Cost-Effectiveness of Public-Private Mixed Models in National Tuberculosis Program in Ho Chi Minh City, Vietnam

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Abstract

Public-private mixed system in Tuberculosis program is internationally recommended by World Health Organization to increase cooperation between public and private sector for effectively providing TB treatment. Although clinical benefits of PPM are apparent, the economic impacts of PPM are still unclear compared with the conventional system, in which only public health system provided TB treatments following DOTS. This study aims to measure the cost-effectiveness of TB treatment and incremental cost-effectiveness in the PPM models compared to the conventional model from a health system perspective under Vietnamese National TB Program in Ho Chi Minh City, Vietnam.

Using activity-based costing method, costs were measured and estimated including financial and economic costs, excluding any costs related to patients. Effectiveness of TB program was measure through detection rate, successful treatment, and life-years gained. All data were collected for the year 2011, using USD in 2011.

This study found that the detection rates of all type of TB were 41.71% and 22.49%; of newly infected TB were 98.41% and 50.9% in PPM and the previous TB system, respectively. Total cost per life-year gained in PPM and in the previous TB system were around 11.89 USD and 9.33 USD, respectively. Incremental cost-effectiveness ratio of PPM implemented was around 5.4515 USD per life-year gained.

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One-way sensitivity analysis and Probabilistic sensitivity analysis proved robustness of these results on ICER which can be variable from 5.4488 (at the 2.5% percentile) to 5.4547 (at the percentile 97.5%).

TB program in Ho Chi Minh City was cost effective, and PPM implemented lead to more cost effective. The first model of PPM is strongly proven that it should be sustained, or even expanded because of the obvious improved effectiveness. PPM was more cost respecting with more effective.

Key Word: Cost-Effectiveness, Ho Chi Minh City, Vietnam, National Tuberculosis Program, Public-Private Mixed Models

Introduction

Tuberculosis (TB) is still significantly a very dangerous disease, a major public health problem throughout the world. Categorized in to anatomical and bacterial types, TB is known as smear-positive (AFB+) and smear-negative (AFB-) pulmonary TB (PTB), and extra-pulmonary TB (EPTB) (NTP, 2009; WHO, 2010). TB impacted negatively on socioeconomic prosperity globally (Ray, Sharma, Singh, & Ingle, 2005). TB is a severe burden not only for TB patients but also on the healthcare system nationally, especially in developing countries. Vietnam was ranked at 13th of top 22 countries have the highest TB burden (HBCs) on over the world (WHO, 2008), and TB situation in Vietnam will be more serious due to the variety of many dangerous TB strains cause severe drug resistances (Buu et al., 2012; Nguyen et al., 2012; Tram et al., 2012).

In the previous TB system, in which healthcare provision based mostly on the public sector, public sector and the private sector were running and independently. There are around one-fourth of observed private healthcare facilities providing TB treatment, of which many treated TB incorrectly from the guidelines of Vietnamese National Tuberculosis Program (NTP) (NTP, 2011). As a matter of fact, the Public-Private Mixed system (PPM) has been implemented since

2008, and since 2009 in Ho Chi Minh City (Dang, 2012) substituted for the previous TB system to provide effective TB treatments.

PPM is an internationally recommended Stop TB strategy to increase cooperation between public and private sector. It contains four models: Model 1 (Referring suspects), Model 2 (Diagnosing), Model 3 (Treating), and Model 4 (Diagnosing and treating). In PPM, TB treatments are strictly following DOTS strategies, an internationally recommended strategy.

The NTP proved that PPM did really increase the detection rate of TB suspects. In 2010, private sectors contributed 10% of detecting newly AFB+ PTB, and increased 22% of the screening rate (Dang, 2011). Although clinical benefits of PPM are apparent, the economic impacts and the cost-effectiveness of PPM are still unclear compared with the previous TB system, in which only public health system provided TB treatments following DOTS (Directly observed treatment, short course). Besides, from a private sector perspective, due to lacking economic evidence, private sector still plays a giant role, leaving the high burden to the public sector in TB treatments (NTP, 2007).

Due to the limitation of resources, cost-effectiveness analysis (CEA) can be the most appropriate solution contributing to the decision-making process. CEA is one of the basic useful tools among economic evaluation methods for evaluating and assessing the effectiveness of healthcare program or health intervention (Drummond, Stoddart, & Torrance, 2005). However, there has been very few, even no research on CEA of TB treatments specifying for NTP in Ho Chi Minh City before. As a matter of facts, this research is essential to provide a specific economic evaluation of PPM compared with the conventional models in TB program, and may become a basis for more advanced researches later on.

