COST-EFFECTIVENESS ANALYSIS OF TUBERCULOSIS TREATMENT UNDER THE DOTS STRATEGY AT DIFFERENT LEVELS OF HOSPITALS IN BHUTAN

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จุฬาลงกรณ์มหาวิทยาลัย
Chulalongkorn University

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การวิเคราะห์ต้นทุน-ประสิทธิผลของการรักษาวัณโรคภายใต้ยุทธศาสตร์ DOTS สำหรับโรงพยาบาลระดับต่างๆ ในประเทศภูฏาน

นายโซนัม พันโช

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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Thesis Title	COST-EFFECTIVENESS ANALYSIS OF TUBERCULOSIS TREATMENT UNDER THE DOTS STRATEGY AT DIFFERENT LEVELS OF HOSPITALS IN BHUTAN
By	Mr. Sonam Phuntsho
Field of Study	Health Economics and Health Care Management
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โซนัม พันโช : การวิเคราะห์ต้นทุน-ประสิทธิผลของการรักษาวัณโรคภายใต้ยุทธศาสตร์ DOTS สำหรับโรงพยาบาลระดับต่างๆ ในประเทศภูฏาน. (COST-EFFECTIVENESS ANALYSIS OF TUBERCULOSIS TREATMENT UNDER THE DOTS STRATEGY AT DIFFERENT LEVELS OF HOSPITALS IN BHUTAN) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: อ. ดร.ชันทาล แฮร์เบอร์โฮลส์, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: ศ. นพ.ภิรมย์ กมลรัตนกุล, , หน้า.

การศึกษาชิ้นนี้เป็นการศึกษาถึงลักษณะที่ค่าใช้จ่ายและผลการรักษาวัณโรคตามกลยุทธ์ DOTS ในโรงพยาบาลทั้งสามระดับจากมุมมองของผู้ให้บริการ การศึกษาฉบับนี้กำหนดให้ต้นทุนต่อหน่วยและต้นทุนทั้งหมดจากการให้ของ DOTS และ cost-effectiveness ratio (CER) ในสัดส่วนต้นทุนต่อผู้ป่วยที่ประสบความสำเร็จในการรักษา (ผู้ป่วยที่ได้รับการรักษาจนหายเป็นปกติ)

ผลการรักษาและค่าใช้จ่ายย้อนหลังถูกเก็บรวบรวมข้อมูลจากสี่โรงพยาบาลในหนึ่งปีงบประมาณต้นทุนการรักษาถูกประมาณการจากการวิธีการรักษา CER ถูกนับรวมในหมวดหมู่การรักษา I ต้นทุนทั้งหมดที่ให้แก่ DOTS เท่ากับ Nu 3,100,817 (USD 56,378) ซึ่งมีอัตราการประสบความสำเร็จในการรักษาร้อยละ 93 ในโรงพยาบาลระดับชาติและ CER เท่ากับ Nu 12,305 (USD 224) และต้นทุนต่อ DOTS เท่ากับ Nu 10,729 (USD 195). ในส่วนโรงพยาบาลระดับภูมิภาคมีอัตราการประสบความสำเร็จร้อยละ 92 และมีต้นทุนทั้งหมดเท่ากับ Nu 1,369,736 (USD 24,904). CER เท่ากับ Nu 15,744 (USD 286) และต้นทุนเฉลี่ยต่อ DOTS เท่ากับ Nu 13,045 (USD 237). ระหว่าง 2 โรงพยาบาลพบว่าโรงพยาบาลประจำจังหวัดซึ่งรายการการรักษาประจำปีมีต้นทุนทั้งหมด Nu 539,521 (USD 9,809) ด้วยอัตราความประสบความสำเร็จในการรักษาร้อยละ 100 และ CER เท่ากับ Nu 22,480 (USD 409) และต้นทุนต่อ DOTS เท่ากับ Nu 15,415 (USD 280). ในขณะที่โรงพยาบาลจังหวัดอีกซึ่งรายงานความประสบความสำเร็จในการรักษาร้อยละ 93 พบว่ามีต้นทุนทั้งหมดเท่ากับ Nu 468,920 (USD 8,526) และ CER เท่ากับ Nu 16,747 (USD 304) และต้นทุนต่อหน่วย DOTS เท่ากับ Nu 15,631 (USD 284)

การศึกษาพบว่าการให้ MoH และผู้มีส่วนได้ส่วนเสียสำหรับการจัดสรรทรัพยากรสำหรับการดำเนินนโยบาย DOTS และสามารถที่จะสำรวจต้นทุนที่มีประสิทธิภาพของการริเริ่มนโยบายในระบบการรักษาพยาบาลที่ฟรีซึ่งนั้นคือการพัฒนาที่ยั้งยืน

สาขาวิชา เศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ ลายมือชื่อนิสิต .....

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SONAM PHUNTSHO: COST-EFFECTIVENESS ANALYSIS OF TUBERCULOSIS TREATMENT UNDER THE DOTS STRATEGY AT DIFFERENT LEVELS OF HOSPITALS IN BHUTAN. ADVISOR: CHANTAL HERBERHOLZ, Ph.D., CO-ADVISOR: PROF. PIROM KAMOL-RATANAKUL, M.D., pp.

This is a descriptive study that looks at cost and TB treatment outcome as per DOTS strategy across three levels hospital from the provider perspective. Study provides unit and total cost of providing DOTS and cost-effectiveness ratio (CER) in terms of cost per patient treatment successful (patient who was cured or who completed treatment).

Retrospective treatment outcome and cost data were collected from the four hospitals for one fiscal year. Cost of treatment was estimated using activity based costing method. CER is calculated among treatment category I. Total cost of providing of DOTS is Nu 3,100,817 (USD 56,378) with treatment success rate of 93% at National Referral Hospital and CER is Nu 12,305 (USD 224) and cost per DOTS is Nu 10,729 (USD 195). Regional Referral Hospital has treatment success rate of 92% and total cost of DOTS is Nu 1,369,736 (USD 24,904). CER is Nu 15,744 (USD 286) and average cost per DOTS is Nu 13,045 (USD 237). Between two District Hospitals, it was found that District Hospital which usually report more cases of TB annually has total cost of Nu 539,521 (USD 9,809) with treatment success of 100% and CER is Nu 22,480 (USD 409) and cost per DOTS is Nu 15,415 (USD 280). District Hospital reporting low TB case has treatment success of 93% with total cost of Nu 468,920 (USD 8,526) and CER is Nu 16,747 (USD 304) and cost per DOTS is Nu 15,631 (USD 284).

This study finding would provide MoH and stakeholders with a baseline to allocate resources for DOTS implementation and also to explore the cost-effectiveness of other program initiatives in a free health care system for reasons of sustainability.

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ABBREVIATIONS

AHB	Annual Health Bulletin
BHU	Basic Health Unit
BLSS	Bhutan Living Standard Survey
DoPH	Department of Public Health
DOTS	Directly Observed Treatment Short Course
FYP	Five Year Plan
GFATM	Global Fund for HIV, TB and Malaria
GNHC	Gross National Happiness Commission
JDWNRH	Jigme Dorji Wangchuck National Referral Hospital
MDGs	Millennium Development Goals
MDR-TB	Multi-Drug Resistant TB
MoH	Ministry of Health
NHA	National Health Accounts
NSB	National Statistical Bureau
NSP	National Strategic Plan
NTCP	National TB Control Program
Nu	Ngultrum (Bhutan currency)
ORC	Out-Reach Clinic
RGoB	Royal Government of Bhutan
SEAR	South East Asia Region
TB	Tuberculosis
USD	US Dollar
VHW	Village Health Worker
WB	World Bank
WHO	World Health Organization

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CHAPTER I

INTRODUCTION

1.1 Rationale

The Royal Government of Bhutan recognizes the importance to improve effectiveness and efficiency of its health spending(MOH, 2011a) in order to sustain the free health care. Alternatives for sustainability strategy are being considered and discussed in Bhutan. The current study would provide cost implication of the treating TB patient in three levels of Hospitals in one fiscal year. Beside Basic Health Unit at primary level this three levels of hospital is the main backbone of Bhutan health service delivery and hence this three levels of hospital is included for the study. As one challenge for the National Tuberculosis Control Programme (NTCP) is to secure financial resources to sustained and improved TB control activities (MOH, 2012b), the current study findings would be of use for program planning and resource allocation in light of scarce resources.

Cost-effectiveness analysis is a one form of economic evaluation(Drummond, 1987) where the outcome of health programmes are measured in the most appropriate natural or physical unit such as 'years of life gained' 'or cost per cases correctly diagnose or treated'. As cost of healthcare services are increasing and therefore economic evaluation plays an increasingly important role in prioritizing the implementation of treatment and prevention(WHO, 2011) in healthcare. The necessity for promoting evidence based health planning and cost-effectiveness intervention in Bhutan is highlighted as one of the policy objectives(GNHC, 2009) in 10th Five Year Plan. Cost-effectiveness analysis is one method of conducting economic evaluation that essentially looks at cost and outcome in natural units.

Such findings are useful to decision makers, health managers, planner and policy-makers to understand and to assess if an intervention and treatment provides value for resources.

In this line WHO states that basic purpose and objective of cost-effectiveness analysis (CEA) is to measure costs and health outcome of a specific intervention(WHO, 2003).

In other countries number of studies has been done on the cost-effectiveness of TB treatment in different settings and alternative strategies are compared. Cost-effectiveness is viewed either from provider or patient or societal perspective in relation to treatment outcome and resources used. In order to improve efficiency and effectiveness, limited resources need to mobilize and move to more efficient and cost-effective intervention and one way to determine where and how to allocate scarce health resources is through conducting cost-effectiveness analysis.

1.2 Problems and Significance

Tuberculosis (TB) still remains a major global health problem with developing countries bearing major share. In 2012, an estimate of 8.6 million people developed TB and 1.3 million died (including 320,000 death among HIV-positive people) from the disease(WHO, 2013b). Disease is known to occur to mostly to economically productive age-group of 25-54 years and it is male that is disproportionately affected. In the region, South-east Asia was seen to be carrying about 40% of global TB burden (WHO, 2012) in 2010 despite declining trend in prevalence and mortality rate.

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Table 1: Estimates of TB disease incidence, prevalence and mortality in Member States of WHO South-East Asia Region (rates per 100 000 population), 2010

Country	Population (in thousand)	*Incidence rate of all forms of TB (confidence interval)	*Prevalence rate of all forms of TB (confidence interval)	Death rate for all forms of TB, excluding HIV (confidence interval)
Bangladesh	149 715	225 (184-269)	411 (188-671)	43 (32-57)
Bhutan	730	151 (127-177)	181 (44-318)	9.2 (7.4-11)
DPR Korea	24 605	345 (295-398)	399 (100-698)	23 (17-39
India	1 232 770	185 (167-205)	256 (161-373)	26 (17-39)
Indonesia	241 588	189 (154-228)	289 (123-484)	27 (18-38)
Maldives	317	36 (31-42)	13 (2.4-34)	3.4 (2.1-5.4)
Myanmar	48 324	384 (328-445)	525 (381-445)	41 (24-445)
Nepal	30 099	163 (134-195)	238 (96-405)	21 (13-31)
Sri Lanka	21 165	66 (54-79)	101 (42-170)	9.1 (5.9-13)
Thailand	70 277	137 (112-163)	182 (80-300)	16 (10-23)
Timor Leste	1 127	_	_	46 (28-79)
SEA Region	1 820 722	193 (179-207)	278 (206-360)	27 (21-35)

Source: Tuberculosis Control in South-East Asia Region 2012, WHO SEARO

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*Incidence=No. of new cases in specified period of time

*Prevalence= Existing cases (new +old cases) at specified point of time

Incidence Rate= $\frac{\textbf{No.of new cases in specified period of time}}{\textbf{Total population at risk(or mid-year pop.)}} \textbf{xF}$

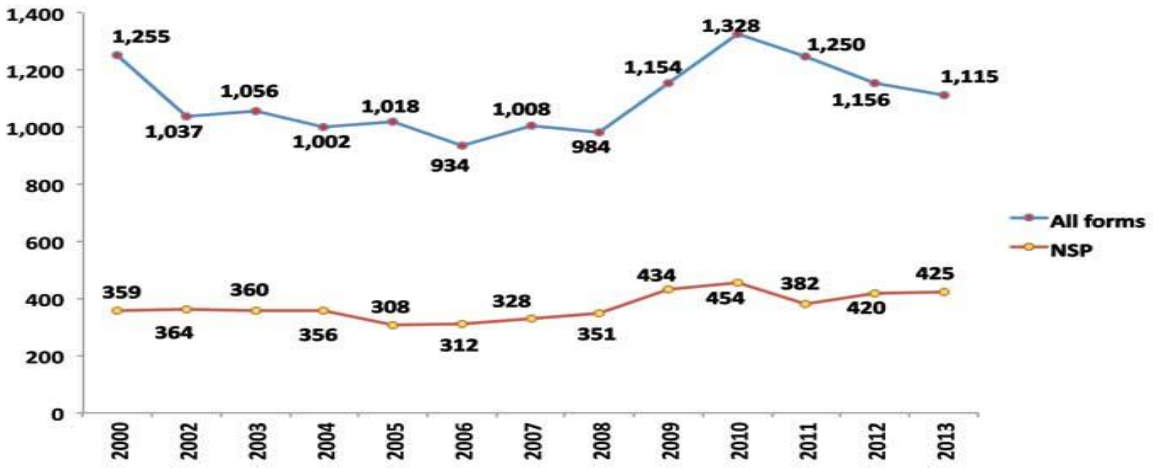
Prevalence rate= $\frac{\textbf{Existing cases at specified point to time}}{\textbf{Total mid-year population (pop.at risk)}} \textbf{xF}$

F= Factor (size of which is chosen so as to enable rate to be expressed as a suitable whole number). The F used commonly is 100, 1,000 or 10,000

Although TB is treatable and preventable disease, it is a major public health problem in Bhutan(Dendup.T., 2013). The first tuberculin survey in 1991 found annual rate of

TB infection (ARTI) was 1.5% and however in 2009 ARTI has declined to 0.4% - 0.5%(MOH, 2010). The total number of cases detected is around 1000 cases every year. It is reported that mortality due to TB among pulmonary positive TB patient in 2011 is 3% compared to 5% in 2005 (MOH, 2012a). TB control activities in Bhutan may have initiated as early as 1986 with start of the National Tuberculosis Control Program (NTCP).

Figure 1: Trend of TB Case Notification from 2000-2013



Source: National TB Control Program, MoH, 2013

* NSP=New Smear Positive, All forms= Includes relapse, new smear negative and Extra-Pulmonary TB

In Bhutan the World Health Organization (WHO) recommended Directly Observed Treatment Short Course (DOTS) program strategy for TB control was introduced in 1994 and later in 1997 DOTS coverage was made 100%-nation-wide coverage(MOH, 2012b; Wangdi, 2012). DOTS is the treatment strategy for tuberculosis control recommended by the WHO and it is consider to be most cost-effective way to stop the spread of tuberculosis in the community. Four major salient components of the DOTS (Frieden, 2006) for TB are; commitment by governments to address the disease through national and international partnership, improved laboratory services for case detection, a continuous supply of good-quality drugs, and a reporting system to

document the progress (and failure) of treatment for individual patients and of the programme. Since the implementation of DOTS strategy case notification rate of all forms of TB have declined over years from 211/100,000 population in 2000 to 191/100,000 population in 2010 (MOH, 2012b). Further in 2010 the case notification rate of new smear positive TB in 2010 was 66/100,000 with treatment success rate reported at 91% among new smear positive(MOH, 2012b).

Prevention and control of TB is priority disease where Royal Government of Bhutan (RGoB) and Ministry of Health (MoH) is committed towards achievement of 2015 Millennium Development Goals (MDGs) related to TB, the Stop TB Partnership's targets and has adapted the Stop TB Strategy. The NTCP has adopted Stop TB strategy for implementation of control in Bhutan following global launch of the strategy in 2006. In this line, NCTP objectives are in line the with Stop TB Partnership target which is liked to Millennium Development Goals-2015(MoH, 2012c; Wangdi, 2012). The objectives (MOH, 2012b)include- detect at least 70% of the estimated new smear-positive cases; to cure at least 85% of the diagnosed new smear-positive cases, to halt and begun reverse TB incidence by 2015 and to halve the prevalence and death rate of TB between 1990-2015. In the 10th Five Year Plan (2008-2013), government has committed indicative cost of Nu. 53.441 million for National Tuberculosis Control Program (GNHC, 2009). In line with international targets, NTCP has three main goals:

- To reduce the TB morbidity and mortality and thus reduce transmission of TB Infection until it is no longer a public health problem
- To prevent and contain the development of drug resistance

A remarkable progress and achievement is noted in the field of TB control in Bhutan. In 2010, the case detection and treatment success rate is above 80% and 85%

respectively in comparison to the global targets of 70% and 85% (MOH, 2012b). International partners like World Health Organization (WHO), Global Fund for AIDS, TB and Malaria (GFATM) continues to play active role in providing financial and technical support in TB control measures. However as resources are scarce and cost increases, the challenges remain to sustain and strengthening TB control activities (MOH, 2012b) in coming years despite current progress and achievement. On other hand there is emergence of TB/HIV co-infections and the increasing trend of Multi-drug resistant TB (MDR-TB) that is posing challenges to TB control efforts(MOH, 2012b). According to WHO, it estimates MDR-TB in Bhutan is (WHO, 2013a) 2.1% among new cases and 16% among retreated cases. MDR-TB is known to be clinically more difficult and expensive to treat.

Like other diagnostic and treatment services, TB treatment as per DOTS is integrated in the overall healthcare delivery system. The health centers at different level perform diagnosis, management and treat TB cases. Hospitals and BHUs are required to identify and train suitable community DOT provider for those patient who are not within the easy reach of BHUs or Hospitals(MOH, 2010). Since the number of case reported at individual community level is less, community DOT providers rather remain limited. DOT is provided by concern health workers of hospitals and BHUs. In line with plans and policies, MoH field required human resources at various health facilities spread across country in order to provide not only timely intervention and treatment of TB alone but health services in general.

Government continues to reach free healthcare services across country(MOH, 2011c), despite healthcare spending in Bhutan is seen increasing in recent year. Per-capita public spending on health has increased substantially from Nu 1400 in 2000-01 to Nu 2569 in 2006-07 (MOH, 2011b). Comparing to some countries in region, in 2001 Bhutan was spending 90.6% (WHO, 2004) was the government expenditure on health

from the total expenditure on health. Whereas country like Bangladesh was spending 44.2% and India with 17.9%. Private expenditure on health in Bhutan as % of total expenditure on health is lowest in the region is lowest in 2001 with 9.4% but external resources for health has played critical role with 38.2% of its share to total expenditure on health.

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Table 2: Selected national health accounts indicators: measured levels of expenditure on health in 2001

	Bangladesh	Bhutan	India	Nepal	Sri Lanka	Thailand
Total expenditure on health as % of GDP	3.5	3.9	5.1	5.2	3.6	3.7
General government expenditure on health as % of total expenditure on health	44.2	90.6	17.9	29.7	48.9	57.1
Private expenditure on health as % of total expenditure on health	55.8	9.4	82.1	70.3	51.1	42.9
General government expenditure on health as % of total government expenditure	8.7	7.5	3.1	8.1	6.1	11.6
External resources for health as % of total expenditure on health	13.3	38.2	0.4	9.4	3.1	0.1

Source: World Health Report 2004 (WHO, 2004)

Rising health care expenditures in light of resource constraint, increasing expectation of public on health care probably due to increase literacy and awareness among

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general population where patient not only expect for good treatment but also quality care, changing life style and diseases pattern due to socio-economic development are some of the key challenges of free health care system in Bhutan. To this effect, MoH in Bhutan recognize importance of further improving efficiency and effectiveness of healthcare services and its health spending but also exploring for alternatives for a sustainability strategy(MOH, 2011a).

Need for conducting economic evaluation in free health care delivery is increasingly felt necessary in Bhutan especially in view of sustaining free health care in long run. The Royal Government of Bhutan is exploring for options and alternatives for sustainability strategy of healthcare financing that would improve efficiency and effectiveness of its health spending(MOH, 2011a). Cost-containment and cost-effectiveness options for the health services delivery in Bhutan are being discussed. The proposed study will highlight cost implication of treating TB at three level hospitals in Bhutan vis-à-vis treatment outcome. Accordingly study will find cost-effectiveness ratio and cost of TB treatment at different levels of hospitals for one fiscal year. Three different levels of hospital is considered for study as at this level of facility is equipped with laboratory and x-ray facilities to diagnose and treatment of TB and other diseases. Three levels of hospital is chosen as the in the Bhutan healthcare service delivery system, we have three levels of hospital reaching the healthcare to general population beside primary health care centers called Basic Health Units. This three levels of hospital plays crucial role where district hospital serve as nodal referral centers for Basic Health Unit within their jurisdiction and to adjoining Basic Health Units of other district(MOH, 2011c). Similarly Regional and National Referral serve nodal center for district hospitals. Study covers four hospitals-one national referral hospital, one regional referral hospital and two district hospitals to find the total cost, cost per treatment case and for treatment successful. National,

Regional referral hospital is also chosen based on size and number of cases seen. Two district hospitals is chosen to see if there is treatment cost difference based on the case seen, considering one as high case reporting hospital and another low case Hospital is chosen on case to see the economies of scale. In 2010 Thimphu the capital of Bhutan where the National Referral hospital is located has total population of 104,214 with TB prevalence rate per 100,000 was 412.61 and incidence rate per 100,000 was 393.42(MOH, 2012b) which is highest rate among the districts. Mongar district where the eastern regional referral is located has total population of 40,653 with 285.34 and 275.50 prevalence and incidence rate per 100,000 respectively(MOH, 2012b) in 2010. One district hospital chosen is located in central part call Trongsa has total population of 14,712 with prevalence rate 54.38 and also incidence rate 54.38 per 100,000 in 2010(MOH, 2012b) and other district hospital in eastern part located in Trashigang District has the total population of 52,538 in 2010 with TB prevalence rate of 159.88 and incidence rate of 150.37 per 100,000(MOH, 2012b). Among the district hospital the Trashigang district hospital is one hospital that annually notifies maximum number of cases. Hospitals are selected based on cases seen and geographical location basically to see if there is cost variation in TB treatment based on the cases seen and geographical location of hospitals. There are many similar studies carried out on cost and cost-effectiveness of TB treatment strategies in other countries, but in Bhutan there is very limited studies done in the context of free healthcare services. This study would provide evidences to MoH and other stakeholders for cost of treating TB patient across different level of hospitals in Bhutan over one fiscal year. This finding will provide baseline information for programs planning and resources allocation in the implementation DOTS strategy and future expansion DOTS programs in Bhutan. Such finding can also help to increase cost awareness and sensitize the policy makers and planners and serve as

starting point for further analysis for costing of other diagnostic services in free healthcare system.

