Cost-effectiveness of TB treatments to Burmese and Laotian patients by Thai hospitals on the border with Myanmar and Laos

Cost-effectiveness of TB treatments

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Abstract

Purpose – The purpose of this paper is to estimate the cost-effectiveness of tuberculosis (TB) treatment and care in two Thai hospitals located on the borders with Myanmar and Laos.

Design/methodology/approach – A retrospective data collection was conducted to analyze all costs relevant to TB treatment and care from Mae Sai and Chiang Sean Hospitals. The cost related to TB treatment and care and the number of successful TB treatment from January 1 to December 31, 2017 were used for the calculation. The cost-effectiveness ratio (C/E) and the incremental cost-effectiveness ratio (ICER) were the outcomes.

Findings – In 2017, the total cost of the TB treatment and care program at Mae Sai Hospital was 482,728.94 baht for 57 TB patients. The cost per treated case per year was 8,468.93 baht. The C/E was 10,971.11 baht per successful TB treatment (44 successful cases). The total cost of the TB treatment and care program at Chiang Sean Hospital was 330,578.73 baht for 39 TB patients. The cost per treated case per year was 8,476.38 baht. The C/E was 22,038.58 baht per successful TB treatment (15 successful cases). The ICER was 5,246.56 baht. The Mae Sai Hospital model was more cost-effective in terms of the treatment and care provided to Burmese patients with TB than the Chiang Sean Hospital model for Laotian patients with TB.

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Originality/value – To improve the cost-effectiveness of TB treatment and care programs for foreign patients in hospitals located on the Thai border, focus should be placed on patient follow-up at the community or village level.

Keywords Tuberculosis, Cost-effectiveness, Burmese, Border hospital, Laotian

Paper type Research paper

Introduction

Tuberculosis (TB) is one of the most serious infectious diseases and necessitates long-term treatment of at least six months duration according to the World Health Organization (WHO) recommendations[1]. TB has become a global threat, particularly in developing countries, including Thailand, which is considered to be one of the highest TB-burdened countries globally[2]. Several studies have shown that factors such as the country or health setting, economy, process of treatment, internal policy and management are all related to TB treatment outcomes[3–6]. Additionally, countries that are faced with problems of HIV/AIDS must double their efforts in their management of TB patients, especially in areas that border two or more countries, such as the Thailand–Myanmar–Republic of Laos border communities[7]. Both Thailand and Myanmar have a long border that stretches from the north to the south and is approximately 2,401 km[8]. For years, northern Thailand has been considered to be the region with the highest epidemic of HIV/AIDS and TB in the country[9]. Chiang Rai is located in the northern-most part of Thailand and borders Myanmar in the west and the Republic of Laos in the north and east[10]. In 2017, there were almost 1.5m registered Thai people in the province. However, the same year, an additional 200,000 non-Thai who were working in different locations also lived in Chiang Rai[11]. Most of the non-Thai did not meet the criteria for free access to the health care system in Thai public hospitals, including medical care for TB treatment[12].

In 2018, the Center of Disease Control No. 1, Chiang Mai Office[13] reported that the number of new TB cases and the number of relapses increased from 5,785 cases (98.6/100,000 pop) in 2017 to 6,251 cases (106.8/100,000 pop) in 2018. However, the cure rates in those respective years were 79.5 and 73.49 percent, which were lower than the WHO's goal of 90.0 percent[14]. In 2018, more than 20,000 HIV/AIDS cases were being treated with ARV, and more than 4,000 new TB cases were detected in 18 public hospitals in Chiang Rai province[15,16]. Chiang Rai province was reported to have the highest registered rate of new TB cases at 26.4 percent and the lowest cure rate at 54.05 percent[13]. People aged 60 years old represented the greatest proportion of all registered TB patients in hospitals, accounting for 20.7 percent, and 9.6 percent of HIV-positive individuals were identified as infected with TB[13].