Objectives and Scope

Objectives

The main objectives of this study are follows:

1. To identify, measure, and valuate the cost of TB treatments in the PPM, the conventional model, and incremental cost of the PPM implemented through separating activities in NTP.

2. To quantify effectiveness of TB treatments through the number of detected TB patients, the number of successful TB treatments, and the total life years gained of successful TB treatment cases in the PPM, the conventional model, and incremental effectiveness of the PPM implemented under NTP.

3. To determine the cost-effectiveness of TB treatment in the PPM compared with the conventional model under NTP.

4. To measure the incremental cost-effectiveness of the PPM implemented.

Scope of Study

Cost-effectiveness analysis for TB treatments of the whole TB program in Ho Chi Minh City pays attention to all activities concerned with TB treatments. This study is conducted in Ho Chi Minh City, Vietnam, including all TB treatment systems on the provincial level and its sub-systems. These are one provincial specific hospital for TB and Lung Diseases, 24 district TB units (DTBU), all 322 communal health centers (CHC), and all contractors under NTP. All information and data are collected for the fiscal year 2011.

Literature Review

Due to the limited resources, economic evaluation is essential for healthcare decision maker. CEA is one of the basic useful tools for evaluating and assessing the effectiveness of healthcare program or health intervention (Drummond, Sculpher, Torrance, O'Brien, & Stoddart, 2007; Drummond et al., 2005; Muennig, 2008; WHO,

2003). There are many guidelines for conducting CEA, mostly summarized into three distinct groups by Walker, D. in a published article in 2001 (Walker, 2001; Wonderling, Sawyer, Fenu, Lovibond, & Laramee, 2011). As a developing country, for conducting CEA in Vietnam focusing on TB programs, WHO guidelines for "Choosing Interventions that are Cost-Effective" (CHOICE) (WHO, 2003) are one of the most appropriate guidelines as published in 2000 by the lead author Murray et al. On "Generalized cost-effectiveness analysis" (Murray, Evans, Acharya, & Baltussen, 2000). CEA can provide evidence for comparison of decision options in monetary term (Petitti, 2000).

CEA in TB treatment following DOTS strategy is a necessary evaluation for NTP in many countries, especially in developing countries and HBCs in Africa and Asia. DOTS reduced 99.98% of the infectivity burden of disease, 89.19% of Life-years lost (LYL), and 78.9% of Life-year disabled (LYD) in Beijing, China (Xu, Wu, Jin, & Zhang, 2002), 50% prevalence and mortality between 1990 and 2010 in sub-Saharan Africa, between 2000 and 2010 in South East Asia (Baltussen, R., Floyd, & Dye, 2005).

DOTS for all type of TB treatment are cost effective strategies. Using US dollar in 2000, authors Xu, Q. et al. showed that DOTS for newly AFB+ TB treatment saved more ten times than non-DOTS per disabled-adverted life-year (DALY) (CN¥45.7 versus CN¥471.4 per DALY, respectively) in Beijing, China (Xu, Jin, & Zhang, 2000). In Thailand, during 1996-1997, author Kamolratanakul, P. et al. reported that the provider cost of newly infected TB treatment per patient were from THB7,020 to THB12,539 for AFB+, and from THB3,916 to THB7727 for AFB-, and of re-treatment were from THB9,696 to THB16,679 (Kamolratanakul et al., 2002). According to author Baltussen, R., et al. reported in 2005, using the international dollar in 2000 (I$), cost of newly AFB+ TB cases in DOTS program are around I $6-8 per DALY in Africa and I$7 per DALY in South East Asia at coverage levels of 50-95% in the context of the millennium development goals (Baltussen, R. et al., 2005). In Kenya, included all costs of health services, patients, family members,

and community, using US dollar in 1998, author Nganda, B. et al. reported that the costs per patient for new AFB+ TB treatment were from US$209 to US$591, and from US$197 to US$311 per treated patient for new AFB- TB and EPTB treatment (Nganda, Wang'ombe, Floyd, & Kangangi, 2003).

Following WHO's guidelines for Public-Private Partnership, the structures of PPM in many HBCs are almost similar. There are four models for different purposes, in which the roles and responsibilities of private sector are different. These are referring model, diagnosing model, treating model, and comprehensive model (Ardian et al., 2007; Arora, Lonnroth, & Sarin, 2004).

