COST ANALYSIS OF DIFFERENT TYPES OF TUBERCULOSIS PATIENT AT TUBERCULOSIS CENTERS IN THAILAND

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Abstract. Tuberculosis (TB) has recently re-emerged as a major public health problem in Thailand. As a consequence of the HIV epidemic in the country, the TB burden has been rising in terms of both morbidity, and mortality which have tremendous socioeconomic impact. However, a study of the cost of various anti-TB drugs in Thailand has never been conducted. A specific aim of this study was to compare the total provider costs of delivering services to different types of TB patient in four zonal TB centers located in the east, northeast, north, and south of Thailand. This aim was accomplished by calculating the unit costs of TB treatment services at these TB centers during the year 1996-1997. All units of the zonal TB centers were classified into 5 cost-center categories: treatment units, laboratory units, radiology units, pharmaceutical units, and administrative/supportive units. The results showed that the average total provider cost of multi-drug resistant TB (MDR TB) patients was ฿ 89,735.49 which was the highest of any type of patient and was 17 times higher than the cost of smear-negative TB cases; this finding was attributed to the high cost of anti-TB drugs for MDR TB cases (฿ 65,870), some 95 times higher than the cost for smear-negative cases. Total provider costs were highest in the northeastern region TB centers and lowest in the southern centers for every type of TB patient: smear-negative TB cases (฿ 7,727 *vs* ฿ 3,916), newly smear positive TB cases (฿ 12,539 *vs* ฿ 7,020), TB with AIDS cases (฿ 15,108 *vs* ฿ 8,369), re-treatment TB cases (฿ 16,679 *vs* ฿ 9,696), and MDR TB cases (฿ 102,330 *vs* ฿ 82,933). The information from this study may be useful when reviewing the role, function, and cost structure of each TB center in Thailand in order to establish a strategic plan for effective TB control.

INTRODUCTION

Tuberculosis (TB) has been re-emerging as a major public health problem in Thailand. As a consequence of the HIV epidemic in the country, the national burden of TB has been increasing both in terms of morbidity and mortality, which have considerable socioeconomic impact. The major strategies used to address this problem are the early and nationwide case finding (at least 70% of cases in the community) and effective standard short-course anti-TB chemotherapy (WHO, 1995).

In 1995, the TB control program in Thailand was reviewed by a team of officials from the Thai Ministry of Public Health (MOPH) and the WHO: this review revealed that the nationwide new-case finding rate was only 60% and that the cure rate by standard short-course treatment was 17-68% (WHO, 1995). While multi-drug resistant TB (MDR TB) cases, the treatment of which is more complicated, expensive and toxic, increased to an average of 2.02% in 1996 (Palipatana *et al*, 1997; Department of Communicable Disease Control/WHO, 1999). This finding called for the urgent revision of the implementation of TB control programs; the activities of the 12 zonal TB

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centers that are found in each region of Thailand were intensifed. However, the cost- effectiveness of case finding and treatment has not been assessed; moreover, there has been no information published regarding the cost of the treatment of the various types of TB patients (*eg* smear-negative cases, newly smear-positive cases, TB cases with AIDS, re-treatment cases, MDR TB cases) that present to TB centers in the different regions of the country. This information will help to identify the cost structure of the treatment system in each region and will provide the basis for reviewing the role, function, and cost structure of the TB treatment given by each center; such a review will maximize the cost-effectiveness of the national TB control program.

This study compared the costs of delivering services to different types of TB patient that were incurred by zonal TB centers located in each of the 4 geographical regions (Eastern, Northeastern, North and South) of Thailand.

MATERIALS AND METHODS

In order to obtain a representative sample of all the TB patients in Thailand, health care facilities at all levels of the health care system and in all areas of the country were included in the study. Four referral centers (zonal TB centers) were randomly selected from a total of 12 centers that were stratified to include the four geographical regions (Eastern, Southern, Northern and Northeastern) of Thailand.

The cost incurred by the provider is the real cost of delivering the service to the patients at the zonal TB centers. Total direct cost (TDC) was calculated from the labor costs, material costs, and capital costs of the 4 zonal TB centers incurred during one year (October 1996 to September 1997). The viewpoint adopted in this study is that of the provider (TB Division, MOPH, Thailand).