Between 2010 and 2018, 14,024 TB cases were reported in Chiang Rai province, and 37.5 percent were identified as members of the stateless population, including individuals of Burmese and Laos nationality[17]. A large proportion of TB cases were reported by Thai hospitals along the borders of Thailand–Myanmar and Thailand–Republic of Laos[7]. Mae Sai and Chiang Sean Hospitals were reported to have the greatest proportion of new foreign TB patients in Chiang Rai province. Among these foreign TB patients, 74.3 percent were Burmese and 24.7 percent were Laos[18]. These patients were frequently listed on the Multidrug-resistant Tuberculosis register in these hospitals, particularly the Burmese and Laos TB patients[18].

All the hospitals located in border areas have very unique characteristics, which are different from those of hospitals in other areas[19]. TB patients face a number of barriers to access to a hospital, particularly those individuals who cross the border to go to Thai hospitals[12]. For instance, at Thai hospitals, foreign TB patients face difficulties with the language and medical fees, and cooperation between doctors who manage TB patients while working in two different hospitals located in different countries is also a barrier[20]. Moreover, the burdens of treatment

and other medical care needs must be closely monitored to maintain the quality of care for Thai citizens[21]. Currently, in Chiang Rai province, there are at least two hospitals located on the Thailand–Myanmar–Republic of Laos borders in northern Thailand that provide care for Burmese and Laos TB patients[15]. Because of the unique conditions, these two hospitals differ on many fronts in terms of how TB treatment and care is provided, such as the overall number of patients, the number of TB patients and the number of foreign TB patients. This type of information is needed to identify the optimal cost-effective program for TB treatment and care. This study aimed to assess the cost-effectiveness ratio (C/E) and the incremental cost-effectiveness ratio (ICER) for TB treatment and care between these two hospitals. Ultimately, the findings of the study could be used to implement policies in hospitals located in border areas.

Materials and methods

Study design

A retrospective study was conducted to analyze the costs and outcomes of the treatment of foreign TB patients in two Thai hospitals located on the borders between Thailand and Myanmar and Thailand and the Republic of Laos.

Study setting

Mae Sai Hospital (a 90-bed hospital) and Chiang Sean Hospital (a 60-bed hospital) were purposively selected as the study settings because these two hospitals are located in border areas in Chiang Rai province, and all the TB staff, including the directors of the hospitals, were willing to participate in the study. Mae Sai Hospital is located in Mae Sai district, west of the Chiang Rai province border with Myanmar. Chiang Sean Hospital is located in the Chiang Sean district, which is bordered by Myanmar in the west and the Republic of Laos in the north and east. The study was conducted from May 2018 to November 2018.

Study population

The study populations included Burmese TB patients who were treated at Mae Sai Hospital and Laos and Burmese TB patients who were treated at Chiang Sean Hospital between January 1 and December 31, 2017.

Sources of data and measurements

Data were collected with specifically designed sheets that were tested for validity and reliability before use. Three different cost categories were included in the analysis: capital costs, material costs and labor costs. The data on capital and material costs were collected based on the provider prospective. These data were collected from hospital accounting documents, hospital records, annual expenditure reports and interviews with hospital officers. The labor cost category (staff salary) was obtained from the accounting documents.

For the outcome measurement, all clinical data for foreign TB patients were collected from the HOSxp database in both the hospitals.

Activity-based costs

Activity-based costs were defined as the operating costs of the TB program and were assessed by developing the activity model and including all possible related domains involved in TB treatment and care. Afterward, an activity analysis was performed to identify the resources used for each activity.

Outcome measures

The outcome measure of the study was the effectiveness of the TB treatment and care program. First, we selected the number of TB cures or cases of successful treatment as the

main measurement of effectiveness. The cure rate was defined as the proportion of patients who received a cured status after treatment, which was confirmed by a sputum examination that was negative for TB bacilli, divided by those who completed a full treatment regimen. Second, other outcomes included the total number of TB patients who received care at a hospital.

Activities related to the costs (Figure 1)

Mae Sai Hospital had three main activities related to the TB treatment and care program: activities related to TB screening, a new TB diagnosis and treatment and care; activities regarding ongoing treatment and care of the whole cohort in a year; and activities related to hospitalized TB patients.

