ( $p = 0.112$ ) or  $\geq 15$  ( $p = 0.407$ ) mm was considered to be a better correlation. A higher positive rate of TST was found in foreign (32, 25%) than local (56, 19%) patients. A similarly positive ESR was shown in

Table 1  
Demographic profile of 425 TB patients attended at the Institute of Respiratory Medicine (IRM) during May-December 2003.

Variable	No of patients (%)		p-value
	Malaysian (297)	Foreigner (128)	
	Aged range = 15 to 93 Aged range = 15-93 years Median = 44 years	with a median of 39 years Aged range = 18-75 years Median = 30 years	
Age group			0.000
≤ 20	11 (3.7)	8 (6.3)	
21-40	118 (39.7)	92 (72)	
41-60	98 (33)	23 (18)	
≥ 61	70 (23.6)	5 (4)	
Sex			0.291
Male	208 (70)	83 (64.8)	
Female	89 (30)	45 (35.2)	
Marital status			0.046
Single	102 (34.3)	57 (44.5)	
Married	195 (65.7)	71 (55.5)	
Present address			0.018
Kuala Lumpur	158 (53.2)	84 (65.6)	
Outsider	139 (46.8)	44 (34.4)	
Occupation			0.000
Laborer	46 (15.5)	78 (61.2)	
Non-laborer	47 (15.8)	30 (23.4)	
Others <sup>a</sup>	204 (68.7)	20 (15.6)	
BCG vaccination status			0.000
Yes	121 (40.7)	12 (9.4)	
No or unknown	176 (59.3)	116 (90.6)	
Risk factors			0.427
Yes	114 (39.4)	40 (31.3)	
Smoking	92 (31)	34 (26.6)	
Alcohol consumption	2 (0.7)	0	
Smoking and drinking	20 (6.7)	6 (4.7)	
No	183 (61.6)	88 (68.8)	
Case category			0.193
New case	270 (90.9)	119 (93)	
Old case (previous TB history)	27 (9.1)	9 (7)	
With completed treatment	10 (3.4)	1 (0.8)	
With uncompleted treatment	17 (5.7)	8 (6.3)	
History of contact with TB			0.391
Yes	39 (13.1)	13 (10.2)	
No	258 (86.9)	115 (89.8)	
Intravenous drug use (IDU)			0.000
Yes	49 (16.8)	3 (2.3)	
No/unknown	248 (83.2)	125 (97.7)	

<sup>a</sup>Others included housewife, students retired persons

the majority of local (269, 90.6%) and foreign (118, 92.2%) patients ( $p > 0.05$ ). Interestingly, HCV infection rates were comparatively higher in local (42, 14%) than foreign (3, 2.3%) patients ( $p = 0.001$ ). Chest X-ray findings showed a higher rate of abnormalities consistent with PTB found in both groups ( $p = 0.014$ ). Lymph node biopsy ( $p = 0.004$ ) and sputum culture ( $p = 0.003$ ) were used significantly to detect the presence of *M. tuberculosis* and confirm the diagnosis of TB.

Table 3 shows the diagnosis and treatment outcomes of the 425 TB patients. Pulmonary (lung) was the most common location (Malaysian, 58.6% vs foreigner, 75%), followed by extrapulmonary (Malaysian, 27.6% vs foreigner, 16.4%), and pulmonary with disseminated TB (Malaysian, 13.8% vs foreigner, 8.6%), which was significant in both groups ( $p = 0.005$ ). Lymph node and lung with lymph node were the most common forms of extrapulmonary, and pulmonary with disseminated TB, respectively. EHRZ+B6 was significantly the most commonly used anti-tubercular drug regimen, found in both local (192, 64.7%) and foreign (116, 90.6%) patients ( $p = 0.000$ ). A higher cure rate of  $\geq 6$  months anti-tubercular drug regimen was significantly found in both groups (Malaysian, 25.6% vs foreigner, 29%), compared to other regimens ( $p = 0.004$ ). A longer duration ( $\geq 9$  and 12 months) of treatment was more commonly found in local than foreign patients. Non-compliance to therapy was more significantly found among foreign (29%) than among local (19%) patients. There were 22 patients (20 Malaysian vs 2 foreigner) who developed adverse drug reactions. Of these, there was hepatitis (4 patients), visual impairment (5), liver impairment (6), skin reaction-rash (4), thrombocytopenia (2), and hearing deficit (1) found in Malaysian patients; while visual impairment (1) and skin reaction-rash (1) were among the adverse reactions recorded in foreign patients. Only 1 patient was recorded having antituberculous drug (rifampicin) resistance. Overall, no MDR-TB or death was reported in these patients during the time of this study.