The first model, which one focuses on finding TB cases and referring TB suspects, are reported as the most successful model in term of clinical benefits with significant improvement of TB cases finding, detections and treated rate (Ardian et al., 2007; Arora et al., 2004). In South India from 2001 to 2003, author Balasubramanian, R. et al. found out that the rate of AFB+ TB patients, who were suspects referred by private trained practitioners, was 24% compared to 10% by self-reported patients ($p < 0.001$ suggested that this difference was very significant). The detection rate increased by nine per hundred thousand population (Balasubramanian et al., 2006). Also in India, other article published in 2005 by author Kumar, M. K. et al. also reported that there were 17% of 2,328 PTB patients registered detected in the private sector, increased new AFB+ TB cases notification rate by 21% from 2000 to 2002 (Kumar et al., 2005).

PPM is an incentive and has effect to shift TB patients from non-DOTS, provided by non-contracted private sectors, to DOTS treatment, uniformly provided by cooperative TB system. Implementing PPM can be cost-effective and reduce the financial burden of TB patients. A study of author Pantoja, A. et al. published in 2009 demonstrated for that statement. Collected data from 1999 to 2005 of TB treatments under NTP in Bangalore City, India, they found out that the implementation of PPM shifted more than seven thousand TB patient from a non-DOTS to DOTS treatment over five years. Using US dollar in 2005 from provider perspective, they

estimated the cost per TB patient was US$69 in PPM, compared with US$71 in pre-PPM TB treatment system (Pantoja et al., 2009). Another article of authors Sinanovic, E. and Kumaranayake, L. concluded that PPM could significantly reduce 64% to 100% costs to the TB patients from US$700-1000 to US$354-979 per patient, and reduce government financing required per TB patient from US$609-690 to US$36-139 (Sinanovic & Kumaranayake, 2006) in South Africa.

Research Method

Study Design

Prevalence-based cost-effectiveness and incremental cost-effectiveness analysis from the healthcare system perspective was conducted with activity-based costing method used for.

Data Collection

This study uses a retrospective secondary data collected from Pham Ngoc Thach TB and Lung Diseases Hospital, the TB Units of Preventive Medicine Centers in 24 districts, 322 Communal Health Centers, and all contractors PPM, for this study in Ho Chi Minh City, Vietnam. Data will be separated into PPM and the previous TB system, which is assumed that the contractors did not participate in the TB treatment system. All data were collected from three sources.

Patients' data from medical records

Available medical records of the patients, who were detected and registered in TB treatment in Ho Chi Minh City's TB program system, are collected in the years 2010 and 2011. There are 13,960 observations in 2010, and for 2011 are 13,945 observations available.

Ho Chi Minh City TB Program's reports

These reports contain treatment outcome reports, screening and detecting reports, activities reports, asset auditing reports, drug and medical supplying reports, financial reports, human resource reports in 2011.

Qualitative data from in-depth interviews and direct observations

There were 30 in-depth interviews conducted using unstructured questions. The collected information was mostly the allocation criterion of human resources for each activity, as well as for TB program compared with the other programs. Allocation criterion of the capital costs were collected by directly observing healthcare facilities.

Conceptual Framework

This study was focusing on comparing the PPM to the previous TB system, in both cost and effectiveness of TB treatment under NTP following DOTS. The PPM in TB program is a system in which the private healthcare facilities contracted with the public healthcare system to provide TB treatments following DOTS in any models. Public and private healthcare systems in PPM linked and supported to each other. The previous TB system under NTP was the system in which TB treatments were provided by public healthcare facilities only. Because the previous TB system has been substituted by PPM, this study was conducted based on the assumption that the previous TB system had been still existed in 2011. A hypothesis was employed in this study that PPM implemented might be increasing the detection rate, treated rate, reducing the cost per outcome, and increasing cost effective of TB program in Ho Chi Minh City.

The conceptual framework of this study is illustrated in Figure 1.