All units of the zonal TB centers were classified into five cost center categories: treatment units, radiology units, laboratory units (sputum examination and culture), pharmaceutical units, and administrative/supportive units. The total direct cost of each unit was calculated from the labor costs (LC), material costs (MC), and capital costs (CC). The total costs incurred by the administrative/supportive units were allocated to their respective service units (treatment, radiology, laboratory, phamaceutical) using a simultaneous equation method modified by appropriate allocation criteria (Balachandran and Dittman, 1978; Meeting, 1978; Berman *et al*, 1986). The full cost of each service unit is the sum of its total direct cost (LC+MC+CC) and its total indirect cost (TIDC), which is allocated from related units. The unit costs of routine services (RSC; overhead costs) of treatment units and pharmaceutical units were then calculated by dividing the full costs by the total number of patients' visits during the year studied (October 1, 1996 to September 30, 1997). Similarly, the RSC of laboratory units and radiology units were calculated by dividing the full cost by the total number of tests requested during the year studied. Because different types of TB patient have different times of follow-up and may have had different laboratory tests, we had to multiply the unit RSC by the number of visits or the number of examinations, as appropriate. The calculation of the total cost of sputum examination, culture, and sensitivity testing (C/S) and chest radiography were finalized by the addition of material costs. For the total costs of the pharmaceutical units, we added the drug cost as well (Fig 1). All costs were expressed and analysed in the currency of Thailand (baht) at the time of study (fl 27 ~ 1 US dollar).

RESULTS

Routine service cost of each treatment unit/ visit at each TB center

As shown in Table 1, the unit cost of routine service was highest at TB centers in the northeast (fl 602.13). The unit costs in the eastern and northern TB centers were approximately the same.

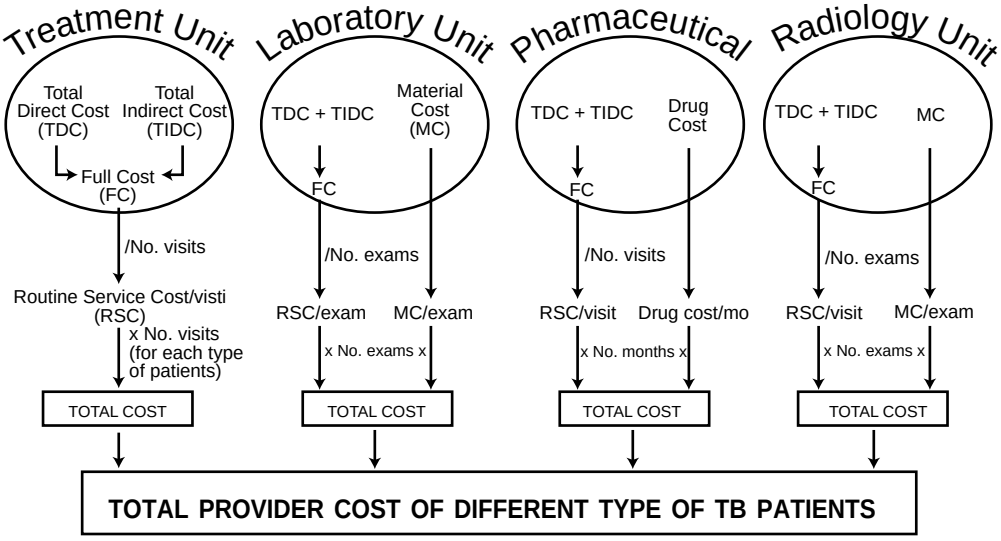

Fig 1–Conceptual framework of total provider cost calulation.

Table 1
Routine service cost (RSC) of treatment unit/visit of each TB center.

TB centers	Total direct cost	Total indirect cost	Full cost	No. of visit	RSC/visit
Region #3 (Eastern)	450,316.11	3,210,639.97	3,660,956.08	8,435.00	434.02
Region # 7 (Northeast)	1,027,220.45	5,103,711.07	6,130,931.52	10,182.00	602.13
Region # 9 (North)	1,172,728.44	2,002,691.27	3,175,419.71	6,927.00	458.41
Region # 12 (South)	938,745.85	3,111,515.81	4,050,261.66	10,397.00	389.56
Total	3,589,010.85	13,428,558.12	17,017,569.97	35,941.00	473.49
Average	897,252.71	3,357,139.53	4,254,392.24		

All figures are in baht.