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Table 3: Selected Morbidity Indicators trend in Bhutan

Indicators	**Year**				
	2008	2009	2010	2011	2012
Alcohol Liver Diseases incidence (per 10,000 population	20	23	28	29	29
Cancer Incidence (per 10,000 population)	10	17	15	14	12
Conjunctivitis Incidence (per 10,000 population)	555	542	948	487	529
Diabetes Incidence (per 10,000 population)	38	38	47	53	57
Diarrhoea Incidence (per 10,000 under 5 children)	2690	2892	2428	2257	2368
Depression Incidence ((per 10,000 population)	11	9	11	7	8
Hypertension Incidence (per 10,000 population)	303	310	343	325	375
Intestinal Worms incidence (per 10,000 under 5 children)	503	397	219	186	133
Malaria Incidence (per 10,000 population at risk)	8	18	7	5	1
Pneumonia Incidence (per 10,000 under 5 children)	1479	1031	1135	974	1204
Skin Infection (per 10,000 population)	1453	1322	1323	1463	1444
STD/STI incidence (per 10,000 population)	19	26	10	12	17
TB prevalence rate (per 10,000 population)	14	15	15	15	16

Source: (MOH, 2013)

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1.3 Research Questions

The following are research questions:

1. What is the unit and total cost of providing TB treatment at different levels of hospitals under DOTS program strategy?

2. What is cost-effectiveness ratio in terms cost per patient treatment successful (patient who was cured or who completed treatment) at different hospital levels?

1.4 Objectives:

1.4.1 General Objective

The general objective of study is to estimate cost and cost-effectiveness in terms of treatment success at different levels of hospital (National, Regional and Districts).

1.4.2 Specific objectives

The following are specific objectives of study:

- To find out the unit cost and total cost of different hospital levels with regard to TB treatment under DOT program strategy
- To find the effectiveness in terms of treatment success among hospitals selected
- To compare of cost-effectiveness between two district hospitals with one high TB cases versus low TB cases and reveal the cost-effectiveness treatment in terms of cost per treatment success among the hospitals

1.5 Study Scope

Three levels of hospital are chosen because in Bhutan hospital is structured into three levels where diagnosis and treatment of TB as per DOTS are being carried out in integration with other health services. Government accord high importance to this

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all three levels of hospitals through allocation resources as they serve as tertiary hospital in their own jurisdiction. This study reviewed the cost of TB treatment and outcome at different levels hospitals – (National Referral Hospital, Regional Referral Hospital and two District hospitals) for one fiscal year July 2012-June 2013. The most recent one fiscal year is considered for the study. However due to time limitation BHU Grade I and II is not included in this study. Patient attending BHU II with TB symptomatic are referred to district hospital or BHU I that have x-ray and laboratory facilities for confirmation of diagnosis(MOH, 2012b). It is mostly during continuation phase treatment, patients are referred to the BHU II for follow up treatment.

The study focuses on one categories (CAT I) of patient treated in hospitals to measure effectiveness or treatment success. Treatment category is segregate into two: CAT I that includes New Smear Positive Case or New Smear Negative or Extra Pulmonary and CAT II includes Retreatment cases (relapse, failure and default). CAT II is excluded to avoid confounders' problem and also due to difficulty in measuring the effectiveness as these are cases of relapse, failed and defaulted cases.

1.6 Possible Benefits

Efficiency and effectiveness of health spending in Bhutan is becoming an important policy discussion in light of sustaining free healthcare services. Resource allocation continues to health sectors to deliver free healthcare but it is increasingly recognized that the policy makers and planners have to know the cost and cost-effectiveness for planning and resource mobilization.

This study is timely and relevant. Bhutan is developing at fast pace, moving from low-income to lower-middle income country status. According to World Bank, per capita gross national income (GNI) has consistently risen from US$730 in 2000 to US$2,070 in 2011(WB, 2014). Resources flow and support to TB program and for that

matter health sector programs in general may not remain same from donors and international partners in near future. Hence, such information will sensitize planners and decision makers on actual cost implication for treatment of TB in relation to treatment outcome at different hospital levels.

The information would be of use to MoH and others stakeholders for informed planning, resource allocation, prioritization and designing program intervention at national, regional and district level. The study in nutshell provides overview of treatment cost of TB at three levels of hospital. The health services are being decentralized to district level and to block level. It is now seen important to identify costs and cost-effectiveness of decentralized services. This study finding provides the government with a baseline to further explore the cost-effectiveness of other program initiatives in a free healthcare system for reasons of sustainability.

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CHAPTER II

BACKGROUND

2.1 Brief Country Profile

Bhutan is small mountainous land locked country located in South Asia bordered by India and China with total population of 733,004(NSB, 2013b). The general literacy rate among the population 6 years and above is 63% and 70% of population lives in rural(NSB, 2013a). With alpine mountain in north and sub-tropical foothills in the south the area of country is mostly cover with forest. The geographically landlocked and difficult mountain terrain pose huge challenges in delivery of healthcare services and healthcare delivery cost is bound to be high. Bhutanese economy is predominantly agriculture based and tourism and hydropower also play important role. According to World Bank, Bhutan Gross Domestic Product (GDP) growth is estimated at nearly 8% in 2011/12 (from 8.5% in 2010/11) and is projected to reach 12.5% in 2012/13 due to the acceleration in hydropower-related construction(WB, 2014).

The country is administratively divided into three regions (Western, Central and Eastern) with 20 *(Dzongkhag)* districts and 205 *(Gewog)* blocks(MOH, 2012b).

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2.2 Health System and Health Care Services

Bhutan modern healthcare is started in the early 1960's (MOH, 2011c) and since then healthcare services is provided through integration both modern and traditional health care. Healthcare services is delivered through a three tiered system(Tobgay, 2011) consisting of the primary, secondary and tertiary levels that provide preventive, promotive and curative services through hospitals spread in 20 districts and BHUs to grass root level. Further down the community level, Village Health Workers (VHWs)

who are on voluntary basis assist BHU staff in delivering out-reach clinic (ORC) and primary health care services.

Table 4: Bhutan Health Human Resource-2012

Categories of Health Workers	Number
Doctors (MBBS/Specialist)	194
Assistant Clinical Officer (ACO)	39
Nurses (Assistant Nurse/GNM/B. Sc. Nurse)	736
Health Assistants	416
Basic Health Workers	162
Drungtsho (Indigenous Physicians)	35
sMenpas (Sowa Menpa)	63
Pharmacists	11
Medical Lab. Technologist	27
Physiotherapists	10
Technicians	780
Administrative & Support Staff (Regular)	1202
General Service Personnel (GSP)	439
Elementary Service Personnel (ESP)	166
Total	4280

Source: Annual Health Bulletin 2013 (MOH, 2013)

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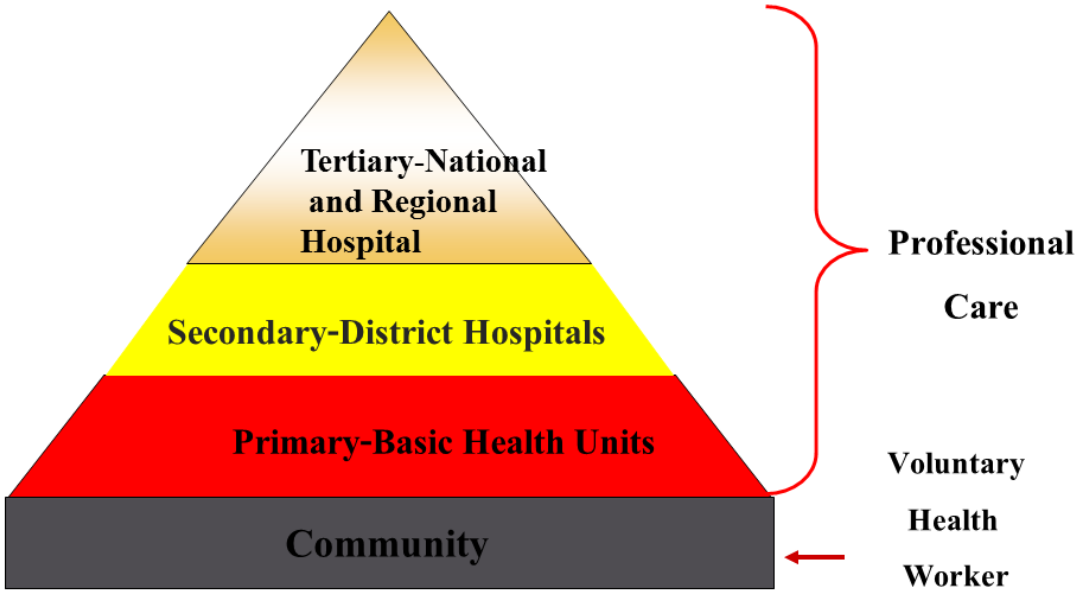
As of 2012 there are 192 Basic Health Units (BHU) and 550 out-reach clinic (ORC) at primary level, 31 districts hospital including at secondary level, 2 regional referral hospitals and one national referral hospital at apex and tertiary level(MOH, 2013). The district hospitals at secondary level health centers serve as referral center for BHUs and regional referral hospitals as the tertiary level health centers serve as referral centers for district hospitals and BHUs within its jurisdiction and from regional and district hospital patient is refer to National referral hospital depending on case.

Districts hospitals and BHU Grade I have basic diagnostic facilities comprising x-ray, complete blood count, blood glucose levels and microscopic services for diagnosing tuberculosis and malaria(Tobgay.T., 2011). It is generally observed that referral system is not working well(MOH, 2011a). Patients visit facility of their own choice.

Figure 2: Health Service Networking System (Referral)



Source: Health Sector Situation and Gap Analysis in Bhutan, MoH, 2012

Healthcare services in Bhutan are solely supported by government from its general revenue and (Tobgay.T., 2011)healthcare is provided free of cost to all population in country including referral outside. As a result Bhutan has sustained primary healthcare coverage at above 90% (percentage of population within 3 hours of walking distance each way to a health service delivery point(MOH, 2011c) as stated in the national health policy 2011.

Table 5: Selected Health Indicators for South-Asia

Country/Year	Bangladesh	Bhutan	India	Indonesia	Maldives	Myanmar	Nepal	Sri Lanka
	1999-00	1999	1998-99	2002	1997-98	2000	2001	1995
Under-five mortality rate (Per 1000 live births)	82	98	96	50	50	108	95	20
Infant mortality rate (Per 1000 live births)	63	75	77	39	37	83	72	16
One-year-olds immunized against measles (2001)-%	76	78	56	76	99	73	71	99
Maternal mortality ratio (Per 100 000 live births)	380	420	540	230	110	360	740	92
Births attended by skilled health personnel-%	12.1	15	42.3	55.8	n/a	56.4	11.9	94.1
HIV prevalence among 15-49-years-olds-%	<0.1	<0.1	0.8	<0.1	<0.1	0.9	0.3	<0.1
Malaria mortality rate (Per 100 000)	9	12	3	4	5	15	20	6
TB prevalence(Per 100 000)	479	223	431	742	68	255	299	97
TB mortality rate (Per 100 000)	56	19	41	67	5	33	27	9
TB cases Detected under DOTS (2001)-%	26	26	23	21	88	59	60	74
TB Cured under DOTS-%	83	90	84	87	95	82	86	77

Source: World Health Report 2004-(WHO, 2004)

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2.3 National Tuberculosis Control Program

The National Tuberculosis Control Program in MoH is under Department of Public Health. The National TB Control Program was started in 1986(MOH, 2012b) and it is fully integrated program into three tiered health system of Bhutan(Dendup.T., 2013). It is a vertical program at national level which is responsible for planning, resource mobilization, implementing, monitoring and evaluation TB control activities in country. As per WHO Bulletin (Elzinga, 2005), vertical program is a program that has three important components such as- intervention strategy, monitoring and evaluation, and intervention delivery. It is discussed that first two components are vertical in nature and third one which is intervention delivery are planned in detail in order to handle health problem instantly for instance at very ground level. By going these norms, National TB Control Program in Bhutan is also vertical program. It has its own intervention strategies designed as per international standard recommended by WHO and international partners which is articulated in the National Strategic Plan for TB Control 2012-2016 and other program routine activities. Similarly, program has its own monitoring and evaluation system in place where periodic reports are submitted from TB reporting centers and being maintained at central program in computerized system and evaluated periodically. Further down the line health centers at various levels are equipped to provide diagnosis and treatment services as per DOTS. The NTCP has articulated the following Stop TB strategy as objectives of the national strategic plan (2005-2010) for the TB control:-

- Government commitment: mobilization of adequate domestic resources and donor funds, provision of drugs and supplies, providing treatment free of charge for all patients and food during hospitalization

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- Strengthening laboratory services: A Laboratory service is made available to all hospitals and BHU Grade I. Increasing accessibility to microscopy services through sputum collection at BHU level is planned.
- Interrupted supply of drugs and logistics: drugs and logistics are continues to be provided through centralized procurement of all drugs, equipment, laboratory consumables with annual distribution and six-monthly reporting. Emergency supplies can be indent at any need time.
- DOT: At every health facilities that provide TB treatment- there are TB-incharges who basically monitored TB patient. After patient is diagnose of TB, the record contact number and supervise the patient.
- Standardized recording and reporting system: all TB patients are recorded in the TB register, which is kept at the district level. The standard internationally recommended reports are generated on quarterly basis and submitted to central NTCP.

At district level, District Health Officers/District Medical Officers are responsible for implementing, planning, coordinating, monitoring and evaluating programme. The hospitals at National Referral/Regional Referral, Districts and BHU Grade-I are responsible for diagnosis and initiation of treatment(Dendup.T., 2013) as per DOTS which is outlined in Guidelines for the Management of TB. Districts hospitals and BHU Grade I do not manage the MDR-TB patient. MDR-TB patients managed at two regional and a national referral hospital(MOH, 2012b). Later MDR TB patient are usually admitted in different hospital called Gidakom Hospital in capital and as of July 2012 there were total of 19 MDR-TB patient(Darnal, 2013) admitted in the above hospital. The study by (Darnal, 2013) has found that the majority of MDR-TB patient in Bhutan were male (63%) and median age for 25 year for male and 30 for female. Total treatment time is 24 month were the patient have to take in different

medicines including injection. TB treatment starts after the confirmation of diagnosis at the health facility. Sputum positive cases is encouraged to be admitted atleast for two week(MOH, 2010) and follow up remaining treatment part of treatment by the designated DOT provider. Sputum negative and extra pulmonary cases also continue their treatment at hospitals/BHU by the designated by DOT provider. Currently, there are total of 32 TB reporting centers (health centers that provide diagnosis, treatment and report outcome) spread across 20 districts(MOH, 2013). TB-in-charge at each district hospital is mandated to provide treatment to patient, default tracing, follow up, reporting of outcomes, and compiling quarterly and annual TB reports for their districts. The quarterly report on case notified and treatment outcomes are submitted by TB-in-charges through District Health Officer to National TB Control Program. Presently, the TB diagnostic microscopy services are available in all 20 districts. Total of 34 laboratories perform smear microscopy which is included in the eternal quality assurance scheme. TB drugs and lab consumable are centrally procured and supply to respective health center based on the number of TB case seen annually.

From the TB reporting center (Hospitals and BHU Grade-I) quarterly report (January-March, April-June, July-September, October-December) (MOH, 2010)consisting of Laboratory Report, new case finding and retreatment, type of cases by age and gender and treatment outcome are submitted to National TB Control Program. These reports are compiled over one year at program and treatment outcome is generated at national level. In the 2012, total of 1156 cases of TB is reported in the country(MOH, 2013) as presented in the table 3 with TB reporting centers:

Table 6: Number of TB cases by Treatment Category -2012

Sl.#	Name of reporting center	CAT I		CAT II		Total
		M	F	M	F	
1	Bajo	30	22	0	0	52
2	Bali	7	5	0	0	12
3	Bumthang	5	5	1	0	11
4	Dagana	3	9	1	1	14
5	Damphu	5	5	0	0	10
6	Deothang	8	2	0	0	10
7	Gasa	0	0	0	0	0
8	Gaylegphu	36	47	4	1	88
9	Gedu	8	7	1	0	16
10	Gidakom	5	5	1	1	12
11	Gomtu	6	3	0	1	10
12	JDWNRH	186	190	12	14	402
13	Lhamoizingkha	5	2	0	0	7
14	Lhuentse	4	4	0	0	8
15	Lungtenphu	23	27	3	3	56
16	Monggar	48	43	1	5	97
17	Nganglam	5	4	0	0	9
18	Pangbang	1	1	0	0	2
19	Paro	15	25	0	1	41
20	Pemagetshel	4	3	0	0	7
21	Phuentsholing	33	44	5	5	87
22	Punakha	9	9	1	0	19
23	Riserboo	6	3	0	0	9
24	S/Jongkhar	12	12	0	1	25
25	Samtse	27	29	3	1	60
26	Sarpang	0	3	0	1	4
27	Sibsoo	7	7	0	0	14
28	Trashigang	20	12	5	1	38
29	Trashiyangtse	2	1	0	2	5
30	Trongsa	8	10	0	0	18
31	Tsimalakha	2	2	0	0	4
32	Yebilaptsa	2	5	1	1	9
Total		532	546	39	39	1156

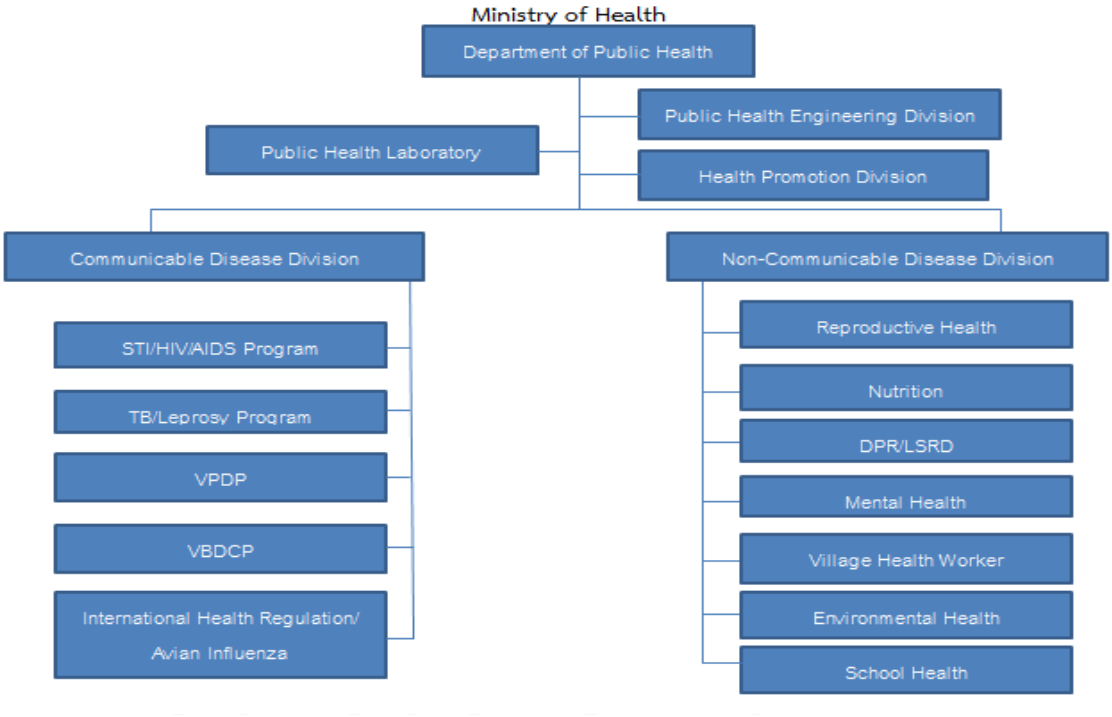
Source: Annual Health Bulletin 2013 (MOH, 2013),

*CAT I=New Smear Positive case or New Smear Negative or EPTB

*CAT II=Re-treatment cases (Relapse, Failure and Default)

At grass root level, patient attends at BHU Grade-II which usually staff with three or four health worker depending on the catchment areas. Patients with TB symptoms are being referred to the district hospitals or BHU Grade-I for confirmation of diagnosis. It is usually during the continuation phase treatment patient being referred back to the BHU Grade-II for follow up treatment(MOH, 2012b). Presently, there is no Non-Governmental Organizations and private body actively partnering NTCP in the intervention of TB control in Bhutan.

Figure 3: Organogram of Department of Public Health



Source: (MOH, 2012b)

CHAPTER III

LITERATURE REVIEW

3.1 Economies of scale in hospitals

In the developing countries hospitals in general consume a larger share of health resources countries but little is known and discussed about efficiency of their scale and scope (Marcia, 2004). It is assumed that that higher level of hospital will be more cost-effective as bigger hospital has economies of scale. It is interesting to note that the unlike other organization, hospital are technically more complex organization to manage. There is general assumption about larger hospital has better scale than but on other hand small hospital may be more efficient and effective than a larger one. The study by (Marcia, 2004) on Economic of scale and scope in Vietnamese hospitals concluded that economies of scale did not depend simply on number of beds and volume of output. It was found the economies of scale and scope depended on the category of the hospital in addition to the number of beds and volume of output. The study revealed that economies of scale were 1.09 for central general and 1.05 for central specialty hospitals with mean of 516 and 226 beds respectively, indicating roughly constant return to scale. The economies of scale for district hospital were 1.16 indicating modest economies of scale. Study sample included was 654 out of 815 public hospitals, six categories of hospitals and broad ranges of sizes. Study founded district hospital like central general and central specialty hospital had similar sort of economies of scale.

3.2 Healthcare delivery Costing study in Bhutan

In Bhutan hospitals and BHUs are spread across the country providing services to scattered settlement. The first study on costing of health services in Bhutan 2009-10, (MOH, 2011a) conducted from facility perspective reveals that the average cost of

OPD visit varies from Nu 161 at a basic health unit-at primary level care to Nu 635 at the regional referral hospital and Nu 307 at district hospital-secondary level of care. With regard to inpatients, the average cost per admission at BHU I is Nu 5,657, increase to Nu 10,116 at district hospitals and Nu 17,354 at referral hospitals. A total of 13 health facilities were included in the study. It was seen that the cost of delivering services was found to be more economical both in OPD and IPD visit at periphery level i.e at primary and secondary level of care respectively than at the referral hospitals. In other words unit cost is higher for higher level of health facility. However, this study doesn't capture the efficiency and cost-effectiveness of delivering services among different facility level specifically look didn't look at disease specific treatment cost. A study has recommended for further analysis in specific areas like costing diagnostic and treatment services at different levels health facilities.

3.3 Cost-effectiveness analyses

The importance evaluating interventions at different levels of health delivery system is also discussed in view of aiding decision making in healthcare. In the article "Generalized Cost-Effectiveness Analysis: An Aid to Decision-Making in Health" (Hutubessy, 2003) emphasized for a needs to evaluate each intervention at different hospital settings and levels. It is put forward that one cannot assume cost-effectiveness on the basis of an intervention being curative or preventive or delivered at a given level of health system unless there is categorical assessment. It is too simplistic to specify that primary health care is cost- effective and hospital care is cost-ineffective. Resource allocation is most important thing in developing countries and it is suggested that there considerable room to enhance efficiency simply by shifting from less efficient interventions that are underutilized to efficient interventions.