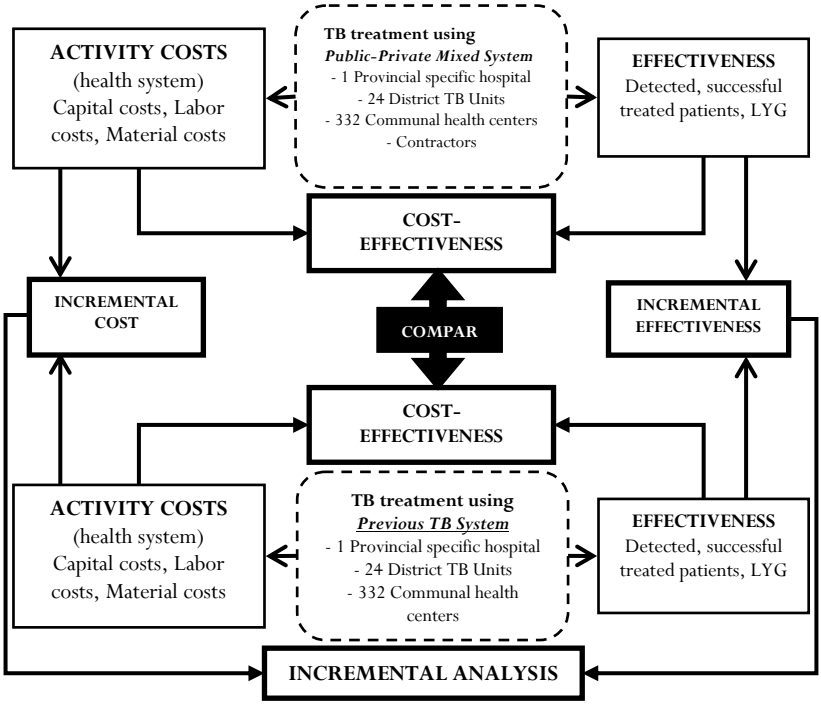

Figure 1 Conceptual framework of study

Costing Method

Costs measured in this study contained both the explicit financial costs and implicit economics costs, which are measured through opportunity costs using shadow price and market price as the proxies. The opportunity costs components are measured flexibly based on the real number of resources used and the estimated unit costs of resources used, which will reflect the potential interests if these resources are invested in the market instead be used in TB program. Cost components of each activity are calculated directly from amount of resources used, assigned cost from jointed cost using allocation criterion specifying for each kind of resource, etc. Base on the perspective of this study, costs of treatments contains all direct medical costs, and indirect medical costs, exclude any costs related to

patients. Costs of each activity are divided into capital costs, material costs, labor costs.

The monetary values of costs in this study were exchanged into USD by using the USD exchange rate at the end of 2011. The exchange rate officially provided by the Ministry of Finance was 20,803 VND/USD.

The activities involved in NTP are classified into six main activities: 1) Administration activities, 2) Monitoring activities, 3) Infection control (IC), Advocacy-Communication-Social Mobilization (ACSM), training, and researching activities, 4) Screening activities, 5) Detecting activities; and 6) Treating activities.

The costs of the program will include related costs in all levels of health system and sub-system that involved in TB treatments under NTP. Capital costs, material costs and labor cost such as opportunity costs of used space, cost of equipment, salaries, etc. will be allocated by percentage used.

Measuring Effectiveness

Outcomes of TB program under NTP detected patients and successful treatment cases, which are defined as the summing of cured cases and treatment completed cases (NTP, 2009; WHO, 2010). Otherwise, patients with TB can be completely treated without incurring any complication. Therefore, life-years gained (LYG) calculated from the remaining life expectancy using life table specifying for Vietnam is also very important for measuring TB related death averted as an effectiveness of TB program (Robberstad, 2005).

Discounting, depreciation, inflation adjustment

In one-year estimation with all information collected in the same year, there is no need to discount. Annuity depreciation for one-year operation of healthcare program was used to measure the costs incurring for a long time, especially for capital costs (Petitti, 2000). The inflation adjustment should be considered for measuring the costs over time. The most common price index used for adjusting inflation is the Consumer Price Index (CPI).

Incremental costs-effectiveness analysis (ICEA)

ICEA is estimating through dividing the different cost by the different effectiveness in term of life-yeas gained of PPM and the conventional TB system in which only public sectors were assumed to be involved.

Research Result

Activity costs

Collecting information, measuring and valuating resources used, and allocating for activities, all costs components are summarized in the Table 1 separately for PPM and the previous TB system in 2011. Accordingly, total cost of TB program for PPM was USD 7,633,749, higher than the previous TB system in which the total cost was estimated at USD 5,936,142 in the year 2011.

Table 1 Summary of Activity cost components in TB program

Activities	PPM			Public only		
	Capital costs	Labor costs	Material costs	Capital costs	Labor costs	Material costs
Administration	889,523	77,115	1,619	889,523	77,115	1,619
Monitoring	263,023	86,208	1,846	263,023	86,208	1,846
IC, ACSM, training, and researching	291,832	284,279	5,215	291,832	284,279	5,215
Screening suspects	652,521	434,748	1,769	458,239	93,684	1,769
Detecting	770,081	57,135	62,026	596,927	46,934	38,804
Treating	2,485,125	268,891	1,000,793	2,084,069	184,189	559,394
Total cost		7,633,749			5,936,142	

Effectiveness

Due to insufficient available data, measuring the effectiveness of TB program in this study is basing on a list of assumptions

1. The TB prevalence, incidence, mortality rate caused by TB in Ho Chi Minh City in 2011 is assumed to be similar with the whole

nation in WHO's Global Report for the year 2011, published in 2012, specified for Vietnam (WHO, 2012).