Unit cost of routine service and material costs of laboratory, pharmaceutical and radiology units

Table 2 shows the unit costs of the other three cost-centers: laboratory units, pharmaceutical units and radiology units. The unit costs of routine services (overhead costs) in each cost-center of the different regions had similar patterns. The highest unit costs were in the northeast (฿ 373.84), while the lowest were in the eastern region (฿ 95.81); the exception was pharmaceutical units of which the lowest unit cost was in the south (฿ 136.27). The unit costs of material in each cost-center were considered to be the same because each TB center obtained support from the TB Division and the drug costs depended on the type of TB patient.

Table 2
Unit cost of overheads and materials of laboratory, pharmaceutical, and radiology units.

TB centers	Sputum examination and C/S			Pharmaceutical service		Chest X-ray	
	Overhead cost	Material cost		Overhead cost	Drug* cost	Overhead cost	Material cost
		Sputum exam	Sputum C/S				
Region # 3 (Eastern)	95.81	2.04	557.90	171.06		52.90	7.98
Region # 7 (Northeast)	373.84	2.04	557.90	533.97		182.29	7.98
Region # 9 (North)	249.03	2.04	557.90	214.83		141.76	7.98
Region # 12 (South)	130.07	2.04	557.90	136.27		91.33	7.98
Average	212.19	2.04	557.90	264.03		117.07	7.98

*Depends on the type of TB patient (see Table 4).
All figures are in baht.

Table 3
Drug costs of different types of patient.

Types of patient	Regimen	Drug cost (fl)
1. Sputum smear-negative cases	2 HRZ / 2 HR	696.48
2. Newly smear-positive cases	2 HRZE (S) / 4 HR	2,484.72
3. TB with AIDS	2 HRZE (S) / 6 HR	2,781.60
4. Re-treatment cases	2 HRZES / 1 HRZE / 5 HRE	3,420.64
5. Multidrug resistant (MDR)	2 KOP* / 22 OP	65,870.00

*K = Kanamycin, O = Ofloxacin, P = PAS.

Drug costs of different types of TB patient

The drug costs of smear-negative cases and newly smear-positive cases were fl 696.48 and fl 2,482.72 respectively. For MDR TB cases, the drug cost increased to fl 65,870, 95 times that of the smear-negative cases (Table 3).

Total material cost of laboratory and radiology units for different types of TB patient

Though the unit cost of material in each cost-center was identical, the frequencies of sputum examination, sputum culture and sensitivity testing and chest radiography for each type of TB patient were different, which resulted in a variety of total material costs (Table 4). Our study found that the MDR TB patients had much higher total material costs than other groups, probably because of more frequent laboratory and radiological examinations.

Total provider cost of smear-negative cases

Different frequencies service-utilization by of smear-negative cases (treatment, laboratory, pharmaceutical, and radiology) might explain the difference in routine service costs. Table 5 shows that the total provider cost of smear-negative cases was highest in the northeast (fl

Table 4
Total material costs of laboratory and radiology units of different types of patient.

Types of patient	Sputum examination			Sputum culture and sensitivity			Chest X-ray			Total cost
	Unit cost	No. exam	Total cost	Unit cost	No. exam	Total cost	Unit cost	No. exam	Total cost	
Smear-negative case	2.04	4	8.16	557.90	0	0.00	7.98	2	15.96	24.12
Smear-positive cases	2.04	6	12.24	557.90	0	0.00	7.98	2	15.96	28.20
TB with AIDS	2.04	6	12.24	557.90	0	0.00	7.98	2	15.96	28.20
Re-treatment cases	2.04	6	12.24	557.90	1	557.90	7.98	2	15.96	586.10
Multidrug resistant	2.04	15	30.6	557.90	3	1,673.70	7.98	4	31.92	1,736.22

All figures are in baht.

Table 5
Total provider costs of smear-negative cases of each TB center.

