COST EFFECTIVENESS ANALYSIS OF DIRECTLY OBSERVED THERAPY, SHORT COURSE MANAGEMENT, FOR PULMONARY TUBERCULOSIS IN MONGOLIA

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การวิเคราะห์ต้นทุนประสิทธิผลของการรักษาแบบสังเกตการณ์โดยตรงระยะสั้นสำหรับผู้ป่วยวัณโรคปอดในประเทศมองโกเลีย

นายเจอรัลท็อด ลุฟซานโนรอฟ

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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Field of Study	Health Economics and Health Care Management
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นายเจอรัลท็อด ลุฟซานโนรอฟ: การวิเคราะห์ต้นทุนประสิทธิผลของการรักษาแบบสังเกตการณ์โดยตรงระยะสั้นสำหรับผู้ป่วยวัณโรคปอดในประเทศมองโกเลีย. (COST EFFECTIVENESS ANALYSIS OF DIRECTLY OBSERVED THERAPY, SHORT COURSE MANAGEMENT, FOR PULMONARY TUBERCULOSIS IN MONGOLIA) อ. ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. ดร. พงศา พรชัยวิเศษกุล, 92 หน้า

วัตถุประสงค์: เพื่อประเมินและเปรียบเทียบต้นทุนและผลการรักษาของรูปแบบการให้ยาระยะสั้นภายใต้การสังเกตโดยตรง (directly observed treatment, short course ; DOTS) ในประเทศมองโกเลียปี 2010 กลุ่มผู้ป่วยรายใหม่ที่ผลป้ายเชื้อพบเชื้อวัณโรคปอดถูกคัดเข้าโครงการ

วิธีการวิจัย: เปรียบเทียบโครงการการให้ยาภายใต้การสังเกตโดยตรง (directly observed treatment, short course; DOTS) 2 โคงการ คือ โครงการควบคุมโรควัณโรคปอดที่บริหารโดยรัฐบาล (ศูนย์วัณโรค) ถูกเปรียบเทียบกับโครงการให้ยาโดยใช้อาสาสมัครที่บริหารโดยหน่วยงานต่อต้านวัณโรคปอดแห่งมองโกเลีย (Mongolian Anti-Tuberculosis Association; MATA) การวิเคราะห์อัตราส่วนต้นทุนประสิทธิผล (Cost effectiveness analysis) ถูกดำเนินการโดยใช้โปรแกรมไมโครซอร์ฟเอ็กซ์เซล แบบจำลองการตัดสินใจ (Decision tree model) ถูกใช้ต่อผู้ป่วยที่รักษาสำเร็จ ต้นทุน (ดอลล่าสหรัฐฯ ณ ปี 2010) ถูกคำนวณจากระยะเวลารักษาและผลการรักษา ผลของการรักษานั้นประเมินได้จากจำนวนผู้ป่วยวัณโรคปอดที่มีผลตรวจเชื้อเป็นบวกที่รักษาหายในช่วงระยะเวลา 1 ปี และผู้ป่วยที่รักษาหายตามเกณฑ์การประเมินประสิทธิผลของวิธีการรักษาของมองโกเลีย

ผลการวิจัย: อัตราส่วนต้นทุนประสิทธิผล (Cost effectiveness ratio; CER) แสดงการเปรียบเทียบผลของการให้ยาวิธี DOTS ระหว่างโครงการของหน่วยต้านวัณโรค MATA ต่อโครงการของศูนย์วัณโรค (Dispensary program) ผลการวิเคราะห์พบว่าผลจากการให้ยานั้นมีความแตกต่างอย่างชัดเจนกล่าวคือ การให้ยาโดยอาสาสมัครในโครงการของ MATA นั้นมีให้ผลสำเร็จในการรักษามากกว่าการให้ยาในโครงการของศูนย์วัณโรค ต้นทุนประสิทธผลของโครงการของศูนย์วัณโรคคือ 954.90 ดอลล่าสหรัฐฯ และ 809.48 ดอลล่าสหรัฐฯสำหรับโครงการของ MATA ต้นทุนของโครงการ MATA ต่ำกว่าเนื่องจากเกิดความล้มเหลวในการรักษาน้อยกว่าและมีจำนวนผู้ป่วยรับยาไม่ครบน้อยกว่าจากการวิเคราะห์ความไว (sensitivity analysis) โดยการลดอัตราการรับยาไม่ครบในโครงการของศูนย์วัณโรคให้เท่ากับค่าพื้นฐานจากโครงการของ MATA ค่าอัตราส่วนต้นทุนประสิทธิผลของโครงการจากศูนย์วัณโรคมีผลที่ดีขึ้นแต่ยังไม่เทียบเท่ากับผลจากโครงการของ MATA ค่ารักษาผู้ป่วยในชนบทนั้นเป็นปัจจัยสำคัญที่เพิ่มต้นทุนของการให้ยาภายใต้การสังเกตโดยตรง (directly observed treatment; DOTS) อย่างไรก็ตาม ถึงแม้จะลดต้นทุนของผู้ป่วยใน โครงการของ MATA ไวต่อการเปลี่ยนแปลงและแสดงให้เห็นว่ายังคงเป็นโครงการที่มีประสิทธิภาพที่ดีกว่า

ผลสรุป:เนื่องจากอัตราความล้มเหลวของการรักษาและจำนวนผู้ป่วยรับยาไม่ครบที่สูงและค่าเดินทางที่สูงของผู้รับผลประโยชน์ที่จากโครงการของศูนย์วัณโรค ทำให้โครงการของ MATA เป็นโครงการที่มีต้นทุนประสิทธิผลที่ดีกว่า จึงสรุปได้ว่าการให้ยาภายใต้การสังเกตโดยตรง (DOTS) ที่ดำเนินการโดยอาสาสมัครของ MATA เป็นรูปแบบการให้ยาที่ประหยัดต้นทุนในมองโกเลีย

สาขาวิชา เศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ ลายมือชื่อนิสิต .....

ปีการศึกษา 2554 ลายมือชื่อ อ. ที่ปรึกษาวิทยานิพนธ์หลัก .....

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KEYWORDS: TUBERCULOSIS/DOTS/COST EFFECTIVENSS/ SPUTUM SMEAR POSITIVE PULMONARY TUBERCULOSIS/MONGOLIA

GERELT-OD LUVSANNOROV: COST EFFECTIVENESS ANALYSIS OF DIRECTLY OBSERVED THERAPY, SHORT COURSE MANAGEMENT, FOR PULMONARY TUBERCULOSIS IN MONGOLIA. ADVISOR: ASSOC. PROF PONGSA PORNCHAIWISESKUL, Ph.D., 92 pp.

Objectives: To evaluate and compare the cost and treatment outcomes associated with different directly observed treatment, short course (DOTS) strategies in Mongolia as of 2010. New cases of smear – positive pulmonary tuberculosis cohorts were enrolled.

Methods: Tuberculosis (TB) control strategy, supervised by government financed tuberculosis dispensary (TB center), was compared with volunteer - based DOTS program from Mongolian Anti-Tuberculosis Association (MATA). Cost effectiveness analysis was undertaken by using conventional method of computation by Microsoft Excel. Decision tree model was used per successfully treated case. Costs (US dollars as of 2010) were calculated on the basis of treatment periods and treatment outcomes. Treatment outcomes were estimated for the period of one year of sputum smear- positive pulmonary tuberculosis patients with cured and successfully treated cases on the basis of Mongolian evidence for the efficacy of the chosen strategies.

Results: Cost effectiveness ratio (CER) presents the preference for DOTS with MATA volunteers over the Dispensary program. The uncertainty ranges surrounding health effects were significantly different, with ample probability that DOTS program with MATA volunteers could lead to more curable outcomes than dispensaries. Cost effectiveness per successful treatment was US$ 954.90 for Dispensary program, while it was US$ 809.48 for MATA program. Cost savings from less failed and defaulted treatment were revealed in relation to DOTS with MATA volunteers. After running the sensitivity analysis by decreasing default rate for dispensary program to the equal rate of DOTS with MATA volunteers, CER of Dispensary DOTS was improved but has not reached to MATA program. High cost of inpatient clinic in rural areas is one of the determining factors for the high cost of DOTS program. However, decreasing cost of inpatient clinic by downsizing inpatient stay, MATA program has shown to be more sensitive and to be even more cost effective intervention.

Conclusions: Due to high rates of failed and defaulted cases, and high travel cost among beneficiaries from dispensary DOTS, volunteer based MATA program demonstrates more cost effective approach. It is decisive that DOTS with MATA volunteers is a cost - saving intervention in Mongolia.

Field of Study: Health Economics and Health Care Management Student's Signature .....

Academic Year: 2011 Advisor's Signature .....

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CONTENTS

Page

LIST OF TABLES

TABLE Page

TABLE Page

Table Page

LIST OF FIGURES

ABBREVIATIONS

AFGPM	Association of Family Group Physicians of Mongolia
CER	Cost Effectiveness Ratio
DOTS	Directly Observed Therapy, Short Course
DSRT	Division of Surveillance and Research for Tuberculosis
DST	Drug Sensitivity Test
ICER	Incremental Cost Effectiveness Ratio
MATA	Mongolian Anti-Tuberculosis Association
MDR	Multi Drug Resistance
MOH	Ministry of Health
MNT	Mongolian National Currency, Tugriks
NCCD	National Center for Communicable Disease
RH	Rifampicin and Isoniazid
RHZ	Rifampicin, Isoniazid, and Pyrazinamide
RHZE	Rifampicin, Isoniazid, Pyrazinamide, and Ethambutol
TB	Tuberculosis

CHAPTER I
INTRODUCTION

1.1 General background

Tuberculosis has long been recognized one of challenging health issues in Mongolia as well as many other countries. Mongolia is considered one of seven countries with high tuberculosis (TB) incidence in the Western Pacific Region (Sodnompil, 2009). This high incidence of TB could be largely attributed to socio-cultural and behavioral factors such as unemployment, poverty, housing, education, nutrition and increasing migration (Atre, 2005).

As from the latest data from Ministry of Health, total population of Mongolia reached to 2.8 million in 2011 and is distributed to a vast area of land, which makes the least densely populated independent nation in the world with a population density of 1.7 per square kilometer (Erdenechimeg. E, 2010). Poverty level is 46.6 percent in rural areas while it is 26.9 percent in urban areas (Chimeddagva, 2008).

Due to a harsh climate, especially in winter season people struggle to live with a cold temperature during long period of time every year. This uniqueness of the sparsest density and high poverty level, together with harsh climate make the country even more challenging to reverse the spread of tuberculosis and even more puzzling to eliminate barriers of access to treatment. More patients burden from travel cost and lost time in order to seek health care.

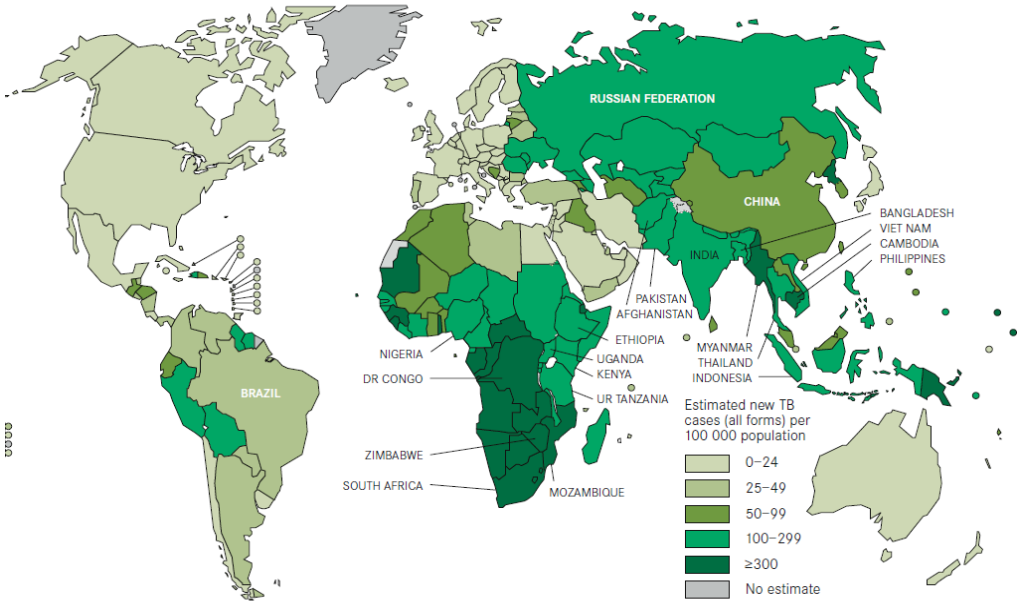
Disparities exist between rural and urban health settings. Population density and air pollution in the city is much higher than rural areas and communicable disease tends to spread rapidly among densely populated and poor neighborhood areas. Higher incidence of infectious disease, in particular, tuberculosis incidence is often correlated with socio – economic status of individuals.

1.2 Rationale

1.2.1 Burden of Tuberculosis in Mongolia

According the latest worldwide report from World Health Organization (WHO), Mongolia endures one of the high TB burden countries globally (see Figure 1.1).

Figure 1.1 Estimated TB incidence rate worldwide, 2010



Source: Global Tuberculosis Control, WHO report, 2011

As of the year 2009, totally 4218 new cases of tuberculosis were reported and comprised 10.9 percent of all infectious diseases. Of these new TB cases, 2390 cases were notified in the capital city of Ulaanbaatar and accounted for 56.7 percent. Among those, who have tuberculosis, 1809 were the smear positive pulmonary tuberculosis, which is the most infectious form of tuberculosis, and were reduced by 29 cases compared with previous year. (MOH, 2009)

In spite of dramatic improvement on prevalence of tuberculosis observed during 2005 – 2009 from 185 to 156 per 100 000 population and decreasing trend of mortality of tuberculosis during 1990 – 2009 from 4.8 – 2.8 per 100 000 population, incidence is on

the rise. (Sodnompil, 2009) Seasonal aspect has been reported in Mongolia. Particularly, due to the ambient temperature in winter time and large containment indoors activity, tuberculosis incidence almost doubles in April each year. It is directly and indirectly related to many other proximal and distal factors such as migration to urban cities, immunity deterioration, low nutrition and living together in poor dwellings (Naranbat, N., Nymadawa, P., Schopfer, K., and Rieder, H. L., 2009).

Besides that multidrug resistant tuberculosis (MDR) is another major health obstacle, arising in the country. Provided by national survey of anti- tuberculosis drug resistance, held in Mongolia, doctors concluded that MDR prevalence is common among previously treated patients. They highlighted that 27, 5% is present in the population, who had prior anti – tuberculosis treatment, whereas it is 1.4% among newly treated patients (Buyankhishig, B., Naranbat, N., Mitarai,S., & Rieder, H. L., 2011).

1.2.2 Current diagnosis of tuberculosis in Mongolia

National Center for Communicable Disease (NCCD) is the only specialized hospital for TB in Mongolia. Based on referral system, NCCD serves all patients with tuberculosis and conduct diagnostic procedures. Several methods of tuberculosis diagnosis are available widely in the country, such as assessing clinical symptoms, chest X-ray, Monteux skin test and positive acid – fast smears of clinical specimens (Ebright. J. R, 2003). Smear test sensitivity was 97% when 1717 suspects underwent smear examination, and increased up to 99% by additional smear slides. Thus, sputum microscopy is considered as a cornerstone for making tuberculosis diagnosis (Mabaera, N., Naranbat, N., Dhliwayo, P., & Rieder, H. L., 2006).

1.2.3 Treatment for pulmonary tuberculosis in Mongolia

Directly observed therapy, short- course (DOTS) is a treatment management program in Mongolia and has been introduced since 1997. Patients are treated with anti-tuberculosis drugs including Isoniazid, Rifampicin, Pyrazinamide, and Ethambutol (or Streptomycin). When patients were diagnosed sputum positive pulmonary tuberculosis, a combination of

these four drugs is used as initial 2 months therapy for every patient in the NCCD. On becoming sputum smear negative pulmonary tuberculosis after initial course, continuous 4 months treatment is conducted with combination of isoniazid and rifampicin.

Administration of continuous treatment has to be completed by direct observation (DOT). In mid of 1990, only 29% of patients received a four-drug therapy course (Ebright, 2003). Direct observation is not easy, as it typically requires weak patients to expend time, energy, and money to attend health centers over long periods. When travel or difficult terrain present obstacles, direct observation of all doses and 100% compliance is unlikely, even among patients not classified as defaulting.

Today most of medical reports and articles in Mongolia show that there has been a drastic improvement, resulted in last few years after implementation of DOTS program. As of 2003 data from the pediatric unit points out that 93% of children turned out to be smear-negative pulmonary TB after initial phase of DOTS. Both the central tuberculosis hospital and regional clinics cooperate to supervise the adherence and completion of therapy after discharge from the TB center hospital. Anti – TB medicines are regulated and distributed via the TB center hospital and local clinics and not allowed on the counter in other pharmacies. Until 2011, second-line anti-TB medicines were not available in Mongolia except Ciprofloxacin as a result of supply shortages and expenses (Ebright, 2003).

Ethambutol, Isoniazid, Rifampicin, and Pyrazinamide are the first line drugs, called category 1, to be used for newly detected tuberculosis patients and Streptomycin is an additional drug choice for second line drugs, which is indicated to use for patients, who undergo re-treatment, called category 2.

WHO recommended that DOTS with first line medication is needed to control both new pulmonary and extra pulmonary tuberculosis and cases with multidrug resistant

tuberculosis needs to be controlled under second – line medication DOTS– Plus program, which requires longer and more complex drug regimens worldwide. (Baltussen, 2005)

1.2.4 DOTS programs in Mongolia

Overall DOTS program requires 6 months of course therapy. It is guided as in two different phases.

First phase: This is an initial therapeutic phase, which covers 2 months regimen for all individuals, who have been diagnosed sputum smear positive pulmonary tuberculosis and have to undergo anti-tuberculosis treatment mandatorily at the National Center for Communicable Disease.

Continuous Phase: This covers remaining 4 months of treatment routine. Mongolia has implemented three types of DOTS programs for tuberculosis management as a continuous phase, which patients were allocated by their supervisors, on becoming sputum negative pulmonary tuberculosis after 2 months initial phase at NCCD of Mongolia. Three programs described as follows.

1) Dispensary Program – DOTS, for tuberculosis patients, is supervised by health professionals at dispensary clinics both in urban and rural areas. Patients come to nearby dispensaries to take drugs under the supervision of government health workers. DOTS is conducted in all dispensaries including 11 in the city of Ulaanbaatar, serving above 100 000 population and 21 in each administrational divisions (provincial level).

2) Program with volunteers of Mongolian Anti – Tuberculosis Association (MATA) – based DOTS, for tuberculosis patients, is supervised by MATA volunteers of both in urban and rural areas. When patients live far from dispensaries or are not able to receive medicines from dispensaries on daily basis due to physical condition, they are arranged to have DOTS at home under MATA volunteers' supervision. MATA volunteers are allocated at the time of starting continuous DOTS for patients at home.