According to (Weinstein, 1996) cost-effectiveness analysis looks at way to measure cost and health outcome of particular program in to describe resources consumed in terms of outcome produced . It is method of measuring a resource consumed in the numerator of cost-effectiveness ratio and estimating the effectiveness of intervention. In ratio, the health outcome is taken as denominators and cost of resources used in the numerator. The (Drummond, 1987) describe this method of economic evaluation as a one form of full economic evaluation where both the costs and outcomes of health programmes are assessed.

Cost and cost-effectiveness to TB diagnosis and treatment is assessed either from provider, patient or society perspective. The perspective of evaluation is very important as it form basis from where cost and expenses are calculated(WHO, 2002). According to WHO guidelines for cost and cost-effectiveness analysis of TB control (WHO, 2002)If it is patient perspective, the focus in mainly on costs borne by patients that includes expenditure for transportation cost to reach health centers, fees paid for services and opportunity cost due to time away from work. In the provider perspective, it basically looks at the cost from the health services providers where providers could be more than one. When societal perspective is considered, the cost and expenses incurred by all members is taken care such as patient, family, community, relatives and health services providers. In this regard, the economist emphasizes evaluation from the societal perspective since it is most comprehensive assessment that takes into accounts of provider, patient and society at large. The choice of the study perspective is an important methodological decision because it determines what costs and effects to count and how to evaluate those (WHO, 2011).

A study to determine cost and cost-effectiveness of health facility and community based directly observed treatment of tuberculosis in an urban setting in Tanzania (Wandwalo, 2005) compared two alternative strategies health facilities DOT by health

personnel and community based DOT by treatment supervisor. The study identifies that community based DOT was more cost-effective at US$ 128 per patient successfully treated compared to US$ 203 for a patient successfully treated with health facility based DOT. The cost is estimated holistically from the perspective of health services, patients and community which is societal perspective in year 2002. In overall the community based DOT reduced cost by 35%. This cost study is conducted along with randomized-clinical trial to obtain the treatment outcome and cost-effectiveness is calculated cost per patient successfully treated. Smear positive, smear negative and extra-pulmonary TB patients were included.

A study in Kenya by (Nganda, 2003) has also assessed the cost and cost-effectiveness of new treatment strategies for tuberculosis patients, involving decentralization of care from hospitals to peripheral health units and the community, compared to the conventional hospital approach. Study was conducted from the perspective of health services, patients, family members and community using 1998 USD value. Study learned that the cost per patient treated for new smear positive patients was USD 591 with the conventional hospital based approach to care, and USD 209 with decentralized care from hospitals to peripheral units and the community. The cost per patient treated for new smear-negative/extra-pulmonary patients was USD 311 with the conventional approach to care, and USD 197 with decentralized care. From all perspective-health services, patient and family, decentralized and community based care was found to be cost-effective. Cost-effectiveness was calculated patient successfully completing treatment (smear-positive cases) and as the cost per patient completing treatment (new smear-negative and extra-pulmonary cases).

In Pakistan, a study (Khan, 2002) on cost and effectiveness of different strategies for implementing directly observed treatment (DOT). Study was conducted to understand the cost and effectiveness of implementing DOT for TB under different

strategies. It was found that DOT centre based health workers was the least cost effective of the strategies tested (USD 310 per case cured) followed by Community health worker DOT cost per cured is USD 172, family member DOT USD 185 cost per cured and unsupervised or self-administered group found to be most cost-effective with cost per cure is USD 164. In this study cost center set up for various component of the programme (such as clinical assessment, radiological investigations, health education, record keeping and TB drugs.

In a similar study done in Bangladesh (Islam, 2002) to compare the cost-effectiveness of the tuberculosis (TB) programme run by the Bangladesh Rural Advancement Committee (BRAC), which uses community health workers (CHWs), with that of the government TB programme which does not involve CHWs. Study included a total of 186 TB patient for BRAC and 185 for government programme over one year and it was found with cure rates among sputum-positive case of 84% and 82% respectively. The unit cost of per patient cured was USD 64 in BRAC compared to USD 96 in government. For a similar outcome government programme was 50% more expensive and given same budget, the BRAC programme could cure three TB patients for every two in the government programme. The involvement of CHWs was found to be more cost-effective in rural Bangladesh.

There is also study done in Indonesia (Johns, 2009) to identify the cost-effectiveness of collaborative arrangements among public and private providers to employ the DOTS strategy for TB control. Three different strategies: hospital outpatient diagnosis with referral to public health centres (PHC) for treatment, hospital out-patient diagnosis and treatment, and private practitioner referral of suspects to PHCs were evaluated to find cost-effectiveness The treatment outcome is measured by the number of sputum smear positive patient treated successfully and only direct cost of patient and providers is included. Findings from this study suggest that average cost

per case successfully treated ranged from USD 169 to USD 567 for different strategies and the incremental cost per additional case successfully treated ranged from USD 152 to USD 982. The study was not able to conclude which collaboration is more cost-effectiveness.

With objective to assess the cost and cost-effectiveness of Public-Private Mix DOTS (PPM-DOTS), a study is conducted in Indian cities of Delhi and Hyderabad(Floyd, 2005). Cost-effectiveness is compared between the PPM-DOTS and Public sector i.e delivered through public sector facilities only. Public sector, private practitioners and patient/attendants cost was assessed pertaining to year 2002 in USD. Effectiveness is measured against the number of cases successfully treated. Study obtains unit cost of patient treated is US$ 111-123 for PPM-DOTS and in public sector DOTS, and USD 111-172 for non-DOTS treatment in the private sector. The unit cost –effectiveness of PPM-DOTS and public sector DOTS was found to be similar –USD 120-140 per patient successfully treated compare to US$ 218-338 for non-DOTS treatment in private sector. Study also suggest apart improvement in treatment outcome, DOTS implementation in either the public or private sector significantly lower cost on patients and their attendants in comparison to non-DOTS treatment in private sector (USD 50–60 for DOTS compared to over USD 100 for non-DOTS). It is concluded that PPM-DOTS is economical and cost-effective approach in India that would result considerable reduction of TB disease burden.

In conclusion evidences suggest that large share of health resources are required to run the hospitals especially in developing countries (Marcia, 2004) but little is known or discussed about the efficiency level in terms of economics of scale and scope. On the other hand there is also literature(Hutubessy, 2003) suggesting for a need to assess and evaluate to find the cost-effectiveness at different level of health system

but this discussion are not backed up by the empirical evidence showing different level of cost-effectiveness ratio different level of health system.

The study in Bhutan from facility perspective (MOH, 2011a) covering 13 health facilities across different level of facility found cost of delivering services is be more economical both in OPD and IPD visit at periphery level i.e at primary and secondary level. Study doesn't cover the effectiveness of service delivery across different level of hospital, meaning cost per patient cured or for treatment completed.

Table 7: Summary of Cost-Effectiveness Ratio for each type of DOTS

Author	**Study place**	**Perspective**	**Health Facility DOTS**	**Community/Decentralized DOTS**	**Home-based/Self-Administered DOT**
(Wandwalo, 2005)	Tanzania	Societal	USD 203*	USD 128*	-
(Nganda, 2003)	Kenya	Societal	USD 591**	USD 209**	
(Khan, 2002)	Pakistan		USD 310*	USD 172*	USD 164*
(Islam, 2002)	Bangladesh	Provider	USD 96***	USD 64***	
(Johns, 2009)	Indonesia	Provider	Ranges between USD 169 to $567* among public & private DOTS		
(Floyd, 2005)	India	Provider	USD 120-140* for PPM-DOTS and public sector and USD 218-338 *for non-DOTS treatment in private sector.		

Sources: (Floyd, 2005; Islam, 2002; Johns, 2009; Khan, 2002; Nganda, 2003; Wandwalo, 2005)

*cost per patiently successfully treated

**cost per patient treated for new smear positive patient

***cost per patient cured

Evidences on cost-effectiveness study on TB treatment suggest that community based or more of decentralized approach of treatment is cost-effective than conventional hospital based approaches. A study in Tanzania (Wandwalo, 2005) and (Khan, 2002)has seen that community based DOT is more cost-effective in comparison to health facility based treatment. Similar findings is presented in Kenya(Nganda, 2003) where involving decentralization of care from hospitals to peripheral health units and the community was more cost-effective in TB treatment compared to the conventional hospital approach. The results and findings in Bangladesh (Islam, 2002)is no different where uses of community health workers for TB control programme were found to be more cost-effective than government run TB program which did not involve community health workers. Cost-effectiveness on TB treatment and intervention is also measured in terms of private-public mix (PPM) DOTS or arrangement among public and private providers. In Indonesia(Johns, 2009) study was conducted to demonstrate the cost-effectiveness of collaborative arrangements among public and private providers using DOTS. The study is not able to identify cost-effectiveness collaboration neither among private practitioners nor among public providers. Study couldn't reveal preferences based on cost-effectiveness. However, different scenario is presented in study findings in India(Floyd, 2005). It is concluded that PPM-DOTS is economical and cost-effective approach in India. Study was done in two cities of Delhi and Hyderabad. However all of these studies don't specify the costing approaches but it is understood that the costing approach are Activity Based Costing as it is based on number activities involved in treatment of TB cases as per DOT. A study in Malaysia (Atif, 2012) to calculate the cost incurred by Penang General Hospital on performing one contact tracing TB patient procedure has used an activity based costing approach. In this study contact tracing record was retrospective data obtained from the TB contact tracing record book and human resource cost was calculated by multiplying the

mean time spent by employees doing specific activities by their salary and cost of consumables obtained from procurement section. The building cost was calculated by multiplying the area of space used by the facility and equivalent annual cost for building and machines was estimated using straight line depreciation method with 3% discount rate.

In conclusion, there is consistent findings that the community DOT or decentralized DOT is more cost –effective than the hospital or facility DOT. Hence, it will be relevant to look into the feasibility of community DOT in Bhutan that would facilitate current facility based DOT.

3.4 Costing Methodologies

Cost in healthcare services includes both direct cost components (such as diagnostic services, consumables, inpatient stay and labour) and indirect cost components (overheads and capital). There are six approaches that are popularly used or recommended in the costing study with its own advantages and disadvantages. First is the Micro-costing (bottom-up approaches). Micro by word itself suggests that this costing approach is to something to deal at the individual level. This costing method is described (Frick, 2009)as costing studies that involve direct enumeration and costing every resources utilized in the process of treatment of particular patient. Therefore, this approach mainly identifies and specifies all of the resources that are used in the treatment of particular patient. Bottom up gross costing values the cost component for each individual patient. It is argued(Petitti, 2000) that this approach may take much time and quite is challenging to collect monetary value because this approach involve the enumeration of patient and costing out every resources consumed.

Second is the Macro-costing (Top-Down) which look at aggregate level cost and this approach is referred to as average costing. In this approach unit cost per patient is determined by the total health expenditures divide by the total number of patient. Limitation of this approach is that it is based on the market price (fee schedules or average payment or charges)(Petitti, 2000).

Gross costing approach cost information collected from electronic data sets or medical literatures. This method may be easier and less time consuming than the micro-costing but it according to the main drawback it fails to trace costs directly to specific cost components. This costing is different(Frick, 2009) from micro-costing where in micro-costing studies attempts include staff time, space occupied for specific treatment, distance travelled and volume of supplies used. In gross-costing average costs of events is taken into consideration such as average length of stay and unit cost of treatment.

Fifth is incidence and prevalence based approach that are mostly used in evaluating cost and outcome related to specific to health state-usually in cost of illness analysis. This kind of study is conducted usually over a period of one year as prevalence cost has to be estimated in fixed time period like one calendar year. Similarly incidence cost is long term cost starting from the point of diagnosis including whole treatment of newly detected case. The prevalence approach is useful for policy maker and healthcare payer or providers and while incidence approach is was seem to useful for from patient perspective(Barlow, 2009).

Sixth is the activity based costing (ABC) approach is one method of a micro-costing approach. This approach to costing based on the cost drivers/centers and it is measurement of the cost activities rather than cost of patient. Cost drivers refer to activities that cause to incur costs. According to (Cardos, 2011; Muto.H., 2011) activity-

based costing (ABC) method measures the cost and performance of activities, resources, and cost objects. This kind of costing method assigns costs through activities within an organization(Cardos, 2011; Waters, 2001) and (Waters, 2001)ABC uses personnel interviews to determine principal activities and the distribution of individual's time among these activities. The approach is based on the observation that costs are incurred because of specific activities. For costing healthcare program, this approach is adopted as more appropriate than other approaches as health program has many specific activities were this methodology can be applied and according to (Atif, 2012)as result is more accurate to estimate of real unit. One advantage of this approach is it precisely define and reflect resource used in in the healthcare program. ABC concept(Hughes, 2003) begin with companies product to determine the activities involved in the production process and delivery of the product and computes those costs of various activities and ABC has (Kaplan, 2005) actually facilitated many ABC method may seem to assigned the cost and effectively evaluate the resource used, however, it is argued (Kaplan, 2005) that ABC in ground reality is that this kind of method is difficult to implement and maintain especially in a large scale operation organization because of many kind of cost drivers. However, ABC is followed by companies to recognize important cost driver and profit enhancement through re-pricing of product. ABC costing method is also used in costing study of Tracing contract of TB patients in the Malaysia(Atif, 2012) and the purpose of the study was to calculate the cost incurred by Penang General Hospital on performing one contact tracing procedure using an activity based costing approach. For costing healthcare program, this approach is adopted as more appropriate than other approaches and according to (Waters, 2001) ABC determine cost of individual clinic, department and services according to activities that originate the cost. Also it was understood that many of the cost-effectiveness study on TB have also used this costing method. Many of hospitals and health organization in

Unites States has explored and used ABC method to improve health resources management(Waters, 2001).

Table 8: Advantages and disadvantages of each costing approaches

Costing Approaches	Advantages	Disadvantages
Micro-costing One method of Micro- costing Approach is Activity Based Costing	Cost every resources utilized. Precisely define and reflect the resources used in the healthcare programmes	Take much time and quite challenging to collect monetary value of each resources consumed. Difficult to implement and maintain especially in large scale operation organization
Macro-costing	Help in determining cost per patient with regard to total health expenditure	Since this cost is based on average, it is affected extreme values and market price
Gross costing	Easier and less time consuming	Fails to trace costs directly to specific cost components
Incidence and Prevalence	Both approaches provide complete picture of the health intervention efficiency and affordability	Since this is new approach of economic evaluation, it was seen complicated as many resources are required for health intervention

Source: (Atif, 2012; Barlow, 2009; Cardos, 2011; Frick, 2009; Kaplan, 2005; Petitti, 2000; Waters, 2001)

3.5 Cost allocation methods

Cost allocation is a process assigning costs from the support cost centers to final cost center. In the hospital resources such as hospital administration, laundry, building, transport etc are used together by different unit, programmes and department in hospital. When the individual department and programme are to be costed, these over overhead shared cost need to be attributed programmes(Drummond, 1987). According to (Drummond, 1987) it is suggested that there is no unambiguous right way to apportion such cost. In that sense, the allocation criteria of overhead cost may depend on the situation and country context in which economic evaluation is planned. (Shephard, 1998) describes hat certain allocation criteria can be devise even if it has not been used elsewhere based on the individual knowledge of one's hospital that can lead to an allocation basis which predicts cost accurately.

In the activity based costing, the overhead cost is allocated based on the some measure of volume and time used.

There are namely four methods for allocating shared or overhead cost(Drummond, 1987).

Direct Distribution Method- in this type of cost allocation method, cost is assigned directly from overhead and intermediate cost center to final cost center or mission centers. In this method each overhead such as administration, housekeeping and laundry, patient diet are allocated directly to mission or to final cost centers like OPD, IPD, treatment unit, surgery. This method is widely used in the cost allocation method but according to (Drummond, 1987) it ignores the fact the overhead or general department may also services to other service department and programmes and this method would underestimate the cost in all final cost centers.

Second method is the *step down method* where allocation of overhead or general cost center and intermediate cost center to final cost centers to get unit cost per visit and per day. According to (Drummond, 1987) this allocation method is define as method to allocate overhead cost department cost in stepwise fashion to all of the remaining overhead department to the final cost centers. In this method firstly support cost center are rank based on the one that is used most other department and programmes and next would be second support cost center. The allocation is based on a proportional distribution of those costs to final cost centers. It is a two-step allocation. In the first step, the costs of general services (administration) are assigned (or "stepped down") to final cost center and intermediate cost centers according to the selected allocation factor. In the second step, the costs of ancillary services are assigned (or stepped down) to final cost centers according to their percentage of use of services. The Step-down costing is the common costing methodology adopted to perform hospital costing analysis since this method efficiently allocates the cost(MoPH, 2012).

The third costing method Step down with iterations: This method follows same like the step down method but only difference is that in this method when allocating cost to final cost center from the overhead cost center it is allocated back to the previous support cost centers but in step wise method, cost are never allocated back to previous support centers that have higher ranked-cost center that is consumed more. In this the general cost allocates in a step wise of all general cost and then to the intermediate or final cost centers. This scheme will repeat several times to reduce remaining unallocated amounts (Drummond, 1987).

Fourth method is Simultaneous Equation Method: this method is mathematical and computer based. This method uses same data from the step down allocation and step down with iterations but it solves a set of linear equation to give

allocations(Drummond, 1987). Method gives answer but involve work (Drummond, 1987) and therefore it very complex and difficult to implement it(Shephard, 1998).

Among the four methods, step down method easily and efficiently allocates the cost and other methods like direct allocation method is not reasonable because the allocation of general cost allocates directly to the final cost center so maybe some part of the cost will be missed from the calculation. And in Step down allocation with iterations the general cost allocates in a stepwise and then to the clinical cost centers, this scheme will repeat several times while the result is the same with Step down method and the simultaneous method is mathematical, computer based and very complex and difficult to implement it.

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CHAPTER IV

RESEARCH DESIGN AND METHODOLOGY

Chapter discusses about the study design and methodology used in the conduct of cost-effectiveness analysis of TB treatment as per DOTS strategy.

4.1 Study Design

This is a descriptive study that looked at costs and TB treatment outcome across three levels hospital for one fiscal year - July 2012-June 2013. The perspective adopted for this study is viewpoint of provider -not from a society or patient perspective. Provider of DOTS in Bhutan refer to Health Center that diagnose and treat the TB cases as under government run health care system. From the provider perspective for economic evaluation, it basically looks at the cost and resources used for health services over period of time for specific intervention or program, In the economic evaluation such as cost-effectiveness analysis, perspective of study is important as it would form a basis to determine what costs and outcome to evaluate. The costs here refer resources used such human, capital, drugs and other operating cost to provide treatment of TB service as per DOTS strategy at three level of hospital in one fiscal year-July 2012-June 2013.

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The study attempts to carry out economic evaluation by following the cost effectiveness analysis model (CEA) where both resources used and outcome of health programme intervention are assessed.

4.2 Study sample

Four hospitals are included in this study as tabled below:

Table 9: Hospital included for study

Facility type	No. of Hospital included
National Referral Hospital	1
Regional Referral Hospital	1
District Hospital	2

4.3 Sampling procedures

The type of sampling used in this study is purposive or judgmental sampling. It is appropriateness for the study. The national referral hospital being the only national level hospital is automatically selected for this study. It is called Jigme Dorji Wangchuck National Referral Hospital located in the western and capital of Bhutan. It is an apex hospital in Bhutan with 350 beds. In 2012, at national referral hospital reported 402 TB cases (MOH, 2013) treated. Regional and District level hospitals was purposively selected based on number of beds, TB patients seen and geographical location Two district hospitals are included for the study- one has seen more TB case (38) and one that has seen low (18) in 2012.