2. This study is assuming that all TB patients would seek and be involved in screening process.

3. All the TB patients are assumed to be registered immediately when they are detected as the Vietnamese National TB management guideline.

4. All TB patients dying during TB treatment is assumed caused by TB, not because of other diseases.

Outcome summary

Extracting information from the reports of NTP in Ho Chi Minh City, the Table 2 summarizes all number of cases categorized into:

1. Number of sputum test through the number of tested sputum smears with two kind of results, including AFB+ and AFB- for detection and monitoring during TB treatments;

2. Number of screened suspects with their determined diagnosis, including number of detected AFB+ TB patients, suspects with AFB- sputum test results. This number of suspects with AFB- sputum test results is not separated for no TB screened suspect, AFB- PTB patients, and EPTB patients;

3. Number of patients registered for TB treatment categorized into all historical and bacterial types of TB patients, excluding TB patients transferred from other provinces or private sector non-contracted under NTP, which were also reported as “transferred in” separately;

4. Number of followed up patients, and lost patients who could not have contacted to during treatment; and

5. Number of treated patients with their treatment outcomes.

Table 2 Outcome summary of TB program in Ho Chi Minh City in 2011

			PPM	Public only
Sputum test (No. of smears)	For detection	AFB+	21,279	17,129
		AFB-	150,619	90,175
	For treatment	AFB+	4,200	2,893
		AFB-	59,302	40,602
Screened suspects		AFB+	9,593	6,822
		AFB-	59,499	31,343
Registered patients	New PTB AFB+		7,444	4,380
	PTB AFB+ Retreated after relapsed		1,580	1,470
	PTB AFB+ Retreated after failure		282	267
	PTB AFB+ Retreated after defaulted		132	115
	Others PTB AFB+		303	296
	New PTB AFB-		3,451	1,203
	New EPTB		3,424	1,360
	Other AFB-, EPTB		553	232
Transfer in			743	706
Treated patients			17,105	8593
Lost			64	31
Treatment outcome	Cured		7,530	4,850
	Complete treatment		6,436	2,502
	Dead		584	304
	Failed treatment		548	328
	Defaulted		656	299
	Transferred out		1,351	309

Detection and treatment

According to WHO's Global Report for TB burden in 2011, published in 2012, the estimates TB prevalence, incidence, and mortality rate caused by TB in 2011 in Vietnam were estimated at 0.323% (ranged from 0.148% to 0.563%), 0.199% (ranged from 0.153% to and 0.033% (ranged from 0.014% to 0.062%) (WHO, 2012).

The estimated effectiveness of TB program in term of detection and treatment is summarized in Table 3.

Table 3 Summary of effectiveness of TB program in term of detection and treatment

	PPM		Public only	
	Frequency	**Probability**	**Frequency**	**Probability**
Estimated TB patient in 2011	41,166		41,166	
Estimated new TB cases in 2011	18,279		18,279	
Estimated deaths caused by TB	4,533		4,533	
In TB population				
Detected cases	17,169	41.71%	9,260	22.49%
Undetected cases	23,997	58.29%	31,906	77.51%
Treated TB patients	17,105	41.55%	9,232	22.43%
Untreated cases	24,061	58.45%	31,934	77.57%
In detected cases				
Treated TB patients	17,105	99.63%	9,232	99.70%
Untreated cases	64	0.37%	28	0.30%
In treated cases				
Successful treatment	13,966	81.65%	7,601	82.34%
Unsuccessful treatment	3,139	18.355%	1,631	17.66%
Dead	584	3.415%	381	4.12%
Alive	16,521	96.59%	8,851	95.88%
In new infected cases				
Detected	14,319	98.41%	7,407	50.90%

The Chi-squared tests and Prevalence Ratio (PR) presented in the Table 4 are showing that PPM is significantly increasing detection and treated rates in all TB population at 1% significance level by approximately two times compared with the previous TB system. However, the Chi-squared tests with p-value being equal to 0.4469

showed that PPM was insignificantly increasing treated rate among detected TB patients.