TB centers	Routine service cost at treatment unit (5 visits)	Pharmaceutical services			Sputum examination			Chest X-ray			Total provider cost
		RSC (4 visits)	Drug cost	Total cost	RSC (5 exams)	Material cost	Total cost	RSC (2 exams)	Material cost	Total cost	
Region # 3 (Eastern)	2,170.10	684.40	696.48	1,380.72	383.24	8.16	391.40	505.80	15.96	521.76	4,463.98
Region # 7 (Northeast)	3,010.65	2,135.88	696.48	2,832.36	1,495.36	8.16	1,503.52	364.58	15.96	380.54	7,727.07
Region # 9 (North)	2,292.05	859.32	696.48	1,555.80	996.12	8.16	1,004.28	283.52	15.96	299.48	5,151.61
Region # 12 (South)	1,947.90	545.08	696.48	1,241.56	520.28	8.16	528.44	182.66	15.96	198.62	3,916.52
Average	2,355.18	1,056.13	696.48	1,752.61	848.75	8.16	856.91	334.14	15.96	350.10	5,314.80

All figures are in baht.

Table 6
Total provider cost of smear-positive cases of each TB center.

TB centers	Routine service cost at treatment unit (7 visits)	Pharmaceutical services			Sputum examination			Chest X-ray			Total provider cost
		RSC (6 visits)	Drug cost	Total cost	RSC (6 exams)	Material cost	Total cost	RSC (2 exams)	Material cost	Total cost	
Region # 3 (Eastern)	3,038.14	1,026.36	2,484.72	3,511.08	574.86	12.24	587.10	505.80	15.96	521.76	7,658.08
Region # 7 (Northeast)	4,214.91	3,203.82	2,484.72	5,688.54	2,243.04	12.24	2,255.28	364.58	15.96	380.54	12,539.27
Region # 9 (North)	3,208.87	1,288.98	2,484.72	3,773.70	1,494.18	12.24	1,506.42	283.52	15.96	299.48	8,788.47
Region # 12 (South)	2,727.06	817.62	2,484.72	3,302.34	780.42	12.24	792.66	182.66	15.96	198.62	7,020.68
Average	3,297.25	1,584.20	2,484.72	4,068.92	1,273.13	12.24	1,285.37	334.14	15.96	350.10	9,001.63

All figures are in baht.

Table 7
Total provider cost of TB with AIDS cases of each TB center.

TB centers	Routine service cost at treatment unit (9 visits)	Pharmaceutical services			Sputum examination			Chest X-ray			Total provider cost
		RSC (8 visits)	Drug cost	Total cost	RSC (6 exams)	Material cost	Total cost	RSC (2 exams)	Material cost	Total cost	
Region # 3 (Eastern)	3,906.18	1,368.48	2,781.60	4,150.08	574.86	12.24	587.10	505.80	15.96	521.76	9,165.12
Region # 7 (Northeast)	5,419.17	4,271.76	2,781.60	7,053.36	2,243.04	12.24	2,255.28	364.58	15.96	380.54	15,108.35
Region # 9 (North)	4,125.69	1,718.64	2,781.60	4,500.24	1,494.18	12.24	1,506.42	283.52	15.96	299.48	10,431.83
Region # 12 (South)	3,506.22	1,090.16	2,781.60	3,871.76	780.42	12.24	792.66	182.66	15.96	198.62	8,369.26
Average	4,239.32	2,112.26	2,781.60	4,893.86	1,273.13	12.24	1,435.46	334.14	15.96	350.10	10,768.64

All figures are in baht.

Table 8
Total provider cost of re-treatment cases of each TB center.

TB centers	RSC at at treatment unit (9 visits)	Pharmaceutical services			Sputum examination			Sputum C/S			Chest X-ray			Total provider cost
		RSC (8 visits)	Drug cost	Total cost	RSC (6 exams)	Material cost	Total cost	RSC (1 exams)	Material cost	Total cost	RSC (2 exams)	Material cost	Total cost	
Region # 3 (Eastern)	3,906.18	1,368.48	3,420.64	4,789.12	574.86	12.24	587.10	95.81	557.90	653.71	505.80	15.96	521.76	10,457.87
Region # 7 (Northeast)	5,419.17	4,271.76	3,420.64	7,692.40	2,243.04	12.24	2,255.28	373.84	557.90	931.74	364.58	15.96	380.54	16,679.13
Region # 9 (North)	4,125.69	1,718.64	3,420.64	5,139.28	1,494.18	12.24	1,506.42	249.03	557.90	806.93	283.52	15.96	299.48	11,877.80
Region # 12 (South)	3,506.22	1,090.13	3,420.64	4,510.80	780.42	12.24	792.66	130.07	557.90	687.97	182.66	15.96	198.62	9,696.27
Average	4,239.32	2,112.26	3,420.64	5,532.90	1,273.13	12.24	1,285.37	212.19	557.90	770.09	334.14	15.96	350.10	12,177.77