Chiang Sean Hospital had four main activities related to the TB treatment and care program: activities related to TB screening, a new TB diagnosis and treatment and care; activities regarding ongoing treatment and care of the whole cohort in a year; activities related to hospitalized TB patients; and village-based follow-up of TB patients.

Cost categories

All relevant costs were classified into categories such as labor, material and equipment. These categories were then classified into either direct or indirect costs. Direct costs referred to all expenses directly and exclusively related to TB treatment and care activities, such as fuel and stationery, that could not be used in other activities. Indirect costs were costs that could be reused or allocated into many activities or programs or had multiple allocable components, such as labor, buildings, X-ray machines, computers, microscopes and scales.

Cost drivers

Cost drivers were the causal factors that influenced the cost of the activity, which was determined and estimated by the nature of the usage of cost drivers regarding the resources utilized for TB treatment and care. We determined the cost drivers for treatment-related activities and supporting activities and included time in the calculation. Cost drivers were

Figure 1.
Process of TB
treatment and care in
Mae Sai Hospital
(Model 1) and
Chiang Sean
Hospital (Model 2)

selected based on the recommendation of selected people from a hospital, which depended on the time used and the material cost. All items were identified as the volume finally used.

Calculation of the annual costs of activities and services

Once the cost drivers were identified, the next measure was the cost allocation rate, which was calculated as the annual cost of the resources and the number of times the resource was used during a whole year (annual quantity of cost driver). Finally, we calculated the annual TB treatment and care program cost by multiplying the actual quantity of allocation based on the allocation rate of each resource for that TB treatment activity.

Outcome measures

The outcome measurement was based on the effectiveness of TB treatment and care. We selected the number of cured patients or successful treatment as the main measure of effectiveness; this is equivalent to the WHO measure of successfully treated patients. The cure rate was defined as the proportion of those patients whose cure was confirmed by sputum examination and found to be negative for TB bacilli and those who completed a full treatment regimen. Other outcomes included were the total number of TB patients who received care at Mae Sai and Chiang Sean Hospitals.

Process of cost calculation

For the calculation of labor costs, we used the monthly gross salary data of the staff base, which was obtained from the salary database and then multiplied by 12 months to convert monthly gross salaries to annual costs incurred by a hospital. Next, we divided the annual cost of labor by the annual quantity of the cost driver, which was derived from $60 \text{ min} \times 8 \text{ h per day} \times 22 \text{ days per month} \times 12 \text{ months}$ (8 day-off in a month) to obtain the cost allocation rate of labor cost per minute of working for Mae Sai and Chiang Sean Hospitals.

We allocated the activity cost for the TB clinic by multiplying the cost allocation rate by the actual quantity of allocation base (time spent on each activity in the TB clinic). Capital and material costs were calculated based on the use in each activity. Some purchase prices and the year of purchase for capital and materials could not be determined due to a lack of records. The estimation of the cost and the year of purchase were ascertained through interviews with the director and staff who had worked at Mae Sai and Chiang Sean Hospitals for more than ten years. The rooms or buildings used by the TB clinics were estimated for 30 years of lifetime-use; however, other lifetime-use materials were estimated at 1–20 years.

A discount rate of 5 percent was used to find all the current prices of capital and materials. Current prices of capital and materials were annualized depending on the discount rate and its lifetime-use estimate. To calculate the cost allocation rate, we divided the annual cost of capital and materials by the time in minutes that capital and materials were used in a whole year (2017) or the annual quantity of cost drivers.

We estimated the annual quantity of cost drivers (number of minutes that capital and materials were used in one year) for capital and materials based on the information obtained from the hospital director and other staff. Three criteria were considered in the study: $60 \text{ min} \times 24 \text{ h per day} \times 30 \text{ days per month} \times 12 \text{ months}$ for resources that were used all the time, such as IPD and the emergency room; $60 \text{ min} \times 8 \text{ h per day} \times 22 \text{ days per month} \times 12 \text{ months}$ for the components employed in office time, such as computers, scales, X-ray machines, mercury sphygmomanometers, automatic blood pressure monitoring devices and patient historical record forms; and $60 \text{ min} \times 3 \text{ h per day} \times 4 \text{ days per month} \times 12 \text{ months}$ for materials and equipment used only by Mae Sai Hospital staff for services and follow-up with people in the villages every Friday afternoon.