Table 4 Chi-squared test for effectiveness of PPM in term of increasing detection and treatment

	PPM	Public only	p-value	PR
Among all TB patients				
Detected	17,169	8,620	<0.001	1.99
Undetected	23,998	32,546		
Among all TB patients				
Treated	17,105	8,593	<0.001	1.99
Untreated	24,061	32,573		
Among detected TB patients				
Treated	17,105	8,593	0.4469	0.99
Untreated	64	27		

Dead averted and Life-year gained

Assuming all non-death treated TB patients will alive until the end their life expectancy, the life year gained estimated from the age of TB patients and life table provided by WHO in 2009. The Table 5 provided more detail.

Table 5 Summary of Life-years gained of each kind of outcome

	PPM	Public only		PPM	Public only
Cured patients	280,506	178,355	**Defaulted**	25,485	11,485
Completed	264,053	112,833	**Transferred out**	52,535	22,958
Failed treatments	19,732	10,508	**Dead**	0	0
Total LYG	642,311	336,139	**Average LYG**	39	38

Cost-effectiveness and incremental cost-effectiveness analysis

Showed in Table 6, the average cost per patient would be calculated by dividing total cost, which provided in the Table 1, by the number of patients, which provided in the Table 3, respectively; and the additional cost per patient would be calculated by summarizing the direct allocation cost of each activity (the screening, detecting, and treating activities provided in the Table 1), and the indirect allocation cost of other activities (the administrative, monitoring, IC, ACSM, training, researching activities also provided in the Table 1) for each respective outcome (the screened suspects, detected TB patient, treated TB patients, and successful treatments provided in the Table 3).

Table 6 Average cost of each type of outcome

	PPM		Public only	
	No.	**Cost (2011 USD)**	**No.**	**Cost (2011 USD)**
Average cost				
TB patients	41,166	185.44	41,166	144.89
Screened suspects	69,092	110.49	38,165	103.21
Detected TB patients	17,169	444.62	8,620	644.13
Treated TB patients	17,105	446.29	8,593	646.09
Death adverted	16,521	462.06	8,851	673.88
Successful treatment	13,966	547.00	7,601	784.70
Additional cost				
Screened suspects	69,092	56.14	38,165	54.28
Detected TB patients	17,169	225.93	8,620	338.77
Treated TB patients	17,105	446.29	8,593	646.09
Death adverted	16,521	462.06	8,851	673.88
Successful treatment	13,966	547.00	7,601	784.70

Basing on the total cost provided in the Table 1, and the total life-years gained provided in the Table 5, total cost per life-years gained in PPM was around 11.8848 USD, significantly less than the previous TB

system, in which the total cost per file-year gained was estimated around 17.7447 USD in 2011.

Incremental effectiveness in term of life-years gained and incremental cost when PPM implemented was around 306,172 life-years and 1,669,080 USD in 2011, respectively. Incremental cost-effectiveness ratio (ICER) was around 5.4515 USD per life-year gained in 2011 meaning that when PPM implemented, to get one more life-year gained, TB program had to pay around 5.4515 USD more in 2011.

Sensitivity analysis (SA)

Uncertainties

This study's result is facing some uncertainties because the data and information used for cost-effectiveness analysis were collected from non-sampled secondary data sources (Baltussen, R. M., Hutubessy, Evans, & Murray, 2002). The variability of each parameter can effect to change ICER in term of life-years gained. The sensitivity analysis could deal with these uncertainties and reflect the robustness of this study's results (Jain, Grabner, & Onukwugha, 2011). In this study, One-way sensitivity analysis (SA) and Probability sensitivity analysis (PSA) would be used.

One-way sensitivity analysis and Tornado diagram

The Figure 2 presents One-way SA of ICER respected with the changes of each parameter in their acceptable range. The vertical line represents the original estimated ICER under base-case conditions.

This study explored those parameters with the greatest effect on the ICER. Those cost-related parameters and the life-years gained are shown as the main factors of uncertainties. According to the Figure 2, the highest level of ICER's variability caused by the cost of treating activities in both PPM (from 5.4511 to 5.4525 USD per life-year gained in 2011) and the previous TB system (from 5.4508 to 5.4528 USD per life-year gained in 2011). All ranges of ICERs in PPM are much narrower comparing to the previous TB system.