All figures are in baht.

Table 9
Total provider cost of multidrug resistant TB patients of each TB center.

TB centers	RSC at at treatment unit (9 visits)	Pharmaceutical services			Sputum examination			Sputum C/S			Chest X-ray			Total provider cost
		RSC (24 visits)	Drug cost	Total cost	RSC (15 exams)	Material cost	Total cost	RSC (1 exams)	Material cost	Total cost	RSC (2 exams)	Material cost	Total cost	
Region # 3 (Eastern)	10,416.48	4,105.44	65,870.00	69,975.44	1,437.15	30.6	1,467.75	287.75	1,673.70	1,961.13	1,011.60	31.92	1,043.52	84,864.32
Region # 7 (Northeast)	14,451.12	12,815.28	65,870.00	78,685.28	5,607.60	30.6	5,638.20	1,121.52	1,673.70	2,795.22	729.16	31.92	761.08	102,330.90
Region # 9 (North)	11,001.84	5,155.92	65,870.00	71,025.95	3,735.45	30.6	3,766.05	747.09	1,673.70	2,420.79	567.04	31.92	598.96	88,813.56
Region # 12 (South)	9,349.92	3,270.48	65,870.00	69,140.48	1,951.05	30.6	1,981.65	390.21	1,673.70	2,063.91	365.32	31.92	397.24	82,933.20
Average	11,304.84	6,336.78	65,870.00	72,206.78	3,182.81	30.6	3,213.41	636.56	1,673.70	2,310.23	668.28	31.92	700.20	89,735.49

All figures are in baht.

7,727.07), where it was nearly twice as much as it was in the south, which had the lowest total provider cost (฿ 3,916.52).

Total provider cost of smear-positive cases

The cost of smear-positive cases was similar to that of smear-negative cases; the highest costs were in the northeast (฿ 12,539.27) and the lowest costs were in the south (฿ 7,020.68) (Table 6). However, the average national cost of smear-positive cases was about 70% higher than that of smear-negative cases (฿ 9,001.63 *vs* ฿ 5,314.80).

Total provider cost of TB cases with AIDS

Total provider costs of TB patients who had AIDS was higher than those for smear-positive cases (an average of ฿ 10,768.44) because of the higher drug costs and the greater number of visits to each service unit (Table 7).

Total provider cost of re-treatment cases

Total provider costs of re-treatment cases were about 35% higher than those of smear-positive cases (an average of ฿ 12,177.77) (Table 8). The reasons for this were the higher drug costs and the greater number of visits to each service unit.

Total provider cost of MDR TB cases

The average cost of MDR TB cases was 17 times higher than that of smear-negative cases (an average of ฿ 89,735.49) (Table 9). This was attributed to the higher drug costs (higher by a factor of 95) mentioned earlier. These patients had to continue drug treatment for 24 months and had 15 sputum examinations, 3 sputum cultures, and 4 chest X-rays, hence the very high total cost. Again, the northeast had the highest total provider costs (฿ 102,330.90), while the difference among the three remaining regions was not great (an average of ฿ 82,933 to ฿ 88,813).

DISCUSSION

This was the first empirical study to give a cost analysis of the treatment of different types of TB patient. Cost analysis of anti-TB chemotherapy in Thailand had been conducted in 1987-1988, when it was shown that short-course chemotherapy was more cost-effective than the standard regimen (Chunhaswasdikul *et al*, 1992). However, this earlier cost analysis considered only the treatment of newly smear-positive cases. Our study confirmed that apart from the burden in terms of morbidity and mortality, TB imposes a huge economic challenge to Thailand.