In average there are 340 volunteers working in this program for a year and they travel to patients home to make sure beneficiaries are taking medicines regularly. Each volunteer receives 20 US dollars per month for travel cost to patients home to serve 3 patients a day in average. Additionally, MATA volunteers program initiated lunch program in order to attract homeless people, who have pulmonary tuberculosis, to comply DOTS for several months. They are supervised by MATA volunteers during lunch time at contracted cafeterias. Global Fund provides 40 US dollars per month for each individual.

1.3 Research Questions

1.3.1 Primary Question

Do DOTS programs with different strategies, using daily dosage regimen with anti-mycobacterium drugs, significantly increase cure rate and decrease mortality among newly treated patients with smear positive pulmonary tuberculosis in Mongolia?

1.3.2 Specific Questions

1) Are there disparities between treatment programs for tuberculosis in terms of treatment cost effectiveness for the DOTS?

2) What is the incremental cost effectiveness between the three programs of DOTS for tuberculosis treatment management?

3) What is the main determinant that weakens effectiveness of treatment DOTS results?

1.4 Research objectives

1.4.1 General objectives

To evaluate the cost effectiveness between DOTS programs, differed by their supervisions, in order to examine possibility of resource maximization of the treatment for pulmonary tuberculosis in Mongolia

1.4.2 Specific objectives

1) To find the clinical benefits and outcomes of DOTS regimen among patients with pulmonary tuberculosis in Mongolia as of 2010.

2) To compute the cost of DOTS management program held for patients who received treatment in Mongolia.
3) To compare defined groups such as dispensary clinic, administration of DOTS at home under MATA volunteers' supervision and with lunch program at contracted cafeteria, and which program can have a greater impact on effective use of drug treatment in terms of cure rate, completed rate, default rate, mortality and.
4) To assess the additional cost per additional cured case of sputum positive pulmonary tuberculosis using DOTS between above mentioned groups.
5) To demonstrate sensitivity analysis to determine what factor can have impact on DOTS due to uncertainty of cost effectiveness analysis.

1.5 Scope of study

In total, 2057 cross sectional observations collected as of 2010. National Center for Communicable Disease (NCCD) of Mongolia is the only specialized tertiary care hospital for infectious disease, covering 9 districts and has 230 inpatient beds for initially diagnosed tuberculosis in this area. On the other hand, in the rest of areas, 21 TB health centers and 340 rural hospitals covering the rest of all administrative divisions in the country with the population circa 2.8 million heads as of 2010 population (Housing census of Mongolia). There are 86 specialized physicians for tuberculosis, 5 laboratory technicians, 3 X-ray technicians, 32 TB coordinators with average of 340 volunteers, working in the country as of 2010 (National Tuberculosis Program, 2010).

1.5 Hypothesis

Treatment strategy of Directly Observed Therapy, Short course (DOTS) for pulmonary tuberculosis, supervised by volunteers from Mongolian Anti Tuberculosis Association (MATA) is a more cost effective approach than DOTS supervised by TB dispensaries.

CHAPTER II
LITERATURE REVIEW

Two kinds of studies were organized and analyzed in this literature review.
First type of studies focused on epidemiological research studies that present burden of tuberculosis worldwide, clinical findings among patients with tuberculosis, demographic characters, laboratory tests, and treatment options both in international and country levels. The purpose of this type of literature reviews is to identify and broaden the horizon of the research target and identify the outcome between Mongolia and other countries in regard to policy implementation for interventions to eliminate tuberculosis and to apply what possible treatment programs can have impacts on treatment outcomes into designing decision analytic model in the research. Moreover, it is crucial to determine the required values and parameters of clinical benefits, whether applicable into the modeling.

Second type of research reviews were related to economic evaluation of different interventions among patients with sputum positive pulmonary tuberculosis in different countries. Collecting similar health economic studies that have been done previously in different countries supports to organize the possible model for current implementation of anti-tuberculosis intervention. The main idea behind the literature review was not only for recognizing the evidence of what have been done previously, but also capturing similarities and dissimilarities the research framework and model structure, also enriching the ideas to shape the research framework, and building general structure of research model and further evaluation analysis of cost effectiveness.

The literature materials, relevant to the study, have been compiled from the library of Chulalongkorn University and online research database. Clinical related data's were collected using keywords such as tuberculosis, treatment, DOTS, and Mongolia. For health economics related materials on tuberculosis treatments searched by keywords such

as tuberculosis, DOTS, cost, cost analysis, cost effectiveness analysis, economic evaluation, world, Asia and Mongolia.

2.1. Medical literatures on tuberculosis

2.1.1 Global burden of tuberculosis

Tuberculosis has existed for many years with us and estimated to have occurred circa 15,000 – 20,000 years ago. (Brosch, March. 19, 2002) Due to industrial revolution in Europe and increasing density of human population led the disease from endemic to epidemic. (Bates, 1993)

Of the pathogenic species of Mycobacterium Tuberculosis complex, the most widespread and major etiologic agent is Mycobacterium Tuberculosis. This type of micro-organisms have numerous genetic polymorphisms and large proportion of genome sequence and structure of their cell wall, linked with different type of lipids, enable them highly resistant to antibiotic treatment and human immune cells and eventually facilitates higher infection among people throughout the world (Braunwald, E. et al, 2001).

As of 2010, 8.5-9.2 million new cases were detected and over 1.1 million HIV negative people died from tuberculosis. Additionally, 0.35 million deaths occurred from HIV associated tuberculosis. Positively, with the great efforts of World Health Organization and successful interventions in many other countries, absolute number of new cases of TB has been decreased significantly since 2006 and the number of mortality cases has plummeted from 2002 in the world (WHO report, 2011). By improving diagnosis and treatment worldwide as WHO recommendation, more than 36 million people cured and up to 6 million deaths from TB had averted between 1995 and 2006. Despite the progress against drug susceptible tuberculosis emergence of multidrug-resistant and extensively-drug resistant (MDR) tuberculosis remain a question today and challenges the health professionals globally.

With current efforts, such as existing technologies and approaches, decreasing incidence to less than one case per million populations by the year of 2050 is probably not reachable (Lönnroth, K., Castro, K. G., Chakaya, J. M., Chauhan, L. S., Floyd, K., Glaziou, P., & Raviglione, M. C., 2010). As estimation of WHO nearly 440 000 cases of MDR tuberculosis were detected and of these, 360 000 were new and relapsed cases and remaining 94 000 cases were patients, who received treatment previously in 2008. This is likely due to recurrence after treatment, transmission of MDR strain and acquired resistance during previous treatment. (Gandhi, N. R., Nunn, P., Dheda, K., Schaaf, H. S., Zignol, M., Soolingen, van D., Jensen, P., & Bayona, J., 2010)

2.1.2 Tuberculosis in developing world

In developing countries TB is the second leading cause of adult mortality and being to be one of the priority issues of public health elsewhere. The United Nations Millennium Development Goal addresses the target for TB control and extended by the intervention Stop TB Partnership. This aims to downsizing TB incidence by 2015, halving TB prevalence and mortality by 2015, diagnosing 70% of new smear-positive TB cases and curing 85% of these cases (Baltussen, Cost effectiveness analysis of strategies for tuberculosis control in developing countries, 2005).

High incidence, large economic losses due mortality and morbidity from tuberculosis and poor clinical outcomes indicate that increasing investment for TB control is crucial and urgent. The research, that has been done in South Africa addressed that rapid expansion of TB culture and drug sensitivity test (DST) could make diagnosis more accurate and could increase clinical effectiveness. This study implies that immidiately scaling up current existing technology investment is necessary for high TB burden countries, especially, low sputum negative TB detection (Dowdy, 2008).

This investment is useful in Mongolia. A hypothetical cohort study of cost analysis for TB suggest that providing medical service available for every individuals, who suffer

from tuberculosis, has proven to have much lower economic losses than the current situation (Peabody, 2005). For instance, WHO recommended if it is imposed that a burden of around 8 million new cases and 1.8 million deaths annually, estimated cost of nearly 5 billion US dollars were spent just to cure new cases in 22 high-burden countries during the period of 2000 to 2005 (Atre, 2005).

2.1.3 Studies on tuberculosis in Mongolia

Several TB related epidemiological studies regarding case detection and different physicians' role on the disease case findings were available from literures. A study that has been done more than a decade ago found that different settings of health workers play important part of TB diagnosis. Long patients delay, meaning patients take long time until it is diagnosed as a TB, has occurred among individuals, who consulted TB specialists. On the other hand physicians delay, which indicates long time to start treatment after referral.

Researchers suggested that general physicians are effective to detect passive case finding for tuberculosis (Enkhbat, 1997). Group of researchers and doctors observed that seasonal patterns appear to be same in each year from 1996-2006. Prevalence of tuberculosis increases in similar pattern after winter as a result of socio-cultural and behavioral change in Mongolia (Naranbat, N., Nymadawa, P., Schopfer, K., and Rieder, H. L., 2009). There was no significant difference between male and female ratio in both urban and rural area. , Positively, there were tremendous improvement observed in mortality rates both rural and urban areas between 1990 and 2009. On the other hand, there is still a large disparity occurring between urban and rural settings in Mongolia. Ascending trend of incidence of tuberculosis in rural area is always higher than that of rural area and treatment success rate is uninterruptedly lower in urban area than in rural area. For example, tuberculosis incidence was 213 while average TB incidence was 113 in rural area per 100 thousand population and treatment success in urban and rural area was 80% and 88% respectively (Sodnompil, 2009).

Report on health indicators shows that trend of tuberculosis incidence almost as high as twice in rural area, while mortality remain similar between these two regions (MOH, 2009). This might be attributed to total increase in population over the years and increasing migration from rural to urban area. Higher resistance rate among prisoners and previously treated patients have observed. Higher rate of default among teenagers comparing to children and adults as of 2008 was reported (National Tuberculosis Program, 2010).

When DOTS program contributed to remarkably decrease in the prevalence and mortality from tuberculosis, there are some inconsistencies occur between anti-tuberculosis drugs as well. For instance, streptomycin resistance was very high 24.2 percent, isoniazid was 15.4% and Rifampicin and Ethambutol resistance was 1.7% (Tsogt, G., Naranbat, N., Buyankhisig, B., Batkhuyag, B., Fujiki, A., & Mori, T., 2002). Researchers concluded that closer monitoring for treatment outcomes and long term follow up are needed on a nationwide scale.

Another oncoming research grant has proposed that daily vitamin supply of vitamin D could possibly prevent individuals from tuberculosis and effectively contribute to successful treatment (Ganmaa, 2008). Researcher suggested that vitamin D is beneficial for maintain immune system, particularly increase the macrophage activity against microbes.

Since, DOTS program has been implemented for more than a decade in Mongolia, conducting research and economic evaluation is important to distinguish DOTS compliance among different programs and to determine where we fail in terms of reaching MDG goals by 2015. Because of disparities in success rates of DOTS for tuberculosis is significantly different between urban and rural settings and government financed TB centers and health volunteers, conducting health evaluation study is beneficial, especially, to distinguish which supervision falters and needs improvement in the implementation of DOTS in Mongolia.

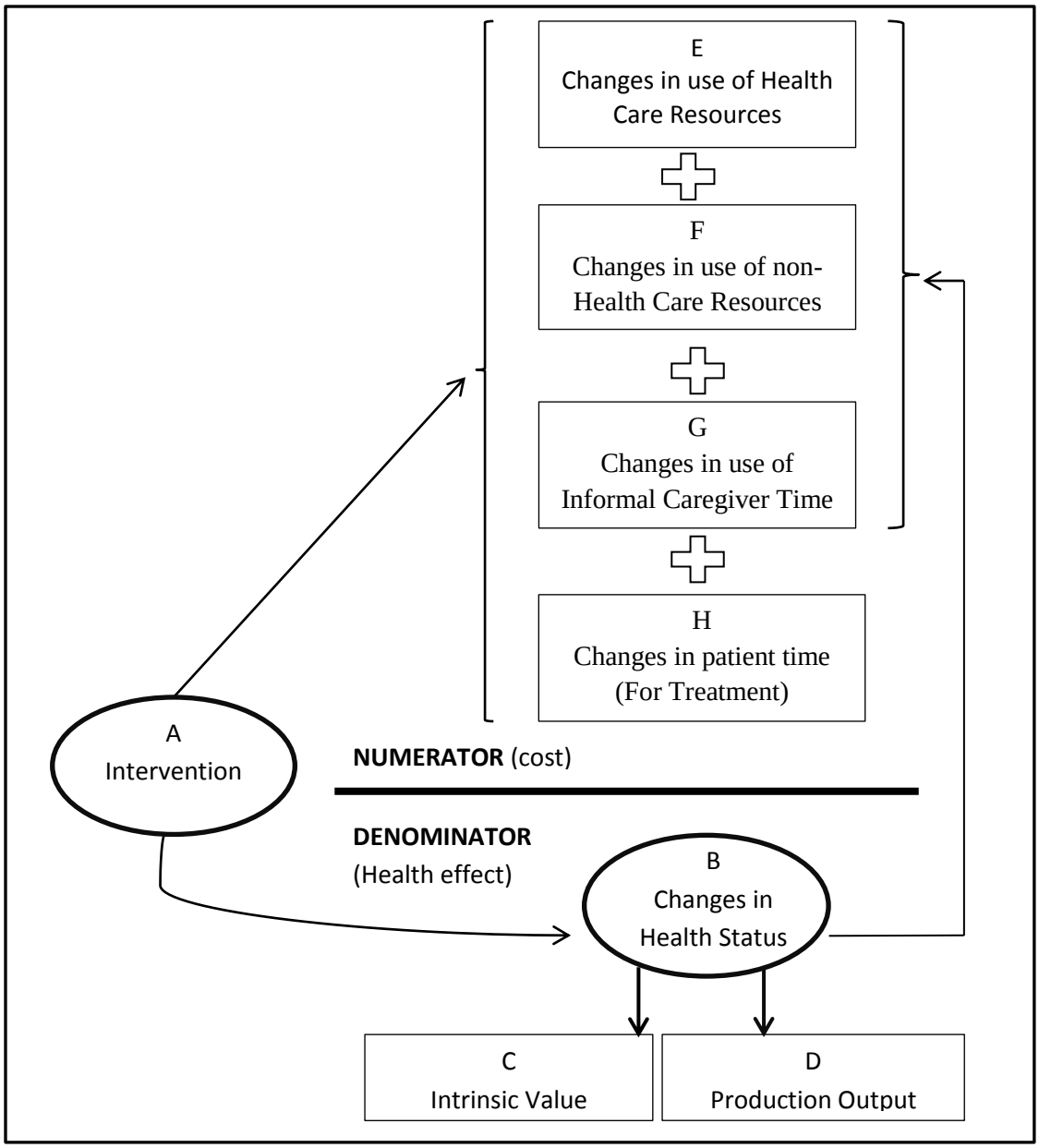
2.2 Cost effectiveness analysis in health and its theoretical framework

Cost effectiveness analysis in health is an assessing method for comparative impacts of expenditures on various health and medicine interventions (Gold, M. R., Siegel, J. E., Russel, L. B., & Weinstein, M. C, 1996). Cost effectiveness analysis is constructed on the concept that for any provided level of resources, society want to maximize the total accumulated health benefits incured. Cost effectiveness analysis can be used from societal and providers point of views. Luce. B. R illustrated the theoretical framework of cost effectiveness analysis in health arena that is found to be useful as a guide of this research project.

An appropriate cost effectiveness analysis starts with identifying and distinguishing all those inputs converted into summary of dollars or monetary values as a cost, numerator, and effects of health status need to be measured, as denominator. The change of the cost and difference for health effects are the basis of cost effectiveness analysis. The ratio of the summary of cost to the change in health effect measure is the cost

By any intervention, let's say (A), utilization of health care resources (E), utilization of non-health related resources (F), utilization of informal caregiver's time (G) and use of patients' time will be changed at certain degrees. All these changes were utilized for necessities to treat individuals as a result of changes in their health status (B). Shown in the following figure (see Figure 2.1)

Figure 2.1 Theoretical Conceptual Frameworks



Source: Cost-Effectiveness in Health and Medicine. Gold, Siegel, Russel, and Weinstein (1996) p.177

2.4 Studies of cost effectiveness analysis for tuberculosis

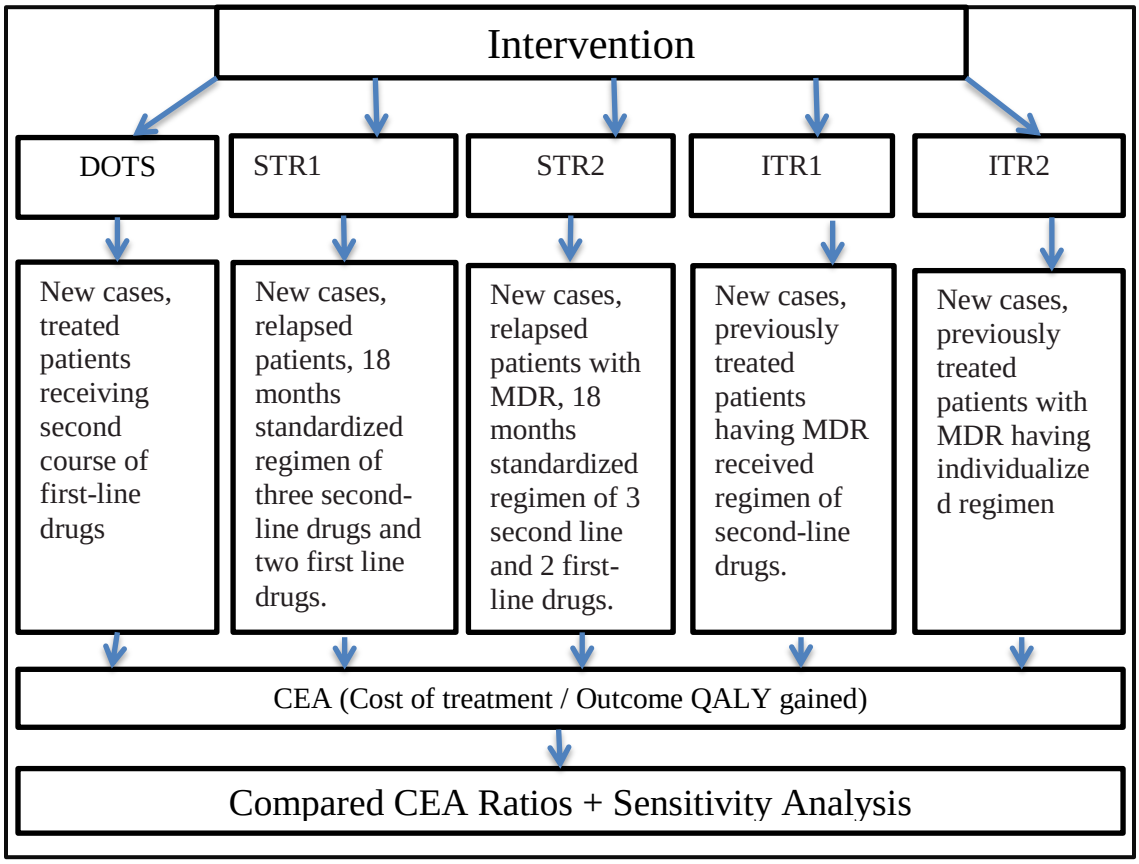
2.4.1 Conceptual frameworks of previous studies

Totally, 17 research works and review analytic studies, which are relative to cost effectiveness analysis (CEA) on tuberculosis diagnosis and treatments, were sorted out of all collected literatures, which were available in English. Most health evaluation studies on TB interventions have evaluated DOTS programs and drug susceptible, smear-positive pulmonary tuberculosis, because of their most frequent infectious but detectable characteristics by sputum test. Research projects have been conducted in the USA, Brazil, Switzerland, Peru, Thailand, Indonesia, Russia, Ethiopia, South Africa, Egypt, Syria and Bangladesh. Only one research study on smear-negative tuberculosis have been done in Peru, 2002. Nevertheless, due to its accessibility and relevance to my research work, this study was omitted from the literature review.