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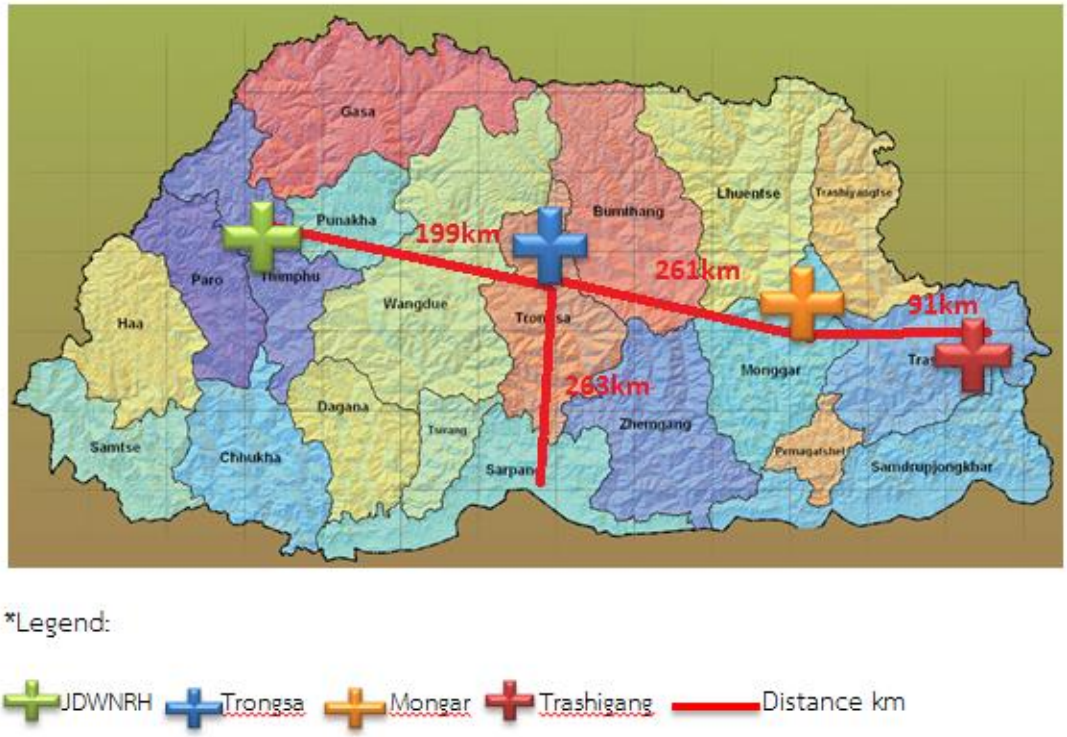
Figure 4: Map of Bhutan showing data collection sites



Source: Annual Health Bulletin, 2012

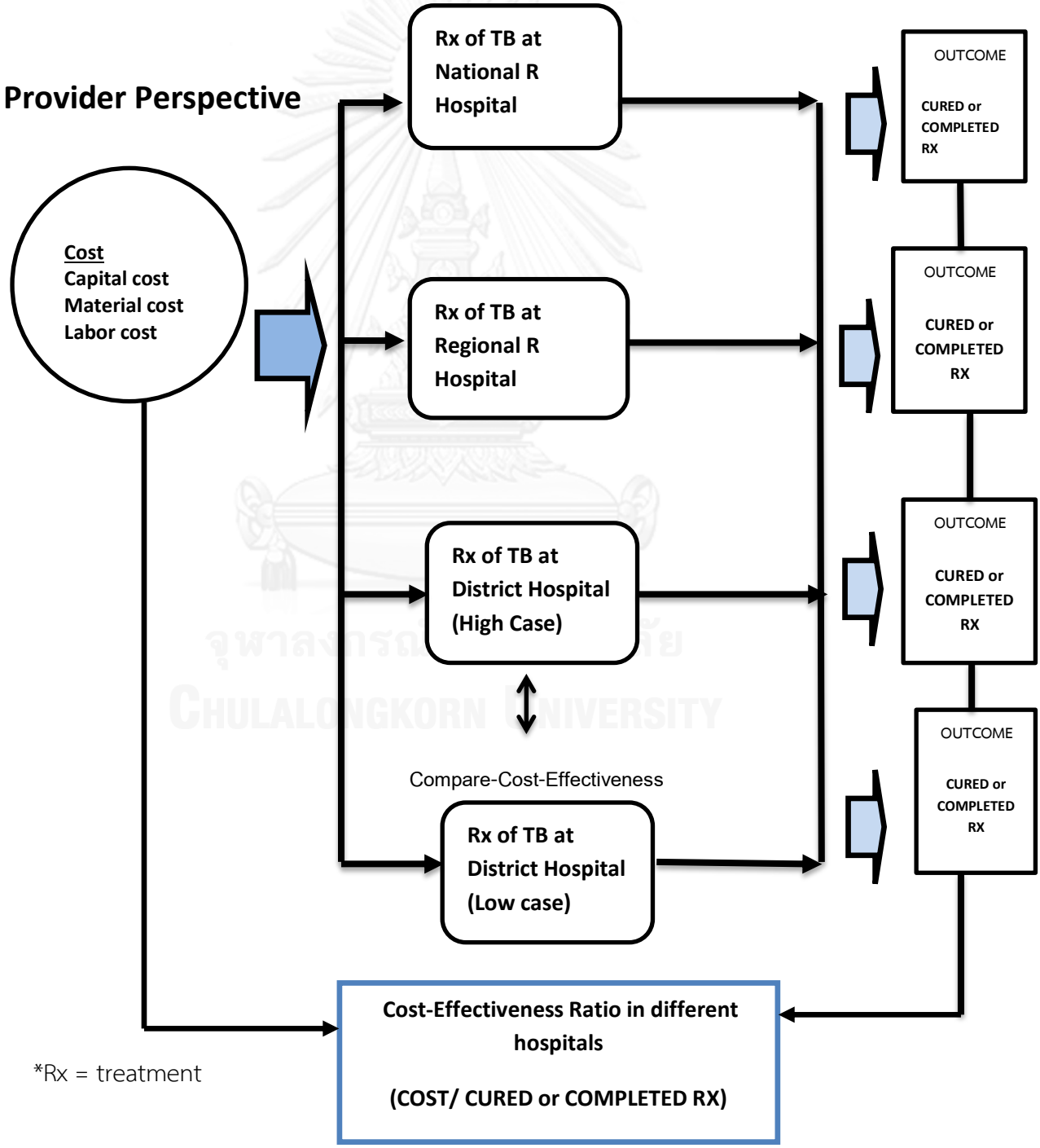
Mongar eastern regional referral hospital is the regional level hospital selected because of the two hospitals in this level, eastern regional referral hospital is bigger in size with total of 100 beds and it sees more TB cases than the other. In 2012 the hospital has treated 97 TB cases(MOH, 2013). Whereas central regional referral hospital is 60 bedded that saw 88 TB cases in 2012.

Trashigang district hospital which is also in eastern part is selected district level hospital because in comparison to the other district hospitals, it sees relatively a higher number of TB cases per year. It is a 40 bedded hospital. Last year district hospital has treated 38 cases of TB (MOH, 2013). This hospital is located near to Mongar eastern regional referral hospital with distance of 91km. The other district hospital selected is the Trongsa district hospital with 20 beds. Located in central

Bhutan and in 2012 hospital has treated 18 cases of TB (MOH, 2013). Distance to reached central referral hospital is from Trongsa District hospital is 263 km and to National referral hospital is 199 km by road.

4.4 Conceptual Framework

Cost-Effectiveness of Tuberculosis treatment at three levels of hospitals



The framework describes overall approach of the study to determine the cost effectiveness of TB treatment. Four hospitals are included in the study. This selected hospital is located in different district in Bhutan. National Referral Hospital is located in western part of Bhutan in capital city of Thimphu, where as Regional Referral is in eastern district called Mongar. Trongsa District Hospital is central and Trashigang District in the extreme east of country. All these hospitals are separated by the mountains, rivers and valleys.

All these hospitals provide TB treatment services as per the Guidelines for management of TB which is in line with DOTS recommended by WHO. All this hospitals as per the financial and budgeting norms of government proposed and allocated the budget through annual fiscal year planning to deliver health services. Total cost of treatment was assessed among selected hospitals for one fiscal year – July 2012-June 2013 specifically for expenses and cost incurred related to TB treatment services. To determine the treatment outcome, the number of cases registered pertaining to one fiscal year was computed and based on the cases registered in hospital, cure rate and completed rate is computed to find the treatment success. From the total cost, unit cost of treatment successful was calculated by dividing total cost of each hospital by total treatment completed and cured for respective hospital to give cost-effectiveness ratio at different hospital levels.

Successfully treated or treatment success: A patient who was cured or who completed treatment(WHO, 2013b).

4.5 Exclusion and inclusion criterion

1. Patients Perspective

Exclusion criteria

- TB cases registered under CAT II is not included especially to measure the cost-effectiveness ratio in the study due to difficulty in measuring treatment success as these are case of relapse, failure and defaulted one.
- MDR-cases is also excluded from the study due to time to take to treat MDR-TB patient is relatively more than CAT I TB and difficulty in measuring the treatment outcome.

2. Facilities perspective

Inclusion criteria

- The study included only four hospitals (national referral hospital, regional referral and 2 district hospital).
- Among two district hospitals, one district hospital in central and other in eastern part of Bhutan is included for the study.

Exclusion criteria

- Central regional referral, remaining district hospitals and Basic Health Unit I and II are excluded from the study due to time limitation.
- This study has excluded patients' choice of seeking treatment from a particular facility. For instance, a patient may choose to seek treatment from the higher facilities level (referral hospitals) in comparison to district hospital.

4.6 Assumption

For this study following assumption is made in order to compare cost-effectiveness across three levels of hospitals:

- Treatment services provided to TB patient are same irrespective of the hospital level as per DOTS.
- All cases registered at this four hospital are get full treatment at the selected hospital only.
- There are no MDR-TB-Cases in all these selected hospitals during the study period.

4.7 Data collection

The secondary retrospective cost and treatment outcome data was collected through by actual site visit to selected hospitals. Respective hospital that fall in the study was visited. Attach annexure sheet was used to collect cost and treatment outcome data. Patient record data for one fiscal year was collected from the TB register maintain at the hospitals and TB-incharges/focal officials who are familiar with record keeping has filled the treatment outcome in format. Cost data was collected from the hospital administration section where it maintain total number of staff in hospital and there pay scale as per the grade and overhead and utilities cost. Hospital administration is also responsible for day to day function of hospital was also interview to approximate overhead cost for TB treatment.

In addition program administrative data, facility report, budget and expenditure files and laboratory records were used for additional information. Staff responsible for TB services in the health facility was also interviewed to estimate the staff time attributed to TB service.

4.8 Cost estimation

The cost of treatment was estimated by using an activity based costing (ABC) method to find total provider cost of the four hospitals that provide TB treatment in line with DOTS. This approach is based on the observation that the costs are incurred because

of certain specific activities. The ABC method evaluates the cost and performance of activities as a result of utilizing allocated resources for assigned activities. From ABC perspective it needs to focus on the activities that drive cost higher. Therefore this method to costing is based on cost driver and measurement of the cost of activities. For the present study following the ABC, cost driver is divided into 3: The activities that cause it to incur cost are referred as cost driver in ABC. Cost driver is identified based on the observation that the costs are incurred because of specific activities in the health care program or health interventions. For the activity based costing, direct distribution method is used were cost is assigned directly from overhead and intermediate cost center to final cost center or mission centers.

1 General and Administrative activities: This includes cost of human resources required including support staff for DOTS treatment and overhead cost on utilities such as telephone, electricity, water, sewerage and other operating cost. This cost is allocated to TB treatment based on staff time devote to TB treatment, building space occupied for TB and overhead cost share is allocated based on interview with hospital administration knowledge on hospital operation cost.
2 Diagnostic activities: Under this activities consist of laboratory supplies and consumables used by the laboratory and x-ray unit in the process of detecting TB cases and capital equipment used for diagnostic purposes and building space occupied for treatment and diagnostic purposes
3 Treatment activities: This activity cost of treating patient under different case and treatment category as per treatment regimen and Fixed Dosage Combination Drugs.

Cost is calculated in terms of Bhutanese currency- Ngultrum (Nu.) and then converted into USD at the annual exchange rate of 1 Nu=55 USD. The Bhutan

currency averaged exchange rate was Nu. 55 per US Dollar in fiscal year 2012/13 (RMA, 2014).

The each cost is classified as direct and overhead cost. Direct cost refer to cost directly linked to the use of particular resources and whereas overhead cost refers to cost that do not directly provide to patient care services(MoPH, 2012).

The provider total cost of each facility will calculated by summing the following relation:

Total provider cost= total labor cost + total capital cost + total material cost

Capital cost pertain cost of resources whose benefits often last more than one year such as building, vehicles, equipment's (x-ray, microscope), furniture, computers, land etc. Information on price of capital goods was furnished from inventory or stock ledger. These prices are based on the government tender rate for one fiscal year. Therefore, for the purpose of this study all capital items were given a financial value and expected useful life in year. Estimated useful lives of Depreciable Hospital Assets is obtained from American Hospital Association (AHA, 1978) and building from Ministry of Health costing study(MOH, 2011a). The yearly cost of capital item was calculated using discount rate of 6% which is the standard discount rate used in economic evaluation(WHO, 2002)

To calculate the yearly annual capital cost of capital items a standard method is used (Drummond, 1987). If the capital outlay is K, we need to find annul sum E which is equivalent annual cost for the capital outlay over period of n years (the expected useful life of year capital item), at discount rate r. This method assumes that the all cost is occurred at the end of year. This is expressed by the following formula.

$$K = = \frac{E}{(1+r)} + \frac{E}{(1+r)^2} + \frac{E}{(1+r)^3} \ldots + \frac{E}{(1+r)^n}$$

$$K = E \frac{1-(1+r)^{-n}}{r} \quad \text{---------- (1)}$$

K= E [Annuity Factor at n periods and interest r]

Annuity factor is obtained from American Hospital Association 1978 ed. (AHA, 1978) or from .(Drummond, 1987)

This method is being also used in the healthcare costing study in Bhutan(MOH, 2011a).

For example cost of providing DOTS treatment found that capital cost (K) is USD 2500, then the annual capital cost (E) for the capital outlay at 5% discount rate (r) and with expected useful life years (n) 10

By applying above formula, when K=2500, r=5% and n=10, then E is

2500= E [Annuity Factor at n=10 and r=5%], which is 7.722 obtained from (AHA, 1978)

Therefore,

E=2500/7.772 = 321.667

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In the present study, this method is used to gain annual capital outlay and accordingly allocated to TB treatment. There are several methods of measuring and valuing capital item in economic evaluation and according to (Drummond, 1987) the best method is annuitize initial capital outlay over the useful life of the asset to calculate the equivalent cost. One advantage of annuitize initial capital outlay to gain annual capital cost it automatically incorporates depreciation aspect and opportunity cost aspect of capital cost.

According to (Drummond, 1987) above approach can be generalized for equipment or buildings have resale value at the end of programme. In such situation following formula is used:

$$E=\frac{K-\frac{S}{(1+r)n}}{A(n,r)} \text{ ----------(2)}$$

Where S= the resale value

n=the useful life of the equipment

r=discount (interest rate)

A(n.r)=the annuity factor (n years at interest rate r)

K=purchase price/initial outlay

E=equivalent annual cost

This formula described is new equipment and in case if it is old equipment two choices is recommended (Drummond, 1987) : 1 use the replacement cost of equipment and a full life and 2. Use the current market value of the old equipment and its remaining useful life.

For the current study this method of annual capital cost calculation is used.

$$K=E\,\frac{1-(1+r)^{-n}}{r}$$

This method is used as so as to estimate annual capital cost at the given discount rate and expected useful life of the capital item because comparing formula (2) this doesn't require certain information like market value of the old equipment and its remaining useful life.

Labor cost mainly covers mainly pay and allowances, other personal emoluments of staff. Information on same was obtained from the pay slip maintained by account section and budget and expenditure record. Labor cost is allocated base on the time spent on TB cases or proportion of time (on average) spent working on the TB

treatment and related work. This was obtained through interview of health staff to get the approximate time for TB related activities.

Materials cost would consist of drugs and medical supplies for treating TB patient. Drugs and supplies cost is obtained from the inventory or stock ledger. For this present study, total material cost (direct) is estimated by summing up total lab/sputum cost examination+ total chest x-ray cost + total drug cost+overhead cost. Drug cost of patient will be calculated to get total drug cost by following Fixed-Dosage Combination (FDC) tablets treatment regimen standard for each diagnostic category as follows: Drugs and consumable such as x-ray films and laboratory supplies were taken from invoice maintain by NTCP and these cost were linked to number of TB patient visiting health centers to produce drugs and material cost. These prices were also based on the government tender rate for one fiscal year.

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Table 10: The dosages of FDC tablets for adults as per Guidelines for the Management of Tuberculosis

New cases

Pre-treatment weight (kg)	Intensive Phase	Continuation Phase
	Daily (first 2 months)	Daily (Next 4 Months)
	Number of 4FDC tablets	Number of 2FDC tablets
30-37	2	2
38-54	3	3
55-70	4	4
>70	5	5

Retreatment case

Pre-treatment weight (kg)	Intensive Phase		Continuation Phase	
	Daily (first 3 months)	Daily (first 2 months)	Daily (next 5 months	
	Number of 4FDC tablets	Injection Streptomycin	Number of 2FDC	Ethambutol 400 mg (Number of tablets)
30-37	2	500 mg	2	2
38-54	3	750 mg	3	2-3
55-70	4	1 mg	4	4
>70	5	1 mg	5	5

Source: Guidelines for the Management of TB (MOH, 2010)

4.9 Effectiveness

The effectiveness is measured by treatment success recorded in one fiscal year. Treatment success includes patient who were cured or those who completed treatment as per WHO definition(WHO, 2013b). This measure of effectiveness is used in many of the cost-effectiveness studies. Treatment success in routine practice is used to refer smear positive patients who are cured or completed treatment to measure the program success. In some study this definition has been expanded to include smear negative and extra pulmonary tuberculosis treatment as well to see overall treatment strategy effectiveness regardless of the TB patient's type. Effectiveness in terms of treatment success is measured by the following formula:

$$\frac{\text{(Cured or treatment completed)}}{\text{No. of cases registered}} * 100$$

For the present study effectiveness is measured among treatment Success among New Smear Positive, New Smear Negative and Extra Pulmonary cases (CAT I) over one fiscal year.

In this study, effectiveness will be determined in two ways:

1. Patient cured which includes new smear positive cases. It is defined as Sputum smear (+) patient who is sputum (-) in the last month of treatment and on at least one previous occasion(MOH, 2010).
2. Treatment completed which includes smear negative and extra pulmonary cases. Treatment completed refers to Patient who has completed treatment but who does not meet the criteria to be classified as a cure or a failure(MOH, 2010).
3. Successfully treated: A patient who was cured or who completed treatment(WHO, 2013b).

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Although treatment success and number of TB case is main outcome to measure the effectiveness, there are other effectiveness analysis used in the cost-effectiveness such as outcome related to mortality or morbidity and life year gained, quality-adjusted life years (QALYs) and disability adjusted life-year (DALYs) calculated using life table of particular country.

4.10 Cost-effectiveness

Cost-effectiveness is calculated based on the cost per case successfully treated at different level hospital among New Smear Positive, New Smear Negative and Extra Pulmonary (CAT I). This can be done by dividing total cost for the respective hospital by the patient successfully treated in one fiscal year.

4.11 Sensitivity analysis

Performance of sensitivity analysis for Cost-Effective Analysis model is essential since it is based on number of assumptions. In the economic evaluation assessment, sensitivity analysis basically done to see if the changes in some key cost or estimate of effectiveness would affect the conclusion drawn from baseline analysis. This kind of analysis useful to determine the actual outcome of a particular variable will have if it differs from what was previously assumed. To evade uncertainty the sensitivity analysis is done for different discount rate (3%, and 6%) which is the standard discount rate used in the economic evaluation(WHO, 2002). Sensitivity analysis is also done by changing the percentage of building space used for TB treatment

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CHAPTER V

RESULTS

This chapter discusses the TB treatment outcome and cost related to TB treatment as per DOTS of four selected hospital in time period of one fiscal year (July 2012-June 2013). The study estimates cost and cost-effectiveness ratio of TB treatment at different levels of hospital (National, Regional and Districts) and find the cost-effectiveness ratio at different hospital levels under DOTS strategy in relation to treatment outcome. Results are presented in two parts- first TB treatment outcome and second cost calculation for TB treatment as per DOTS for the four hospitals included for the study.

5.1 Treatment Outcome at different hospital levels

5.1.1 National Referral Hospital

National Referral Hospital is located in the capital of Bhutan with population of 104,214 (MOH, 2012b) in 2010. Hospital provides services not only to people residing in city and Thimphu district, it also attend to both referred and non-referred cases from the hospital of 20 districts. It is the apex hospital in Bhutan. Annually it reports over a third of all TB cases given large proportion of population resides or moves to capital for various reasons. DOTS service for TB is provided at national referral hospital along with other health services. Hospital has a separate treatment unit with TB-incharges for DOTS supervision. During the fiscal year of July 2012-June 2013, the hospital has total registered cases of 289

Overall treatment success at national referral hospital (267/289) which including retreatment case is 92% during the study period. Cure rate which is the number of new smear positive cases cured divide by all registered new smear positive cases for a given period. Cure rate is an important indicator for TB treatment outcome.

National referral hospital had cure rate among new smear positive of 86% (82/95) and for retreatment is 78% (14/18). Treatment success rate of National Referral hospital has met the national goal of increase treatment success of ≥ 90%. Table 11 present the total number of TB cases registered and its outcome.

Table 11: Treatment outcome for JDWNRH - July 2012-June 2013

Type	Case registered	Cured	Treatment Completed	Failure	Died	Defaulted	Not Known
New Smear Positive	95	82	0	8	3	2	0
New Smear Negative	26	0	26	0	0	0	0
Extra Pulmonary	150	0	144	0	3	1	2
Re-treatment	18	14	1	3	0	0	0
Total	289	96	171	11	6	3	2

5.1.2 Regional Referral Hospital

Among two regional referral hospitals, eastern regional referral is included for the purpose of the study. Regional hospital is at tertiary level hospital where the patient depending on the case is referred from hospital and BHU of nearby districts. DOTS treatment services are provided for TB at regional referral hospital with separate treatment unit and staff with DOTS supervisor (TB-incharges). Cure rate for new smear positive case is 86% (32/37) and for retreatment case is 0% (0/10). Overall treatment success rate (who cured or completed) is 88% (92/105). Treatment success rate of regional referral hospital is slightly below national goal of increase treatment success of ≥ 90% among the 10 retreatment cases only 5 have completed treatment. Table 12 present the number of TB patients registered and its outcome.

Table 12: Treatment outcome for Regional Referral Hospital - July 2012-June 2013

Type	Case registered	Cured	Treatment Completed	Failure	Died	Defaulted	Not Known
New Smear Positive	37	32	0	3	0	0	2
New Smear Negative	6	0	5	0	1	0	0
Extra Pulmonary	52	0	50	0	1	0	1
Re-treatment	10	0	5	2	2	0	1
Total	105	32	60	5	4	0	4

5.1.3 District Hospital (High Case)

Among the district hospitals, Trashigang District Hospital which is located in the extreme east of Bhutan usually report high number of TB cases more than 30 cases annually is included for the purpose of study. DOTS treatment services are provided for TB at hospital with separate treatment unit and staff with DOTS supervisor (TB-incharges). In 2010 district has total population of 52,387(MOH, 2012b). During period one fiscal year hospital has 35 registered case of TB. It was found that the all the 35 recorded cases as the treatment success (who cured or completed treatment) and hence both treatment success rate is 100%. Cure rate among new smear positive cased cured divided by all registered new smear positive for given period was 100% (12/12) and cure rate for retreatment was also reported 100% (11/11). Cure rate for new smear positive and retreatment is the most important outcome indicator for TB treatment. Table 13 present total numbers of TB cases registered and its treatment outcome for one fiscal year.

Table 13: Treatment outcome for Trashigang District Hospital-July 2012-June 2013

Type	Case registered	Cured	Treatment Completed	Failure	Died	Defaulted	Not Known
New Smear Positive	12	12	0	0	0	0	0
New Smear Negative	5	0	5	0	0	0	0
Extra Pulmonary	7	0	7	0	0	0	0
Re-treatment	11	11	0	0	0	0	0
Total	35	23	12	0	0	0	0

5.1.4 District Hospital (Low Case)

Trongsa District Hospital is a centrally located hospital in Bhutan. In 2010 district has a total population of 14,712(MOH, 2012b). DOTS treatment services are provided for TB at district hospital with separate treatment unit and staff with DOTS supervisor (TB-incharge). In one fiscal year, the district hospital has a total of 30 TB cases registered. Cure rate which is calculated by number of new smear positive cases cured divided by all new smear positive cases for given period. Trongsa hospital has reported no retreatment cases but among new smear positive cases cure rate (13/15) is 87%. Overall treatment success (cured or completed) rate is 93% (28/30) which is above national goal to sustain and increase treatment success rate of ≥ 90%. Table 14 present total number TB cases registered and its treatment outcome for a period of one fiscal year.

Table 14: Treatment outcome for Trongsa District Hospital -July 2012-June 2013

Type	Case registered	Cured	Treatment Completed	Failure	Died	Defaulted	Not Known
New Smear Positive	15	13	0	1	0	0	1
New Smear Negative	8	0	8	0	0	0	0
Extra Pulmonary	7	0	7	0	0	0	0
Re-treatment	0	0	0	0	0	0	0
Total	30	13	15	1	0	0	1

5.2 Cost of TB Treatment as per DOTS at different levels of Hospital

The objective of the study is to estimate the cost and cos-effectiveness of TB treatment as per DOTS strategy in one fiscal year for the four selected hospital. Costs were estimated on the three cost driver or activities for the respective hospitals.