## DISCUSSION

From our study, the incidence of TB was

comparatively higher in foreign patients in this country. This is not surprising as this has also become increasingly apparent in many countries such as Australia, Canada, the Netherlands, and the United State (Rieder *et al*, 1994; Raviglione *et al* 1995; Wells *et al*, 1999). Tuberculosis was significantly more common in older locals. This could be explained because the majority of foreign patients stay temporarily in this country for the improved income or standard of living, as clearly shown in this study. The reactivation of primary infection due to lowered body immunity with age or other co-diseases such as diabetes mellitus or disease requiring the use of steroids would be alternative explanations for the local patients (Venugopalan, 2004). Moreover, a higher rate of TB cases was found in men than women in both groups. This finding is supported by most of the previous studies worldwide and this could also be explained by the higher mobility of the male group due to work requirements (Venugopalan, 2004; WHO, 2004a). Nevertheless, women progress from infection to active TB faster than men do, but the reported incidence of pulmonary TB among women is nearly always lower than for men (WHO, 2004b).

Approximately, one-third of these patients (more in local than foreign patients) were given BCG vaccination. This suggests that BCG vaccination is still compulsory, and public health awareness should be more consistently implemented to promote the national vaccination program in any given population, particularly in limited resource settings. However, the development of a vaccine better than BCG is also encouraged for the developing countries where the risk of TB infection remains high (Shimao, 2005). We observed that IDUs was more likely found among local TB patients. This supports with the fact that IDUs is not only the most common route of HIV transmission, particularly in the younger age group in Malaysia, but also a significant risk factor in contributing to the transmission of TB/HIV co-infection as reported worldwide. Therefore, the higher authorities should take more serious steps to tackle this problem, since these two diseases are very contagious and pose a major public health concern in this region.

Looking at the clinical diagnosis, our findings

Table 2  
Clinical manifestations and investigation results of 425 TB patients.

Variable	No of patients (%)		p-value
	Malaysian (297)	Foreigner (128)	
<b>Clinical manifestations</b>			
Fever	163 (55)	86 (67.2)	0.018
Loss of appetite	164 (55.2)	86 (67.2)	0.021
Loss of weight	167 (56.2)	93 (72.7)	0.001
Cough	217 (73.1)	101 (79)	0.203
Sputum	160 (54)	68 (53.1)	0.887
Hemoptysis	50 (16.8)	43 (33.6)	0.000
Dysnea	39 (13.1)	21 (16.4)	0.374
Others	63 (21.2)	23 (18)	
Lymphadenopathy	59 (20)	17 (13.3)	0.104
Site of lymph node involvement			0.554
Cervical	42 (14.1)	10 (7.8)	
Other	17 (5.7)	7 (5.5)	
<b>Investigation results</b>			
Mantoux test			0.07
Positive $\geq$ 10 mm	56 (19)	32 (25)	
Negative	41 (13.8)	9 (7)	
Unknown	200 (67.3)	87 (68)	
ESR			0.381
Normal	10 (3.4)	6 (4.7)	
Positive $\geq$ 10 mm/1 <sup>st</sup> hour	269 (90.6)	118 (92.2)	
Unknown	18 (6.1)	4 (3.1)	
HBV infection			0.753
Positive	14 (4.7)	4 (3.1)	
Negative	102 (34.3)	44 (34.3)	
Unknown	181 (61)	80 (62.5)	
HCV infection			0.001
Positive	42 (14)	3 (2.3)	
Negative	71 (24)	35 (27.3)	
Unknown	184 (62)	90 (70.3)	
CXR finding			0.014
Normal	47 (15.8)	9 (7)	
Positive for PTB	176 (59.3)	95 (74.2)	
Positive for PTB and disseminated	43 (14.5)	11 (8.6)	
Positive for ETB	31 (10.4)	13 (10.2)	
Lymph node biopsy			0.004
Yes	46 (15.5)	7 (5.5)	
No/Unknown	251 (84.5)	121 (54.5)	
Sputum smear			0.173
Positive	102 (34.3)	56 (43.8)	
Negative	191 (64.3)	70 (54.7)	
Unknown	4 (1.4)	2 (1.6)	
Sputum culture for MTB			0.003
Positive	125 (42.1)	77 (60.2)	
Negative	156 (52.5)	47 (36.7)	
Unknown	16 (5.4)	4 (3.1)	

Table 3  
Diagnosis and treatment outcomes of 425 TB patients.