All capital and material costs were allocated to the TB program by multiplying the cost allocated rate to each item by its annual quantity of cost drivers.
Finally, the cost-effectiveness was calculated for Mae Sai and Chiang Sean models.

Results

In 2017, the TB treatment and care program provided by Mae Sai Hospital was more cost-effective than that provided by Chiang Sean Hospital. At Mae Sai Hospital, the total cost of the TB treatment and care program was 482,728.94 baht for 57 Burmese TB patients. Therefore, the cost per treated case per year was 8,468.93 baht per case. The number of TB patients who had successfully completed treatment was 44 Burmese patients. Thus, the C/E was 10,971.11 baht per successful TB treatment per year (Table I). In the same year, the total cost of the TB treatment and care program at Chiang Sean Hospital was 330,578.73 baht for 39 Laotian TB patients. Therefore, the cost per treated case per year was 8,476.38 baht per case. The number of successful treatments was 15 Laotian TB patients, and the C/E was 22,038.58 baht per successful TB treatment per year (Table I).

The TB treatment and care program provided by Mae Sai Hospital was approximately 2.2 times more cost-effective than the program provided by Chiang Sean Hospital. The ICER was 5,246.56 baht per successful TB treatment per year.

The majority of the cost for TB treatment and care was the capital cost, which was up to 67 percent for the TB treatment and care program at Mae Sai Hospital and 46 percent at Chiang Sean Hospital (Table II).

Cost	Chiang Sean Hospital (Burmese TB patients)	Mae Sai Hospital (Laotian TB patients)
<i>Activity I: screening new TB patient</i>		
Capital cost ^a	108,558.16	26,357.68
Material cost ^b	75,742.96	23,881.00
Labor cost	18,922.06	4,811.84
<i>Activity II: hospitalized TB patient</i>		
Capital cost ^a	40,744.29	264,980.05
Material cost ^b	13,576.25	1,554.00
Labor cost	5,284.48	12,667.99
<i>Activity III: ongoing treatment and care</i>		
Capital cost ^a	4,215.78	30,665.16
Material cost ^b	8,321.68	4,218.00
Labor cost	55,213.08	65,680.57
<i>Activity IV: community follow-up</i>		
Capital cost ^a	–	2,035.13
Material cost ^b	–	21,022.00
Labor cost	–	24,855.54
Total cost	330,578.73	482,728.94

Notes: ^aCalculation of the depreciation of capital cost by using annualization factor:

$$a(r,n) = r[(1+r)^n]/[(1+r)^n - 1],$$

where r is the interest rate and n is the usable life of capital asset; ^bCalculation of the current price of material:

$$C_t = C_o(1+r)^t,$$

Table I.
Cost of tuberculosis
treatment and care at
the TB clinic

where C_t is the current price of the asset, C_o is the purchase price, r is the interest rate and t are the years since purchase

Discussion

Two different models of TB treatment and care represented by the Mae Sai and Chiang Sean Hospitals located on the Thai–Myanmar–Republic of Laos borders showed a difference in the ICER of 5,246.56 baht per case. Mae Sai Hospital had a greater number of foreign TB patients than Chiang Sean Hospital but fewer expenses. The component of community follow-up of TB care included in the Mae Sai Hospital model was an influencing factor in achieving a more cost-effective model.

TB is a major communicable disease, particularly in developing countries, including Thailand, Myanmar and the Republic of Laos. A number of TB patients cross the borders to gain access to Thai hospitals each year. The strengthening of the health care system between countries depends on both internal and inter-country policies. Thailand enjoys good collaboration with the local health agencies in the Republic of Laos, which includes a memorandum of understanding between countries regarding referrals of patients with a TB diagnosis[22]. Therefore, all Laotians diagnosed with TB will be referred back to their country. However, this process has to be accepted by Laotian TB patients who express a desire to go to Thai hospitals. The result is that health professionals at Chiang Sean Hospital do not have a working plan at the community level for foreign TB patients.