5.2.1 Cost estimate of TB treatment - National Referral Hospital

1. General and Administrative activities

This includes cost of human resources required including support staff for DOTS treatment and overhead cost on utilities such as telephone, electricity, water, sewerage and other operating cost

1.1 Labor Cost for TB treatment at National Referral Hospital

The health workers and support staff who directly or indirectly involved for DOTS services for TB is taken into account. The hospital working hour in Bhutan is from 9:00 AM to 3:00 PM on weekdays and 9:00 AM-1:00 PM on Saturday. Monthly basic

salary and allowance was obtained from administration section. In this study average working hour in a day is taken as 5 hours. The approximate time the health worker devotes was collected through interview of respective health staff. The allocation factor was calculated on the basis of time spend to perform the TB related activities as presented in table 17 and table 16 provide example of allocation criteria used to allocate cost for TB treatment. Different staff has different time devote to TB. Among the health workers and support staff it was observed that TB-incharges or DOTS supervisor spent most time for TB related activities.

As DOTS treatment for TB is integrated service. Labor cost of laboratory and x-ray unit staff is also calculated. Ward boy and sweeper that attach for TB treatment unit, laboratory and x-ray unit cost were also calculated for comprehensive labor cost for DOTS treatment service. Table 16 present the labor cost for TB at national referral hospital in one fiscal year. This time was approximated based on the on interview of health workers in hospital who are involved in the TB treatment related services.

Table 15: Labor cost allocation-criteria National Referral Hospital

Day	5 hours	In a weeks (5hr*6days)	30 hours
Approximate time In a month Dr. devote to TB patient.	8.4 hours	Month (30 hr*4weeks)	120 hours
Allocation Criteria of Dr. time for TB in month	8.4/120		

Above table describe the cost allocation of hospital staff for the TB treatment. As we have taken the average working hour in hospital is 5 hour a day and therefore, total hour worked in a week is (5 hr*6 day) 30 hrs. In a month total hour work 4 weeks* 30 hours a week and total hour worked in a month is 120 hour. From the interview it was found that Dr, was working around 8 hour and 40 minute for TB for a TB related activities in a month. Therefore, Dr. salary in a month was allocated based (8.4/120)on this working hour to TB related activities.

Table 16: Human Resource cost for TB at National Referral Hospital

Staff	Number **(n)**	Monthly Basic Salary **(a)**	Annual Basic Salary **(a*12*n)**	Annual Allowances (leave Encashment) **(b)**	Total annual allowance **(b*n)**	Total annual salary and allowance **(a*12*n) +(b*n)**	Time spent on TB treatment (month) **(t)**	Annual salary attributable for TB treatment **(a*12*n) +(b*n)*t**
Doctor (Medical Specialist, GDMO)	9	26,175	2,826,900	26,175	235,575	3,062,475	(8.4/120)=0.07	214,373
Pathologist	2	27,520	660,480	27,520	55,040	715,520	(6/120)=0.05	35,776
Radiologist	1	32,520	390,240	32,520	32,520	422,760	(11/120)=0.09	38,048
Radiographer	2	15,690	376,560	15,690	31,380	407,940	(5/120)=0.04	16,318
X-ray technician	10	13,432	1,611,840	13,432	134,320	1,746,160	(10.3/120)=0.09	157,154
Microbiologist	1	22,620	271,440	22,620	22,620	294,060	(7.2/120)=0.06	17,644
Lab Technologist	4	17,660	847,680	17,660	70,640	918,320	(5.4/120)=0.05	41,324
Lab technician	8	14,000	1,344,000	14,000	112,000	1,456,000	(7.2/120)=0.06	87,360
TB-Incharges	2	14,430	346,320	14,430	28,860	375,180	(115/120)=0.96	360,173
Receptionist	8	7,325	703,200	7,325	58,600	761,800	(3.3/120)=0.03	22,854
Cook	6	5,000	360,000	5,000	30,000	390,000	(3/120)=0.02	8,970
Ward Girl/Boy	10	7,895	947,400	7,895	78,950	1,026,350	(8.4/120)=0.07	71,845
Wet Sweeper	6	8,025	577,800	8,025	48,150	625,950	(8.4/120)=0.07	43,817
Total (Nu)	69	212,292	11,263,860	212,292	938,655	12,202,515		1,115,655
Cost Type			Labor Cost					

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1.2. TB treatment overhead cost – National Referral Hospital

There is no specific overhead cost allocated for provision of DOTS in the hospital. Overhead cost incurred in TB treatment is met from the overall budget allocated for the one fiscal year from the overall hospital budget allocation. Overhead cost includes expenses for electricity, water, sewerage, patient diet, laundry etc. There are different departments and treatment unit that consumed the overhead cost. After interviewing with hospital administration it was approximated that the TB treatment would take 2% of the overhead cost from the overhead expenditure. This share of TB treatment is used as allocation factor for TB treatment cost from overhead cost. Even in some literatures it is mentioned that the there is no as such exact allocation criteria that can used to allocate overhead cost and it is recommended allocation criteria be devise even if it has not been used elsewhere on the individual knowledge of one hospital on the basis which can predict the cost accurately. Table 17 present the overhead cost for national referral hospital during one fiscal year.

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Table 17: Overhead cost for TB treatment- National referral hospital

Items	Annual cost (Nu.) **(c)**	Allocation Proportion for TB **(p)**	Total cost for TB treatment **(c*p)**
Telephone,Tele,Fax, E-mail, Internet	3,100,000	0.02	59,202
Telegram, Wireless, Postage	220,000	0.02	4,201
Electricity, Water, Sewerage	16,910,000	0.02	322,936
Patient Diet	5,110,000	0.02	97,587
Fuel Wood	500,000	0.02	9,549
Uniform, Extension, Kits, Linens	4,000,000	0.02	76,389
Maintenance of Building	2,200,000	0.02	42,014
Maintenance of Equipment	23,290,000	0.02	444,777
Office supplies, printing, publications	1,563,000	0.02	29,849
Transportation	300,000	0.02	5,729
Infection Control, Global Event Celebration	4,380,000	0.02	83,646
Laundry Outsource Services	2,340,000	0.02	44,688
Total (Nu)	63,913,000		1,220,568
Cost Type		Material Cost	

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2. Diagnostic activities

Under this activities consist of laboratory supplies and consumables used by the laboratory and x-ray unit in the process of detecting TB cases and capital equipment used for diagnostic purposes and also building space occupied for treatment and diagnostic purposes

2.1 Cost of capital-Building and Equipment

National referral hospital is tertiary care hospital in Bhutan. Hospital building cost is obtain from the previous study "the costing of health care services in Bhutan 2009-2010"(MOH, 2011a) and equipment cost from the Drugs, Vaccine & Equipment Division of Ministry of Health. DOTS center or TB treatment unit operates together along with other department and treatment unit in hospital. Estimated space occupied for TB treatment unit is allocated to treatment cost of capital. X-ray and laboratory are function in integration with other treatment services. Most of TB cases are diagnosed by sputum smear microscopy. The total slides examine for TB sputum is 6675 from the overall slides test 125, 7394 during the study period and total x-ray 867 from total of 25,332. Based on this number share of equipment cost is allocated to TB treatment. Table 19 present capital cost for TB at discount rate of 6%. Capital cost are discounted or annualized to calculate the annual value of a capital item.

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Table 18: Allocation criteria for capital cost-National Referral Hospital

Item	Unit	Total (a)	Share of TB (b)	Allocation criteria (b/a)
Building	Space	6,070 m^2	304 m^2	0.05
Microscope	No. of sildes	125,7394	6675	0.005
X-ray machine and film drier	No. of x-ray done	25,332	867	0.034

Table 19: Capital cost of National Referral Hospital at 6% discount rate

Items	Cost/Value **(K)**	Useful life **(n)**	Annulization Factor **(a)**	Annual Capital cost **E=(K/a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(K/a)*(c)**
Building	45,187,725	30	13.7648	3,282,846	0.05	164,142
Microscope	33,987	10	7.3601	4,618	0.005	23
X-ray Machine	1,280,000	8	6.2098	206,126	0.034	7,008
Computer Desktop	28,790	7	5.5824	5,157	0.20	1,031
X-ray film drier	29,980	8	6.2098	4,828	0.034	164
Automatic x-ray film processor	485,000	8	6.2098	78,102	0.034	2,655
Digital x-ray machine	3,182,500	8	6.2098	512,496	0.034	17,425
Total (Nu)	50,227,982			4,094,174		192,450

K=$E\frac{1-(1+r)^{-n}}{r}$

K= *E*[Annuity Factor at *n* periods and interest *r*]

2.2 Laboratory supplies and consumable cost

These costs consist of supplies, x-ray films and chemicals used by the laboratory and x-ray unit. The cost was calculated based on the quantity used multiply with the unit price. Additionally reporting forms for TB patient during the treatment process in one

fiscal year was calculated on basis quantity used. Table 20 present the supplies, consumables and forms used by the national referral hospital.

Table 20: Supplies and consumable cost for TB treatment

Items	Cost	Unit cost **(c)**	Qty. Used **(q)**	Cost **(c*q)**
X-ray film (100 sheets)	6,357	6	867	5,462
Developer (13.5 l)	503	37	41	1,528
Fixture (13.5 l)	472	35	41	1,433
Carbon Fusin solution (500ml)	425	31	24	756
Sulpheric Acid (500 ml)	185	2.70	4,221	11,408
Methalene Acid (500ml)	215	2.33	4,221	9,816
Slides (50 pcs)	43	1	867	737
Sputum container (500 pcs)	3,514	7	578	4,062
Patient card	7	7	289	2,023
Quarterly Reporting Form	4	4	72	288
Patient Discharge Form	4	4	289	1,156
Monthly Reporting Form	4	4	289	1,156
Treatment Card	4	4	289	1,199
Patient Transfer and Acknowledgement Form	12	12	24	288
Total (Nu)				41,313
Cost type		Material Cost		

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3. Treatment activities

This activity cost the treating patient under different case and treatment category as per treatment and Fixed Dosage Combination Drugs.

3.1 Drugs cost

Drugs cost were calculated on the basis of TB patient registered under type of treatment category from July 2012-June 2013 as per the standard treatment regimen for each category. Fixed Dosage Combination (FDC) drugs are used as treatment is more effective. The dosage of FDC is depends on the body weight of patient. Patient weight category of 38-54 dosage was used to calculate drug cost for each type of cases where 3 tablets of dosage is recommended. Dosage category is also used by NTCP for quantification of TB drugs for procurement and indenting by hospitals for TB drugs. New smear positive, new smear negative and extra pulmonary are treated under category I and whereas retreatment cases (failure, relapse, defaulted) are under treated under the category II. Depending on the treatment category drugs cost also varies.

National referral hospital has total of 289 registered case in one fiscal year of which 95 was new smear positive, 26 new smear negative, 150 extra pulmonary and 18 retreatment cases.

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Drug costs for each type of case were calculated in the following manner as per treatment regimen and duration.

- New Smear Positive the treatment duration is total of 6 month where 4-FDC drugs of 3 tablets is consumed for 2 month daily in the intensive phase and 2-FDC drugs of 3 tablets for another 4 month daily by per patient i.e **2(4FDC)+4(2FDC).**

- New Smear Negative total duration of treatment is 6 month where FDC drugs dosage is 4-FDC is given for 2 month daily 3 tablets and 4 month daily for 2-FDC 3 tablets per patient i.e **2(4FDC)+4(2FDC)**
- For-extrapulmonary is 2 month of 4-FDC daily 3 tablets and 10 month of 2-FDC daily 3 tablets per patient. The total duration of treatment is 12 month i.e **2(4FDC)+10(2FDC).**
- For retreatment is 2 month 4-FDC daily 3 tablets along with 1 vial of Strepmoycin 750 mg (inj) daily and 1 month of 4-FDC 3 tablets and 5 month of 3-FDC daily 3 tablets per patient i.e **2(4FDC+Strepmoycin inj)+1(4FDC)+5(3FDC).**

For example, in National Referral Hospital in one fiscal year hospital had New Smear Positive 95 case and therefore, Drugs cost for 4-FDC where the unit cost of drug is Nu 3.4 is = 2 month X 95 case X 3tablets X 30 days X 3.4 Nu which comes to Nu 58,140 as presented in Table below. In same way cost of drugs for each type is calculated as presented in Table 21.

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Table 21: Drugs cost for National Referral Hospital

Item	**Category I**			**Category II**	**Cost**
	New Smear Positive (N=95)	New Smear Negative (N=26)	Extra Pulmonary (N=150)	Retreatment (N=18)	
*4-FDC	58,140	15,912	91,800	16,524	182,376
Calculation (Month*No. Of Tablets*No. Of days *case*Unit price)	(2*3*30*95*3.4)	(2*26*3*30*3.4)	(2*150*3*30*3.4)	(3*18*3*30*3.4)	
*3-FDC				22,356	22,356
Calculation	-	-	-	(5*18*3*30*2.76)	
*2-FDC	54,720	14,976	216,000	-	285,696
Calculation	(4*95*3*30*1.6)	(4*26*3*30*1.6)	(10*150*3*30*1.6)		
Strepmoycin 750 mg (inj)	-	-	-	40,403	40,403
Calculation				(2*18*1*30*37.41)	
Total (Nu)	112,860	30,888	307,800	79,283	530,831
Cost Type	Material Cost				

*4-FDC (isoniazid 75 mg+rifampicin 150 mg+pyrazinamide 400 mg+ethambutol 275 mg)

*3-FDC (isoniazid 75 mg+rifampicin 150 mg+ethambutol 275 mg

*2-FDC (isoniazid 75 mg+rifampicin 150 mg)

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5.2. Total provider cost at National Referral Hospital

From all the above calculation under different cost driver, cost of treatment at national referral hospital is summed in the following Table 23.

Table 22 present the overall cost of treating patient at national referral hospital in one fiscal year:

Table 22: Total Provider Cost for TB treatment – National Referral Hospital

Cost Type	Nu	USD
Capital Cost (Table 19)	192,450	3,499
Labor Cost (Table 16)	1,115,655	20,285
Material Cost (Table 17+Table 20+Table 21)	1,792,712	32,595
Total Cost	3,100,817	56,878

Table 23: Direct and Overhead cost for TB treatment –National Referral Hospital

Cost	Nu	USD
Direct Cost (Table 20+Table 21+Table 19+Table 16)	1,880,249	34,186
Overhead Cost (Table:17)	1,220,568	22,192
Total	3,100,817	56,878

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5.2.2 Cost estimate for TB treatment - Regional Referral Hospital

1. General and Administrative activities

This includes cost of human resources required including support staff for DOTS treatment and overhead cost on utilities such as telephone, electricity, water, sewerage and other operating cost.

1.1 Labor cost for TB treatment at Regional Referral Hospital

The hospital staffs who are involved in provision of DOTS services for TB are taken into account in this study to estimate human resource cost for TB treatment. The cost was calculated on the basis of the monthly salary obtained from the administration section of hospital. The allocation factor was calculated on the approximate time spend to perform the TB treatment related activities which is by interviewing the relevant staff in the hospital. Different allocation factor were used for different staff as time they devote differ.

Table 24: Labor cost allocation criteria

Day	5 hours	In a weeks (5hr*6days)	30 hours
Approximate time In a month Dr. devote to TB patient.	8.4 hours	Month (30 hr*4weeks)	120 hours
Allocation Criteria of Dr. time for TB in month	8.4/120		

Above table describe the cost allocation of hospital staff for the TB treatment. As we have taken the average working hour in hospital is 5 hours a day and therefore, total hour worked in a week is (5 hr*6 day) 30 hrs. In a month total hour work 4 weeks* 30 hours a week and total hour worked in a month is 120 hour. From the interview it was found that Dr, was working around 8 hour and 40 minute for TB related activities in a month. Therefore, Dr. salary in a month was allocated based (8.4/120)on this working hour to TB related activities.

Table 25: Human Resource for TB treatment at Regional Referral Hospital July 2012-June 2013

Staff	Number **(n)**	Monthly Basic Salary **(a)**	Annual Basic Salary **(a*12*n)**	Annual Allowances (leave Encashment) **(b)**	Total annual allowance **(b*n)**	Total annual salary and allowance **(a*12*n) +(b*n)**	Time spent on TB treatment (month) **(t)**	Annual salary attributable for TB treatment **(a*12*n) +(b*n)*t**
Doctor (Meidcal Specialist, GDMO)	7	26,175	2,198,700	26,175	183,225	2,381,925	(8.4/120)=0.07	166,735
Pathologist	1	32,520	390,240	32,520	32,520	422,760	(12/120)=0.1	42,276
Radiologist	1	19,830	237,960	19,830	19,830	257,790	(10.3/120)=0.09	23,201
Laboratory Officer	1	17,660	211,920	17,660	17,660	229,580	(11/120)=0.06	13,775
Lab Technincian	4	13,835	664,080	13,835	55,340	719,420	(18/120)=0.15	107,913
TB-Incharges	1	14,630	175,560	14,630	14,630	190,190	(102/120)=0.85	161,662
Receptionist	5	8,540	512,400	8,540	42,700	555,100	(2.4/120)=0.02	11,102
X-ray technician	5	12,775	766,500	12,775	63,875	830,375	(18/120)=0.15	124,556
Cook	4	8,025	385,200	8,025	32,100	417,300	(4/120)=0.03	12,519
Laundry Women	3	6,280	226,080	6,280	18,840	244,920	(18/120)=0.15	36,738
Ward Girl/Boy	2	8,415	201,960	8,415	16,830	218,790	(14/120)=0.12	26,255
Night Guard	2	5,000	120,000	5,000	10,000	130,000	(2.3/120)=)0.02	2,600
Wet Sweeper	2	8,025	192,600	8,025	16,050	208,650	(2.3/120)=0.02	4,173
Security Guard	5	5,000	300,000	5,000	25,000	325,000	(2.3/120)=0.02	6,500
Total Salary (Nu)	43	186,710	6,583,200	186,710	548,600	7,131,800	0.10	740,004
Cost Type				Labor Cost				

1.2 Overhead cost for TB treatment at Regional Referral Hospital

DOTS treatment service in hospital function in integration with other diagnostic and treatment services. Hence the overhead expenses incurred DOTS treatment of TB is met from the overall hospital budget for overhead expenditure. Therefore, share of overhead cost is estimated based on the interview with hospital administration about the approximate percentage of overhead expenditure for TB from total overhead cost of hospital. So overhead cost of TB treatment as total overhead cost was taken as 2.4% in one fiscal year. This allocation criterion is used to allocate the TB treatment overhead cost. Table 26 present the overhead cost for regional referral hospital during one fiscal year.

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Table 26: Overhead cost for TB at Regional Referral Hospital

Items	Annual cost **(c)**	Allocation Proportion for TB **(p)**	Total cost for TB treatment **(c*p)**
Telephone,Tele,Fax, E-mail, Internet	750,000	0.024	18,000
Telegram, Wireless, Postage	37,000	0.024	888
Electricity, Water, Sewerage	1,380,000	0.024	33,120
Patient Diet	2,009,000	0.024	48,216
Fuel Wood	1,500,000	0.024	36,000
Uniform, Extension, Kits, Linens	97,100	0.024	2,330
Maintenance of Building	536,000	0.024	12,864
Maintenance of Equipment	2,800,000	0.024	67,200
Office supplies, printing, publications	757,000	0.024	18,168
Transportation	105,000	0.024	2,520
Total (Nu)	9,971,100	0.024	239,306
Cost Type		Material Cost	

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2. Diagnostic activities

Under this activities consist of laboratory supplies and consumables used by the laboratory and x-ray unit in the process of detecting TB cases and capital equipment used for diagnostic purposes and building space occupied for treatment and diagnostic purposes

2.1 Capital Cost for TB treatment at Regional Referral Hospital

Cost of capital included building space occupied for TB treatment, x-ray and microscope cost. These costs were discounted at 6% discount rate and capital cost based on space occupied and equipment used, cost is allocated to TB treatment. TB treatment that provided DOTS services to TB patient. The laboratory and x-ray unit are integrated with other services. Building cost was obtained from the costing of health care services in Bhutan 2009-2010" and equipment price from Drugs, Vaccine and Equipment Division of MoH.

In the study period lab has performed total of 29,220 slide test and from this 467 test was for TB sputum and therefore, cost of microscope is (467/29,220) for TB and x-ray machine is (315/3,832). Table 28 present the cost of capital discounted at 6% and allocation to TB treatment.

Table 27: Allocation criteria for capital cost- Regional Referral Hospital

Item	Unit	Total (a)	Share of TB (b)	Allocation criteria (b/a)
Building	Space	4046 m^2	202 m^2	0.05
Microscope	No. of lab test	29220	467	0.016
X-ray machine and film drier	No. of x-ray done	3832	315	0.08

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Table 28: Capital cost of Regional Referral Hospital for TB treatment at 6% discount rate

Items	Cost/Value **(K)**	Useful life **(n)**	Annualization Factor **(a)**	Annual Capital cost **E=(K/a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(K/a)* (c)**
Building	27,316,053	30	13.7648	1,984,486	0.05	99,224
Microscope	33,987	10	7.3601	4,618	0.016	74
X-ray Machine	1,280,000	8	6.2098	206,126	0.08	16,490
Computer Desktop	28,790	7	5.5824	5,157	0.2	1,031
X-ray film drier	29,980	8	6.2098	4,828	0.08	386
Automatic x-ray film processor	485,000	8	6.2098	78,102	0.08	6,248
Digital x-ray machine	3,182,500	8	6.2098	512,496	0.08	41,000
Total (Nu)	32,356,310			2,795,813		164,454

K=$E\frac{1-(1+r)^{-n}}{r}$

K= *E*[Annuity Factor at *n* periods and interest *r*]

2.2 Laboratory supplies and consumable for the TB treatment

The cost of laboratory supplies and consumable is calculated on the quantity used for TB related diagnostic purposes. Different chemicals and x-ray films etc was quantified over one fiscal year and unit cost was calculated and allocated cost to TB treatment. Various reporting form are also used in the DOTS treatment process to record the treatment and monitor TB patient cost was also calculated. Table 29 presents the laboratory supplies and consumable cost at regional referral hospital.

Table 29: Supplies and consumable cost –Regional Referral Hospital

Item	Cost	Unit Cost **(c)**	Qty. Used **(q)**	Cost **(c*q)**
X-ray film (100 sheets)	6,375	6	315	1,985
Developer (13.5 l)	503	37	22	805
Fixture (13.5 l)	472	35	22	755
Carbon Fusin solution (13.5l)	425	31	12	378
Sulpheric Acid (500 ml)	185	2.70	3,226	8,719
Methalene Acid (500 ml)	215	2.3	3,226	7,502
Slides (50 pcs)	43	1	315	268
Sputum container (500 pcs)	3,514	7	210	1,476
Patient card	7	7	105	735
Quarterly Reporting Form	4	4	48	192
Patient Discharge Form	4	4	105	420
Monthly Reporting Form	4	4	105	420
Treatment Card	4	4	105	436
Patient Transfer and Acknowledgement Form	12	12	4	48
Total (Nu)				24,138
Cost Type		Material Cost		

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3. Treatment activities

This activity cost of treating patient under different case and treatment category as per treatment and Fixed Dosage Combination Drugs.