Most research studies were published in the period between1997 and 2012. Of these, 8 studies were on CEA between different initial DOTS programs among patients with smear positive pulmonary tuberculosis, 5 research works focused on CEA comparing DOTS with Non- DOTS groups, 1study projected comparison between groups before and after DOTS regimen and remaining 1 study targeted to prophylactic anti-tuberculosis treatment among HIV negative and positive patients. In addition, 10 studies were held among patients with drug susceptible tuberculosis, 4 were among multidrug resistant (MDR) tuberculosis patients and 2 researches have chosen patients with TB among HIV positive individuals .

One study, from Peru 2002, showed cost effectiveness of intervention for multidrug resistant tuberculosis between first line (DOTS) and second line (STR and ITR) drugs (Resch, S. C., Salomon, J. A., Murray, M., & Weinstein, M. C., 2002). The research framework was shown below in order to get idea that how researchers have taken comparison between different interventions, particularly on regimens of various drug combinations. (see Figure 2.2)

Figure 2.2 Framework of study among MDR patients in Peru 2002



Source: A National Cohort Study in Peru. Resch, Salomon, Murray, & Weinstein (2002)

Interesting finding is that treatment of the second line drugs for chronic tuberculosis patients with MDR was cost effective than repeating first line drugs of DOTS. In a single review work, a group of American doctors supported the idea that using DOTS-plus regimen (second line drugs) had as much as 80% cure rate, whereas, repeating DOTS for MDR patients resulted 47% cure rates (Nardell, 2003). Another similar cost-utility analysis research have been done in Philippine, comparing MDR patients, grouped by chronic TB (diagnosed as MDR) using DOTS-Plus treatment regimen and retreated TB (defaulted or relapsed from first DOTS) using DOTS again. They suggested that DOTS-Plus for MDR is feasible and cost effective for lower income patients (Tupasi, 2006). The research works added the idea of possibility to do a cost effectiveness research among similar groups of people, who underwent DOTS regimen. Most studies assessed

indicators that are more specific to tuberculosis control, such as different programs comparing treatments between their different characteristics of DOTS supervision such as DOTS at private vs. government health facilities or DOTS adherence by community health workers vs. home based guardians (see Table 2.1).

Table 2.1 Studies on initial treatment DOTS phase 1

Comparing DOTS cohorts in the previous studies		Cost	Outcome	Cost Effective Supervision	Study
Community health workers	Government health workers	Facility Patient	Cure rate	Community health workers	Bangladesh (Islam, 2002)
Primary Health Care	Specialist Clinic	Facility	Cure rate	Primary Health Care	Egypt and Syria (Vassal, 2002)
Private Non-Governmental Partnership	Public and Private Partnership	Treatment Patient	Cure rate	Private Non-Gov. Partnership	South Africa (Sinonovic, 2006)
HIV inpatient	HIV outpatient	Treatment	Per patient	HIV(-) outpatient	USA (Burgos, 2005)
TB assay tested patients	Tuberculin tested patients	Treatment Patient	Life year gained	TB assay	Switzerland (Diel, R., et al, 2007)
Health Extension Workers	Hospital health service providers	Treatment Patient	Cure rate	Health Extension Workers	Ethiopia (Datiko, 2010)
Private Practitioners	Public Hospital Practitioners	Treatment Patient	Cure rate	Private Practitioners	Indonesia (Mahendradhata, 2010)
Community Health workers	Home based treated patients	Treatment Patient	Completed rate	Home based treatment group	Brazil (Prado, 2011)

Only one study aimed to assess the CEA on transmission of tuberculosis among African and South East Asian countries, which requires more extensive and consistent tracking records and database (Baltussen, 2005).

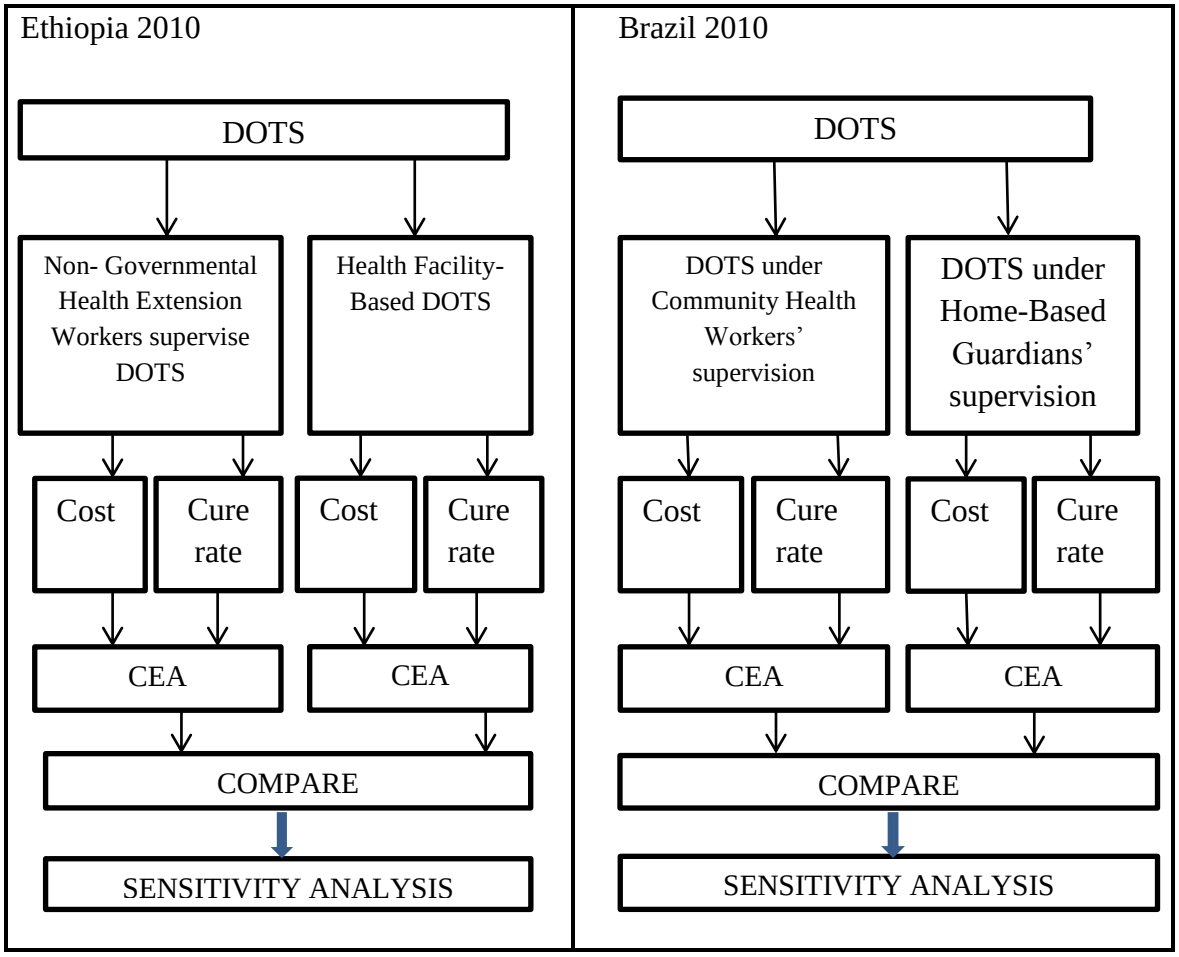
Considering current implementation of DOTS interventions in Mongolia, two of the abovementioned studies are possible examples for cost effectiveness of different approaches among patients with smear positive pulmonary tuberculosis for the study. Because, Mongolia implemented DOTS in two approaches such as DOTS at dispensary, DOTS at home based observation by MATA volunteers and DOTS at contracted cafeteria, providing lunch for homeless population. These two studies have been conducted in Brazil 2011 and in Ethiopia 2010.

Essential finding after comparing these two studies was DOTS under non-governmental health workers to be more cost-effective than government health workers in Brazil, while DOTS under home-based guardians to be more cost-effective than under supervision of community health workers. Compared frameworks of these two researches are shown below to make it easier to understand. This finding can be a good evidence for policy proposal in these countries, which health authorities need to draw attention.

Yet, DOTS at cafeteria program, applied in Mongolia, is not launched widely in other countries, it is expected to be adherent practices to comply treatment successfully among low income group, especially, by attracting the homeless. In other words, it can be assumed as an incentive program for these people.

The research highlights the importance of doing cost-effectiveness analysis on DOTS between two supervisor groups in Mongolia, as mentioned previously (dispensary and volunteer) and yields feasible opportunity to add the evidence in the literature review. Compatible frameworks are postulated below (see Figure 2.3).

Figure 2.3 Frameworks of CEA on various tuberculosis managements



Like the above studies community health workers are useful approach for DOTS implementation. Squire and Wilkinson suggested the idea of taking advantage and benefit of community health workers. They emphasized that community health workers are one of the efficient ways of case finding and controlling for TB program among society (Squire and Wilkinson, 1997). Richard de Soldenhoff strengthens this idea and added the importance of community based supervision. Particularly, in rural area where travel and time costs are obstacles of adhering DOTS, community health workers, such as carefully briefed and entrusted relative or neighbor can work effectively rather than health facilities (Soldenhoff, 1998).

Therefore, we hypothesize that community health workers like MATA volunteers in Mongolia are valuable to TB management.

2.4.2 Costing in previous studies

Almost all research works considered total cost from societal perspective. Thus, they included all direct and indirect costs into the analysis. Direct costs are collected through various sources, such as statistical departments, hospitals and insurance companies, whereas indirect costs from patients were gathered through questionnaire surveys by researchers. Only one research presented longitudinal study but used undiscounted costs of treatment. (Squire, and Wilkinson, 1997)

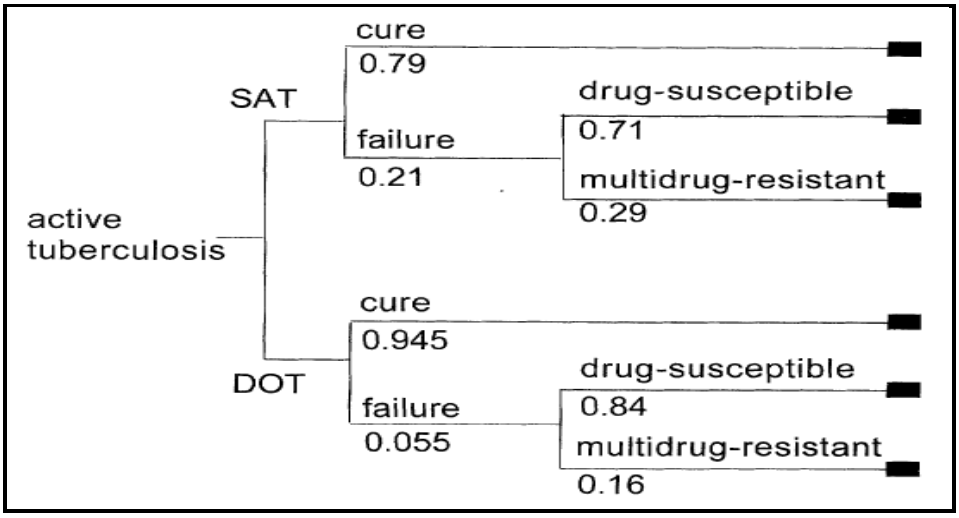
One study held in Indonesia using discount rate for treatment cost including capital cost, because of mid-year to mid-year data collection. Most works clearly brought about cost estimation. Researchers often accounted recurrent and capital costs for the treatment cost. Five research studies clearly defined the obtaining data of patients' costs. They set interview among certain group of people, who were being treated by DOTS. The number of patients who were interviewed by researchers is 58 in average.

All researchers defined patients' cost by slightly different categories and approaches. Some use travel or time cost by calculating income and sick leave, while others concerning both travel and productivity loss. All costs in monetary terms transferred by average exchange rate of the year of 2010.

2.4.3 Algorithms for computing cost effectiveness in literatures

Four out of 16 research works explicitly demonstrated and indicated algorithms for decision analysis of cost effectiveness on the paper, which I mostly concerned to see as an example. Research from Indonesia used algorithms by number of patients in order to show number of patients' flow and the other work of Diel et al. showed the more detailed algorithm using Markov's model of decision analysis. One of the applicable but adjustable probabilistic model algorithms to the present situation of Mongolia's DOTS program is shown below (see Figure 2.4).

Figure 2.4 Probabilistic models for decision analysis



Source: Cost effectiveness analysis of directly observed therapy vs. self - administered therapy for tuberculosis (Burman, 1997)

Drummond introduced several examples of decision tree models for sensitivity analysis when conducting cost effectiveness analysis. He proposed two different types of decision tree analysis, which mostly economists use for their works. Decision tree algorithm using absolute number of comparison groups was suggestible for incremental analysis, while he showed clear explanation about algorithm for probabilistic decision tree combining sensitivity analysis (Drummond, 2005).

Since any treatment has related to some other factors such as life years saved and life saved health effects. Besides, comparing incurred costs per cured cases in any setting, deaths, resulting from the treatment, is important to know whether treatment program is cost effective option. Likewise, sensitivity analysis has commonly been done in most studies and this type of analysis depends on parameters which, researchers established and drawn from other sources. (Drummond, 2005)

2.4.4 Sensitivity analysis in various studies

Due to the uncertainty of determinants in the components of the evaluation, it is important to demonstrate sensitivity analysis by repeating the comparison between cost items and outcomes while changing the assumptions underlying estimations. Most studies have completed sensitivity analysis by assessing either univariate or multivariate. Study for cost effectiveness analysis comparing two different tests showed multivariate sensitivity analysis, while others completed univariate analysis.

Two studies in Bangladesh and Indonesia have not indicated sensitivity analysis, but other researchers assessed sensitivity analysis by varying cost of providers and drugs. However, when doctors salary or travel cost were cut off down to 50% in countries such as Ethiopia, Egypt and South Africa, the outcome of cost effectiveness ranking did not change, which implies that there were other determining factors underlining effectiveness. (Datiko, 2010)

Conversely, only two studies have done sensitivity analysis by changing the range of cure rate and death rate. Both of the cases rankings between comparison groups did not change significantly as well. Researchers found that DOTS under community health workers is more cost effective than government health care professional in terms of supervision. (Sinanovic and Kumaranayake, 2006)

Lastly, assessing cost effectiveness among different groups of DOTS can be accomplished by the current guideline of TB treatment implementation in Mongolia. Most importantly, DOTS treatment among homeless people resulted higher cure rates than amongst people who received DOT from dispensaries. (National Tuberculosis Program, 2010) This illustrates that treatment with incentive program might have higher success rate and implies to conduct whether it is cost effective from patients' perspective.

CHAPTER III
RESEARCH METHODOLOGY

3.1. Study design

An observational, analytical, and case control study have been undertaken by applying cost effectiveness analysis into the research project on the basis of data for the year 2010 in Mongolia.

1) To identify important factors, affecting treatment outcomes such as age, gender, body weight, occupation, location of treatment adherence and treatment supervision, via descriptive and logistic model with multiple regressions
2) To calculate total cost, unit cost, number of patients in each treatment group and to define cost effectiveness of treatment by comparing cost effectiveness ratio (CER) and incremental cost effectiveness ratio per cured, per successful treatment and per default prevention of each defined groups
3) To compute the patients' flow in each setting and to estimate probability of treatment results by decision tree analysis in order to see the cost effectiveness per success rate
4) To conduct sensitivity analysis using probabilistic decision tree model along with the different scenarios by adjusting effects, in terms of successful treatment and default prevention, and impact of decreasing inpatient care cost by shortening inpatient days.

3.2 Data collection

With aiming to reach the research objectives, secondary data for patients' disease history and cost of treatment will be accumulated from the statistical and financial departments of the NCCD, the Ministry of Health of Mongolia (MOH), Division of Surveillance and Research for Tuberculosis (DSRT), Association of Family Group Physicians of Mongolia (AFGPM) and the Mongolian Anti-Tuberculosis Association (MATA) as of 2010. Data of costing is to be collected either from NCCD, MOH and National Statistics Office's website. Primary data will be done in terms of estimating travel cost by interview with available group of health beneficiaries at TB dispensaries both in rural and urban settings.

3.3. Conceptual frameworks

Following the guidelines of National Program for Tuberculosis in Mongolia, all new cases with sputum positive tuberculosis from the regions of capital city Ulaanbaatar have to be admitted in the NCCD and those patients, who live in rural areas, have to undergo treatment at TB center in each province for two months as an initial treatment.