During the past fifteen years, the incidence of reported TB cases in Thailand had declined from 150/100,000 (1975) to 85/100,000 (1993) due to the nationwide implementation of short course anti-TB chemotherapy in 1985 (Payanandana *et al*, 1995). This strategy also brought about a 10-times decrease in TB mortality: from 65/100,000 in 1945 to 6.2/100,000 in 1997 (Department of Communicable Disease Control/WHO, 1999). However, since 1994, TB has been re-emerging as a public health problem in Thailand. The incidence of TB has gradually increased, particularly in the far north of the country (7-10% per year) (Payanandana, 1999). Approximately one-third of the population of Thailand is infected with TB and nearly 100,000 people suffer from TB every year, including 37,000 who have infectious disease and spread the bacteria among the community (Department of Communicable Disease Control/WHO, 1999). In addition, despite the efficacy of treatment, TB is still the fifth leading cause of death in the country (Akarasewi, 1999). The HIV epidemic in Thailand is believed to account for these phenomena; the epidemic is associated with the high TB-related morbidity and mortality in the region and with the high prevalence of HIV infection, as is found in the northern province,as well as the increasing HIV co-infection rate among new TB cases, which rose from 3% in 1989 to 22% in 1996 (Akarasewi, 1999).

Cost-effective nationwide case finding and treatment, using a standard short-course anti-TB regimen, are critical components of the National Tuberculosis Program (Expert Committee on Tuberculosis, 1992). The program calls

for a treatment unit, laboratory unit, radiology unit, pharmaceutical unit, and administrative/ supportive unit at each TB service center. The cost of each unit at each TB center is a key determinant of the cost-effectiveness of the TB service system as a whole.

This study has some limitations. Firstly, although four zonal TB centers were randomly selected, the centers might not be representatives of all the TB centers in their respective regions because of substantial differences in the costs of each unit. Secondly, the unit costs of anti-TB treatment were analyzed on the assumption that the frequencies of sputum examination, sputum culture and chest radiography were identical among different types of TB patient and among different TB centers: this assumption may be flawed.

Our study found that the total provider costs of the northeastern TB center were the highest while those of the south were the lowest for every type of TB patient. This finding might be explained by the difference in the total number of patients' visits and by the cost structure among different TB centers. However, during the study period, most TB centers were in the process of revising their organizing structure by integrating some posts within the Regional Communicable Disease Centers and the provincial hospitals. The degree of this integration varied among different TB centers; the southern TB centers had the least integration. This factor might also contribute to the different total provider costs after cost analysis. Most of the total overhead costs of the zonal TB centers were labor costs, which were similar to those in most of Thailand's public sectors.

Anti-TB drug resistance is another barrier to the effective control of TB in Thailand. The resistance to anti-TB drugs is continuously high: INH 9-15%; streptomycin 5.5-11%; rifampicin 1-4%; ethambutol 2-6% (Hongthiamthong *et al*, 1994; Cohn *et al*, 1997; Punnotok, 1999). A survey of anti-TB drug resistance during 1997-1998 found that the resistance to one or more drugs (non-MDR TB) was 25.4% and that MDR TB affected 2.02% of new cases (WHO, 1995). However, one study in a particular area (the Central Chest Disease Hospital) and an urban area in Chiang Rai Province showed even higher rates of MDR TB: 6.2% and 6.9% respectively (Chuchottitaworn, 1998). The risk factors for MDR TB were intravenous drug use, HIV-infection, and repeated imprisonment (WHO, 1995). The cure rate of MDR TB cases was much lower than that for non-MDR TB cases (40-60%) (Goble *et al*, 1993; Punnotok, 1996). In our study, the total provider cost of MDR TB cases was 17 times higher than that for smear-negative cases. This was attributed to the higher drug costs (by a factor of 95) and more frequent monitoring and evaluation (sputum examination, sputum culture, sensitivity testing, and chest radiography) of MDR TB cases. If MDR TB cases nationwide increase to 6-7% (as in some high-risk area), which equals 6,000-7,000 cases per year, the government will have to spend approx ﬂ 500-600 million a year in order to treat all of these cases: a significant burden on the economy of Thailand. This emphasizes the urgent need for strategies for the national control and prevention of MDR TB, including the early detection of TB and its prompt treatment with standard short-course anti-TB drugs under the DOTS program. The finding of this study call for the revision of the role, function, and cost structure of each TB center in Thailand, in order to maximize the effectiveness of the TB service system in the current climate of limited national resources.