3.1 TB treatment Drugs cost at Regional Referral Hospital

Table 30 present the drug cost as per treatment regimen for each diagnostic category at regional referral hospital. Cost was calculated by linking the type of case to unit cost of drugs over different treatment completion time depending on case. Hospital has total 105 case registered from July 2012-June 2013. Drugs cost varies from types of cases and to treatment category. Drugs dosage depends on body weight of patient. For this study body of TB patient with weight category of 38-54 kg dosage is used to calculate the cost. This calculation criterion is also being used by the program for quantification of TB drugs procurement and indenting by the health facility. Price of drugs was obtained from the National TB Control Program.

Drug costs for each type of case were calculated in the following manner as per treatment regimen and duration.

1. New Smear Positive the treatment duration is total of 6 month where 4-FDC drugs of 3 tablets is consumed for 2 month daily in the intensive phase and 2-FDC drugs of 3 tablets for another 4 month daily per patient i.e **2(4FDC)+4(2FDC).**
2. New Smear Negative total duration of treatment is 6 month where FDC drugs is dosage is 4-FDC is given for 2 month daily 3 tablets and 4 month daily for 2-FDC 3 tablets per patient i.e **2(4FDC)+4(2FDC)**
3. For-extrapulmonary is 2 month of 4-FDC daily 3 tablets and 10 month of 2-FDC daily 3 tablets per patient. The total duration of treatment is 12 month i.e **2(4FDC)+10(2FDC).**

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4. For retreatment is 2 month 4-FDC daily 3 tablets along with 1 vial of Strepmoycin 750 mg (inj) daily and 1 month of 4-FDC 3 tablets and 5 month pf 3-FDC daily 3 tablets per patient i.e **2(4FDC+Strepmoycin inj)+1(4FDC)+5(3FDC).**

For example, in Regional Referral Hospital in one fiscal year hospital had New Smear Positive 37 case and therefore, Drugs cost for 4-FDC where the unit cost of drug is Nu 3.4 is = 2 month X 37 cases X 3tablets X 30 days X 3.4 Nu which comes to Nu 22,644 as presented in Table below. In same way cost of drugs for each type is calculated as presented in Table 30.

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Table 30: Drugs cost for Regional Referral Hospital

Items	**Category I**			**Category II**	**Total Cost**
	New Smear Positive (N=37)	New Smear Negative (N=6)	Extra Pulmonary (N=52)	Retreatment (N=10)	
*4-FDC	22,644	3,672	31,824	9,180	67,320
Calculation ***(Month*No. of Tablets*No. of days *case*Unit price)***	(2*37*3*30*3.4)	(2*6*3*30*3.4)	(2*52*3*30*3.4)	(3*10*3*30*3.4)	
*3-FDC	-	-	-	12,420 (5*10*3*30*2.76)	12,420
*2-FDC	21,312	3,456	74,880	-	99,648
Calculation	(4*37*3*30*1.6)	(4*6*3*30*1.6)	(10*52*3*30*1.6)		
Strepmoycin 750 mg (inj)	-	-	-	22,446	22,446
Calculation				(2*10*1*30*37.4)	
Total (Nu)	43,956	71,28	106,704	44,046	201,834

*4-FDC (isoniazid 75 mg+rifampicin 150 mg+pyrazinamide 400 mg+ethambutol 275 mg)

*3-FDC (isoniazid 75 mg+rifampicin 150 mg+ethambutol 275 mg)

*2-FDC (isoniazid 75 mg+rifampicin 150 mg)

5.2.2 Total Provider Cost for TB treatment at Regional Referral Hospital

From all the above calculation under different cost driver, cost of treatment at regional hospital is summed in the following Table 31.

Table 31: Total Provider Cost-Regional Referral Hospital

Cost Type	Nu	USD
Capital Cost (Table 28)	164,454	2,990
Labor Cost (Table 25)	740,004	13,455
Material Cost(Table 30+Table29+Table 26)	465,278	8,460
Total Cost	1,396,736	24,904

Table 32: Direct and Overhead Cost for TB Treatment-Regional Referral Hospital

Cost	Nu	USD
Direct Cost (Table 25+Table 28+Table 29+Table 30)	1,130,430	20,553
Overhead Cost (Table:26)	239,306	4,351
Total	1,396,736	24,904

5.2.3 Cost estimate for TB treatment - District Hospital (high case)

1. General and Administrative activities

This includes cost of human resources required including support staff for DOTS treatment and overhead cost on utilities such as telephone, electricity, water, sewerage and other operating cost.

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1.1 Labor cost for TB treatment-District Hospital (high case)

The hospital staffs who are involved in provision of DOTS services for TB are taken into account in this study to estimate human resource cost for TB treatment. The cost was calculated on the basis of the monthly salary obtained from the administration section of hospital. The allocation factor was calculated on the approximate time spend to perform the TB treatment related activities. Different allocation factor were used for different staff as time they devote differ. Table 34 present the capital human resource cost for TB treatment at district hospital selected

for the study. Costs are calculated for both clinical staff who directly deals with patient and non-clinical staff as they are involved in DOTS treatment services.

Table 33: Labor cost allocation criteria

Day	5 hours	In a weeks (5hr*6days)	30 hours
Approximate time of Dr. devote to see TB patient.	.30 hr day	Month (30 hr*4weeks)	120 hours
Allocation Criteria of Dr. time for TB in month	9/120		

Above table describe the cost allocation of hospital staff for the TB treatment. As we have taken the average working hour in hospital is 5 hours a day and therefore, total hour worked in a week is (5 hr*6 day) 30 hrs. In a month total hour work 4 weeks* 30 hours a week and total hour worked in a month is 120 hour. From the interview it was found that Dr, was working around 9 hour for TB related work in a month. Therefore, Dr. salary in a month was allocated based (9/120)on this working hour to TB related activities

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Table 34: Labor cost for TB treatment at Trashigang District Hospital-July 2012-June 2013

Staff	Number **(n)**	Monthly Basic Salary **(a)**	Annual Basic Salary **(a*12*n)**	Annual Allowances (leave Encashment) **(b)**	Total annual allowance **(b*n)**	Total annual salary and allowance **(a*12*n) +(b*n)**	Time spent on TB treatment (month) **(t)**	Annual salary attributable for TB treatment **(a*12*n) +(b*n)*t**
Doctor	3	20,377	733,572	20,377	61,131	794,703	(10/120)=0.08	63,576
TB In-charges	1	14,630	175,560	14,530	14,530	190,090	(78/120)=0.65	123,559
X-ray Technician	3	12,310	443,160	12,310	36,930	480,090	(11/120)=0.090	43,208
Lab Technincian	3	11,362	409,032	11,362	34,086	443,118	(9/120)=0.075	33,234
Store Assistant	1	9,405	112,860	9,405	9,405	122,265	(4/120)=0.03	3,668
Receptionist	1	7,325	87,900	7,325	7,325	95,225	(3/120)=0.021	2,000
Wet Sweeper	4	8,415	403,920	8,415	33,660	437,580	(5/120)=0.045	19,691
Dispatcher	1	7,325	87,900	7,325	7,325	95,225	(2/120)=0.02	1,905
Cook	2	7,405	177,720	7,405	14,810	192,530	(4/120)=0.03	5,776
Ward Boy	4	8,025	385,200	8,025	32,100	417,300	(6/120)=0.05	20,865
Laundry Women	2	8,415	201,960	8,415	16,830	218,790	(6/120)=0.05	10,940
Hospital Care Taker	2	5,000	120,000	5,000	10,000	130,000	(4/120)=0.03	3,900
Total Salary (Nu)	27	119,994	3,338,784	119,894	278,132	3,616,916	0.09	332,320
Cost type				Labor cost				

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1.2 Overhead cost for TB treatment-Trashingang District Hospital

DOTS treatment service in hospital function in integration with other diagnostic and treatment services. Hence the overhead expenses incurred DOTS treatment of TB is met from the overall hospital budget for overhead expenditure. The overhear cost for TB treatment is allocated after interview of the hospital administration that has knowledge about the hospital operation and administration. Therefore, share of overhead cost is estimated 2 % of the overhead cost expenditure in one fiscal year. This share is used to allocate the cost for TB treatment for overhead cost. Table 35 present the overhead cost for regional referral hospital during one fiscal year.

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Table 35: Overhead cost for TB treatment-Trashigang District Hospital

Items	Annual cost (Nu.) **(c)**	Allocation Proportion for TB **(p)**	Total cost for TB treatment **(c*p)**
Telephone ,Tele,Fax, E-mail, Internet	180,000	0.02	3,600
Telegram, Wireless, Postage	50,000	0.02	1,000
Electricity, Water, Sewerage	200,000	0.02	4,000
Patient Diet	500,000	0.02	10,000
Fuel Wood	80,000	0.02	1,600
Uniform, Extension, Kits, Linens	40,000	0.02	800
Maintenance of Building	100,000	0.02	2,000
Maintenance of Equipment	30,000	0.02	600
Office supplies, printing, publications	90,000	0.02	1,800
Transportation	30,000	0.02	600
Total (Nu)	1,300,000		26,000
Cost Type		Material Cost	

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2. Diagnostic activities

Under this activities consist of laboratory supplies and consumables used by the laboratory and x-ray unit in the process of detecting TB cases and capital equipment used for diagnostic purposes and building space occupied for treatment and diagnostic purposes

2.1 Capital Cost for TB treatment at District Hospital

Cost of capital included building space occupied for TB treatment, x-ray and microscope cost. These costs were discounted at 6% discount rate and capital cost based on space occupied and equipment used, cost is allocated to TB treatment. The laboratory and x-ray unit are integrated with other services. Building cost was obtained from the study "costing of health care services in Bhutan 2009-2010"(MOH, 2011a) and equipment price from Drugs, Vaccine and Equipment Division of MoH. Same allocation technique was used to allocate the capital cost to TB treatment as per DOTS.

In the study period lab has performed total of 44,756 slide test and from this 1,232 test was for TB sputum and therefore, cost of microscope is (467/29,220) for TB and x-ray machine is (315/3,832). Table 35 present the cost of capital discounted at 6% with expected useful life and allocation to TB treatment. Expected useful life of capital is obtained from the "estimated useful lives of depreciable hospital Assets" American hospital Association.

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Table 36: Allocation criteria for capital cost-Trashigang District Hospital

Item	Unit	Total (a)	Share of TB (b)	Allocation criteria (b/a)
Building	Space	2630 m^2	132 m^2	0.05
Microscope	No. of lab test	44756	1232	0.027
X-ray machine and film drier	No. of x-ray done	2175	105	0.048

Table 37: Capital cost of Trashigang District Hospital (high case) at 6% discount rate

Items	Cost/Value **(K)**	Useful life **(n)**	Annualization Factor **(a)**	Annual Capital cost **E=(K/a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(K/a)* (c)**
Building	21,316,053	30	13.7648	1,548,592	0.05	77,430
Microscope	33,987	10	7.3601	4,618	0.027	125
X-ray Machine	1,280,000	8	6.2098	206,126	0.048	9,894
X-ray film drier	29,980	8	6.2098	4,828	0.048	232
Computer	28,790	7	5.5824	5,157	0.2	1,031
Total	22,688,810			1,769,320		88,711

K=$E\frac{1-(1+r)^{-n}}{r}$

K= *E*[Annuity Factor at *n* periods and interest *r*]

2.2 Cost of laboratory supplies and consumable for the TB treatment:

Cost of laboratory supplies is calculated on the basis of quantity consumed during one fiscal year. For DOTS treatment of TB laboratory supplies and consumable are for microscopic test and x-ray. The cost of all this supplies and consumable are obtained from the Drugs, Vaccine and Equipment Division of MoH pertaining to one fiscal year. In addition TB reporting forms used in one fiscal year were also

calculated. Cost of form was obtained from National Tuberculosis Control Program. Table 38 present supplies and consumable cost for TB treatment at Trashigang District Hospital.

Table 38: Supplies and consumables cost for TB treatment –Trashigang District Hospital

Items	Cost	Unit cost **(c)**	Qty. Used **(q)**	Cost **(c*q)**
X-ray film (100 sheets)	6357	6	105	662
Developer (13.5 l)	503	37	7.2	268
Fixture (13.5 l)	472	35	7.2	252
Carbon Fusin solution (13.5 l)	425	31	8	252
Sulpheric Acid (500 ml)	185	2.7	1324	3578
Methalene Acid (500ml)	215	2.3	1324	3079
Slides (50 pcs)	42.5	1	105	89
Sputum container (500 pcs)	3514	7	70	492
Patient card	7	7	35	245
Quaterly Reporting Form	4	4	30	120
Patient Discharge Form	4	4	30	120
Monthly Reporting Form	4	4	35	140
Treatment Card	4.15	4	35	145
Patient Transfer and Acknowledgement Form	12	12	3	36
Total (Nu)				9,478
Cost Type		Material Cost		

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3. Treatment activities

This activity cost of treating patient under different case and treatment category as per treatment and Fixed Dosage Combination Drugs.

3.1 Drugs cost for TB treatment at District Hospital (High case)

Drugs cost was calculated for all type of case registered in Trashigang District Hospital as per standard treatment regimen for July 2012-June 2013. The district hospital has total of case registered and cases were linked to unit cost of drugs to find the drugs cost for treatment under different category: Drugs dosage depends on body weight of patient. For this study body of TB patient 38-54 kg dosage is used to calculate the cost. This calculation criterion is also being used by the program for quantification of TB drugs procurement and indenting by the health facility. Price of drugs was obtained from the National TB Control Program. Table 38 present the drugs costs incurred by district hospital in one fiscal year against the case registered. Drugs cost for each type of case is calculated in following way:

1. New Smear Positive the treatment duration is total of 6 month where 4-FDC drugs of 3 tablets is consumed for 2 month daily in the intensive phase and 2-FDC drugs of 3 tablets for another 4 month daily per patient i.e **2(4FDC)+4(2FDC).**
2. New Smear Negative total duration of treatment is 6 month where FDC drugs is dosage of 4-FDC is given for 2 month daily 3 tablets and 4 month daily for 2-FDC 3 tablets per patient i.e **2(4FDC)+4(2FDC)**
3. For-extrapulmonary is 2 month of 4-FDC daily 3 tablets and 10 month of 2-FDC daily 3 tablets per patient. The total duration of treatment is 12 month i.e **2(4FDC)+10(2FDC).**
4. For retreatment is 2 month 4-FDC daily 3 tablets along with 1 vial of Strepmoycin 750 mg (inj) dialy and 1 month of 4-FDC 3 tablets and 5

month of 3-FDC daily 3 tablets per patient i.e **2(4FDC+Strepmoycin inj)+1(4FDC)+5(3FDC).**

For example, in Trashigang District Hospital in one fiscal year hospital had New Smear Positive 12 and therefore, Drugs cost for 4-FDC where the unit cost of drug is Nu 3.4 . Total 4-FDC Drugs cost = 2 month X 12 cases X 3tablets X 30 days X 3.4 Nu which comes to Nu 7,344 as presented in Table below. In same way cost of drugs for each type is calculated as presented in Table 39.

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Table 39: Drugs cost for District Hospital

Items	**Category I**			**Category II**	**Total Cost**
	New Smear Positive (N=12)	New Smear Negative (N=5)	Extra Pulmonary (N=7)	Retreatment (N=11)	
*4-FDC	7,344	3,060.00	4,284	10,098	24,786
Calculation ***(Month*No. of Tablets*No. of days *case*Unit price)***	(2*12*3*30*3.4)	(2*5*3*30*3.4)	(2*7*3*30*3.4)	(3*11*3*30*3.4)	
*3-FDC	-	-	-	13,662	13,662
Calculation				(5*11*3*30*2.76)	
*2-FDC	6,912	2,880	10,080	-	19,872
Calculation	(4*12*3*30*1.6)	(4*5*3*30*1.6)	(10*7*3*30*1.6)		
Strepmoycin 750 mg (inj)				24,691	24,691
Calculation				(2*11*30*1*37.41)	
Total (Nu)	1,4256	5,940	14,364	48,451	83,011

*4-FDC (isoniazid 75 mg+rifampicin 150 mg+pyrazinamide 400 mg+ethambutol 275 mg)

*3-FDC (isoniazid 75 mg+rifampicin 150 mg+ethambutol 275 mg)

*2-FDC (isoniazid 75 mg+rifampicin 150 mg)

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5.2.3. Total Provider Cost for TB treatment at District Hospital (high case)

Table 40 present the summary of treatment cost at Trashigang District Hospital for one fiscal year.

Table 40: Total Provider Cost- Trashigang District Hospital

Cost Type	Nu	USD
Capital Cost (Table 37)	88,711	1,613
Labor Cost (Table 34)	332,320	6,042
Material Cost (Table 35+Table 38+Table 39)	118,489	2,154
Total Cost	539,521	9,809

Table 41: Direct and Overhead Cost for TB Treatment-District Hospital (High case)

Cost	Nu	USD
Direct Cost (Table 34+Table 37+Table 38+Table 39)	513,521	9,337
Overhead Cost (Table:35)	26,000	473
Total	539,521	9,809

5.2.4 Cost estimate for TB treatment - District Hospital (low case)

1. General and Administrative activities

This includes cost of human resources required including support staff for DOTS treatment and overhead cost on utilities such as telephone, electricity, water, sewerage and other operating cost.

1.1 Labor cost for TB treatment-District Hospital

Hospital staffs those who are involved for DOTS treatment services are taken into account into for study. Their basic monthly salary was obtained from the administration section. Annual salary with allowances for all staff was calculated and

based on the allocation factor calculated on the basis of time spend to perform TB related activities is allocated to TB treatment cost. Table 43 present the labor cost for TB treatment at Trongsa District Hospital in one fiscal year.

Table 42: Labor cost allocation criteria

Day	5 hours	In a weeks (5hr*6days)	30 hours
Approximate time of Dr. devote to see TB patient.	.30 hr day	Month (30 hr*4weeks)	120 hours
Allocation Criteria of Dr. time for TB in month	9/120		

Above table describe the cost allocation of hospital staff for the TB treatment. As we have taken the average working hour in hospital is 5 hours a day and therefore, total hour work in a weeked is (5 hr*6 day) 30 hrs. In a month total hour work 4 weeks* 30 hours a week and total hour worked in a month is 120 hour. From the interview it was found that Dr, was working around 8 hour and 40 minute for TB. Therefore, Dr. salary in a month was allocated based (9/120)on this working hour to TB related activities

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Table 43: Human Resource cost for TB Treatment-Trongsa Hospital-July 2012-June 2013

Staff	Number **(n)**	Monthly Basic Salary **(a)**	Annual Basic Salary **(a*12*n)**	Annual Allowances (leave Encashment) **(b)**	Total annual allowance **(b*n)**	Total annual salary and allowance **(a*12*n) +(b*n)**	Time spent on TB treatment (month) **(t)**	Annual salary attributable for TB treatment **(a*12*n) +(b*a)*t**
Doctor	2	19,830	475,920	19,830	39,660	515,580	(9/120)=0.08	41,246
TB In-charges	1	15,690	188,280	15,690	15,690	203,970	(48/120)=0.4	81,588
X-ray Technician	1	17,660	211,920	17,660	17,660	229,580	(11/120)=0.09	20,662
Lab Technincian	4	12,703	609,744	12,703	50,812	660,556	(11/120)=0.09	59,450
Store Assitant	1	9,405	112,860	9,405	9,405	122,265	(4/120)=0.03	3,668
Receptionist	1	8,540	102,480	8,540	8,540	111,020	(4/120)=0.03	3,331
Wet Sweeper	3	7,895	284,220	7,895	23,685	307,905	(12/120)=0.1	30,791
Dispatcher	1	7,325	87,900	7,325	7,325	95,225	(2/120)=0.02	1,905
Cook	2	6,155	147,720	6,155	12,310	160,030	(10/120)=0.08	12,802
Ward Boy	3	7,895	284,220	7,895	23,685	307,905	(9/120)=0.07	21,553
Laundry Women	1	8,025	96,300	8,025	8,025	104,325	(6/120)=0.05	5,216
Hospital Care Taker	2	5,000	120,000	5,000	10,000	130,000	(4/120)=0.03	3,900
Total	22	126,123	2,721,564	126,123	226,797	2,948,361	0.10	286,112
Cost Type		Labor Cost						

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1.2 Overhead cost for TB treatment-District Hospital (low case)

Same allocation method was used to allocate the overhead cost for TB treatment at Trongsa Hospital. Overhead cost was allocated on based on interview with the hospital administration. At this hospital it is approximated that the for TB treatment related activities that share for overhead cost was 4.2% and this allocation is used as gain the TB treatment related activities overhead cost.. Table 44 present the overhead cost for TB treatment at Trongsa District Hospital in one fiscal year

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Table 44: Overhead cost for TB treatment

Items	Annual cost (Nu.) **(a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(a)*(c)**
Telephone,Tele,Fax, E-mail, Internet	140,000	0.042	5,880
Telegram, Wireless, Postage	35,000	0.042	1,470
Electricity, Water, Sewerage	97,000	0.042	4,074
Patient Diet	292,000	0.042	12,264
Fuel Wood	304,000	0.042	12,768
Uniform, Extension, Kits, Linens	50,000	0.042	2,100
Maintenance of Building	100,000	0.042	4,200
Maintenance of Equipment	41,000	0.042	1,722
Office supplies, printing, publications	350,000	0.042	14,700
Transportation	45,000	0.042	1,890
Total (Nu)	1,454,000	0.042	61,068
Cost Type		Material Cost	

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2. Diagnostic activities

Under this activities consist of laboratory supplies and consumables used by the laboratory and x-ray unit in the process of detecting TB cases and capital equipment used for diagnostic purposes and building space occupied for treatment and diagnostic purposes

2.1 Capital cost for TB Treatment – District Hospital

Capital item was annualized using discount rate of 6% to get capital cost for year. X-ray and laboratory services operate integration with other services in hospital. TB cases are most diagnosed through the sputum smear microscopy. Building cost was obtain from previous study “costing of health care services in Bhutan 2009-2010”(MOH, 2011a) and was discounted to get one year cost. Based on the space occupied by d treatment unit, capital cost was allocated to TB treatment.

Building cost to TB was allocated based on the space occupied by TB treatment unit. X-ray machine and x-ray film drier cost is allocated where from total of x-ray filmed used for against total x-ray performed (90/826) in one year. Similarly for Microscope cost is also allocated based on TB sputum conducted to total number (269/9,880) of test performed. Cost for TB was allocated on this criterion for a one fiscal year. Table 46 present the capital cost for TB treatment at Trongsa District Hospital.

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Table 45: Allocation criteria for capital cost-Trongsa District Hospital

Item	Unit	Total (a)	Share of TB (b)	Allocation criteria (b/a)
Building	Space	1821 m^2	91 m^2	0.05
Microscope	No. of lab test	9880	269	0.02
X-ray machine and film drier	No. of x-ray done	826	90	0.10

Based on the above criteria share of capital cost for TB treatment is allocated in the given in Table 43.