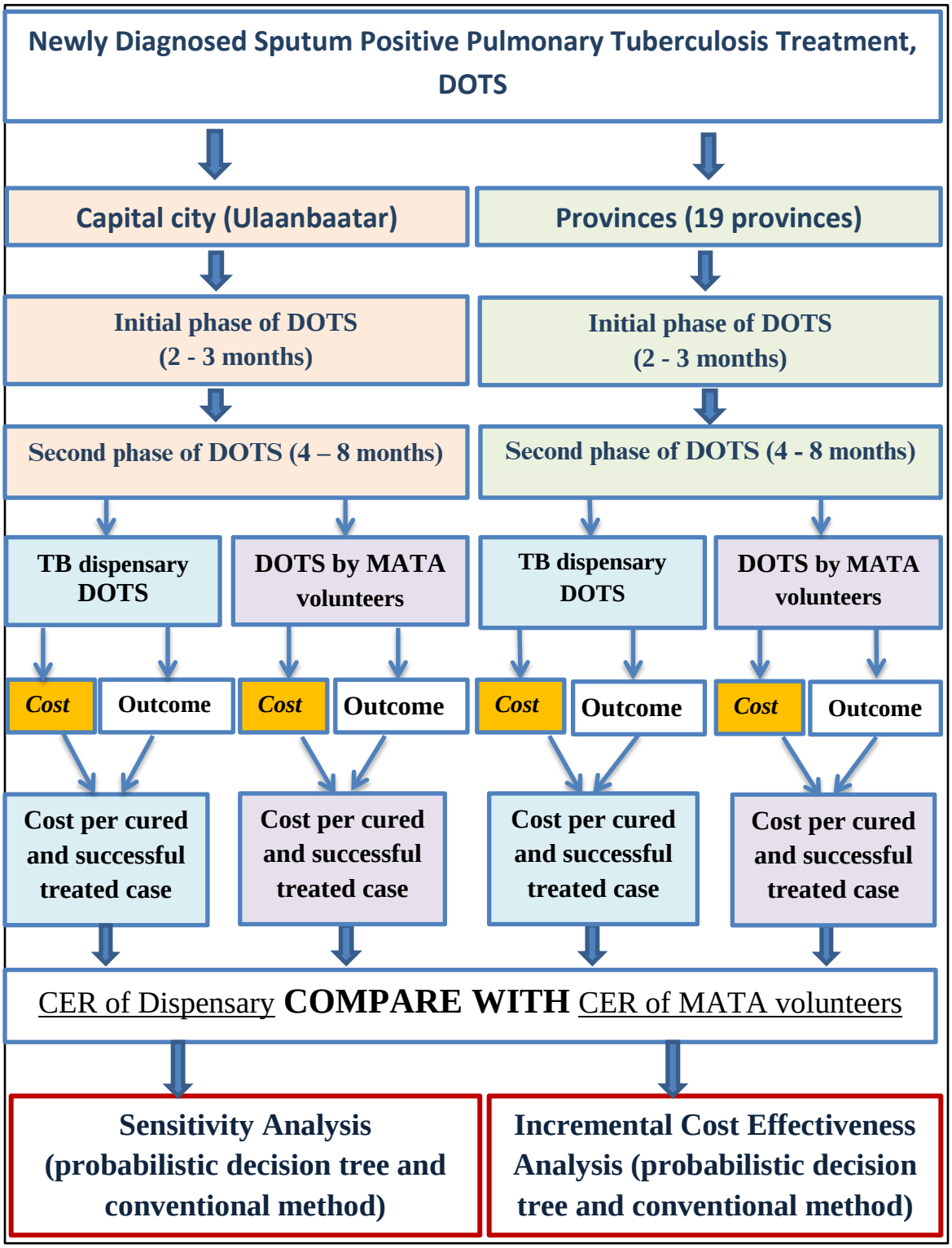
Conceptualizing frameworks by location of TB supervisions separated capital city vs. rural settings is essential for initial costing appliance. Because during the initial treatment, there will be a significant difference in costs, incurred patients. The NCCD is a tertiary clinic and more advanced and can be costly than rural centers. Also, there is common dissimilarity in regard for length of hospital stay at inpatient clinic, which will effect on costing at inpatient level.

After discharge from inpatient clinics the individuals have to continue treatment for 4 to 8 months under the supervision of government health workers or volunteers from MATA to adhere DOTS second phase. This will be a further grouping by supervisors in the framework like dispensary and MATA volunteers in each area, as shown in Figure 3.1.

After calculation of cost effectiveness ratio, the incremental analysis needs to be done to assess the difference of the treatment approaches in terms of per life saved or per default averted case using patient flow in the decision tree model.

Sensitivity analysis is desired to be accomplished in order to check the uncertainty of various factors influencing treatment outcome such as default rate. Sensitivity analysis either by using conventional method of economic evaluation on EXCEL or probabilistic decision tree analysis. Both, health effect such as the possibility of increasing successful rate by controlling various default rates at dispensaries and cost effect of inpatient care by shortening inpatient stays, are to be considered and examine how it affects the cost effectiveness of these interventions.

Figure 3.1 Conceptual framework of CEA for DOTS in Mongolia



3.4 Costing

By the reason of doing research from providers perspective all costs incurred besides patients will be counted. Therefore, it is useful to know where and which step of DOTS compliance needs to be maximized in order to reach MDG 2015 goals. Based on data collection monetary value will be converted to US dollar terms using the formula below:

$$\textbf{Cost in year 2010} = \textbf{Cost in Year 2010} * (\textbf{CPI}_{2010} / \textbf{CPI}_{2012})$$

Because, the standard unit cost will be calculated from the cost data of the year 2010, the cost per patient will be converted and reported in 2012 Tugrik (currency) using the consumer price index (CPI). Every sputum positive pulmonary TB patients from the city should stay at NCCD inpatient clinic of TB for 24 days in average followed by 144 days treatment and patients from rural areas must stay at provincial TB center for 56 days as an intensive treatment phase and followed by 112 days continuous phase treatment in each city and rural setting. Costing will be carried out via 7 steps (see Table 3.1).

Table 3.1 Costing steps during DOTS for pulmonary sputum (+) TB patients

Steps	Costing category	Dispensary	Volunteers
1	Inpatient treatment	Total cost of patients	Total cost of patients
2	TB drug treatment	Total cost of DOTS	Total cost of DOTS
3	Laboratory test	Total cost of sputum test	Total cost of sputum test
4	Cost for volunteers	-	Total cost of travel, spent
5	Cost for lunch	-	Total cost of lunch, spent
6	Patients' out of pocket payment	Total cost of travel and loss of opportunity cost	Volunteers' opportunity cost
7	Cost of health workers	Yearly wages of doctors and nurses at dispensaries	Yearly wages of doctors and nurses of MATA
8	Total cost	Sum of steps 1, 2 , 3, 6, 7	Sum of steps 1, 2, 3, 4, 5, 7

3.4.1. Step 1 Costing for initial inpatient treatment of DOTS

Total treatment cost for the urban and rural patients will be different if cost for inpatient treatment is considered. Because of the different length of inpatient stay, food, fixed and variable costs between the two groups, rural and urban hospitals. Besides anti-tuberculosis treatment, cost of hospital bed days including fixed costs such as usage of water, sewage, electricity, warming, food and non-tuberculosis drug cost and variable cost such as health workers' salaries including physicians', nurses' and laboratory technicians, are taken into account.

Since, the health insurance payment is funded by per capita or by services per person, these costs are available in total cost divided by total number of patients (MOH, 2011). Costs at TB centers in rural areas are used from the recent survey among rural and district secondary care hospitals Mongolia and estimated by the total cost of inpatient clinics using step down method of costing. Calculation method of inpatient care is illustrated in Table 3.2.

Table 3.2 Costing for initial inpatient treatment of DOTS

N	Category	NCCD patients in the City		TB centers in total 19 Provinces
		Children	Adults	Children and adults
1	Inpatient Average length of stay	Days	Days	Days
2	Food cost	Per day	Per day	Per day
3	Non-TB drug cost	Per head	Per head	Per head
4	Inpatient bed day cost	Per head	Per head	Per head
5	Number of Patients	Total number patients		Total number patients
Inpatient cost per patient		= (1*2)+3+4		= (1*2) +3+4
Total inpatient cost		= ((1*2)+3+4)*5		(1*2+3+4)*5

3.4.2. Step 2 Costing for TB drug treatment of DOTS

There are 8 types of drug doses and 2 categories of treatments included in the research. This variety of options may have impact on drug cost to be different among comparing groups. Generally, all patients receive the same type of drugs namely, Rifampicin, Pyrazinamide, Ethambutol and Isoniazid, but not always the same period of time and amounts of these medicines. Drug doses need to be thoroughly calculated in each cohort not only by adjusting weight and age, but also need to be computed by treatment duration. Successful treatment has often been conducted for 6 months as a standard, but defaulted, died, failed and transferred out cases will all have different timing. Doses and drug combination are shown below (see Table 3.3 - 3.5).

Actually there 3 categories of treatments for TB but this study selects only 1 and 2 categories and patients who have smear positive pulmonary tuberculosis. Category - 3 is a treatment mainly for extra pulmonary or smear negative pulmonary tuberculosis, so this type of treatment is extracted from this study. Category 1 and 2 treatment options, indications and dosages are explained below in detail.

Name of drugs used for treatment (all drugs are combined in one tablet as a fixed dose, only Streptomycin is used as injection and contained in vial)

- Isoniazid (H) 10-12 mg/kg/day,
- Rifampicin (R) 10-15 mg/kg/day
- Pyrazinamide (Z) 30-40 mg/kg/day
- Ethambutol (E) 12-25 mg/kg/day
- Streptomycin (S) 12-18mg/kg/day

Category 1 treatment indications

- Patients with new sputum smear positive pulmonary TB
- Patients with new sputum smear positive pulmonary TB
- Patients with new sputum smear positive pulmonary TB

Category 1 treatment regimen with combination of drugs

- For children for 2 months of RHZ (phase 1) and for 4 months of RHE (phase 2)
- For adults for 2 months of HRZE (phase 1) and for 4 months of HR (phase 2)
- Additional 1 month RHZ, if patients' tests remain no improvement

Table 3.3 Category 1 Treatment dosage according to body weight for children

Children	Combination	5-7kg	8-14kg	15-20kg
2 months	RHZ	1 pill	2 pills	3 pills
4 months	RH	1 pill	2 pills	3 pills

Table 3.4 Category 1 Drug dosage according to body weight for children over 20kg

Children	Combination	20-30kg	Over 30 kg
2 months	RHZE	2 pills	Same as adults
1 month (additional)	RHZE	2 pills	Same as adults
4 months	RH	2 pills	Same as adults

Table 3.5 Category 2 Treatment dosage according to body weight for adults

Adults	Combination	30-39kg	40-54kg	55-70kg	Over 70kg
2 months	RHZE	2 pills	3 pills	4 pills	5 pills
1 month (additional)	RHZE	2 pills	3 pills	4 pills	5 pills
4 months	RH	2 pills	3 pills	4 pills	5 pills

Category 2 treatment indications (as similar concept as re-treatment)

- Relapse after successfully treated patients
- Failure during initial treatment of DOTS
- Default during initial treatment of DOTS

Category 2 treatment regimen with combination of drugs

- For children less than 20kg:
  3 months RHZ+E (phase 1) and 5 months of RHE (phase 2)
- For children over 20kg: 3 months RHZE (phase 1) and 5 months of RH (phase 2)
- For adults: 3 months of HRZE (phase 1) and 5 months of HR (phase 2)
  2 months of Streptomycin

Since only Streptomycin is used as injection, each syringe, needle broker, IM fluid and vial are all calculated in the costing process. Total number of days of treatment will be calculated from data source associated with treatment result such as cured, completed, defaulted, failed, died and transferred out. All patients receive drugs for various numbers of days except cured and completed patients. Costing is to be done individually one by one, because, some patients quit the treatment early, whereas others quit in late months of treatment. Likewise, some patients may die during earlier stages of the treatment, while others may die in late course of treatment. Calculation methods of costing category 1 and 2 drugs are indicated in Tables 3.6 – 3.9.

3.4.3 Step 3 Costing for laboratory tests – sputum smear test

Following information need to be gathered in order to compare rural and urban groups of patients. Unit cost of laboratory test includes cost per service of laboratory technicians, used chemical substances, slides, glass place mats and containers and boxes.

1. Laboratory cost per sputum test (Unit cost)
2. Transportation cost to TB center per test different in rural and in city
3. Number of tests need to be checked that have been done for each treated patients:

- Cured
- Failed
- Died
- Completed
- Defaulted
- Transfer out

4. Total number of tests in each comparing program. Calculation:

Total cost = (Unit cost + Transport cost /sputum test) * Total number of tests

Table 3.6 Costing method for Category 1 TB drugs for children

N	Category 1 children	5-7kg	8-14kg	15-20kg	Over 20kg
1	Total N of days phase 1	+	+	+	+
2	Total N of days phase 2	+	+	+	+
3	RHZ tab/day	1 pill	2 pills	3 pills	
4	E(100)	1 pill	2 pills	3 pills	
5	RHZE tab/day				2 pills
6	RH (60/30) tab/day	1 pill	2 pills	3 pills	
7	RH (60/60) tab/day				2 pills
8	Cost of RHZ /tab	+	+	+	
9	E (100)	+	+	+	
10	Cost of RHZE /tab				+
11	Cost of RH (60/30)/tab	+	+	+	
12	Cost of RH (60/60)/tab				+
Total cost for children in each weight category		= (3 * 8 + 4 * 9) * 1 + (6 * 9 * 2) for less than 20kg child = (2 * 8 * 1) + (7 * 10 * 2) for 20-30kg child			
Total cost of program		Sum of all total costs in each weight			

Table 3.7 Costing for category 1 TB drugs among adults

N	Category 1 children	30-39kg	40-54kg	55-70kg	Over 70kg
1	Total N of days phase 1	+	+	+	+
2	Total N of days phase 2	+	+	+	+
3	RHZE tab/ day	2	3	4	5
4	RH (60/60) tab/ day	2	3	4	5
5	Cost of RHZE /tab	+	+	+	+
6	Cost of RH (60/60)/tab	+	+	+	+
7	Total cost for adults in each weight category = (3 * 5 * 1) + (4 * 6 * 2)				
	Total cost for program	Sum of all total costs in each weight category			

Table 3.8 Costing for Category 2 drugs among children

N	Category 1 children	5-7kg	8-14kg	15-20kg	20-30kg
1	Total N of days phase 1	+	+	+	+
2	Total N of days phase 2	+	+	+	+
3	RHZ tab/day	1 pill	2 pills	3 pills	
4	RHZE tab/day				2 pills
5	E (100)	1 pill	2 pills	3 pills	
6	RH (60/30) tab/day	1 pill	2 pills	3 pills	
7	RH (60/60) tab/day				2 pills
8	Cost of RHZ /tab	+	+	+	
9	Cost of RHZE /tab				+
10	Cost of E(100)/tab	+	+	+	
11	Cost of RH (60/30)/tab	+	+	+	
12	Cost of RH (60/60)/tab				+
Total cost for children		= ((3 * 8 + 5 * 10) * 1) + (5 * 9 * 2) for less than 20kg = (4*9*1) + (7*12*2) for 20-30kg			
Total cost of program		Sum of all total costs with each weight category			

Table 3.9 Costing for category 2 TB drugs among adults

N	Category 1 children	30-39kg	40-54kg	55-70kg	Over 70kg
1	Total N of days phase 1	+	+	+	+
2	Total N of days phase 2	+	+	+	+
3	RHZE tab/ day	2	3	4	5
4	S (10) vial/day	1	1	1	1
5	RH (60/60) tab/ day	2	3	4	5
6	Cost of RHZE /tab	+	+	+	+
7	Cost of S	+	+	+	+
8	Cost of RH (60/60)/tab	+	+	+	+
Total cost for adults in each weight category		= (3 * 5 * 1) + (4 * 8 * 1) + (4 * 6 * 2)			
	Total cost for program	Sum of all total costs in each weight category			

3.4.4. Step. 4 Costing for travel cost incentives from MATA volunteers

Incentive was provided in DOTS MATA intervention and each volunteer received US$20 per month. In average, each volunteer serve for 3 patients in a working day. Calculation method is shown in Table 3.10.

Table 3.10 Costing for services received from MATA volunteers

N	Information from data	Value
1	Incentive for 1 volunteer per month	$20^ˆ$
2	Average service per day	3
3	Cost for 1 service per patient	=1 / (22 * 3)
4	Number of services received by each patients	+
Total number of services received by patients		Sum of all services, received
Total cost of services received from volunteers (US$)		= 3 * 4

ˆ MATA volunteers receive 20 dollars per month and serve 3 persons in average a day.

3.4.5. Step. 5 Costing for lunch received by pulmonary smear positive TB patients

Lunch incentive is provided in cafeterias for patients on becoming negative sputum smear tests. Therefore, patients' laboratory test records are highly desirable to check each patient who benefits from lunch program, as shown Table 3.11.

Table 3.11 Costing for lunch received by sputum smear (+) pulmonary TB patients

N	Information from data	Value
1	Lunch cost per patient (US$)	1.82
2	N of services for patients, who became smear (-) after 2^{nd} test	+
3	N of services for patients, whobecame smear (-) after 3^{rd} test	+
4	N of services for patients, who became smear (-) after 4^{th} test	+
5	Total services	= 2 + 3 + 4
Total cost for lunch (US$)		= 5 * 1

3.4.6. Step. 6 Costing for patients travel cost and spent time due to drug intake at dispensaries.

Need to collect survey from beneficiaries who receive treatment from government financed TB center hospitals. Estimated survey will be collected 60 patients from both rural and city dispensaries. (see Table 3.12)

Table 3.12 Estimation for travel and opportunity cost for patients at dispensaries

N	Parameters	Value
1	Total travel time during treatment course	+
2	Average travel cost (from survey)	+
3	Average time spent in order to take medicine (from survey)	+
4	Working days per month	22
5	Working hours a day	8
6	Unskilled workers salary per month 2010 (MNT)	108 000
7	Average currency exchange rate 2010 (Forex website)	1352.55
Total travel cost		= 2 * 1
Total opportunity cost		= 3 * 1 * (6 / 4 * 5)

3.4.7 Step. 7 Costing for state health workers salary

Salary scale for doctors and nurses will be taken into account. Additionally, bonus and incentives will be included. Since, doctors and nurses work closely and observe TB treatment it is important to take both of their wages are desired to be calculated in cost effectiveness analysis.

Labor cost of dispensary (cost of DOTS supervisor)

- Doctors salary including incentives per month (salary scale)
- Nurses salary including incentives per month (salary scale)
- Total number of nurses and physicians

Calculation:

Physicians' cost = N of doctors * monthly salary * 12 months + Training cost a year

Nurses' cost = N of nurses * monthly salary * 12 months + Training cost a year

Total labor cost = Physicians' cost + Nurses' cost

3.5 Treatment outcomes and definitions

There are seven possible treatment outcomes, which will be analyzed through a decision tree analytic modeling.

1) Cure rate is a number of patients, who had sputum smear negative test after DOTS program (WHO guidelines, 2010) . Cure rate will be counted by number of patients and will be used in cost effectiveness ratio.
2) Default rate is a number of patients, who did not finish the DOTS (WHO guidelines, 2010) or who interrupted treatment for 2 consecutive months or more (MOH, 2010). Both rate and its probability are to be counted in sensitivity analysis by holding in various levels to examine how the descending default rate affects cost effectiveness of different interventions. Since successful treatment is related to the decreasing default rate, this is to be used for sensitivity analysis, whether it has impact on cost effectiveness of DOTS
3) Completed rate is a number of patients, who finished the DOTS and have not tested by laboratory at the end of treatment (WHO guidelines, 2010). This rate is also expressed by the number of patients and is to be included in successful treatment for cost effectiveness ratio
4) Mortality is a number of patients, who died during the treatment (WHO guidelines, 2010) or who died for any reason during the therapeutic course. Mortality rate and its probabilities will be accounted in decision tree model
5) Transferred out is a rate of patients, who has been moved to another location during the treatment period and will also accounted in decision tree model
6) Failure rate is a rate of patients, who have no significant improvement for treatment and measured by the negativity of sputum tests. Once patients are detected three consecutive positive sputum test, which implies not improvement, they fail the

treatment and considered to undergo category 2 treatment. The failed will be accounted in decision tree analysis.

7) Additionally, cured and completed rate are together can be assumed successfully treated patients (MOH, 2010) and will be used both in cost effectiveness ratio of TB interventions and probabilistic decision tree analysis. Successful treatment rate is the major interest of effectiveness in the study, so total cost of each intervention will be counted per successful treatment case. Authorities takes action and implement strategy to increase success rate. Particularly, providing of ancillary drugs for management of adverse events through free of charge, decentralization of treatment to be available and closer to where patients live by means of reducing costs, provision of psychosocial support, and use of patient incentives.