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REFERENCES

Akarasewi P. Epidemiology and trend of tuberculosis in Thailand. In: Prichayanont B, Nuchprayoon C, Sapcharoen S, eds. Tuberculosis. Bangkok: Chulalongkorn University Press, 1999: 31-63 (in Thai).

Balachandran V, Dittman DA. Cost allocation for maximizing hospital reimbursement under third party cost contracts. *Health Care Management* 1978; 3: 61-70.

Berman HJ, Weeks LE, Kikla SF. The financial management of hospital. Michigan: Health Administration Press; 1986: 117-38.

Chuchottitaworn C. Multidrug resistant tuberculosis. In: Satapatayawong B, ed. An update on infectious disease. Bangkok : Infectious Disease Society of Thailand, 1998 : 30-44 (in Thai).

Chunhaswasdikul B, Kamolratanakul P, Jittinandana A, Tangcharoensathien V, Kuptawintu S, Pantumabamrung P. Anti-tuberculosis program in Thailand : a cost analysis. *Southeast Asian J Trop Med Public Health* 1992; 23: 195-9.

Cohn DL, Bustreo F, Raviglione MC. Drug resistance in tuberculosis: review of worldwide situation and WHO/IUATLD Global Surveillance Project. International Union Against Tuberculosis and Lung Diseases. *Clin Infect Dis* 1997; 24 (suppl): S121-30.

Department of Communicable Disease Control/WHO (Joint Team). 2nd Review of the National Tuberculosis Programme in Thailand, 10-23 July 1999. Geneva : World Health Organization, *WHO/CDS/TB/99.273*. 1999.

Expert Committee on Tuberculosis. Case-finding and short- course therapy in the situation of AIDS epidemic, Ministry of Public Health, Bangkok: Thai Mitr Press, 1992.

Goble M, Iseman MD, Madsen LA, Waite D, Ackerson L, Horsburgh CR Jr. Treatment of 171 patients with pulmonary tuberculosis resistant to isoniazid and rifampin. *N Engl J Med* 1993; 328: 527-32.

Hongthiamthong P, Chuchottaworn C, Amattayakul N. Prevalence of drug resistance in Thai human immunodeficiency virus seropositive tuberculosis patients. *J Med Assoc Thai* 1994; 77: 363-7.

Meeting DT. Four cost-financing methods. Which one is best? *Hosp Finan Managem* 1978; 33: 34-9.

Palipatana T, Tantivessa S, Kesvitaya W. Situation of MDR-TB in Thailand, 239 BE. *Wkly Epidemiol Surv Rep* 1997; 28: 169-70,176-9.

Payanandana V, Kladphuang B, Talkitkul N, Tornee S. Information in preparation for an external review of the national tuberculosis programme, Thailand 1995. Bangkok: Tuberculosis Division, Department of Communicable Disease Control, Ministry of Public Health, 1995.

Payanandana V. Tuberculosis control in Thailand: new strategies in the era of HIV/AIDS epidemic. In: Prichayanont B, Nuchprayoon C, Sapcharoen S, eds. Tuberculosis. Bangkok: Chulalongkorn University Press, 1999: 92-116. (in Thai).

Punnotok J. Treatment of multi-drug resistant tuberculosis. In: Prichayanont B, Nuchprayoon C, Sapcharoen S, eds. Tuberculosis. Bangkok: Chulalongkorn University Press, 1999: 410-28 (in Thai).

Punnotok J. Treatment of drug resistant tuberculosis. *Thai Centr Chest Dis J* 1996; 1: 49-60.

World Health Organization. WHO Tuberculosis programme : framework for effective tuberculosis control. Geneva : World Health Organization, *WHO/TB/94.179*. 1994.

World Health Organization. Tuberculosis program review, Thailand, conducted by a joint team of Thailand Ministry of Public Health and WHO, 18-30 June 1995, Geneva: World Health Organization, *WHO/TB/95.192*. 1995.