Table 46: Capital cost of District Hospital (low case) at 6% discount rate

Items	Cost/Value **(K)**	Useful life **(n)**	Annualization Factor **(a)**	Annual Capital cost **E=(K/a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(K/a)* (c)**
Building	16,563,989	30	13.7648	1,203,358	0.05	60,168
Microscope	33,987	10	7.3601	4,618	0.02	92
X-ray Machine	1,280,000	8	6.2098	206,126	0.1	20,613
X-ray film drier	29,980	8	6.2098	4,828	0.1	483
Computer Desktop	28,790	7	5.5824	5,157	0.08	413
Total	17,936,746					81,768

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K=$E\frac{1-(1+r)^{-n}}{r}$

K= *E*[Annuity Factor at *n* periods and interest *r*]

2.2 Cost of laboratory supplies and consumables for the TB treatment

For DOTS treatment of TB laboratory supplies and consumable are for microscopic test and x-ray. Cost of laboratory supplies is calculated on the basis of quantity consumed during one fiscal year. Table 47 present supplies and consumable cost for TB treatment at Trongsa District Hospital.

Table 47: Laboratory supplies and consumable for the TB treatment Trongsa District Hospital

Items	Cost	Unit cost **(p)**	Qty. Used **(q)**	Cost **(p*q)**
X-ray film (100 sheets)	6,357	6.3	90	567
Developer (13.5 l)	503	37	7.2	268
Fixture (13.5 l)	4,72	35	7.2	252
Carbon Fusin solution (13.5 l)	425	31	6	189
Sulpheric Acid (500 ml)	185	2.7	1,200	3,243
Methalene Acid (500ml)	215	2.3	1,200	2,791
Slides (50 pcs)	42.5	0.85	30	26
Sputum container (500 pcs)	3,514	7.028	60	422
Patient card	7	7	30	210
Quarterly Reporting Form	4	4	24	96
Patient Discharge Form	4	4	30	120
Monthly Reporting Form	4	4	14	56
Treatment Card	4.15	4.15	30	125
Patient Transfer and Acknowledgement Form	12	0	4	0
Total				8,364
Cost Type			Material Cost	

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3. Treatment activities

This activity cost of treating patient under different type of case and treatment category as per treatment guideline for Fixed Dosage Combination Drugs.

3.1 Drugs cost for TB treatment at District Hospital (low case)

Drugs cost were calculated on the basis of TB patient who registered under different treatment category in July 2012-June 2012 for district hospital that annually report low case**.** A drugs expense varies from case to case and from one category to another category**.** Table 47 present the drugs costs incurred for different case under two categories.

. Drugs cost for each type of case is calculated in following way:

- New Smear Positive the treatment duration is total of 6 month where 4-FDC drugs of 3 tablets is consumed for 2 month daily in the intensive phase and 2-FDC drugs of 3 tablets for another 4 month daily per patient i.e **2(4FDC)+4(2FDC).**
- New Smear Negative total duration of treatment is 6 month where FDC drugs is dosage of 4-FDC is given for 2 month daily 3 tablets and 4 month daily for 2-FDC 3 tablets per patient i.**e 2(4FDC)+4(2FDC)**
- For-extrapulmonary is 2 month of 4-FDC daily 3 tablets and 10 month of 2-FDC daily 3 tablets. The total duration of treatment is 12 month per patient i.e **2(4FDC)+10(2FDC).**
- For retreatment is 2 month 4-FDC daily 3 tablets along with 1 vial of Strepmoycin 750 mg (inj) dialy and 1 month of 4-FDC 3 tablets and 5 month of 3-FDC daily 3 tablets per patient i.e **2(4FDC+Strepmoycin inj)+1(4FDC)+5(3FDC).**

On this basis cost of each drug is calculated along the total case in each type. For example, in Trongsa District Hospital had New Smear Positive 15 and therefore, Drugs

cost for 4-FDC where the unit cost of drug is 3.4 Nu. Total 4-FDC Drugs cost = 2 month X 15 cases X 3tablets X 30 days X 3.4 Nu which comes to Nu 9,180 as presented in Table below. In same way cost of drugs for each type is calculated as presented in Table 48.

Table 48: Drugs cost at District hospital (low case)

Items	**Category I**			**Category II**	**Total Cost**
	New Smear Positive (N=15)	New Smear Negative (N=8)	Extra Pulmonary (N=7)	Retreatment (N=0)	
*4-FDC	9,180	4,896	4284	0	18,360
*Calculation (Month*No. of Tablets*No. of days *case*Unit price)*	(2*15*3*30*3.4)	(2*8*3*30*3.4)	(2*7*3*30*3.4)		
*3-FDC	-	-	-	0	
*2-FDC	8,640	4,608	10080	0	23,328
Calculation	(4*15*3*30*1.6)	(4*8*3*30*1.6)	(10*7*3*30*1.6)		
Strepmoycin 750 mg(inj)	-	-	-	0	
Total (Nu)	17,820	9504	14364		41,688
Cost Type	Material Cost				

*4-FDC (isoniazid 75 mg+rifampicin 150 mg+pyrazinamide 400 mg+ethambutol 275 mg)

*3-FDC (isoniazid 75 mg+rifampicin 150 mg+ethambutol 275 mg

*2-FDC (isoniazid 75 mg+rifampicin 150 mg)

5.2.4 Total Provider cost at District Hospital (low case)

Table 49 present the total cost of providing a TB treatment in one fiscal year for the Trongsa District Hospital.

Table 49: Total Provider cost for TB treatment at District Hospital (low case)

Cost Type	Nu	USD
Capital Cost (Table 45)	81,768	1,487
Labor Cost (Table 43)	286,112	5,202
Material Cost (Table 44+Table 47+Table 48)	101,040	1,837
Total Cost	468,920	8,526

Table 50: Direct and Overhead Cost for TB Treatment-District Hospital (Low case)

Cost	Nu	USD
Direct Cost (Table 43+Table 46+Table 47+Table 48)	407,852	7,415
Overhead Cost (Table:44)	61,068	1,110
Total	468,920	8,526

5.3 Sensitivity Analysis

In Economic evaluation of cost effectiveness it is essential to perform sensitivity analysis to understand whether alteration of some key variables would affect the conclusion drawn from the baseline analysis. The basic purpose of carrying out sensitivity analysis is to indicate how much decision maker can rely or have assurance of using result in the process decision making process. WHO advocates standard discount rate used in the economic evaluations are 0%, 3% and 6% but it is caution discount rate differs between country's interest rate and annual inflation rate. In this context, discount rate of 3% was used to check uncertainty and sensitivity of results as previously in this study all capital cost was discounted at 6%. The analysis revealed that changes in key input variables did not change the cost-effectiveness ratio. Other way to conduct the sensitivity analysis is changing percentage of building space used for TB treatment. Even with this analysis only

doesn't give huge change in CER. From this analysis, tuberculosis treatment is not a capital intensive strategy. Following tables presents cost-effectiveness ratio of four hospitals with 3% and 6% discount rate of capital cost.

Table 51: Cost-effectiveness ratio of four hospitals with capital annualized at 3% for fiscal year 2012/2013

Hospital	Capital cost	Total cost	Cost-effectiveness ratio
National Referral Hospital	Nu 140,236 (USD 2,551)	Nu 3,048,693 (USD 55,431)	Nu 12,098 (USD 220)
Regional Referral Hospital	Nu 127,395 (USD 2,316)	Nu 1,332,678 (USD 24,231)	Nu 15,318 (USD 279)
District Hospital (High case)	Nu 64,367 (USD 1,170)	Nu 515,176 (USD 9,367)	Nu 21,466 (USD 390)
District Hospital (low case)	Nu 61,365 (USD 1,116)	Nu 449,674 (USD 8,176)	Nu 16,060 (USD 292)

Table 52: Cost-effectiveness ratio of four hospitals with capital annualized at 6% for fiscal year 2012/2013

Hospital	Capital cost	Total cost	Cost-effectiveness ratio
National Referral Hospital	Nu 192,450 (USD 3,499)	Nu 3,100,817 (USD 57,378)	Nu 12,305 (USD 224)
Regional Referral Hospital	Nu 164,454 (USD 2,990)	Nu 1,369,736 (USD 24,904)	Nu 15,744 (USD 286)
District Hospital (High case)	Nu 88,711 (USD 1,613)	Nu 539,521 (USD 9,809)	Nu 22,480 (USD 409)
District Hospital (low case)	Nu 81,768 (USD 1,487)	Nu 468,920 (USD 8,526)	Nu 16,788 (USD 305)

Table 53: Cost-effectiveness ratio of four hospitals with percentage of building space used for TB increase to 7%

Hospital	Capital cost	Total cost	Cost-effectiveness ratio
National Referral Hospital	Nu 258,107 USD 4,693	Nu 3,166,474 USD 57,572	Nu 12,565 USD 228
Regional Referral Hospital	Nu 204,144 USD 3,712	Nu 1,409,426 USD 25,626	Nu 16,200 USD 295
District Hospital (High case)	Nu 119,683 USD 2,176	Nu 570,493 USD 10,373	Nu 23,771 USD 432
District Hospital (low case)	Nu 105,835 USD 1,924	Nu 494,145 USD 8,984	Nu 17,648 USD 321

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CHAPTER VI

DISCUSSION AND CONCLUSION

6.1 Cost and cost-effectiveness ratio

The general objective of study is to estimate cost and cost-effectiveness in terms of treatment success at different levels of hospital (National, Regional and Districts). Cost and cost-effectiveness ratio varied with different level of hospitals. Total provider cost is largely depends upon the infrastructure, human resources, and number of patients etc. Table 54 presents the cost of treating TB as per DOTS across three levels hospital in Bhutan in one fiscal year. This implies that different levels of resources are needed to successfully treat the TB patient depending on the hospital

The main determinant of cost of treatment is not different irrespective of hospital level as functional and cost structure is similar in all hospitals. Findings from the study should be broadly generalizable since the cost of main item such as staff pay and drugs cost follow same standard in all hospital in Bhutan.

Figure 5: Comparison of cost per patient treated and cost-effectiveness ratio

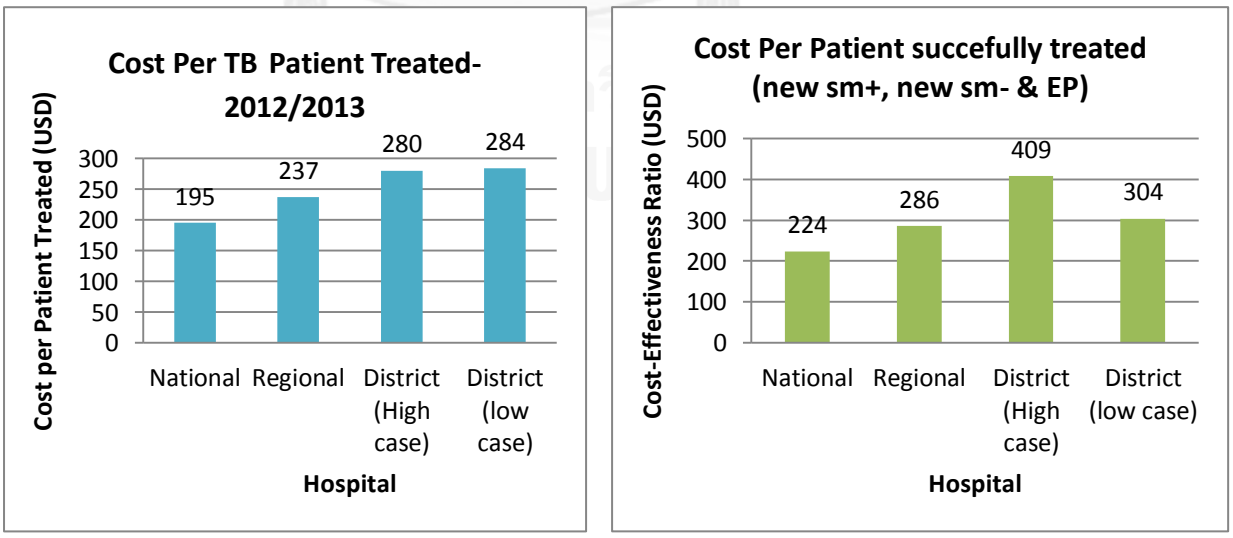

Table 54: Cost-effectiveness Ratio, Average Unit and Total cost for TB treatment at different levels of hospital in Bhutan from July 2012-June 2013

Types of Hospitals	No. of Bed	No. of TB cases **(a)**	COST		Effectiveness		Cost-Effectiveness Ratio (CER)* (b/CAT I)
			Total (b)	Unit (b/a)	No. of Treatment Success (CAT I)	%	
National Referral	350	289	Nu 3,100,817 (USD 56,378)	Nu 10,729 (USD 195)	252	93 (252/271)	Nu 12,305 (USD 224)
Regional Referral	100	105	Nu 1,369,736 (USD 24,904)	Nu 13,045 (USD 237)	87	92 (87/95)	Nu 15,744 (USD 286)
District Hospital (high case)	40	35	Nu 539,521 (USD 9,809)	Nu 15,415 (USD 280)	24	100 (24/24)	Nu 22,480 (USD 409)
District Hospital (low case)	20	30	Nu 468,920 (USD 8,526)	Nu 15,631 (USD 284)	28	93 (28/30)	Nu 16,747 (USD 304)

*CER is measured among treatment Category I (New Smear Positive or New Smear Negative or Extra Pulmonary)

*1 USD = 55 Nu (Average Exchange Rate 2012/13) -(RMA, 2014)

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The study reveals that the average cost per DOT ranges between Nu 10,729 (USD 195) to Nu 15, 631 (USD 284). Total provider cost ranges between Nu 3,100,817 (USD 56,378) to Nu 468,920 (USD 8,526). Average cost per DOT is found to be less at national and regional referral hospital as the number of TB patient visit is more than district hospital and so there is economic of scale in large hospitals. Therefore, cost of treatment per TB patient from the provider's perspective differ depending on the level of hospitals in Bhutan.

Cost-effectiveness ratio which measured among the treatment Category I (New Smear Positive Case or New Smear Negative or Extra Pulmonary) which is otherwise term as treatment success (patient who cure or completed treatment). Cost-effectiveness ratio was also found to be less at national referral hospital at Nu 12,305 (USD 224) and at the regional referral hospital cost-effectiveness ratio is Nu 15,744 (USD 286). Among two district hospital that report high TB case has cost-effectiveness ratio of Nu 22,480 (USD 409) and other district hospital is Nu 16, 747 (USD 304).

6.2 Cost

Cost represents resources used over time for specific purposes. Comparing the total provider cost, different cost driver/activities have contributed to the total provider cost of TB treatment as per DOTS at various levels of hospitals. . Investment is made in view of delivering a quality healthcare to all population and as a result heavy capital investment is borne by government. Human resources for DOTS treatment services, TB drugs, overhead and supplies cost contributes to more total provider cost. Obviously higher level of hospital has higher cost of providing DOTS treatment services comparing to the district hospital DOTS but in terms of unit cost and cost-effectiveness ratio, it is lesser at national and regional referral hospital.

The allocation criteria used for the shared cost to allocate to TB treatment as per DOTS might not be free from question and criticism. Allocation criteria for building are based on space occupied by TB treatment unit and number if test related to TB for equipment. The overhead cost was allocated on the basis TB cases registered with assumption more TB patient will have more overhead cost to TB treatment. It was found that the human resource cost is major cost that contributes to total provider cost at more than 60% at two district hospital and 57% at regional referral hospital and 40% at national referral hospital. This conveys that Ministry of Health accord priority if adequately staffing health workers for the provision of integrated

healthcare services. Material costs are second in the total cost including overhead utilities cost, drugs and supplies is second at above but it varies depending on the level of hospital.

6.3 Effectiveness

For the present study effectiveness is measured among treatment success (cured or completed treatment) among New Smear Positive, New Smear Negative and Extra Pulmonary cases (CAT I) over one fiscal year. For National referral total case registered under category I was 271 and from which 252 had cured or completed treatment and hence hospital treatment success among treatment category I is 93%. At Regional referral hospital had total of 95 case registered under treatment category I and from which 87 had cured or completed treatment and treatment success is 92%. The district hospital with high case had total of total of 24 case under treatment category I and of which all 24 had cured or completed treatment and treatment success is 100%. Other district hospital had total of 30 case registered in the treatment category I and from which 28 had cured or completed treatment and treatment success rate at this hospital is 93%.

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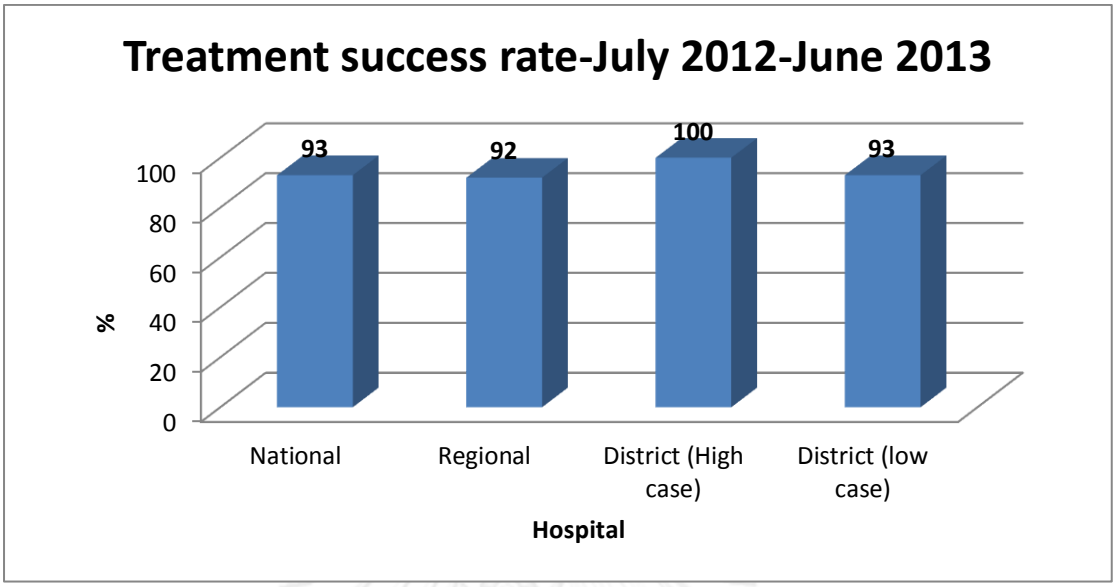
Figure 6: Treatment success rate among category I treatment four selected hospital



6.4 Cost-effectiveness ratio (CER)

Cost per treatment success among is treatment category is quite high at the district hospital with. District hospital which report 100% treatment success in July 2012 to June 2013 has highest cost-effectiveness ratio of Nu 22,480 (USD 409) and other district hospital CER of Nu 16,747 (USD 304). The main source of variation is that district with low case has total treatment success at category I of 28 and where as in other district has reported 24 case of treatment success in category I. Cost per treatment success at among category I at national level hospital is Nu 12,305 (USD 224) with total treatment success in category I is 252 cases and at the regional referral hospital CER is Nu 15,744 (USD 286) and total treatment success of category is 87 cases. Geographical location has also some linked to cost of TB treatment. National referral hospital located in the capital has higher total cost than the regional and two district hospitals. Among the two district hospitals, the hospital that is located in the east has higher cost than the central district hospital.

6.5 Conclusion

A huge cost is incurred on the government to treat a TB patient as per DOTS at different levels of hospitals in Bhutan. Adequate human resources, medical supplies and infrastructure are put in place to provide in the implementation of DOTS with other general healthcare services. TB treatment is one component of integrated healthcare services approach in Bhutan. By looking at TB treatment cost alone from four hospitals it is evident that government is incurring huge cost for the free health care. Generally public now not only desire good treatment but better care and also as health technology changes, future cost implication to government will escalate.

While present study reveals that compare to findings of the other countries health facility DOTS, cost per TB patient treatment success in Bhutan healthcare system from four hospitals is found to be in similar range. Average cost-effectiveness ratio ranges between USD 224 to USD 409 depending on the level of hospital treated. Treatment success among treatment category I is 93% and 92% respectively at national and regional referral hospital and among two district hospital it is 100% for district hospital that report high case and 93% for other district hospital. Given the low demographic profile with scattered population settlement and geographically challenging, among many constraints, these make the healthcare service delivery costly in Bhutan. Considering the kind of settings that the healthcare services has reach to population, it may be said that in Bhutan context, cost per treatment success of TB patient is cost-effective although variation in cost may observe depending on the level at which patient is seen. Since the inception of DOTS in 1994 and made into 100% coverage of DOTS in 1997, a steady progress is made towards control of TB. At national level the case detection and treatment success rate is above 80% and 85% respectively which is above global target of 70% and 85% as of 2010.

6.6 Recommendations

Evidences shows that community based or decentralized approach DOTS in most countries is more cost-effective than conventional hospital based approach in many countries. In Bhutan, DOTS is provided by health workers from the health facility. DOTS implementation in Bhutan has proved to very effective as case detection and treatment success has reached above 80% and 85% respectively as of 2010 in comparison to the global targets of 70% and 85%. However, as resource becomes scarce it is appropriate to explore the potential of extending DOTS services beyond the health facility. Community participation and decentralized DOTS in many countries has revealed that it is more cost effective than the conventional health facility based approach both from provider and community perspective. In Bhutan community DOTS was once implemented but remain very limited. Reviving community DOTS may have to be look into going by findings of other countries and acknowledging that the community based DOTS has the potential of increasing the number of TB patient treated without significant increase in resources. Such community empowerment in implementation of DOTS may not only cost-effective but will also create awareness of TB to communities. One potential of extending community DOTS in Bhutan is through the network of Village Health Workers (VHWs) who are volunteered community health worker that provide very basic health services to community. Important role could be played by VHWs in TB control activities, like in treatment supervision as they know where patient resides. Community DOTS may have to be considered in future. Therefore, National Tuberculosis Program may look at the possibility of implementing the community DOTS in collaboration with VHWs in near future as like other country and as such community DOTS in Bhutan can also be cost-effective in the long run.

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On other hand there is concern and discussion going on regarding the increasing case of MDR-TB patient that adds challenges to National TB Control Program. MDR-TB is more expensive to treat than the normal TB as it doesn't respond to the first line drugs and duration taken to treat is substantially long. This will escalate the cost in treatment beside public health threat. Understanding the public health challenges and resource implication it is appropriate to look into the underlying factor that attributes rise in MDR-TB. Socio-economic factors have important linkages in the health seeking behavior not only among TB patient but in general health seeking behavior. The study in Thailand(Kamolratanakul, 1999) found that the average out-of pocket expenditures among the TB patient amounted to more than 15% of annual household income. Social economic consequences is also seen partly for low case detection and treatment completion rate because patiently were not able to cope with diagnosis and treatment as a consequences of out-of pocket payment. There are evidences showing non-adherence to DOTS being influenced by the socio economic characters. In Nepal(Mishra, 2005) it was founds that the risk of non-adherence to TB treatment was significantly associated unemployment, low status of occupation, low income and cost to travel to the TB treatment facility. As such there is no study or information available regarding the socio economic and demographic pattern of TB in Bhutan. Comprehensive study on socio economic determinant of TB in Bhutan is also suggested as it would give extra input to the program and planners in designing program intervention and resource allocation in future for further strengthening DOTS strategy.