3.6 Cost Effectiveness Calculation

By calculating and comparing Cost Effectiveness in each program via conventional method of cost effectiveness analysis, following procedures are to be completed.

- Total Cost (in each intervention by Dispensary and MATA volunteers)

- Outcome (in each intervention) = E (cure rate or success rate)

- Cost Effectiveness Ratio (CER)

  Formula: CER = Total Cost / E (cost per cured case)
  CER = Total Cost / E (cost per successful treatment)

  Comparison CER of DOTS Dispensary vs. DOTS MATA intervention

- Incremental Cost Effectiveness Ratio (ICER)

$$\text{ICER} = \frac{\text{Cost dispensary DOTS} - \text{Cost volunteer based DOTS}}{\text{E at dispensary DOTS} - \text{E at home based DOTS}}$$

3.7 Incremental Analysis

This is used to determine how much DOTS from MATA program spent more or saved to prevent 1 defaulted case of DOTS comparing to the program of DOTS as dispensary. Decision analysis model will be used to calculate the number of patients flow in each settings categorized by outcomes. Particularly, defaulted cases will be calculated. Then cost of each program, averted default cases, and incremental cost per averted default case calculation is indicated in the table below.

Table 3.13 Incremental Analysis Calculation Table

Programs	Cost per 630 patients	Default per 630	Incremental Cost	Not successful treatment prevented	C/ratio (cost per default prevented)
Dispensary	X	E1	Y - X	E2-E1	(Y –X) /(E2-E1)
MATA	Y	E2			

3.8 Sensitivity Analysis

Since DOTS outcome will be accounted as five outcome categories such as cure rate, default rate, completed rate and mortality rate. Data will be used for computation of the probability in each outcome category, in each comparing group and in both urban and rural areas. Due to uncertainty of data default rate will be varied and to assess how default rate affects cost effectiveness ranking among two program settings. For probabilistic decision tree model, default rate and mortality rate are desired to be estimated by using data. One of the important factors, that need to be checked, is default rate among patients with pulmonary sputum positive patients. Cost effectiveness of preventing from TB mortality can be done as similar way after collecting the data at the same time. Then incremental analysis is going to be applied to assess whether DOTS

strategy is cost effective in terms of changing default rate. Sensitivity analysis will be done on the basis of conventional method and probabilistic decision tree model.

Possible benefit

Provided with a limited budget in health care, I keen to contribute to set up feasible solutions to improve effectiveness by doing possible research on DOTS for tuberculosis and activities of which, authorities can use for their future policy implementation for the best practice and its performance to decrease mortality by improving treatment success.

It is not only beneficial to patients and health professionals, but also beneficial for government to spend money efficiently and effectively on tuberculosis treatment management. Within the budget, ineffective strategy to fight TB is going to be burden on patients, otherwise on the government in the near future because of loss of resources from high failure and default rates of DOTS in dispensaries.

As mentioned earlier treatment of multidrug resistant pulmonary tuberculosis (MDRT) is arising problem among Mongolians and is costly, and often fails to cure. If we do not manage treatment effectively, MDRT tend to increase and would be left without cure with transmission to the community.

Ultimately this dramatically contributes to increase in health expenditure. Conducting cost effectiveness study on DOTS is valuable for implementing treatment at the right time and right place among right patients to achieve Millennium Development Goals to have halted the spread of tuberculosis. (Sodnompil, 2009)

CHAPTER IV

RESULTS

Cost effectiveness analysis has been done among DOTS dispensary and DOTS MATA groups in Mongolia during one year period of 2010. Costing was estimated by US dollar as of 2010 (as the same rate of I$). Official exchange rate of US$ 1 = 1357.06 MNT (Mongolian National Tugriks) average exchange rate of year according to a World Bank report and CPI indices, 2010 = 223.992 and 2012 = 248.069 according to the International Monetary Fund, were obtained from Trading Economics website (Trading Economics, 2012). The consumer price indices are based on the year of 2000 = 100. Health outcome were estimated on the basis of treatment outcome of dataset for 2010. Descriptive analysis has been done by EpiInfo 7 and binary logistic correlation regressions have been undertaken by Eview 4 among determining factors of treatment outcomes. Cost effectiveness per cured and successful treatment, and sensitivity analysis have been done by conventional method of calculation on EXCEL windows. Cost effectiveness analysis per successful treatment, incremental analysis for per prevented default rate and sensitivity analysis on decreasing cost of inpatient care by varying rates of inpatient stay have been demonstrated by probabilistic decision tree model.

4.1. General description

The data in the study was collected from Department of Tuberculosis Surveillance and Research at National Center for Communicable Disease in Mongolia as of the year 2010. In total, 2077 cohorts are included in the analysis, after excluding 32 cohorts because they changed locations of their treatment between two comparing groups, rural and city. Nonetheless, the study involved the cohorts, who changed the locations province to province in rural areas or district to district in the city.

In addition, 9 out of 9 districts and 1 hospital of prison from the city and 19 out of 21 provinces included in data collection, which highlights only two provinces are not counted due to accessibility of data. Summary of data is illustrated in Table 4.1.

Table 4.1 Data analysis

Parameters	Number (%) of cohorts		P Value
	Dispensaries n =1427	MATA volunteers n = 630	CI (95%)
Gender			
Male	821 (57.53)	332 (52.70)	
Female	606 (42.47)	298 (47.30)	
Occupation			
Employed	257 (18.01)	103 (16.35)	
Unemployed	751 (52.63)	340(53.97)	
Age median (range)	31.5 (23.5-45.5)	31 (23.5-45.5)	.55
Weight median (range)	54.5 (48.5-60.0)	53.5 (48.5-60.0)	.65
Category 1 treatment	1070 (74.98)	611 (96.98)	
Category 2 treatment	357 (25.02)	19 (3.02)	
Sputum test changed to (-)			
After 2 months	745 (52.21)	468 (74.29)	
After 3 months	436 (30.55)	145 (23.02)	
After 5 months	1047 (73.37)	579 (91.90)	
After 8 months	944 (66.15)	541 (85.87)	
After 12 months	55 (3.87)	20 (3.17)	
Treatment outcome			
Cured	1005 (77.94)	589 (96.20)	
Completed	113 (2.70)	17 (7.92)	
Failed	177 (12.40)	19 (3.02)	
Defaulted	71 (4.98)	1 (0.01)	
Died	48 (3.36)	5 (0.79)	
Transferred out	13 (0.91)	0 (0.00)	
Total number of patients in the city	964 (67.55)	262 (41.59)	
Total number of patients in provinces	463 (32.45)	368 (58.41)	

Circa, 58% and 53% of patients in comparing two groups, Dispensary and MATA, were males, respectively. Median age was around 31 in those groups and median weight was also around 54kg. There were no significant differences between these two comparing groups in terms of gender, age, and weight.

4.1.2 DOTS Effectiveness, binary logit with multiple regressions

The binary logistic regression was run to assess and estimate the prediction of treatment outcome between different determining variables and treatment outcomes, particularly success rate. Treatment success rate were major interest in the regression and chosen to be dependent variable as it is a treatment outcome. DOTS supervisors (Dispensary vs. MATA volunteers), location of treatment, (Urban vs. city), and patient's physical status such as weight and gender have shown significant prediction factors as explanatory variables. Because, the study needs to determine the influential elements for tuberculosis treatment to evaluate further cost effectiveness analysis among supervisors. If DOTS supervisors are correlated to treatment effectiveness strongly, it is worth doing further cost effectiveness analysis. The study has chosen only significant explanatory variables to show the effect of treatment outcome. Logit regression model as follows.

Relative frequency of successful treatment of DOTS:

Probability of successful treatment = $1 / 1 + e^{-Z}$

Z is the linear combination for successful treatment and presented as follows:

$Z = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5$

S is probability of successful treatment after selecting significant determinants:

$S = b_0 + b_1$*Supervisor+ b_2* Location + b_3* Weight + b_4* Gender + b_5* Infiltrative

Strength of association between successful and not successful outcome of DOTS:

Odds = Probability of successful treatment/ (1 – Probability of successful treatment)

Strength of intervention association with successful outcome of DOTS

$$\text{Odds ratio} = \frac{\text{Odds of DOTS MATA in those, who are treated successfully}}{\text{Odds of DOTS Dispensary in those, who are treated successfully}}$$

Explanatory variables:

Supervisor - DOTS supervision, DOTS Dispensary = 1 and DOTS MATA volunteers = 0

Location - Dummy variable, DOTS held in the city = 1 and DOTS in provinces = 0

Weight is a numerical variable and indicates patients' body mass at the start of treatment

Gender is a dummy variable, and representing Male = 1 or if it is Female = 0

Infiltrative – Diagnosis, a categorical variable, was made at the start of the DOTS

Tuberculosis is often prevalent among the malnourished with poor neighborhood, so individuals' weight has been denoted as one of the significant predictors of successful treatment. Hence, treatment outcome would be allied considerably to body mass measurement.

Moreover, employment and education are concerned as fundamental causal factors that are frequently emphasized among tuberculosis patients and how they are correlated with the treatment outcome is worthwhile for decision makers. However, in this study, these factors are excluded from the most relevant factors due to their statistical insignificancies. All other insignificant variables were omitted. Following table shows significant determining factors for successful treatment of DOTS.

Table 4.2 Success rate correlation with determining variables (2023 observations) after 6 iterations at 95% of CI for male patients

Variables	Coefficient	Standard Error	Significance
Supervisor	-1.6033	0.2724	0.0000
Infiltrative form of TB	0.7164	0.1839	0.0001
Weight	0.0257	0.0099	0.0090
Sputum negativity after test 8	6.8496	0.5796	0.0000
Sputum negativity before test 8	2.1952	0.5202	0.0000
Constant	-2.7986	0.7581	0.0002

Note: Correct prediction = 83.86%, McFadden R-squared = 0.5327

Table 4.3 Correlation matrix of determining variables (2023 observations)

Successful treatment	Correlation of determining variables
Dispensary	-0.2215
Infiltrative form of pulmonary tuberculosis	0.1545
Weight	0.0792
Sputum negativity after test 8	0.6657
Sputum negativity before test 8	-0.5918

Table 4.4 Strength of intervention association with successfully treatment of DOTS

DOTS intervention	Exponential	Probability	Odds	Odds ratio	Partial change
Dispensary	0.4159	0.7063	2.4047	0.6698	-0.0831
MATA	0.2785	0.7821	3.5903	1.4930	0.0683

Binary logit with multiple regressions indicate that probability of successful treatment is much higher in DOTS with MATA-volunteers strategy for both in city and urban areas and male and female patients comparing to DOTS under TB dispensaries. However, both males and females in the city under DOTS Dispensary group indicated the least odds, which is 2.4047. This tells that probability of successful treatment is 2.4 times higher than unsuccessful treatment. On the other hand, both males and females under DOTS MATA group showed the higher odds of successful treatment, which is 3.5903.

Strength of DOTS MATA intervention with successful treatment outcome comparing to DOTS under TB dispensaries is 1.4930, which indicates that successful treatment of DOTS under MATA supervision is roughly 1.5 times higher than Dispensary DOTS. In other words, DOTS MATA intervention increases the probability of successful treatment by 1.5 times. Once, we increase the patients by 0.01 unit the probability of successful treatment is increased by 0.0683 in DOTS MATA, while it is plummeted by 0.0831 in in DOTS Dispensary.

Therefore, DOTS under health volunteer (MATA) strategy is evident to be more effective intervention for tuberculosis treatment and further cost effectiveness analysis is valuable asset for DOTS in Mongolia.

4.1.3 Cost Estimation

As described before costing needs to have organized into two different groups such as City and Provinces, due to their disparities among health care settings. Each location divided by the study groups like Dispensary and MATA DOTS. Costing has been followed by the following steps.

Table 4.5 Costing steps during DOTS for pulmonary sputum (+) TB patients and converted into US$ as of 2010

Steps	Costing category	Dispensary DOTS	MATA DOTS
1	Inpatient treatment	Total cost of patients	Total cost of patients
2	TB drug treatment	Total cost of DOTS	Total cost of DOTS
3	Laboratory test	Total cost of sputum test	Total cost of sputum test
4	Cost for volunteers	-	Volunteers incentive
5	Cost for lunch	-	Total cost of lunch, spent
6	Patients' out of pocket payment	Total cost of travel and opportunity cost	Volunteers opportunity cost -
7	Cost of supervisors (allocated to the study cohorts)	Yearly wages of doctors and nurses (including training cost)	Yearly wages of doctors and nurses (including training cost)
Total cost of programs		Sum of steps 1,2,3,6,7	Sum of steps 1,2,3,4,5,7

4.1.3 Step 1 Costing for inpatient care, initial treatment of DOTS

Costing inpatient care is important initial step for cost effectiveness analysis in this research. There are number of dissimilarities between hospitals' inpatient length of stays for TB patients among rural and urban area. In the reality, because of high patients' load, TB inpatient stay is less than normal 56 days in the city.

Also, we note that in the city average staying in inpatient clinic is different between children and adults. Data for provincial TB center is captured from the recent hospital services costing survey for provincial and district health facilities. The survey accounted

TB centers from 5 provincial hospitals as a representative of 21 provinces in Mongolia and selected one secondary hospital from each regions such as eastern, western, northern, southern and central provinces.

Mongolian National Center for Communicable Disease makes the data related to the inpatient clinic available and varying the costs by three categories such as food cost per day, non-TB drug cost per TB patient and inpatient bed day cost per head due to a different funding and payment mechanisms, while provincial hospitals were estimated the inpatient cost by total cost per head from 2008 survey MOH.

All inpatient costs, gathered from the survey, from either rural or urban TB centers were estimated by total cost, including fixed and variable costs using step down method of allocation (MOH, 2011). Because of Mongolian health insurance plan and its payment mechanism, per capita cost was available for costing of the inpatient care as initial treatment of tuberculosis (MOH, 2011).

Table 4.6 Calculation of inpatient stay for TB patients

Category	Formula
Total cost of inpatient care for children (City)	= Number of children * ((average bed day * food cost) + non TB drug cost + Cost of average inpatient care, excluding food and non-TB drug cost))
Total cost of inpatient care for adults (City)	= Number of adults * ((average bed day * daily food cost) + non TB drug cost + Cost of average inpatient care excluding food and non-TB drug cost)
Total cost (City)	= Total cost for children + Total cost for adults
Total cost (Provinces)	= Total number of TB patients * Cost of average inpatient care cost

Source: MOH, Hospital services costing survey at aimag (province) and district health facilities, 2011 and Administration and statistics office of the National Center for Communicable Disease (NCCD)

Table 4.7 Inpatient care costing, separated by Dispensary and MATA volunteers

Category	Dispensary (City)	Dispensary (Rural)	MATA (City)	MATA (Rural)
Inpatient stay				
Children	34.7	56	34.7	56
Adults	24	56	24	56
Food cost (US$)	2.22	-	2.22	-
Non TB drug cost per head (US$)	39.76	-	39.76	-
Bed day cost per head (US$)	256.55	621.91	256.55	621.91
Number of children	16	4	5	9
Number of adults	948	258	458	358
Subtotal cost (US$)	336,323.70	286,985.14	91,399.22	228,100.50
Total cost (US$)	623,308.84		319,499.72	

Note: All costs were collected in monetary terms of Mongolian National Currency (MNT) and converted into US$ and US$ 1 = MNT 1357.06 using official average currency rate as of 2010 (Trading Economics, 2010)

Comparing dispensary DOTS program with MATA DOTS program necessitates varying calculations of inpatient care into the city and provinces, also needs to separate the cost into children and adults due to different average stay in inpatient clinics.

4.1.3 Step 2 Costing for TB drugs during DOTS treatment

Costing on TB drugs, spent during 2010, is accounted in each category of treatment plus extended therapy. Due to unsuccessful result of sputum test after 2 months therapy, patients needed to prolong the treatment by HRZE combination by a month, 28 days, which was available to calculate from the dataset. Patients with successful treatment results spent standard 6 months therapy for category 1 and 8 months duration for category 2 treatment options. Nevertheless, it was necessary to check patients' treatment duration by disease history of each patient in the dataset. Particularly, patients with treatment

results like failed, defaulted, died and transferred out, have different treatment lengths due to interrupting the regular regimen in various times.

Table 4.8 Costing for TB drugs in each comparing group during DOTS period

Drug category	Dispensary DOTS (US$)	MATA DOTS (US$)
Category 1	40,285.86	24,766.26
Extended drug therapy	2,067.78	734.89
Category 2	21,960.63	1,190.95
Total cost for TB drugs	64,314.28	26,692.10

Note: Detailed calculation in the appendices A.1 – A.9 and all costs were collected in monetary terms of MNT and converted into US$ using average currency rate as of 2010 at the time of purchasing drugs.

Instead of taking average expenditure for TB drugs, costing had been calculated according to each individual's weight, age, treatment duration and category due to its different amount of doses taken by patients. The number of patients with category 2 treatment is roughly three times less than that of category- 1 treatment. But, cost is almost half of category 1 treatment (6 months) as a consequence of long time treatment required (8 months) in dispensaries.

4.1.3 Step. 3 Costing for TB laboratory test

During the treatment each patient has to provide 3 tests after initial test of diagnosis. Patients with cured results have 3 tests each. However, patients, who completed, defaulted, failed, died and transferred out, have given indifferent test counts. Thus, checking by total number of tests in each treatment result was crucial for the costing. Total laboratory costs in the city and rural areas are differed by its transportation cost. Transportation cost is provided by separate financial source, sputum transportation project, in rural areas whereas it is provided by Mongolian Association of Family Group Physicians. Cost per sputum test includes all the fixed and cost such as chemical

substances, boxes and mats but limited by non- fixed cost. Laboratory technician's salary, included, was considered by general salary scale as provided by Ministry of Health.

Table 4.9 Costing for laboratory sputum tests in each comparing group as of 2010

Costing categories	Dispensary (city)	Dispensary (rural)	MATA (city)	MATA (rural)
Cost per sputum (US$)	2.41	2.41	2.41	2.41
Transportation cost per sputum (US$)	5.00	13.00	5.00	13.00
Total number of tests	3,568	1,397	1,058	1,143
Subtotal cost (US$)	26,438.88	21,527.77	7,839.78	17,613.63
Total cost (US$)	47,966.65		25,453.41	

Note: Costs were collected and calculated on the basis of US$ as of 2010. Detailed calculation is available in the Appendices B.1- B.3

4.1.3 Step.4 Costing for travel incentives from MATA volunteers

Volunteers from MATA work closely with patients in order to observe patients' drug intake but they only started to serve after patients discharge from TB centers (inpatient). Thus after deduction 24 inpatient average length of stay days for adults, 37 for children in the city and 56 days in rural areas, the rest days are counted as MATA volunteers served in this group. This cost is only counted for DOTS MATA volunteer cohorts both in rural and urban areas (see Table 4.10).