Variable	No of patients (%)		p-value
	Malaysian (297)	Foreigner (128)	
Site of organ involvement			0.246
Lung	174 (58.6)	96 (75)	
Lung and LN	25 (8.4)	9 (7)	
Lung and other (pleura, spine, larynx and miliary)	16 (5.4)	2 (1.6)	
Lymph node (LN) and/or others	39 (13.1)	9 (7)	
Miliary and/or others	20 (6.7)	5 (3.8)	
Other (pleura, bone, GIT, GUT, etc)	23 (7.7)	7 (5.5)	
Type of tuberculosis			0.005
Pulmonary	174 (58.6)	96 (75)	
Pulmonary and extrapulmonary	41 (13.8)	11 (8.6)	
Extrapulmonary	82 (27.6)	21 (16.4)	
Anti-tubercular drugs regimen			0.000
EHRZ+B6	192 (64.7)	116 (90.6)	
SHRZ+B6	85 (28.6)	9 (7)	
Other	20 (6.7)	3 (2.3)	
Treatment outcome			0.004
≥ 6 months	76 (25.6)	37 (29)	
≥ 9 months	69 (23.2)	12 (9.4)	
≥ 12 months	13 (4.4)	1 (0.8)	
On going treatment			
< 6 months	55 (18.5)	30 (23.4)	
≥ 6 months	28 (9.4)	11 (8.6)	
Loss to follow-up	56 (19)	37 (29)	
Transfer out	15 (5.1)	10 (7.8)	

showed that both groups displayed similar clinical features, which also depend upon organs involvement relating to TB disease. Pulmonary TB patients were significantly found as having clinical manifestations such as fever, loss of appetite and weight, and hemoptysis, which is in agreement with an earlier study (Chowell *et al*, 2005). This suggests that TB should be considered one of differential diagnosis for patients with persistent fever or unresolved in management of other diseases in these cases. TST was used as one of the routine investigations for the diagnosis of latent TB infection and showed a higher positive rate among foreign compared with local patients. A TST reading of 10 mm had a higher sensitivity than 15 mm (Tan *et al*, 2002) as a cut-off point in

TB diagnosis (Loh *et al*, 2005), as also shown in this study. However, interpretation of TST might be difficult, particularly in the Malaysian settings of multi-ethnicity and high BCG coverage (Loh *et al*, 2005). This test is of limited value in the diagnosis of active tuberculosis because of its low sensitivity and specificity (Raviglione and O'Brien, 2005); it often gives false results (Kunst, 2006) and is therefore not applicable for the diagnosis of latent TB infection. Interferon-gamma assays are newly available tests to detect latent TB infection and might allow targeting chemoprophylaxis to reduce the burden of active TB. However, this assay is currently not routinely used (Kunst, 2006). Radiographic images from chest X-ray finding are one of the important

investigations used, particularly in diagnosing PTB. Pulmonary tuberculosis is unlikely in the absence of any radiographic abnormality (Raviglione and O'Brien, 2005). At the same time, sputum examination, particularly from sputum culture, is used not only as a significantly confirmatory method in detecting the presence of *M. tuberculosis* but also for screening of both primary drug susceptibility and resistance, which could prevent further escalation of the existing multi-drug resistant TB.

Concerning TB treatment and its outcome, a higher overall cure rate was found in local compared with foreign patients. Compliance is one of the potential factors to increase the cure rate in TB patients and the type of treatment, gender, occupation, history of contacting TB, perception in health status, attitude, knowledge, and social support were found to be significantly contributing factors (Lertmaharit *et al*, 2005). With the presently available anti-tuberculosis drugs, a six months regimen is comparatively effective in treating PTB, found in both groups of patients. In addition, the regimen of more than 9 months duration was given more in PTB-disseminated and ETB patients when compared to only PTB cases. This therefore indicates that compliance and sites of TB involvement determine the duration of treatment regimen used in these patients. A revolutionary concept for TB drug development and leveraging the potential of the existing drugs pipeline (Freire, 2006) is the future trend for the treatment of TB. In addition, a potent new drug, which has no cross-resistance with existing TB drugs, is targeted to make another great contribution to global TB control (Shimao, 2005).