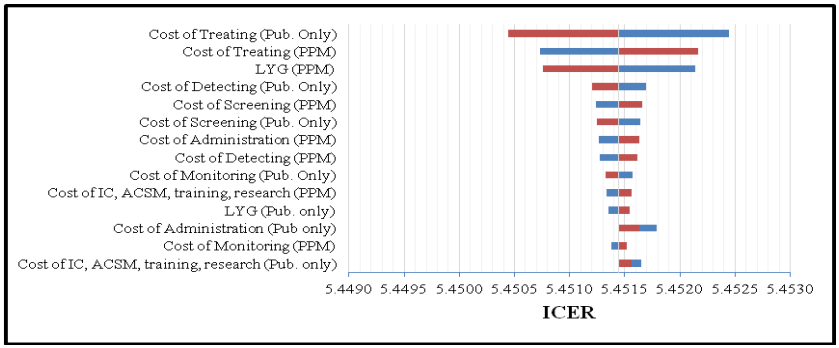

Figure 2 Tornado diagram for One-way SA of ICER (parameter is varying by its own range)

Probabilistic sensitivity analysis (PSA)

One-way sensitivity analysis is still limited due to providing the change of only one parameter one time. In PSA, rather than assigning a single value to each parameter, it is necessary to assign a distribution to all parameters in the model. The ranges are determined by the average value, or the standard error. Running PSA got the ICERs plotted on Figure 3, and statistical summary of ICER in Table 7. According to the results showed in Table 7 and Figure 3, the ICER estimated in this study is proven that it is robust.

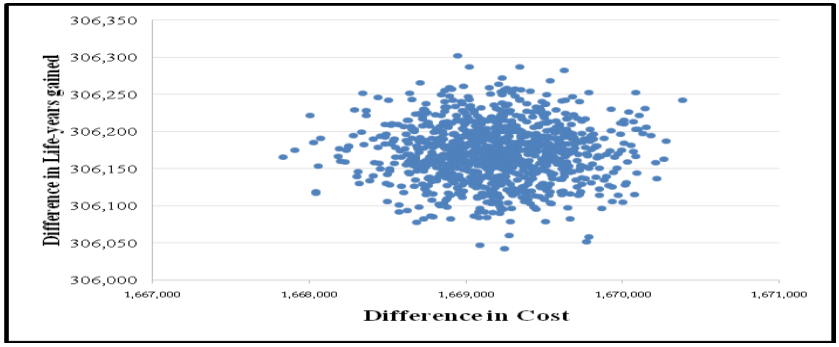

Figure 3 Scatter Plots for Probabilistic sensitivity analysis

Table 7 Statistical summary of ICER in PSA

		ICER in term of life-years gained				
Deterministic		5.4515				
Probabilistic	**Mean**	5.45177921	**2.5%**	5.44886291	**75%**	5.45280847
	SD	0.00147544	**5%**	5.44930888	**95%**	5.45420291
	Median	5.45176695	**25%**	5.45078851	**97.5%**	5.45465305

Discussion

Costs

The PPM implemented was significantly increasing the cost of screening activities, especially in labor cost, and particularly increasing the cost of detecting activities. This is reasonable because PPM implemented initially focusing on the first model, in which the suspects would be screened, and sometimes be detected, in contractors, then, be referred to public TB system.

The capital costs of treating activities are always the highest components in both PPM and the previous TB system. According to the DOTS strategy for TB treatment, TB patients will be treated and directly observed based on community. However, due to the limited human resources, DOTS applying in Ho Chi Minh City is basing on healthcare worker at healthcare facilities. It caused the capital cost of treatment faced by health system increasing too much.

Effectiveness

While there is huge difference of detection rate between PPM and Public, the treated rate among detected patients and the successfully treated rate among treated patient were not significantly different between PPM and the previous TB system. PPM implemented in Ho Chi Minh City since 2009, initially, mostly based on the first model in which the TB suspects would be referred to public TB system after being symptom screened in contractors. That means PPM in the year 2011 was focusing on screening and detecting activity. Under that model, the chance of a TB patient to be detected earlier, and correctly, was significantly increased when PPM

implemented. The increased newly infected TB detection rate reached 98.41% in PPM compared with 50.90% in the previous TB system. This result is similar with the conclusion of author Xu et. al. published in 2002 (Xu et al., 2002), and author R. Baltussen et. al. published in 2005 (Baltussen, R. et al., 2005). The effectiveness of PPM, especially in the first model, is increasing detection rate, the same with many previous articles (Ardian et al., 2007; Arora et al., 2004; Balasubramanian et al., 2006; Kumar et al., 2005)

Cost-effectiveness

TB program in both systems was proved that it was a cost effective intervention. The average cost of all type of TB program's outcomes were less than the GDP per capita of Vietnam, which was reported by World Bank at 1,407 USD per capita in the year 2011 (The World Bank, 2013). So TB program used the smaller cost for getting higher saving. However, this statement is not so strong because this study did not include the cost incurred by patient and productivities lost caused by treatment process. It is necessary to conduct another study, or expand this study, focusing on the patients' costs and productivities lost caused by TB treatment.