Table 4.10 Costing for services from MATA volunteers used for incentives

Costing Categories (US$)	Dispensary DOTS	MATA DOTS (US$)
Monthly volunteers service incentive	-	20
Service, per patient, one time a day	-	0.3
Number of services, patients received	-	39,205
Total cost for volunteers' services	-	11,880.22

Note: Detailed calculation is available in the Appendix C.1

4.1.3 Step.5 Costing for lunch received by pulmonary smear positive TB patients

As a MATA guideline, lunch is provided for selected patients, who are homeless and sometimes students, after sputum test becomes negative, which means no infection for others. Hence, it is highly valuable to check patient's history to select sputum tests negativity during the treatment. Then by counting total number of tests in this group was multiplied by lunch cost per patient. Additionally, travel cost of all MATA volunteers, before patients had lunch service, was contracted need to be calculated (see Table 4.11).

Table 4.11 Costing for lunch received by sputum smear (+) pulmonary TB patients

Costing categories (US$)	Value
Lunch cost per patient (US$)	1.82
N of lunch for patients (test becomes (-) after 2nd month)	13,480
N of lunch for patients (test becomes (-) after 3rd month)	2,180
N of lunch for patients (test becomes (-) after 5th month)	300
Cost of per service from volunteers before lunch provision (US$)	0.30
Total Number of services patients received before lunch	3,466
Total number of services for lunch program	15,960
Total cost of services from volunteers before lunch provision (US$)	1,039.80
Total cost for lunch (US$)	29,047.20
Total cost for volunteers observation during lunch (US$)	4,788.00
Total cost for lunch services from MATA (US$)	34,875.00

Note: Calculation is illustrated in Appendices C.2 and C.3

4.1.3 Step.6 Estimation of travel and opportunity cost for patients in case of drug intake at TB dispensaries

Collected survey from beneficiaries who receive treatment from government financed TB center hospitals. Totally, 73 patients, 34 from 7 rural dispensaries and 39 from 3 districts

of the city were surveyed by interview at dispensaries during the time of treatment observation. Doctors at TB dispensaries in each district and province conducted survey. This calculation is not counted for comparing group from MATA, because patients in this group do not pay for travel and lunch expenses during DOTS treatment. The survey was only intended to estimate average expenditure of patients travel cost (round way, not one way) at dispensaries for regular intake of anti-tuberculosis medicine. Adding per patient visit to dispensaries for DOTS solves to find total number of patients' visits from treatment duration in disease history. Moreover, patients were assigned to take medicine in every 5 working days. Thus, cost was calculated not by daily but weekly visits to the dispensaries (see Table 4.12).

Table 4.12 Estimation of travel and opportunity cost

Costing categories	Dispensary DOTS		MATA DOTS	
	City	Rural	At home	Lunch
Total number of travel	18,483	8,195	39,204	19,426
Cost of round way per travel	1.0	0.94	-	-
Opp. cost per lunch	-	-	-	0.90
Opp. cost of volunteers before patients were provided by lunch	-	-	-	0.45
Opp. cost per travel time	0.61	0.49	0.45	-
Total travel cost for travel	19,104.85	7,758.66	-	-
Total opportunity cost	11,562.86	4,028.37	17,727.00	23,217.00
Total cost burden on patients (US$)	42,454,74		-	
Total opp. cost of volunteers	-		33,728.48	

Note: By survey from 73 patients, as of February, 2012. Detailed calculation is available in the Appendices D.1- D.4. Cost of round way per travel time is not calculated in MATA DOTS due to a subsidy (as incentives) in table 4.11

4.1.3 Step.7 Costing for health workers allocated to the study group

Salary was calculated by the scale provided by MOH as of 2010. Cost of health workers for this study was allocated per capita. Using percentage of patients in this study from total number of patients with tuberculosis, who had been diagnosed and treated as pulmonary and non-pulmonary tuberculosis in 2010, allows estimating overall cost allocated from government expenditure for this study.

Base salary included the average amount of salary scale and government responsible incentives and subsidies, but did not include the amount of cost adjustments for working year experience (see Table 4.13).

Table 4.13 Costing for health workers (supervisors)

Category	Dispensary	MATA
Number of TB Physicians	68	12
Number of TB nurses	160	2
Total number of cohorts in the study	1,427	630
Total number of TB patients in 2010	3,421	742
Total salary	658,740,98	42,199.39
Training cost, spent in 2010	35,357.83	3,049.00
Cost allocated per patient (US$)	202.89	60.98
Total cost allocated for each intervention (US$)	289,529.09	38,418.44

Note: Wage of physicians and nurses is taken by government scale as of 2010 and converted to US$ terms. Detailed calculation is available in the appendix E

In 2010, totally 207 new volunteers were trained to observe DOT among tuberculosis patients and total expenditure for only training accounts for $3,049.00, as a source provided by MATA office. So, it is calculated into volunteers' incentive program and all costs for incentive totaled to $15,060.39 which was spent for beneficiaries with sputum smear positive tuberculosis in this study from MATA.

4.1.8 Total cost

Total cost is sum of all appropriate incurring costs in each program. Treatment strategy of DOTS Dispensary seems to be expensive intervention, but this is because of larger sample size of study cohorts in dispensary DOTS (see Table 4.14).

Table 4.14 Total cost in each program as of 2010

Categories (US$)	DOTS Dispensary (US$)	DOTS MATA (US$)
Total cost of inpatient care	623,308.84	319,499.72
Total cost of TB drug treatment	64,314.28	26,692.10
Total cost of sputum test	47,966.65	25,453.41
Total cost of health workers	289,529.09	38,418.44
Total cost volunteer services (incentive)	N/A	11,880.22
Total cost of lunch provision	N/A	34,875.00
Total opportunity and travel cost	42,454.74	33,728.48
Total cost of each intervention	1,067,573.60	490,547.37

When we account into the average cost of TB patients DOTS MATA becomes more costly than DOTS Dispensary, US$ 778.65 and US$ 748.12 respectively. Cost effectiveness analysis is needed to be done for further evaluation to examine which strategy is effectively used for DOTS

4.2. Cost Effectiveness Analysis

Cost effectiveness analysis has been done from both providers' and patients' perspectives. Cost effectiveness ratio per cure rate for DOTS Dispensary intervention is US $1,062.26, while it is US $ 832.85 for DOTS MATA in Mongolia as of 2010. The two strategies are compared by their total cost for each program per cured case (see Table 4.15).

Table 4.15 Cost effectiveness of DOTS by per cured cases

Groups (2010)	Cost per program (US$)	Incremental Cost (US$)	Cure Rate	Incremental Effectiveness	CER (US$)	ICER (US$)
Dispensary	1,067,573.60	577,026.23	1,005	416	1,062.26	1,387.08
MATA	490,547.37	-	589	-	832.85	-

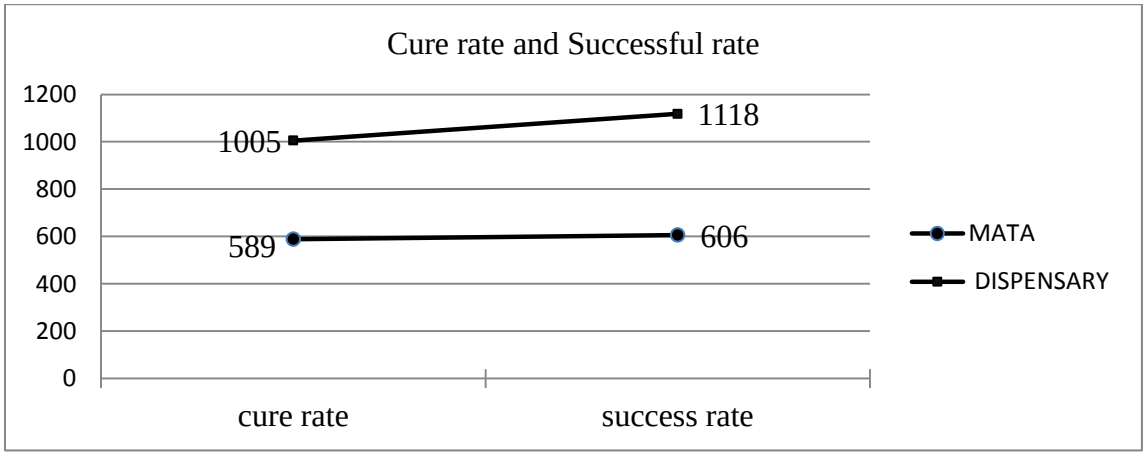
Cost effectiveness ratio per cured case of MATA DOTS was US$ 229.41 less than government financed Dispensary DOTS. Therefore, DOTS with MATA volunteers appears to be more cost effective approach in terms of patients, who are cured.

Moreover, the incremental cost for Dispensary DOTS is US$ 577,026.23 more than DOTS with MATA volunteers due to its larger sample size (total number of patients in Dispensary DOTS is roughly as twice more as MATA DOTS). When it is accounted for incremental cost effectiveness ratio, DOTS Dispensary is $US 1,387.08 per additional cured cases from TB. Dispensary DOTS spent more money on additional cured patients in 2010 and highlights to be not cost effective approach for TB treatment.

Since successful rate is another measurement of work result for DOTS program and as it is defined chapter 3, patients, who had cured and completed treatment with improved test result previously, but haven't checked by the last test, are considered as successfully treated patients.

DOTS Dispensary has more patients, who had completed the treatment. If we add up the cured case and the completed case, effectiveness of DOTS Dispensary will be improved (see Figure 4.1).

Figure 4.1 Effectiveness of DOTS using cure rate and successful rate



When these two programs are compared by the effectiveness, including number of cured patients and of completed patients, success rate increases in Dispensary program more than MATA program. Therefore, the study also aimed to account successful result in the cost effectiveness and sensitivity analysis whether it affects cost effectiveness ratio. DOTS by dispensary program tend to have 96 cases, which are completed treatment when accounted as successful cases, more than MATA program. So, it may increase the number of denominator and change cost effectiveness ratio (see Table 4.16).

Table 4.16 Cost effectiveness of DOTS programs per successful treatment

Groups (2010)	Cost per program (US$)	Incremental Cost (US$)	Success rate	Incremental Effectiveness	CER (US$)	ICER (US$)
Disp.	1,067,573.60	577,026.23	1,118	512	954.90	1,127.00
MATA	490,547.37	-	606	-	809.48	-

Cost effectiveness ratio for successful treatment of DOTS with MATA volunteers was US$ 145.41 less than Dispensary DOTS and when comparing with CER per successful case from DOTS dispensary, it becomes closer to MATA program. But, still MATA DOTS appears to be robust and more cost - effective as well. The incremental cost effectiveness ratio of DOTS dispensary program is $US 1,127.00 per additional

successfully treated individual, which is less than its incremental cost effectiveness ratio per cured patients.

The cost effectiveness and incremental cost effectiveness of these two approaches are computed by the following calculation:

1. CER per cured case:

   Dispensary CER = Total Cost / E = 1,067,573.60/ 1005 = US$1,062.26

   MATA CER = Total Cost / E = 490,547.37/ 589 = US$ 832.85

2. CER per successful case:

   Dispensary CER = Total Cost / E = 1,067,573.60/ 1118 = US$ 954.90

   MATA CER = Total Cost / E = 490,547.37/ 606 = US$ 809.48

3. ICER for cured result:

$$\text{ICER} = \frac{\text{Cost of dispensary DOTS} - \text{Cost of MATA DOTS}}{\text{Cure rate of Dispensary} - \text{Cure rate of MATA DOTS}}$$

$$\text{ICER} = \frac{1{,}067{,}573.60 - 490{,}547.37}{1005 - 589} = \text{US\$ } 1{,}387.08$$

4. ICER for successful result:

$$\text{ICER} = \frac{\text{Cost of dispensary DOTS} - \text{Cost of MATA DOTS}}{\text{Success rate of Dispensary} - \text{Success rate of MATA DOTS}}$$

$$\text{ICER} = \frac{1{,}069{,}707.86 - 491{,}658.44}{1118 - 606} = \text{US\$ } 1{,}127.00$$

4.3. Sensitivity Analysis

There are various factors of uncertainty in economic evaluation. First, it can be parameter uncertainty. This applies to parameters such as event probabilities, costs, utilities, and treatment effects (Drummond, 2005). Based on available data the informed assumption is applied. In 2010, totally 2057 patients, enrolled in the study, had undergone anti – tuberculosis treatment. Patients receiving treatment from dispensary have higher rate of defaulted cases, which implies that whether default rate affects cost effectiveness ratio among two programs. Second, it is uncertain that whether cost of inpatients stay of treatment influence cost effectiveness for programs. Sensitivity analysis will be done by one way sensitivity approach with two different scenarios.

Decreasing default rate is important and possible way to improve effectiveness of treatment and way to decrease the number of TB contacts to the public, otherwise the more defaulted patients from DOTS are exist, the more infectious people would be released to the public and the more expensive treatment the providers would pay in the future.

Therefore, after decreasing the default rate until zero as the same as MATA volunteers program, which has no default rate among DOTS patients, ranking of the cost effectiveness between these two programs doesn’t change, which implies that there is other factor that correlates this effect. It is due to an expensive treatment that DOTS require in order to comply for relatively a longer period of time at least 6 months as a standard. For example, inpatient stay in rural area is twice longer than that in urban area.

Because of uncertainty of DOTS adherence the National TB guidance requires patients to stay in hospitals (TB centers) for two months and be discharged after second test negativity. Also, all patients need to be observed by health workers and volunteers to assure whether they take medicine routinely.

On the other hand, study is conducted to assess the sensitivity analysis by decreasing inpatient stay of hospital in order to check how it affects cost effectiveness of each program. In the study default rate among patients, who received medical services from dispensaries, is 71 whereas MATA program have none. Thus, decreasing default rate from 71 to 0 will show how treatment result can affect cost effectiveness ratio (see Table 4.17).

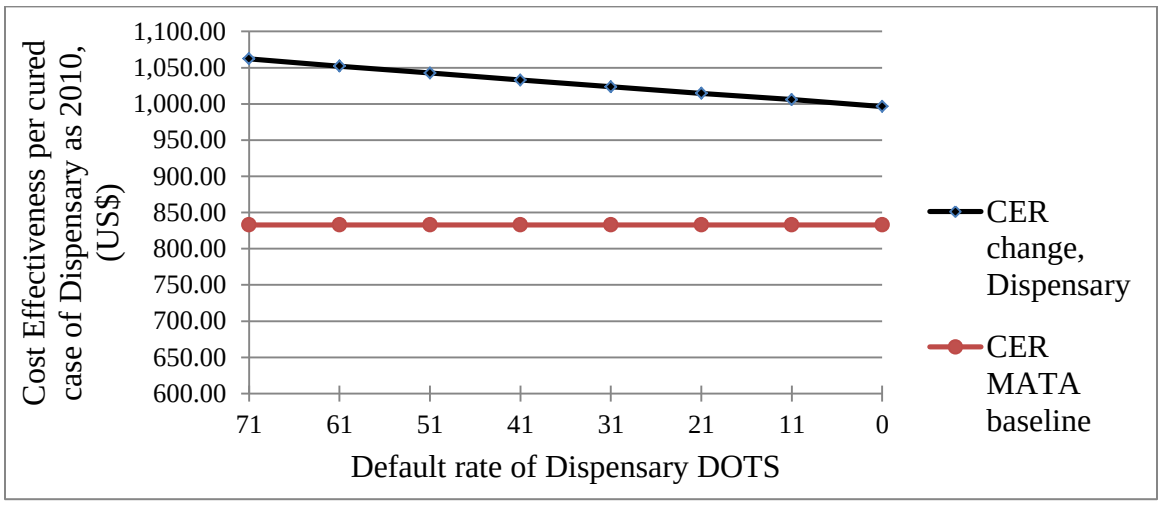
Table 4.17 Sensitivity analysis for the cured, using various default rates among DOTS with dispensary program

Default rate	Cost (US$)	Incremental Cost (US$)	Effectiveness (Cure rate)	Incremental Effectiveness	CER (US$)	ICER (US$)
71	1,067,573.60	577,026.23	1005	416	1,062.26	1,387.08
61	1,068,001.78	577,454.42	1015	426	1,052.22	1,106.23
51	1,068,624.23	578,076.86	1025	436	1,042.56	1,325.86
41	1,069,139.44	578,592.07	1035	446	1,032.98	1,297.29
31	1,069,769.93	579,222.56	1045	456	1,023.70	1,270.22
21	1,070,342.97	579,795.60	1055	466	1,014.54	1,244.20
11	1,071,222.10	580,674.73	1065	476	1,005.84	1,219.90
0	1,072,094.99	581,547.62	1076	486	996.37	1,194.14

CER and ICER calculations have been done by varying default rate of DOTS from 71 to 0 at dispensary. Nevertheless, cost effectiveness ratio is decreased from US$ 1,062.26 to US$ 996.37 for Dispensary DOTS, it is relatively inelastic as it is compared to the baseline of MATA intervention and could not improve cost effectiveness significantly.

At a zero default rate (in its maximal resource utilization) DOTS Dispensary is still more expensive than DOTS MATA volunteers per cured case. In other words, even if DOTS Dispensary strategy successfully implements treatment to the zero default rate, cost effectiveness ratio per cured case in MATA DOTS (base line at CER per cured case = US$ 832.85) dominates the other. Summary of sensitivity analysis of CER for cured case is simplified and illustrated below (see Figure 4.2)

Figure 4.2 Sensitivity after adjusting default rate at different levels for Dispensary DOTS intervention comparing DOTS with MATA volunteers



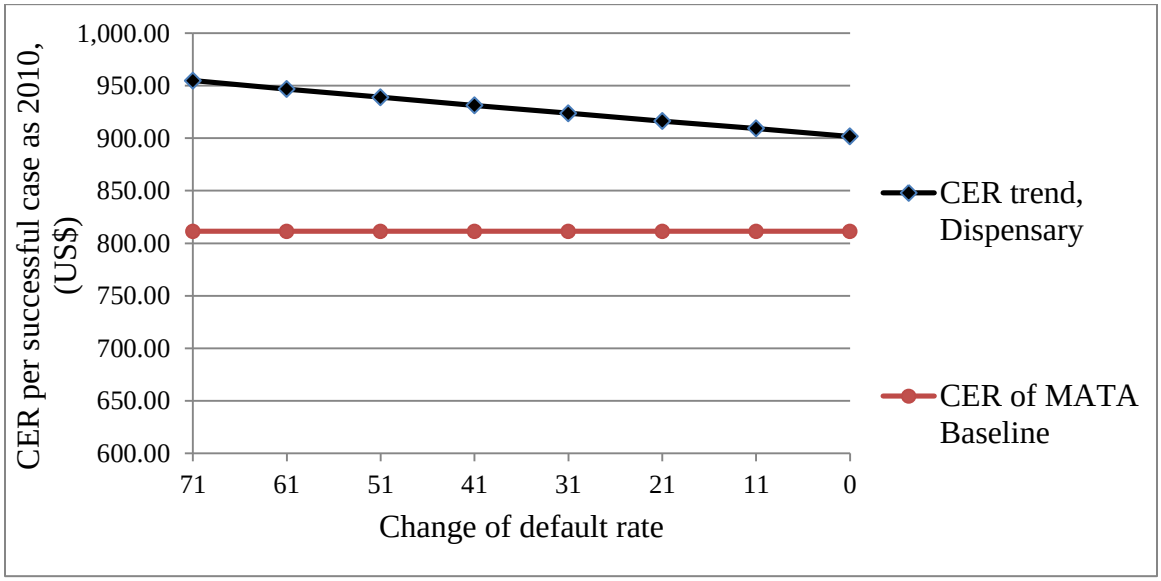
Furthermore, as this was discussed previously, sensitivity analysis can be done for CER per successful treatment, which is another useful measurement for DOTS achievement from provider's perspective. CER has been assessed and illustrated below Table 4.18.