Thailand and Myanmar have also made great progress toward developing a collaboration regarding TB case management along the border. The health management system in Myanmar is different from the Thai health management system. Mae Sai is bordered by Ta Kei Lek district, Shan State, on the Myanmar side, which has a different concentration of people from that represented by their central government because most people living in Ta Chi Leik are from a minority population[23].

Thailand and Myanmar do not have any memoranda of understanding with regard to TB case management. Therefore, most individuals diagnosed with TB at Mae Sai Hospital are asked to attend a hospital in Thailand or to live in a village close to a hospital in Thailand. This enables the TB clinic staff to closely monitor their patients and improve the successful treatment rate.

Our study findings indicate that hospitals with community or village-based TB case monitoring achieve better cost-effectiveness compared to those that do not have this service. This coincides with the findings of several studies of cost-effectiveness in TB case management[24–27].

Some limitations were found during data collection. The rotation of staff in TB clinics was one of the problems faced when collecting labor costs. Labor costs (staff salaries) were difficult to access in some hospitals.

Conclusion

The study findings show that providing TB treatment and care with standard treatment procedures (screening, ongoing treatment and hospitalized care) combined with patient follow-up in a village significantly improves treatment outcomes and the

Cost-
effectiveness of
TB treatments

Item	Chiang Sean Hospital (Burmese TB patients)	Mae Sai Hospital (Laotian TB patients)
Total TB cases	39.00	57.00
Cost per treated case per year	8,476.38	8,468.93
Number of successful treatments	15.00	44.00
Successful TB treatment per year	22,038.58	10,971.11
ICER		5,246.56

Table II.
The cost-effectiveness
ratios and incremental
cost-effectiveness
ratios

cost-effectiveness of treating foreign TB patients who go to Thai border hospitals. Most TB patients and those receiving care at Mae Sai Hospital are advised to stay in a village in Thailand for several months. This method supports the patient care that can be provided at home or in the village by a health professional. With the community follow-up activity, Mae Sai Hospital can produce a better TB treatment outcome and decrease expenses. This model should be considered for implementation at all similar hospitals located in border areas.

References

1. World Health Organization [WHO]. Tuberculosis (TB). 2018. [Cited Dec 2018]. Available from: www.who.int/tb/en/
2. World Health Organization [WHO]. Global tuberculosis report 2018. 2019. [Cited Dec 2018]. Available from: www.who.int/tb/publications/global_report/en/
3. Mishkin K, Alaei K, Alikeyeva E, Paynter C, Aringazina A, Alaei A. Association between antiviral therapy and antitubercular drug resistance in TB treatment outcome among Kazakh TB/HIV co-infected patients. *J Glob Antimicrob Resist*. 2018; 14: 104-8.
4. Li D, Ge E, Shen X, Wei X. Risk factors of treatment outcomes for multi-drug resistant tuberculosis in Shanghai, 2009-2012. *Procedia Environ Sci*. 2016; 36: 12-19.
5. Javaid A, Ullah, Masud H, Ahmad W, Butt ZA, Qasim M. Predictors of poor treatment outcomes in multidrug-resistant tuberculosis patients: a retrospective cohort study. *Clin Microbiol Infect*. 2018; 24(6): 612-17.
6. Borisov SE, D'Ambrosio L, Centis R, Tiberi S, Dheda K, Alffenaar JW, *et al*. Outcomes of patients with drug-resistant tuberculosis treated with bedaquiline-containing regimens and undergoing adjunctive surgery. *J Infection*. 2019; 78(1): 35-9.
7. Apidechkul T. A 20-year retrospective cohort study of TB infection among the hill tribe HIV/AIDS population in Thailand. *BMC Infect Dis*. 2016; 16: 1-14. doi: 10.1186/s12879-016-1407-4
8. Royal Thai Survey Department, Royal Thai Armed Forces Headquarters. Border Thailand-Myanmar; 2014. [Cited Dec 2018]. Available from: www.rtsd.mi.th
9. Bureau of Tuberculosis, Ministry of Public Health. Tuberculosis in Thailand 2018. [Cited Jan 2019]. Available from: www.tbthailand.org/documents.html
10. Chiang Rai Province. General information of Chiang Rai province; 2016. [Cited Dec 2018]. Available from: www.chiangrai.net/cpwp/
11. Charoensook P, Upala P, Anuwatnonthakate A, Ruangjai T, Apidechkul T. Pulmonary tuberculosis screening and quality of life among migrant workers, northern Thailand. *J Infect Dev Ctries*. 2018; 12(12): 1056-61.
12. Apidechkul T, Laingoen O, Suwannaporn S. Inequity in accessing health care service in Thailand in 2015: a case study of the hill tribe people in Mae Fah Luang District, Chiang Rai, Thailand. *J Health Res*. 2016; 30(1): 67-71.
13. The Center of Disease Control No. 1, Chiang Mai Office, Department of Disease Control. TB situation in northern region of Thailand in 2018; 2019. [Cited Mar 2019]. Available from: <https://ddc.moph.go.th/th/site/office/view/odpcl>
14. World Health Organization [WHO]. End TB-end TB strategy, global plan to end TB, targets, 2016-2035; 2014. [Cited Mar 2019]. Available from: www.tbfacts.org/end-tb/
15. Chiang Rai Public Health Office. HIV/AIDS in Chiang Rai, 2018; 2018. [Cited Jan 2019]. Available from: <http://cro.moph.go.th/moph/index.php>
16. Jinasen R. Situation of HIV infection and ARV treatment in HIV infection/AIDS patient analysis in Chiang Rai Prachanukroh Hospital, Chiang Rai province. *J AIDS*. 2018; 30(2): 57-68.
17. TB/HIV Research Foundation. TB situation in Chiang Rai 2010-2018; 2019. [Cited Mar 2019]. Available from: www.tbhivfoundation.org