With different setting in different context, as well as the different cost components included in this study, it will be very incommensurate in comparing with other studies from other countries. Reviewing the article of author Pantoja et al. (Pantoja et al., 2009) and author Sinanovic, E. and Kumaranayake, L. (Sinanovic & Kumaranayake, 2006), they concluded that PPM could significantly reduce costs, and government financing required per TB patient while this study found that PPM implemented in Ho Chi Minh City had higher cost per TB patient than these researches concluded, and would increase cost per TB patient than the previous TB system. It is incomparable because of two obvious reasons: (1) This study included the economic costs, which were mostly excluded out of government financing required; and (2) this study based on the assumption that the previous TB system had been still existed in 2011, and assessed costs and effectiveness in the same year with the same setting with the

implemented PPM, while the other researches assessed and compared costs and effectiveness between two different settings, ones was the pre-PPM and the other ones was PPM.

Otherwise, there was not cost-effectiveness of TB program conducted specifying for Ho Chi Minh City in Vietnam. This study can be the base-line for conducting other economic evaluation researches later on.

Incremental cost-effectiveness

The additional cost for PPM implementation to get one more life-year gained is quite low. ICER was plotted on the first quarter of the scatter plots diagram meaning that PPM implementation leads more cost respecting with more effective. The One-way SA and PSA proved that the ICER result of this study is robust due to the narrow variability of ICER even when some uncertainties lead the parameters changed.

Limitation of study

The widest limitation of this study was caused by the previous TB system, which have been no longer available. However, because the data for costing and measuring effectiveness can be relatively separated for those models, this study result could be acceptable.

The epidemiological indicators used in this study for Ho Chi Minh City were assumed to be similar with WHO's Global Report. However, because of the specifics of Ho Chi Minh City, these indicators were not so accurate.

Assumptions that all TB patients would seek, be involved in screening process, and all death during TB treatment caused by TB, as well as all detected TB patients would be registered immediately are uncertainties those this study could not cover because no evidence from epidemiological survey proved for that statement.

This research is very specific in the context only one city with its own characteristics, so that the results may be comprehensive because of the vary activities and the strength of Ho Chi Minh City, but may not be able to generalize for TB program in the whole nation. For

applying this result in other provinces' context, adjustment is essential in each specific context.

Besides, the MDR treatment had been excluded out of this study due to unavailable data.

Conclusion and recommendation

The capital cost of treating activities was still high while it should be lower because the DOTS should leads TB patients to be treated based on community. Reducing this cost is possible if the policy maker develop the DOTS system basing on home guardian as some previous researches.

The first model of PPM is strongly proved that it leads to many advantages and improve obviously effectiveness of TB program. This model should be sustained, or even expanded.

Although PPM was significantly increasing detection rate, the treated and successful treatment rates were not increased. TB program should try to encourage and support for contractors, improve their capabilities, so that they can meet the requirement for contracting the other advance models. In that condition, expecting for more effectiveness in treating activities is visible.

The average cost per a screened suspect was slightly increased while the others were significantly reduced when PPM were implemented. TB program is cost effective, and PPM implemented lead TB program became more cost effective.

The incremental cost-effectiveness ratio when PPM implemented was around 5.4515 USD per life-year gained in 2011. The PPM was increasing cost respecting with the increasing of effectiveness. It is necessary to conduct a further research on willingness to pay in order to build up the cost-effectiveness acceptability curve for a more comprehensive view.

Avoiding the limitation for further studies, an epidemiological survey should to be done for getting the real epidemiological indicators. It will lead the result be more precise. TB system in Vietnam should also improve the information and referral system for

the purpose to control and manage TB patient thoroughly, as well as avoid losing TB patients.

This study allows us to understand the cost effectiveness of TB program at provincial levels as well as incremental cost-effectiveness of PPM implemented in Vietnam. It reveals the average costs and additional costs of each kind of outcome, and the particular cost of each activity in TB program.

The result of this study is useful for:

1. The policy makers in the health sector, specifically for Ho Chi Minh City, use this information to help in budget planning. The policy makers can allocate resources or make some policy to cover the costs of the health service provision. Furthermore, this study provides an overview of cost-effectiveness of TB program for sustaining PPM when external funding is no longer available.

2. For public health sector, this study result can be used as the evidence for the development of a national standardized activity framework, which should be adjusted for other provinces.

3. For private health sectors, this study result can be considered as a transparent evidence for encouraging the private healthcare facilities to expand their roles.

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