Table 4.18 Sensitivity analysis for cost effectiveness per successful treatment case of Dispensary DOTS intervention as compared to base case of DOTS MATA

Default rate	Intervention	Cost (US$)	Incremental Cost (US$)	Effectiveness (Success)	Incr. Effect	CER (US$)	ICER (US$)
71	Disp.	1,067,573.60	577,026.23	1118	512	954.90	1,127.00
61	Disp.	1,068,001.78	577,454.42	1128	522	946.81	1,106.23
51	Disp.	1,068,624.23	578,076.86	1138	532	939.04	1,086.61
41	Disp.	1,069,139.44	578,592.07	1148	542	931.31	1,067.51
31	Disp.	1,069,769.93	579,222.56	1158	552	923.81	1,049.32
21	Disp.	1,070,342.97	579,795.60	1168	562	916.39	1,031.66
11	Disp.	1,071,222.10	580,674.73	1178	572	909.36	1,015.17
0	Disp.	1,072,094.99	581,547.62	1189	582	901.68	997.51
1	MATA	491,658.44	-	606	-	809.48	-

Comparing CER per successful case of DOTS Dispensary vs. DOTS MATA strategy appeared to be the closest US$ 901.68 and US$ 809.48 respectively, as default rate was adjusted to only zero. Yet, cost effectiveness of DOTS Dispensary is still not significantly improved, the difference is US$ 92.20, and did not change ranking as MATA was dominant in both sensitivity analysis (see Figure 4.3).

Figure 4.3 Sensitivity after adjusting default rate at different levels for Dispensary DOTS comparing with DOTS MATA program.



The reason why, CER of DOTS MATA has not changed is that default rate is only 1 in this intervention, whereas it is 71 in DOTS Dispensary. Thus, DOTS MATA was assumed as a baseline to compare how CER of DOTS Dispensary alters, when default was decreased from 71 to 0 level. Due to a large number of patients in Dispensary program associated with much higher cost may affect the robustness of cost effectiveness.

Therefore, following sensitivity analysis with probabilistic decision tree algorithm is needed to be undertaken on the basis of assumption if both programs have same number of patients and each intervention has the same probability of treatment outcome as it occurs in the original data set.

Sensitivity analysis based on probabilistic decision tree model

The decision tree algorithm was built on the basis of available data and its treatment outcomes. At the beginning of DOTS comparing two interventions separated with equal number of patient flow, 630 each. The reason why we select the number of patients' flow as 630 is due to availability and the most significant sample size of DOTS MATA intervention.

In DOTS Dispensary, there were 1427 patients had underwent treatment whereas 630 patients in DOTS MATA treatment in total. So, if both groups are compared with the same 630 patients, then comparison of two interventions reasonable to do cost effectiveness analysis. After allocating 630 patients in each intervention initial chance node was built on the basis of data of category-1 treatment. Each chance node presents 6 possible outcomes such as successful treatment, relapsed, defaulted, failed, died and transferred out.

After initial treatment if patients were registered to become relapsed, defaulted and failed, they start next treatment, which is called category-2 treatment as discussed previously. This category-2 treatment stands for second chance node in the decision tree algorithm. After category-2 treatment, all outcomes were grouped by successful treatment (S), otherwise not successful (NS). Probabilities of outcomes in each arms in the decision tree are computed by simplistic method of calculation. Calculation:

1) Chance node 1 – Initial treatment, Total number of patients = 611 in each intervention

   Probability of the success rate = success rate / total number of patients

   Probability of the failed = rate of failure / total number of patients

   Probability of the defaulted = rate of defaulted treatment /total number of patients

   Probability of the dead = rate of the mortality/ total number of patients

   Probability of the transferred out = rate of transfer out/ total number of patients

   Probability of relapse = relapsed cases / total number of success rate

Probability of no relapse = 1- probability of relapse

2) Chance node 2 – Re-treatment, Total patients = 19 in each intervention

Probability of success = success rate, re-treatment/ total number of re-treated patients

Probability of not successful treatment = 1 – successful rate of re-treatment

3) Expected cost

Cost of each arm = Probability * Cost of associated treatment outcome (successful and not successful)

Total expected cost = Sum of all costs associated with successful treatment outcomes

4) Expected health effect

Successful treatment outcomes = 1 and Not successful treatment outcomes = 0

5) Cost effectiveness (CER)

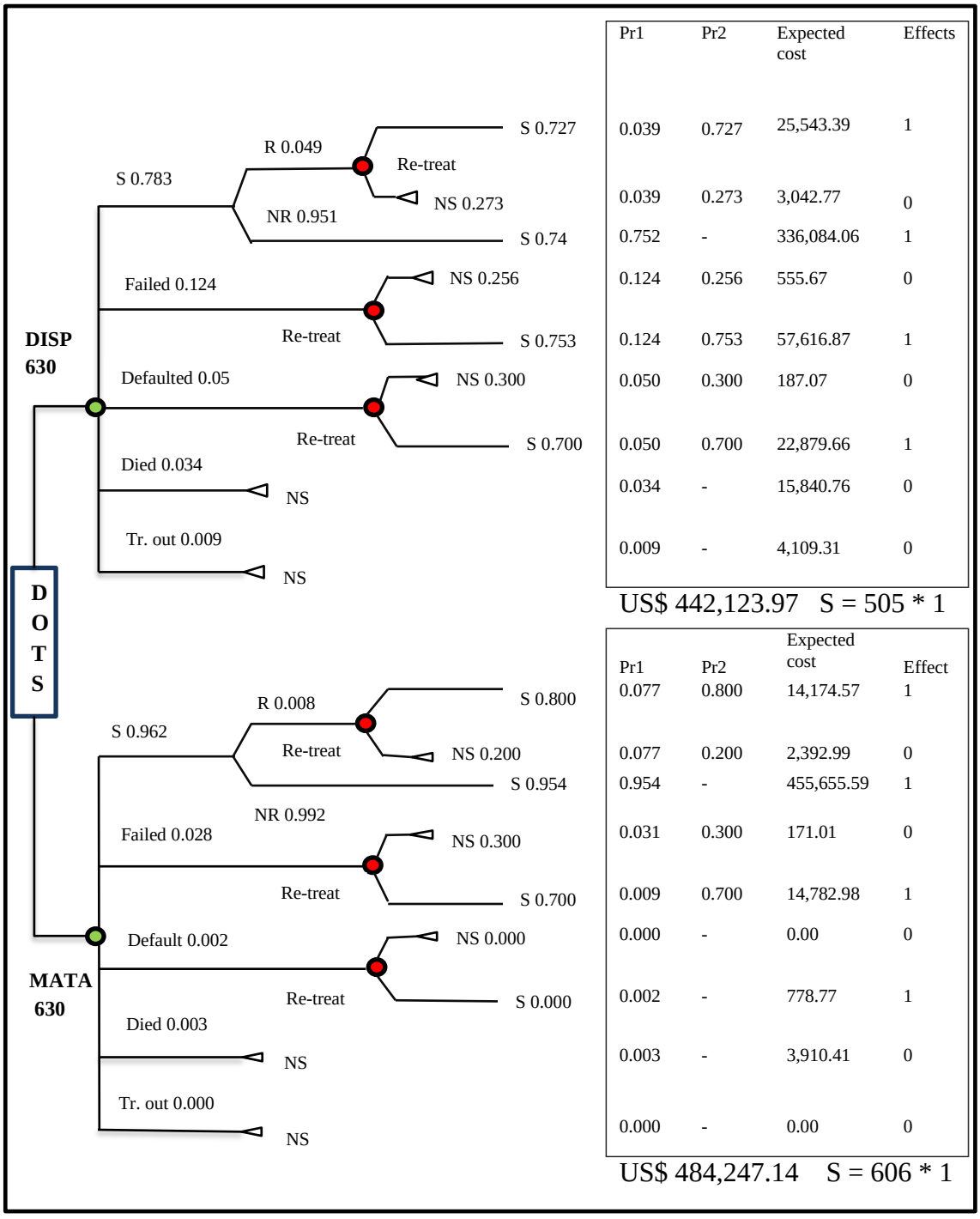
CER = Total expected cost for successful treatment / total number of successful treatment

6) Decision tree explanation

R- relapse, NR- no relapse, Tr. out- transfer out, S- successful, NS – not successful, Pr1 – probability after initial treatment, Pr2 – probability after re-treatment, I- chance node1 for initial treatment, Re-treat – chance node 2 for re-treatment. Results are shown on the decision tree algorithm (see Figure 4.4)

The analysis shows that among equal number of patients in each DOTS intervention. With the same number of patients total expected cost of DOTS Dispensary intervention is less than the DOTS MATA intervention. However, CER per success rate in DOTS Dispensary intervention is US$ 875.54, while it is US$ 799.10 in DOTS MATA intervention. It is evident that DOTS MATA intervention highlights to be cost effective approach per successful treatment as of 2010 (see Table 4.19)

Figure 4.4 Cost effectiveness of DOTS on the basis of probabilistic decision tree model



Pr1	Pr2	Expected cost	Effects
0.039	0.727	25,543.39	1
0.039	0.273	3,042.77	0
0.752	-	336,084.06	1
0.124	0.256	555.67	0
0.124	0.753	57,616.87	1
0.050	0.300	187.07	0
0.050	0.700	22,879.66	1
0.034	-	15,840.76	0
0.009	-	4,109.31	0

US$ 442,123.97 S = 505 * 1

Pr1	Pr2	Expected cost	Effect
0.077	0.800	14,174.57	1
0.077	0.200	2,392.99	0
0.954	-	455,655.59	1
0.031	0.300	171.01	0
0.009	0.700	14,782.98	1
0.000	-	0.00	0
0.002	-	778.77	1
0.003	-	3,910.41	0
0.000	-	0.00	0

US$ 484,247.14 S = 606 * 1

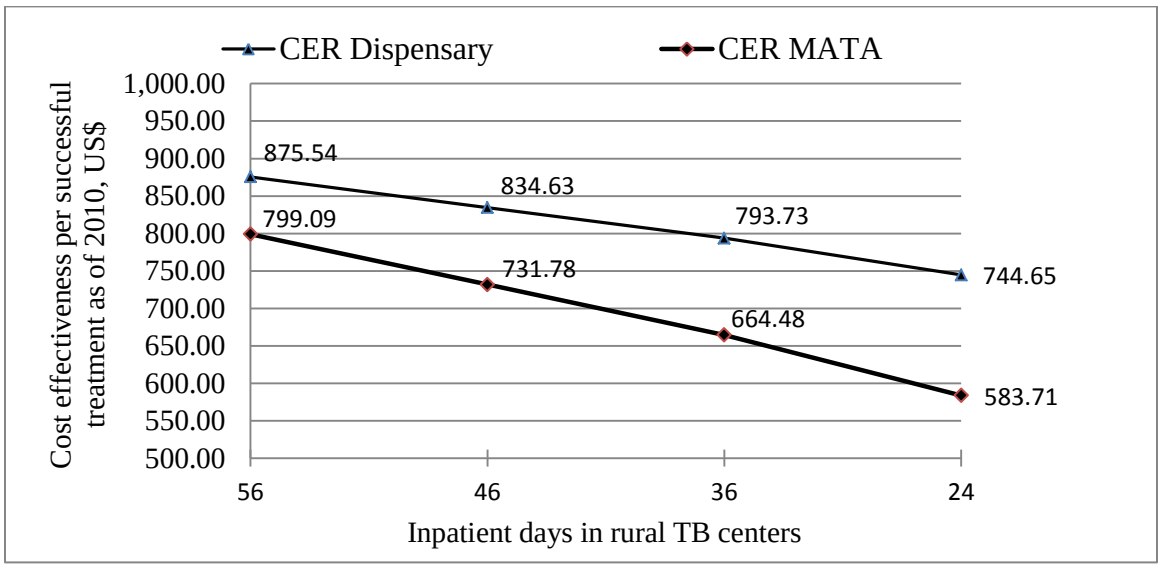
Table 4.19 Cost effectiveness of DOTS per 630 persons based on decision tree model

Categories	DOTS Dispensaries	DOTS MATA
Total number of patients initial treatment	611	611
Cost of initial treatment (US$)	451,075.84	475,833.74
Total number of patients re-treatment	19	19
Cost of re-treatment (US$)	14,783.68	14,633.79
Total expected cost of successful treatment	442,123.97	484,247.14
Expected effectiveness (successful)	505	606
Cost effectiveness ratio per success (US$)	875.54	799.09

There are numbers of uncertainties framing the cost estimation when decreasing inpatient stay days at the beginning of DOTS. Because, uncertainties such as patients clinical presentations, whether successful or not successful, adults or children, treatment categories and location of dispensaries make the analysis even imprecise to do costing for patients' treatment. Decision tree algorithm is also useful method for sensitivity analysis to assess whether inpatient care cost affects cost effectiveness of these interventions with the same 630 patients each. Therefore, the assumption was made on the basis of condition that if other uncertainty factors are consistent and remain to have the same as the initial data. Inpatients stay in rural area lasts 56 days in average, which is costly and roughly twice as much as the city. So, how shortening of inpatients stay affects the cost effectiveness of these two interventions is a major interest for further sensitivity analysis.

Only decreasing inpatient stay in rural TB centers has been evaluated in the sensitivity analysis to estimate how shortening for inpatient day affects overall cost effectiveness of DOTS (see Figure 4.5). All corresponding costs in DOTS Dispensary such as patients travel cost and opportunity cost were adjusted in the analysis. Likewise, costs from volunteer services and opportunity costs are accounted in DOTS MATA. In addition, decreasing cost of inpatient care in rural area is corresponded to the inpatient stay (see Figure 4.5).

Figure 4.5 Sensitivity analyses for cost effectiveness per successful treatment based on probabilistic decision tree model as various inpatient stay days in rural TB center.



Note: Cost (US$) with each dot (marker) in the lines indicates CER per successful treatment of DOTS

4.1.6 Incremental Analysis

The assumption is made that if per 630 persons have the same probability as the original data set (1427 people in dispensary program) the following incremental analysis can be calculated. Since, unsuccessful treatment is another factor for cost effectiveness. If unsuccessful treatment rate (effectiveness) increases providers incur loss of money and this predictor tells us whether health workers utilize the resources fully.

DOTS is a costly strategy itself in order to comply treatment regimen completely for 6 to 8 months. In contrary, assessing cost effectiveness per successful treatment is not enough. Thus, incremental cost effectiveness (ICER) per unsuccessful treatment is another major interest in this research (see Tables 4.20 and 4.21). In other words, higher ICER per unsuccessful treatment reveals providers incur higher economic loss due to mortality, incompliance of DOTS or multi-drug resistance of bacteriological nature of TB.

Table 4.20 Incremental analysis using decision tree model

Programs	Cost per 630 patients	Unsuccessful treatment per 630 patients	Incremental Cost (US$)	Incremental effect (unsuccessful treatment)	ICER, per unsuccessful treatment avoided (US$)
Dispensary	442,123.97	125	-	-	-
MATA	484,247.14	24	41,924.83	-101	-379.49 < 0

Since, for MATA DOTS, incremental cost per incremental effectiveness (avoided unsuccessful treatment) is US$ -379.49, which is less than "0" tells us this intervention in cost effective approach for tuberculosis treatment. In other words, MATA fully utilized the incurring cost for DOTS and influenced to be cost effective approach in terms of preventing non treated patients releasing to the public.

Table 4.21 Economic loss for interventions

Intervention	Expected total cost of unsuccessful treatment per 630 patients	Unsuccessful treatment per 630 patients	Incremental Cost (US$)	Incremental effect (unsuccessful treatment)	ICER, per unsuccessful treatment avoided (US$)
Dispensary	23,735.55	125	17,261.14	101	170.90
MATA	6,474.41	24	-	-	-

There is a cost saving associated with unsuccessful cases in DOTS MATA, if it is assumed that incremental effect is preventable. Calculation revealed that DOTS Dispensary intervention spent US$ 170, 90 per additional unsuccessful treatment. Therefore, we assume that DOTS MATA spent money effectively more than DOTS Dispensary intervention in Mongolia as of 2010

4.2 Discussions

Public health personnel have believed that DOTS program with health volunteers is essential and important tool for the public, particularly, for some diseases, which require long term treatment and adherence like tuberculosis. Once, we look through the health effectiveness from patients' perspectives, this recommendation remains to be undisputable. But, when health intervention is considered with its cost, it is always questionable that which intervention is needed in the society.

Population of Mongolia is very sparse, so travel cost is relatively high among rural patients. For instance, just one sputum transport expenditure costs 13.04 US dollars and almost twice as high as urban area. Due to a long distance from health care providers, patients are more likely to receive service from MATA volunteers.

The results of the study were not that sensitive to the parameter such as clinical effectiveness cure and success rates. This may be due to a high cost of labor wages after allocation for the study group. Since, doctors and nurses are paid by per capita and provided by government, this high cost is not likely to decrease in the future. The study contains labor costs by scale of government workers, which is a least amount of wages in this category.

All of these factors prove that DOTS itself is costly for both patients and providers. Long duration treatment requires long travel and more assessments from health workers, and loss of productivity. Therefore, all costs incurring patients were estimated based on available data.

Treatment success rate is higher with DOTS from MATA supervision, 94%, while it was 78% for the DOTS by dispensaries. Only default rate can be in control in order to achieve successful results like MATA program. However, study estimates that zero percent of default rate was observed in MATA services, which implies that DOTS is a

strategy that demands health volunteers to provide long term care to the disadvantaged people.

Since, the study was carried out and calculated per cured or per successful treated case, there are other possibility to develop the research using more health utility outcome such as cost effectiveness per Disability Adjusted Life Years, one of the most arising research interest in this field.

CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Tuberculosis remains one of leading causes of infectious diseases and still being burdensome for most of countries globally. Mongolia is, therefore, setting goals to halt the disease prevalence and increase the treatment effectiveness. DOTS under supervision of MATA volunteers has shown to be more cost effective approach to manage disease treatment.

Provided by the available resources in Mongolia, DOTS with MATA volunteers has shown to be cost effective approach for the public compared to DOTS held in dispensaries. In urban areas, DOTS with volunteer program can reduce tuberculosis prevalence and decrease its default rate. Health volunteer based intervention can reduce default rate, which implies to decrease the prevalence of multi drug resistant tuberculosis (MDR).

It is evident that the more we save people from quitting their adherence of TB treatment, the more the treatment will be effective and less costly. National Stop Tuberculosis Program could increase their efficiency for its activities by utilizing health volunteers. Accompanying treatment with health volunteers is effective and has a positive relationship with successful result.