Non-compliance to therapy was more likely found in foreign compared with local patients. A significant reason in this finding was occupation, with a majority of these patients being laborers (24/37) who might not understand the disease, particularly long-term treatment that requires strict cooperation throughout the course of treatment. To circumvent this problem, their employers should take the initiative to provide job security and especially medical services to prevent the spread of tuberculosis infection within their respective communities.

Adverse drug reactions were found at a higher rate among local than among foreign patients. Hepatitis was one of the most common side effects in patients with the age of more than 45 years (3/4), and there was evidence of relapse TB found in one of these patients. Supporting this finding, one study showed that the risk of hepatitis increased from 2.6% to 4.1% as age exceeded 49 years, and, if patients at risk of both hepatitis and relapse were to receive standard treatment, daily dosing was preferable (Chang *et al*, 2006). This suggests that observation of these side effects should be consistently taken into serious consideration, and communication between medical personnel and patients would be mandatory to prevent future drug resistance. So far, only one local patient developed drug resistance, while there was no report among foreign patients. However, one study showed that the risk of drug resistance was the highest for younger TB patients and among foreign-born patients from Vietnam and the Philippines (Moniruzzaman *et al*, 2006). This assists clinicians in prescribing and tailoring more appropriate anti-tuberculosis regimens for immigrants (Moniruzzaman *et al*, 2006). However, there was no registered case of multi-drug resistant tuberculosis (MDR-TB), in either local and foreign (Nissapatorn *et al*, 2005) patients found in this study. MDR-TB is not yet a serious problem in Malaysia as evidenced by the Drug Resistance Surveillance completed in 1996/1997 with WHO collaboration, and MDR-TB prevalence was found to be 0.1% in Malaysia (Iyawoo, 2004). MDR-TB, however, is the subject of great interest and has consistently gained attention worldwide. The monthly monitoring of sputum culture for AFB in the initial 6 months of treatment helps greatly to predict treatment outcomes (Yew *et al*, 2000). Moreover, one study suggested that regimens with at least four sensitive drugs are mandatory for the successful treatment of MDR-TB and fluoroquinolones are needed in the majority of cases to ensure the success of the four-drug regimen, because of frequent drug resistance or toxicity to other anti-tuberculosis drugs (Shigetoh, 2001). Overall, most patients with multi-drug-resistant tuberculosis can be cured with the use of appropriate, intensive

treatment regimens (Tahaoglu *et al*, 2001), and drug selection must rely on treatment history, results of susceptibility testing and an evaluation of the patient's adherence (API Consensus Expert Committee, 2006).

In conclusion, tuberculosis is still highly prevalent and found in a given population in Malaysia. Age group certainly contributes to the occurrence of TB. BCG vaccination and TST are still compulsory in developing countries where the incidence of TB remains high. Clinical presentations have shown similarity between both groups and depended upon the sites of TB involvement. A higher cure rate of anti-tuberculosis therapy of  $\geq 6$ -month duration was found in both groups of TB patients. Medical examinations should be a strictly mandatory prerequisite in order to obtain a work permit among foreigners before they enter the country. Moreover, the presence of a substantial number of illegal migrants, who are highly mobile within the country as well as across borders, and who do not undergo any health screening, further complicates the national tuberculosis control program in the future.