6.8 Limitations

This study has number of limitations. Cost-effectiveness analysis is usually undertaken to measure effectiveness between different approaches- public vs private provision or community and hospital base intervention. In Bhutan

government is key player in the health service provision and hence DOTS treatment is provided integration with other health services. There is no prominent private player or even community based DOTS services remain very limited. In this regard, study has to focus on the finding the unit cost of treating TB patient effectively at various level of hospitals.

Study was carried out for a period of one fiscal year covering only four hospitals in Bhutan from provider perspective. The findings of the study are not representative due to non-representative of sample size. Study also did not include the out-of-pocket expenditure incurred by patient in availing DOTS services at the health facilities. Further, expenses by the National Tuberculosis Control Program in building a capacity of health workers in provision of DOTS services and monitoring and supervision is not captured.

Since this study aimed at finding cost and cost-effectiveness ratio of TB treatment at different hospital level under DOTS strategy by combining cost data and treatment outcome data of smear positive, smear negative and extra-pulmonary. In real practice, treatment outcome are reported separately and some cost allocation factor of joint cost may have disproportionately under or over estimated cost of treating TB patient.

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This study was conducted from the provider perspective using purposive sampling. Therefore, study doesn't capture the cost incurred by community or by society in relation to availing TB treatment services at various hospitals.

Cost allocation of overhead and labor cost is done based on the interview and hence this allocation may not be accurate enough to estimate cost for TB treatment.

APPENDIX I

Capital cost of National Referral Hospital for TB treatment at 3% discount rate

Items	Cost/Value **(K)**	Useful life **(n)**	Annulization Factor **(a)**	Annual Capital cost **E=(K/a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(K/a)* (c)**
Building	45,187,75	30	19.6000	2,305,46	0.05	115,275
Microscope	33,987	10	8.5300	3,984	0.005	20
X-ray Machine	1,280,000	8	7.0200	182,336	0.034	6,199
Computer Desktop	28,790	7	6.2300	4,621	0.20	924
X-ray film drier	29,980	8	7.0200	4,271	0.034	145
Automatic x-ray film processor	485,000	8	7.0200	69,088	0.034	2,349
Digital x-ray machine	3,182,500	8	7.0200	453,348	0.034	15,414
Total (Nu)	50,227,92			3,023,15		140,326

Capital cost of Regional Referral Hospital for TB treatment at 3% discount rate

Items	Cost/Value **(K)**	Useful life **(n)**	Annualization Factor **(a)**	Annual Capital cost **E=(K/a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(K/a)* (c)**
Building	27,316,03	30	19.6000	1,393,66	0.05	69,684
Microscope	33,987	10	8.5300	3,984	0.016	64
X-ray Machine	1,280,000	8	7.0200	182,336	0.08	14,587
Computer Desktop	28,790	7	6.2300	4,621	0.2	924
X-ray film drier	29,980	8	7.0200	4,271	0.08	342
Automatic x-ray film processor	485,000	8	7.0200	69,088	0.08	5,527
Digital x-ray machine	3,182,500	8	7.0200	453,348	0.08	36,268
Total (Nu)	32,356,30			2,111,5		127,395

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Capital cost of District Hospital (high case) for TB treatment at 3% discount rate

Items	Cost/Value **(K)**	Useful life	Annualization Factor **(a)**	Annual Capital cost **E=(K/a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(K/a)* (c)**
Building	21,316,053	30	19.6000	1,087,554	0.05	54,378
Microscope	33,987	10	8.5300	3,984	0.027	108
X-ray Machine	1,280,000	8	7.0200	182,336	0.048	8,752
X-ray film drier	29,980	8	7.0200	4,271	0.048	205
Computer	28,790	7	6.2300	4,621	0.2	924
Total (Nu)	22,688,810			1,282,76		64,367

Capital cost of District Hospital (high case) for TB treatment at 3% discount rate

Items	Cost/Value **(K)**	Useful life **(n)**	Annualization Factor **(a)**	Annual Capital cost **E=(K/a)**	Allocation Proportion for TB **(c)**	Total cost for TB treatment **(K/a)* (c)**
Building	16,563,989	30	19.6000	845,101	0.05	42,255
Microscope	33,987	10	8.5300	3,984	0.02	80
X-ray Machine	1,280,000	8	7.0200	182,336	0.1	18,234
X-ray film drier	29,980	8	7.0200	4,271	0.1	427
Computer Desktop	28,790	7	6.2300	4,621	0.08	370
Total	17,936,746					61,365

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APPENDIX II

Overview of selected Hospital inn 2013

Hospital	Number of Beds	Number of Staff	OPD visit	Admission
Trongsa District Hospital	20	52	23342	705
Trashigang District Hospital	40	75	31197	1625
Mongar Regional Referral Hospital	100	296	71672	4343
JDWNRH	350	1100	427116	15133

Laboratory Test by Hospital 2012/2013

Hospital	Haemoglobin levels	Blood Grouping	Malaria Slide	TB Sputum	Urine	Stool	HIV	Others	Total
Trongsa District Hospital	1268	824	69	269	1228	134	349	5739	9880
Trashigang District Hospital	6196	4282	172	1232	11801	194	1090	19789	44756
Mongar Regional Referral Hospital	9,672	2,969	498	467	12409	1457	1764	16	29,220
JDWNRH	82793	84368	10127	6675	66568	3285	13472	989106	1256394

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X-ray Test by Hospital 2012/2013

Hospital	Chest	Extremities	Others	Total
Trongsa District Hospital	308	280	238	826
Trashigang District Hospital	1138	562	475	2175
Mongar Regional Referral Hospital	2086	816	930	3832
JDWNRH	11785	9283	4264	25332

Supplies and Consumable cost 212/2013

Item	Unit	Unit cost (Nu)
X-ray machine		1,280,000
X-ray film(14x17) -100 sheets	100 sheets	6,357
Developer (3.5 l)	3.5 l	503
Fixture (3.5 l)	3.5 l	472
Deskstop Computer		28,790
Microscope		33,987
Patient card		7
Quaterly Reporting Form		4
Patient Transfer and Acknowledgement Form		12
Patient Discharge Form		4
Monthly Reporting Form		4
Carbon Fusion (13.5L)	13. 5l	425
Sulpheric acid (500 ml)	500ml	185
Methalene acid (500 ml)	500ml	215
Slides (50 pcs)	50 pcs	42.5
Sputum container (500 pcs)	500 pcs	3,514
Refrigerator		17,115
Digital x-ray machine		3,182,500
Automatic x-ray film processor		485,000
x-ray film dyer		29,280

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Drug cost

Item	USD	Nu
2 FDC (Box of 672 tablets)	19.50	1073
1 tablet 2 FDC	0.03	1.6
4 FDC (Box of 672 tablets)	41.55	2285
1 tablet 4 FDC	0.06	3.40
1 tablet 4 FDC	0.06	3.4
3 FDC (Box of 672 tablets)	33.68	1852
1 tablet 3 FDC	0.05	2.8
Strepmoycin 750 mg(inj) 100 vial	68.0	3741
1 vial	0.68	37.4

Hospital Name: Trongsa District Hospital			July 2012-June 2013	
Human Resource for TB treatment				
Staff	Number	Monthly Basic Salary	Annual Allowances (leave Encashment)	Approximated Time spent for TB (in Month) hr
Doctor	2	19,830	19,830	9
TB In-charges	1	15,690	15,690	48
X-ray Technician	1	17,660	17,660	11
Lab Technincian	4	12,703	12,703	11
Store Assitant	1	9,405	9,405	4
Receptionist	1	8,540	8,540	4
Wet Sweeper	3	7,895	7,895	12
Dispatcher	1	7,325	7,325	2
Cook	2	6,155	6,155	10
Ward Boy	3	7,895	7,895	9
Laundry Women	1	8,025	8,025	6
Hospital Care Taker	2	5,000	5,000	4
Total	22	126,123	126,123	

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Overhead Expenditure-Trongsa District Hospital	
	July 2012-June 2013
Items	Annual cost (Nu.)
Telephone,Tele,Fax, E-mail, Internet	140,000
Telegram, Wireless, Postage	35,000
Electricity,Water, Sewerage	97,000
Patient Diet	292,000
Fuel Wood	304,000
Uniform, Extension, Kits, Linens	50,000
Maintenance of Building	100,000
Maintenance of Equipment	41,000
Office supplies, printing, publications	350,000
Transportation	45,000
Total	1,454,000

Capital item

Items	Cost/Value	Purchased Year
Building	16,563,989	2010
Microscope	33,987	2003
X-ray Machine	1,280,000	2004
X-ray film drier	29,980	1997
Computer Desktop	28,790	2004
Total	17,936,746	

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Hospital Name: Trashigang District Hospital		July 2012-June 2013		
Human Resource for TB treatment				
	Number	Monthly Basic Salary	Annual Allowances (leave Encashment)	Approximated Time spent for TB (in Month)
Doctor	3	20,377	20,377	10
TB In-charges	1	14,630	14,530	78
X-ray Technician	3	12,310	12,310	11
Lab Technician	3	11,362	11,362	9
Store Assistant	1	9,405	9,405	4
Receptionist	1	7,325	7,325	3
Wet Sweeper	4	8,415	8,415	5
Dispatcher	1	7,325	7,325	2
Cook	2	7,405	7,405	4
Ward Boy	4	8,025	8,025	6
Laundry Women	2	8,415	8,415	6
Hospital Care Taker	2	5,000	5,000	4
Total (BTN)	27	119,994	119,894	

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Overhead cost expenditure-Trashigang District Hospital	
Telephone,Tele,Fax, E-mail, Internet	180000
Telegram, Wireless, Postage	50000
Electricity, Water, Sewerage	200000
Patient Diet	500000
Fuel Wood	80000
Uniform, Extension, Kits, Linens	40000
Maintenance of Building	100000
Maintenance of Equipment	30000
Office supplies, printing, publications	90000
Transportation	30000
Total	1300000
Items	Qty. Used
X-ray film (100 sheets)	105
Developer (13.5 l)	7.2
Fixture (13.5 l)	7.2
Carbon Fusin solution (13.5 l)	8
Sulpheric Acid (500 ml)	1324
Methalene Acid (500ml)	1324
Slides (50 pcs)	105
Sputum container (500 pcs)	70
Patient card	35
Quaterly Reporting Form	30
Patient Discharge Form	30
Monthly Reporting Form	35
Treatment Card	35
Patient Transfer and Acknowlegdement Form	3
Total	

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Items	Qty. Used
X-ray film (100 sheets)	105
Developer (13.5 l)	7.2
Fixture (13.5 l)	7.2
Carbon Fusin solution (13.5 l)	8
Sulpheric Acid (500 ml)	1324
Methalene Acid (500ml)	1324
Slides (50 pcs)	105
Sputum container (500 pcs)	70
Patient card	35
Quarterly Reporting Form	30
Patient Discharge Form	30
Monthly Reporting Form	35
Treatment Card	35
Patient Transfer and Acknowledgement Form	3
Total	

Items	Cost/Value	Purchased Year
Building	21316053	2010
Microscope	33987	2004
X-ray Machine	1280000	1997
X-ray film drier	29980	2014
Computer	28790	2006
Total	22688810	

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Hospital Name:Mongar Regional Referral Hospital			July 2012-June 2013	
Human Resource for TB treatment				
Staff	Number	Monthly Basic Salary	Annual Allowances (leave Encashment)	Approximated Time spent for TB (in Month)
Doctor (Meidcal Specialist, GDMO)	7	26175	26175	8.4
Pathologist	1	32520	32520	12
Radiologist	1	19830	19830	10.3
Laboratory Officer	1	17660	17660	7.2
Lab Technician	4	13835	13835	18
TB-Incharges	1	14630	14630	102
Receptionist	5	8540	8540	2.4
X-ray technician	5	12775	12775	18
Cook	4	8025	8025	4
Laundry Women	3	6280	6280	18
Ward Girl/Boy	2	8415	8415	14
Night Guard	2	5000	5000	2.3
Wet Sweeper	2	8025	8025	2.3
Security Guard	5	5000	5000	2.3
Grand Total Basic Salary	43	186710	186710	

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Overhead cost-Regional Referral Hospital	
Items	Annual cost
Telephone,Tele,Fax, E-mail, Internet	750,000
Telegram, Wireless, Postage	37,000
Electricity,Water, Sewerage	1,380,000
Patient Diet	2,009,000
Fuel Wood	1,500,000
Uniform, Extension,Kits, Linens	97,100
Maintenance of Buliding	536,000
Maintenance of Equipment	2,800,000
Office supplies, printing, publications	757,000
Transportation	105,000
Total	9,971,100

Items	Qty. Used
X-ray film (100 sheets)	315
Developer (13.5 l)	22
Fixture (13.5 l)	22
Carbon Fusin solution (13.5 l)	12
Sulpheric Acid (500 ml)	3,226
Methalene Acid (500ml)	3,226
Slides (50 pcs)	315
Sputum container (500 pcs)	210
Patient card	105
Quarterly Reporting Form	48
Patient Discharge Form	105
Monthly Reporting Form	105
Treatment Card	105
Patient Transfer and Acknowledgement Form	4

Items	Cost/Value	Purchased Year
Building	27,316,053	2,010
Microscope	33,987	2,003
X-ray Machine	1,280,000	2,004
Computer Desktop	28,790	2,005
X-ray film drier	29,980	2,000
Automatic x-ray film processor	485,000	2,010
Digital x-ray machine	3,182,500	2,010
Total	32,356,310	

Hospital Name: JDWNRH			July 2012-June 2013	
Human Resource for TB treatment				
Staff	Number	Monthly Basic Salary	Annual Allowances (leave Encashment)	Approximated Time spent for TB (in Month)
Doctor (Meidcal Specialist, GDMO)	9	26175	26175	8.4
Pathologist	2	27520	27520	6
Radiologist	1	32520	32520	11
Radiographer	2	15690	15690	5
X-ray technician	10	13432	13432	10.3
Microbiologist	1	22620	22620	7.2
Lab Technologist	4	17660	17660	5.4
Lab technician	8	14000	14000	7.2
TB-Incharges	2	14430	14430	115
Receptionist	8	7325	7325	3.3
Cook	6	5000	5000	3
Ward Girl/Boy	10	7895	7895	3
Wet Sweeper	6	8025	8025	3
Grand Total Basic Salary	69	212292	212292	

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Overhead cost for National Referral Hospital	
Items	Annual cost (Nu.)
Telephone,Tele,Fax, E-mail, Internet	3100000
Telegram, Wireless, Postage	220000
Electricity,Water, Sewerage	16910000
Patient Diet	5110000
Fuel Wood	500000
Uniform, Extension,Kits, Linens	4000000
Maintenance of Building	2200000
Maintenance of Equipment	23290000
Office supplies, printing, publications	1563000
Transportation	300000
Infection control, Global Event Celebration	4380000
Laundry Outsource Services	2340000
Total	63913000

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Items	Qty. Used
X-ray film (100 sheets)	867
Developer (13.5 l)	41
Fixture (13.5 l)	41
Carbon Fusin solution (500ml)	24
Sulpheric Acid (500 ml)	4221
Methalene Acid (500ml)	4221
Slides (50 pcs)	867
Sputum container (500 pcs)	578
Patient card	289
Quaterly Reporting Form	72
Patient Discharge Form	289
Monthly Reporting Form	289
Treatment Card	289
Patient Transfer and Acknowledgement Form	24
Total	

Items	Cost/Value	Purchased Year
Building	45,187,725	2,010
Microscope	33,987	2,006
X-ray Machine	1,280,000	2,004
Computer Desktop	28,790	2,002
X-ray film drier	29,980	2,005
Automatic x-ray film processor	485,000	2,009
Digital x-ray machine	3,182,500	2,009
Total (Nu)	50,227,982	

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APPENDIX III

Treatment Outcome and Cost Information Collection Sheet

TB cases and treatment Outcome: July2012-June 2013

Name of Hospital:

Type/Result	Case registered	Cured	Completed	Failure	Died	Default	Not Known	Remarks
New Smear Positive								
New Smear Negative								
Extra Pulmonary								
Re-treatment								
Total								

1. **Cured:** Sputum smear (+) patient who is sputum (-) in the last month of treatment and on at least one previous occasion
2. **Treatment completed:** Patient who has completed treatment but who does not meet the criteria to be classified as a cure or a failure
3. **Treatment failure:** Patient who sputum smear (+) at 5 months or later during treatment (also a patient who was initially smear (-) and become smear(+) at 2 month
4. **Died:** Patient who dies from any cause during the course of treatment
5. **Default:** Patient whose treatment was interrupted for 2 consecutive months or more
6. **Not Known:** Patient who is lost to follow up or transfer out case whose outcome feedback is not known

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Treatment Category

CAT I: New Smear Positive Case or New Smear Negative or Extra Pulmonary

CAT II: Re-treatment cases (Relapse, Failure and Default)

Cost Information Collection Sheet (July 2012-June 2013)

Name of Hospital

1. **Staff required for TB treatment**

Staff	Number	Monthly Basic Salary	Allowances	Other fringe benefit
Doctor				
Nurses				
X-ray Technician				
Lab Technician				
Administration				

2. **Capital Cost**

Items	Unit	Number	Cost/Value	Purchased Year	Remark
Building					
Vehicle					
Microscope					
X-ray Machine					

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3. Material Cost

Items	Unit	Number	Cost	Remark
Lab reagent				
X-ray				
Pharmacy				

4. Drug Cost

Items	Unit	Number	Cost	Remark
4-FDC: isoniazid 75mg +rifampicin 150 mg+pyrazinamide 400 mg+ethambutol 275 mg				
2-FDC; isoniazid 75 mg+ rifampicin 150 mg				
3-FDC:isoniazid 75 mg+ rifampicin 150 mg+ ethambutol 275 mg				
Streptomycin injection				

5. Overhead cost

Items	Unit	Unit Cost	Amount (Annual Cost)	Remark
Telephone				
Water				
Electricity				
Patient diet				
Uniform and linen				

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APPENDIX IV

หลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาเศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ
Master of Science Programme in Health Economics and Health Care Management

No. 0037 February 5, 2014

TO WHOM IT MAY CONCERN

This is to inform that **Mr. Sonam Phuntsho** is a student in the Master of Science in Health Economics and Health Care Management at the Faculty of Economics, Chulalongkorn University, Bangkok, Thailand. Upon the passing of thesis proposal examination, he has scheduled to collect secondary data on cost and TB treatment outcome for one year fiscal year (June 2012-July 2013) from the selected hospitals in Bhutan.

Thesis is a compulsory requirement for fulfillment of the above master degree. Student must submit thesis within given time frame. Further, any associated cost and expenditures as a result of thesis work have to bear by the individual student.

In this regard, **Mr. Sonam** wii be visiting selected hospitals from February 14th for his data collection. His thesis title is "COST-EFFECTIVENESS ANALYSIS OF TUBERCULOSIS TREATMENT UNDER THE DOTS STRATEGY AT DIFFERENT LEVELS OF HOSPITALS IN BHUTAN".

We will appreciate your kind consideration to process his necessary services and convenience.

For further information, please contact our Health Economics and Health Care Management Programme Office at mschecon@chula.ac.th.

Siripen Supakankunti, Ph.D.
Associate Professor of Economics
and Programme Director

คณะเศรษฐศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ถนนพญาไท เขตปทุมวัน กรุงเทพฯ 10330 โทร. 0-2218-6298 โทรสาร 0-2218-6212
Faculty of Economics, Chulalongkorn University, Phya Thai Road, Bangkok 10330 Tel. 0-2218-6298 Fax. 0-2218-6212
E-mail: mschecon@chula.ac.th

14th February 2014

The Chief HR Officer
Human Resource Division
Ministry of Health
Sub: Thesis Data Collection

Dear Madam,

As partial fulfillment of Master Degree of Science Program in Health Economics and Health Care Management from Chulalongkorn University, Bangkok, Thailand, students are compulsory required to undertake thesis. Students have to collect/generate data in order to complete work on time and graduate as scheduled.

In this regard, I will carry out a thesis title "Cost-Effectiveness Analysis of TB treatment under the DOTS strategy at different levels of hospitals in Bhutan".

In order to collect secondary data on cost and TB treatment outcome for one year fiscal year (June 2012-July 2013), I will be visiting following selected hospitals tentatively from 14th February 2014.

1. JDWNRH
2. Mongar Regional Referral Hospital
3. Trashigang District Hospital
4. Trongsa District Hospital

Since this is for academic needs and have to complete in given deadline, I would like to seek approval for the following:

- Visiting selected hospitals and collecting related data through interaction with relevant officials.
- Meeting TA/DA during data collection, stationeries and printing work expenses/actual reimbursement of expenses.

Relevant documents attached for kind reference.

Thanking you

Yours faithfully,

SonamPhuntsho
Msc. Student (PPD)

Submitted to Hon'ble DG, DMS for kind approval to carry out this Thesis Data Collection as part of the Programme (Degree).

14/02/2014

Visite to health facilities and collection of information as proposed is allowed.

Director General
Department of Medical Services
Ministry of Health
Thimphu : Bhutan

དཔལ་ལྡན་འབྲུག་གཞུང་།
གསོ་བ་རིག་པའི།

ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF HEALTH
THIMPHU BHUTAN
P.O BOX: 726

Ref.No. 715/DMS/DHS/51/2013-2018/4990 14th February 2014

.....

JDWNRH/Mongar RH/Trongsa and Trashigang Hospital

Sir,

Mr. Sonam Phuntsho of PPD, Ministry of Health, currently pursuing M.Sc. Program in Health Economics and Health Care Management at the Chulalongkorn University, Thailand, will be carrying out thesis title "Cost-Effectiveness Analysis of TB treatment under the DOTS strategy at different levels of hospitals in Bhutan" for partial fulfillment of the degree.

In this regards, he will visit your hospital tentatively from 14thFebruary 2014 to collect data on TB treatment outcome and cost for the fiscal year 2012-2013 (July 2012-June 2013).

We would like to request sir and relevant official to render your kind support and cooperation in providing the required data.

Thanking you.

Yours sincerely,

Jamtsho
(Offtg. Director General, DMS)

Cc:

1. District Health Officer-Mongar, Trasihigang and Trongsa

PABX: + 975-2-322602, 322351, 328091, 328092, 328093 Minister: 323973 Fax: 323113 Secretary 326627
Fax: 324649 HRD: Tel/Fax- 323953 Extension 333

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HIV/AIDS and STI Control and Prevention Project.

2011 till date-Planning Officer, Ministry of Health,

Royal Government of Bhutan.

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