18. Chiang Rai Public Health Provincial Office. TB situation in district hospitals; 2018. [Cited Mar 2019]. Available from: <http://cro.moph.go.th/moph/index.php>
19. Assawapalanggool S, Kasatpibal N, Sirichotiyakul S, Arora R, Suntornlimsiri W. Risk factors for cesarean surgical site infection at a Thai-Myanmar border hospital. *Am J Infect Control*. 2016; 44(9): 990-5.
20. Bochaton A. Cross-border mobility and social network: laotians seeking medical treatment along the Thai border. *Soc Sci Med*. 2015; 14: 364-73.
21. Sonkong K, Suggaravetsiri P, Chaiklieng S. Treatment seeking behavior and prevalence of treatment delay among malaria patients along Thailand-Myanmar border in Tak province. *Asian Pac J Trop Dis*. 2015; 5(4): 279-83.
22. Chiang Sean District Health Office. Communicable disease control: TB and memorandum of understanding between Thailand and Republic Laos; 2018. [Cited Dec 2018]. Available from: <http://gishealth.moph.go.th/pcu/admin/pcu.php?code=00620>
23. Shan State Government Office. Shan State Government; 2014. [Cited Dec 2018]. Available from: www.shanstate.gov.mm
24. Kaplan RS, Witkowski M, Abbott M, Guzman AB, Higgins LD, Meara JG, *et al*. Using time-driven activity-based costing to identify value improvement opportunities in healthcare. *J Healthc Manag*. 2014; 59(6): 399-412.
25. Pichenda K, Nakamura K, Morita A, Kizuki M, Seino K, Takano T. Non-hospital DOT and early diagnosis of tuberculosis reduce costs while achieving treatment success. *Int J Tuberc Lung Dis*. 2012; 16(6): 828-34.
26. Yassin MA, Datiko DG, Tulloch O, Markos P, Aschalew M, *et al*. Innovative community-based approaches doubled tuberculosis case notification and improve treatment outcome in Southern Ethiopia. *Plos One*. 2013; 8(5): 1-8. doi: 10.1371/journal.pone.0063174
27. Atif M, Sulaiman SA, Shafie AA, Asif M, Babar Z. Resource utilization pattern and cost of tuberculosis treatment from the provider and patient perspectives in the state of Penang, Malaysia. *BMC Health Serv Res*. 2014; 14: 1-11.

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