#### REFERENCES

- API Consensus Expert Committee. API TB consensus guidelines 2006: management of pulmonary tuberculosis, extra-pulmonary tuberculosis and tuberculosis in special situations. *J Assoc Physicians India* 2006; 54:219-34.
- Chang KC, Leung CC, Yew WW, Tam CM. Standard anti-tuberculosis treatment and hepatotoxicity: do dosing schedules matter? *Eur Respir J* 2006;29:347-51.
- Chowell G, Diaz-Duenas P, Chowell D. The dynamics of pulmonary tuberculosis in Colima, Mexico (1999-2002). *Scan J Infect Dis* 2005;37:858-62.
- Dony JF, Jamaliah A, Yap KT. Epidemiology of tuberculosis and leprosy, Sabah, Malaysia. *Tuberculosis* 2004;84:8-18.
- Freire MC. Opportunities for overcoming tuberculosis: new treatment regimens. *World Hosp Health Serv* 2006;42:34-7.
- Iyawoo K. Tuberculosis in Malaysia: problems and prospect of treatment and control. *Tuberculosis* 2004;84:4-7.
- Kunst H. Diagnosis of latent tuberculosis infection: The potential role of new technologies. *Respir Med* 2006;100:2098-106.
- Lertmaharit S, Kamol-Ratankul P, Sawert H, Jittimane S, Wangmanee S. Factors associated with compliance among tuberculosis patients in Thailand. *J Med Assoc Thai* 2005;88: S149-56.
- Loh LC, Chan SK, Ch'ng KI, Tan LZ, Vijayasingham P, Thayaparan T. Influence of co-morbidity in the interpretation of Tuberculin skin test reactivity in multi-ethnic adult patients with tuberculosis. *Med J Malaysia* 2005;60:426-31.
- Moniruzzaman A, Elwood RK, Schulzer M, FitzGerald JM. Impact of country of origin on drug-resistant tuberculosis among foreign-born persons in British Columbia. *Int J Tuberc Lung Dis* 2006;10:844-50.
- Nissapatorn V, Kuppasamy I, Wan-Yusoff WS, Khairul Anuar A. Clinical analysis of foreign-born patients with tuberculosis found in Malaysia. *Southeast Asian J Trop Med Public Health* 2005;36:713-21.
- Pai *et al*, 2006.
- Raviglione MC, O'Brien RJ. Tuberculosis. In: Kasper DL, Braunwald E, Hauser S, *et al*. eds. Harrison's principles of internal medicine. 16<sup>th</sup> ed. New York: McGraw-Hill, 2005:953-66.
- Raviglione MC, Snider DE, Kochi A. Global epidemiology of tuberculosis. Morbidity and mortality of a worldwide epidemic. *JAMA* 1995;273:220-6.
- Rieder HL, Zellweger JP, Raviglione MC, Keizer ST, Migliori GB. Tuberculosis control in Europe and international migration. *Eur Respir J* 1994;7:1545-53.
- Shigetoh E, Murakami I, Yokosaki Y, Kurimoto



- N. Treatment outcomes of multidrug-resistant tuberculosis--comparison between success and failure cases. *Kekkaku* 2001;76:723-8 (in Japanese).
- Shimao T. Tuberculosis and its control: lessons from the past and future prospect. *Kekkaku* 2005;80:481-9 (in Japanese).
- Tahaoglu K, Torun T, Sevim T, *et al.* The treatment of multidrug-resistant tuberculosis in Turkey. *N Engl J Med* 2001;345:170-4.
- Tan LH, Kamarulzaman A, Liam CK, Lee TC. Tuberculin skin testing among healthcare workers in the University of Malaya Medical Centre, Kuala Lumpur, Malaysia. *Infect Control Hosp Epidemiol* 2002;23:584-90.
- Venugopalan B. An evaluation of the tuberculosis control programme of Selangor State, Malaysia for the year 2001. *Med J Malaysia* 2004;59:20-25.
- Wells CD, Ocana M, Moser K, Bergmire-Sweet D, Mohle-Boetani JC, Binkin NJ. A study of tuberculosis among foreign-born Hispanic persons in the US States bordering Mexico. *Am J Respir Crit Care Med* 1999;159: 834-7.
- WHO. Global tuberculosis control: surveillance, planning, financing. In: WHO report 2002. Geneva: World Health Organization; 2002.
- WHO. Global tuberculosis control: surveillance, planning, financing. In: WHO report 2004. Geneva: World Health Organization; 2004a.
- WHO. Gender in tuberculosis research. Geneva: World Health Organization; 2004b.
- Yew WW, Chan CK, Chau CH, *et al.* Outcomes of patients with multidrug-resistant pulmonary tuberculosis treated with ofloxacin/levofloxacin-containing regimens. *Chest* 2000;117:744-51.