5.2 Policy implications

The outcome indicates that cost per cured case and per successful treatment from MATA volunteers is lower than Dispensaries. If treatment has been done successfully, with less cost, broader implementation of that program is valuable for the society. Thus, DOTS with trained health professionals is one of the suggestible and supplementary approaches to government run hospitals to treat TB patients. Particularly, default rate can be prevented by MATA volunteers in areas, where DOTS is often fail. Since, DOTS under

health volunteers supervision is cost effective approach for the compliance, it could be broaden in urban areas as well.

Government and health authorities need to maintain the support for both patients and health volunteers to halt tuberculosis in the future. Tuberculosis is not just an infectious disease. Besides, its own nature of etiology and causal relationship with human beings called as proximal factor, it is proven to be a public disease that highly correlated with body mass, which often associated with socio-economic status of individuals. Attention needs to be drawn to its distal factors such as poverty, living area, employment, education and environment as a whole.

Consequently, treatment requires to be combined with some degree of support and incentives to encourage patients to overcome such difficulties or to subsidize their financial burden. Low income patients in this group can't be left out. Because, tuberculosis has been prevalent among vulnerable group in the society and often caused negative externalities in each community. Without taking actions confronting this fundamental causal relationship of disease, it is doubtful to achieve positive results. Therefore, I encourage health authorities to fulfill this gap in order to reach National Stop Tuberculosis Goals.

5.3 Limitations

This study was carried out from patients' perspective. However, it did not touch other aspects of TB disease such as extra pulmonary, sputum negative pulmonary tuberculosis and other adverse effects of treatment. Those patients were excluded from the study which allows more rooms to study in the future. Data analysis can be done by decision tree algorithms and Markov's model. MATA programs organized precise registration since 2010. Therefore, more additional years of data for several years of period are beneficial in order to track the patients flow for the continuous and re-treatment groups. Low sample size of patients, who were relapsed after treatment in MATA volunteers' intervention, results not significant in the logit model regression. Hence, the decision tree

algorithm is computed by conventional method of probability calculation. More extensive data need to be accounted for further study.

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APPENDICES

APPENDIX A: COSTING FOR DRUGS

Table A.1 Number of category 1 TB drugs per patient Category 1for (Children)

Number of drugs	Children, by weight			
Drugs	5-7kg	8-14kg	15-20kg	20-30kg
Number of tab RHZE in phase 1				2
Number of tablet RH in phase 2				2
Number of tab RHZ in phase 1	1	2	3	
Number of tab E in phase 1	1	2	3	
Number of tab RH in phase 2	1	2	3	
Phase 1 period (days)	56	56	56	56
Phase 2 period (days)	112	112	112	112
Total number of tabs in phase 1	112	224	336	112
Total number of tabs in phase 2	112	224	336	224

Note: Doses were adjusted during calculation (mg per kg). RH dose was calculated on the basis of standard dose (150/75) per kg weight for 20-30kg children whereas, RH (60/30) is for under 20kg children

Table A.2 Costing for category 1 TB drugs for children

Cost of TB drugs	5-7kg	8-14kg	15-20kg	20-30kg
Unit cost of tab RHZE (MNT)				98.96
Unit cost of tab RH (MNT)				98.96
Unit cost of tab RHZ(MNT)	35.7	35.7	35.7	
Unit cost of tab E (MNT)	54.56	54.56	54.56	
Unit cost of tab RH (MNT)	58.83	58.83	58.83	
Phase 1 cost for 56 days (MNT)	5,054.56	10,109.12	15,163.68	11,083.52
Phase 2 cost for 112 days (MNT)	6,588.96	13,177.92	19,766.88	22,167.04
Phase 1 cost (USD)	3.49	6.99	10.48	7.66
Phase 2 cost (USD)	4.55	9.11	13.66	15.32

Drug transfer cost (USD)	1.97	1.97	1.97	1.97
Total cost in the city (USD)	8.05	16.09	24.14	22.98
Total cost in provinces (USD)	10.02	18.06	26.11	24.95

Note: Currency rate of USD was used the data of the NCCD at the time of buying drugs in 2010. USD 1 = 1447.00 MNT (Mongolian National Tugrik)

Table A.3 Number of category 1 TB drugs for adults per patient

Number of TB tablets	Adults' weight			
Weight	30-39kg	40-54kg	55-70kg	over 70kg
Number of tab RHZE in phase 1	2	3	4	5
Number of tab RH in phase 2	2	3	4	5
Phase 1 period (days)	56.00	56.00	56.00	56.00
Phase 2 period (days)	112.00	112.00	112.00	112.00
Number of tablets phase 1	112.00	168.00	224.00	280.00
Number of tablets phase 2	224.00	336.00	448.00	560.00

Table A.4 Costing of category 1 TB drugs for adults

Costs	Adults' weight			
	30-39kg	40-54kg	55-70kg	over 70kg
Unit cost of RHZE tab (MNT)	98.96	98.96	98.96	98.96
Unit cost of RH tab (MNT)	98.96	98.96	98.96	98.96
Phase 1 cost (MNT)	11083.52	16625.28	22167.04	27708.80
Phase 2 cost (MNT)	22167.04	33250.56	44334.08	55417.60
Phase 1 cost (USD)	7.66	11.49	15.32	19.15
Phase 2 cost (USD)	15.32	22.98	30.64	38.30
Total cost in the city	22.98	34.47	45.96	57.45
Total cost in provinces	24.95	36.44	47.93	59.42

Note: Drugs doses were calculated on the basis of standard dose per kg weight, Currency rate of USD was used the data of the NCCD at the time of buying drugs in 2010. USD 1 = 1447.00 MNT (Mongolian National Tugrik)

Table A.5 Costing TB drugs in Category 2 treatment for children

Costing category	Children's weight			
Phase 1	5-20kg	8-14kg	15-20kg	20-30kg
HREZ (days)				84
RHZ (days)	84	84	84	
Ethambutol (days)	84	84	84	
Phase 2				
RH	140	140	140	140
Number of tab per day				
Phase 1	1	2	3	2
Phase 2	1	1	2	2
Number of tabs in each phase				
Number of tablets phase 1	168	336	504	168
Number of tablets phase 2	140	140	280	280
Unit Cost				
HREZ (MNT)				98.96
RHZ (MNT)	35.7	35.7	35.7	
Ethambutol (MNT)	54.56	54.56	54.56	
RH (MNT)	58.83	58.83	58.83	58.83
Cost by each phase				
Phase 1 cost (MNT)	7, 581.84	15,163.68	22,745.52	16,625.28
Phase 2 cost (MNT)	8,236.2	8,236.2	16,472.4	16,472.4
Phase 1 cost (USD)	5.93	11.86	17.78	13.00
Phase 2 cost (USD)	6.44	6.44	12.88	12.88
Transport cost (USD)	1.97	1.97	1.97	1.97
Total cost in the city (USD)	12.37	18.30	30.66	25.88
Total cost in provinces (USD)	14.34	20.27	32.63	27.85

Note: Currency rate of MNT was computed on the basis of data as 2010 at the time of purchasing drugs, 1USD = 1279 MNT

Table A.6 Costing TB drugs in Category 2 treatment for adults

Cost for drugs	Adults' weight			
Cost of Streptomycin injection	30-39kg	40-54kg	55-70kg	over 70kg
Unit of vial	1	1	1	1
Streptomycin (ML)	1	2	3	3
Unit cost of streptomycin (MNT)	222.13	222.13	222.13	222.13
Unit cost syringe (MNT)	108.56	108.56	108.56	108.56
Unit cost of needle broker (MNT)	57.43	57.43	57.43	57.43
Unit cost of intravenous fluid (MNT)	103.00	103.00	103.00	103.00
Total cost (MNT)	491.12	491.12	491.12	491.12
Treatment duration (days)				
Phase 1 period HREZ	56	56	56	56
Phase 2 period HRE	28	28	28	28
Phase 3 period HRE	140	140	140	140
Total number of tabs				
Number of tabs phase 1	112	168	224	280
Number of tabs phase 2	56	84	112	140
Number of tabs phase 3	280	420	560	700
Unit cost of TB tablets				
cost of 1 tab HREZ (MNT)	98.96	98.96	98.96	98.96
cost of 1 tab HRE (MNT)	57.68	57.68	57.68	57.68
Cost by phase				

Phase 1 cost (MNT)	38,586.24	44,128.00	49,669.76	55,211.52
Phase 2 cost (MNT)	5,541.76	8,312.64	11,083.52	13,854.40
Phase 3 cost (MNT)	16,150.40	24,225.60	32,300.80	40,376.00
Phase 1 cost (USD)	30.17	34.51	38.83	43.17
Phase 2 cost (USD)	4.33	6.50	8.67	10.83
Phase 3 cost (USD)	12.63	18.94	25.25	31.57
Transport cost (USD)	1.97	1.97	1.97	1.97
Total cost in the city (USD)	47.13	59.94	72.76	85.57
Total cost in provinces (USD)	49.10	61.91	74.73	87.54

Table A.7 Calculating drug cost by body mass (weight) by each patient

Costing drugs	Patients (kg)	Cured	Completed	Failed	Defaulted	Died	Tr. out
City Dispensary							
Category I	30-39	12	0	8	1	1	0
Adults	40-54	271	29	48	21	9	3
	55-70	228	22	24	21	3	3
	over 70	23	0	1	0	1	2
Total patients		534	51	81	43	14	8
Category II	30-39	4	4	4	1	1	0
Adults	40-54	57	13	20	10	9	1
	55-70	50	19	18	6	5	0
	over 70	9	0	1	0	1	0
Total patients		120	36	43	17	16	1
Rural dispensaries							
Category I							
Children	5-7kg	1	0	0	0	0	0
Adults	30-39	6	0	2	0	3	0
	40-54	120	6	21	5	9	2
	55-70	123	11	8	6	3	2
	over 70	9	0	2	0	0	0

Total patients		259	17	33	11	15	4
Category 2							
Adults	30-39	10	0	0	0	0	0
	40-54	39	4	12	0	3	0
	55-70	42	5	8	0	0	0
	over 70	1	0	0	0	0	0
Total patients		92	9	20	0	3	0
City MATA	Weight	Cured	Completed	Fail	Default	Died	Tr. out
Category 1	(kg)						
Adults	30-39	11	0	0	0	0	0
	40-54	121	1	6	0	2	0
	55-70	91	8	4	0	0	0
	over 70	7	0	0	0	0	0
Total		230	9	10	0	2	0
Category II	(kg)						
Adults	40-54	7	0	1	0	1	0
	55-70	1	0	0	0	1	0
Total patients		8	0	1	0	2	0
Rural MATA	weight	Cured	Completed	Fail	Default	Died	Tr.out
Category I							
Children	20-30kg	3	0	0	0	0	0
Adults	30-39	14	0	0	0	0	0
	40-54	172	1	4	0	0	0
	55-70	144	5	4	0	0	0
	over 70	11	2	0	0	0	0
Total patients		344	8	8	0	0	0
Category II	40-54	4	0	0	0	0	0
	55-70	3	0	0	0	1	0
Total patients		7	0	0	0	1	0

Table A.8 Drug cost extracted by weight difference among children

Cost of category 1 Provinces	5-7kg	8-14kg	15-20kg	20-30kg
Phase 1 cost	3.49	6.99	10.48	7.66
Phase 2 cost	4.55	9.11	13.66	15.32
Total cost	10.02	18.06	26.11	24.95
Cost of drug category 1 City				
Phase 1 cost	3.49	6.99	10.48	7.66
Phase 2 cost	4.55	9.11	13.66	15.32
Total cost (USD)	8.05	16.09	24.14	22.98
Cost of drug category 2 City				
Phase 1 cost	5.93	11.86	17.78	13.00
Phase 2 cost	6.44	6.44	12.88	12.88
Total cost (USD)	12.37	18.30	30.66	25.88
Cost of drug category 2 Provinces				
Phase 1 cost	5.93	11.86	17.78	13.00
Phase 2 cost	6.44	6.44	12.88	12.88
Total cost (USD)	14.34	20.27	32.63	27.85

Table A.9 Drug cost extracted by weight differences among adults

Province category 1	30-39kg	40-54kg	55-70kg	over 70
Phase 1 cost	7.66	11.49	15.32	19.15
Phase 2 cost	15.32	22.98	30.64	38.30
Total cost (USD)	24.95	36.44	47.93	59.42
City category 1	30-39kg	40-54kg	55-70kg	over 70
Phase 1 cost	7.66	11.49	15.32	19.15
Phase 2 cost	15.32	22.98	30.64	38.30
Total cost (USD)	22.98	34.47	45.96	57.45
Category 2 City	30-39kg	40-54kg	55-70kg	over 70
Phase 1	30.17	34.50	38.83	43.17
Phase 2	4.33	6.50	8.67	10.83
Phase 3	12.63	18.94	25.25	31.57
Total cost (USD)	47.13	59.94	72.76	85.57
Category 2 Rural	30-39kg	40-54kg	55-70kg	over 70
Phase 1	30.17	34.50	38.83	43.17
Phase 2	4.33	6.50	8.67	10.83
Phase 3	12.63	18.94	25.25	31.57
Total cost(USD)	49.10	61.91	74.73	87.54

APPENDIX B: Calculation of costing for sputum test

Table B.1 Direct cost of laboratory sputum test calculation

Costing category	Buying price (US$)	Buying pieces, gram, ml	Per 1000 specimens	Specimens per test	Per test level	Unit cost / test (US$)	Test cost per patient (US$)
Direct cost							
Sputum container	100	1000	1000	2	2	0.10	0.20
Place mat glass	4	50	1000	2	2	0.08	0.16
Basic Fuchsin (0.3%-5ml) gr	80	25	15	2	0.09	3.2	0.288
Phenol (5%-5ml) gr	32	500	500	2	1	0.064	0.064
Hydrochloric acid (3%-10ml)	15	500	300	2	0.6	0.03	0.018
Methylene blue (0.3%-5ml)	18	25	15	2	0.03	0.72	0.0216
Alcohol (96%)	12.569	1000	9700	2	19.4	0.013	0.244
Xylol ml	61	1000	1000	2	2	0.061	0.122
Immerse oil. ml	8	100	100	2	0.2	0.08	0.016
Slide box	20	100	10	2	0.02	0.2	0.4
Lens paper	19	250	1000	2	2	0.076	0.152
Total direct cost (US$)							1.68

Table B.2 Indirect cost of sputum test

Category	Salary per test	Number of test/month	Salary allocation / test
Lab. Technician (US$)	226.15	220	1.028

B3 Total unit cost of laboratory sputum test

Category	Cost
Travel cost in the city (US$)	5.00
Travel cost in province (US$)	12.99
Unit Test Cost in the city (US$)	7.40
Unit test cost in provinces (US$)	15.403

APPENDIX C: Calculation of MATA Services

Table C.1 Calculation for Mata services in the city

Category	cat 1	cat 2	Extended	N of service	N of service	N of service	Total
Cured	159	7	33	16,354	1,120	660	18,120
Completed	7	0	3	720	0	60	780
Failed	10	1	7	1,143	121	0	1,264
Default	0	0	0	0	0	0	0
Died	2	1	0	49	40	0	89
Tr. Out	0	0	0	0	0	0	0

Table C.2 Calculation for lunch service for patients with category 2 treatment

Costing for Lunch	Number of patients		Number of services	Lunch & travel (USD)	Total (USD)
	City	Rural			
After test 2	1	0	120	1.82	218.40
After test 3	1	1	200	1.82	364.00
Volunteer obs.	3		320	0.30	96.00
Obs. before lunch	66	20	86	0.30	26.40
Total cost (USD)					704.80

Table C.3 Calculation for lunch services for patients with category 1 treatment

Costing	Number of patients		Number of observations		Number of services	Lunch & travel cost ($)	total (USD)
	City	Rural	City	Rural			
After test 2	54	113	4,320	9,040	13,360	1.82	24,315.20
After test 3	14	19	840	1,140	1,980	1.82	3,603.60
After test 5	5	10	100	200	300	1.82	546.00
Volunteer observation	73	142	5,260	10,380	15,640	0.30	4,692.00
Service before lunch	73	142	2,400	980	3,380	0.30	1,014.00
Total	73	142	11,871	22,300			33,625.00

APPENDIX D: Calculation for Opportunity Cost

Table D.1 Estimation for travel cost and opportunity cost from total of 69 patients surveyed (31patients from rural areas and 38 patients from the city, DOTS at dispensary)

Rural (Cohorts)	Travel cost (MNT)	Patients time (hour)	City (Cohorts)	Travel cost (MNT)	Patients time (hour)
1	600.00	1	1	2,000.00	1.5
2	4,200.00	1	2	0.00	2
3	1,000.00	2	3	1,500.00	1.3
4	1,000.00	2	4	3,400.00	2
5	0.00	0.5	5	3,000.00	2.5
6	0.00	0.75	6	3,500.00	2.5
7	0.00	0.5	7	3,500.00	1
8	800.00	1	8	3,000.00	2
9	800.00	1	9	3,000.00	2.5
10	700.00	0.5	10	1,000.00	0.5
11	0.00	0.4	11	1,000.00	0.75
12	0.00	0.75	12	1,000.00	0.75
13	2,200.00	1	13	800.00	0.5
14	400.00	0.75	14	1,000.00	0.8
15	400.00	0.5	15	500.00	3
16	1,000.00	0.5	16	3,000.00	2
17	1,000.00	0.75	17	1,000.00	1
18	1,000.00	0.75	18	3,000.00	2
19	1,000.00	0.5	19	3,000.00	1.5
20	1,000.00	0.5	20	1,000.00	1
21	1,000.00	0.8	21	1,000.00	1
22	1,000.00	0.75	22	1,000.00	1
23	4,000.00	3	23	0.00	1
24	2,400.00	1.5	24	800.00	1.25

25	2,000.00	1.5	25	0.00	1.5
26	4,000.00	2	26	1,200.00	0.5
27	4,000.00	1.5	27	1,500.00	1
28	1,280.00	2	28	1,600.00	1.75
29	4,800.00	2	29	1,200.00	2
30	1,000.00	1	30	800.00	1
31	1,000.00	1	31	700.00	1
			32	0.00	0.5
			33	1,600.00	1.3
			34	1,600.00	1
			35	0.00	1
			36	1,600.00	1
			37	1,600.00	1.3
			38	1,400.00	1

Table D.2 Cost for travel and opportunity for patients of Dispensary DOTS

	Provinces		City	
	Travel cost	Opportunity cost	Travel cost	Opportunity cost
Average cost (MNT)	1,405.81	1.09	1,494.74	1.35
Currency rate 2012	1,356.22	-	1,356.22	-
Currency rate 2010	-	1,357.55	-	1,357.06
Average cost (USD)	1.04	0.49	1.10	0.61
CPI 2010	223.99	-	223.99	-
CPI 2012	248.07	-	248.07	-
Cost as of 2010 (USD)	0.94	0.49	1.00	0.61

Note: Consumer price indices are available in website (Trading Economics, 2010)

Table D.3 Estimation of travel times during DOTS in category 2, excluding prison

Category	N of patient	City	Rural	N, travel, city	N, travel, rural	Unit cost City (USD)	Unit cost Rural (USD)	Cost of travel (USD)
cured	212	115	92	3680	2944	1.00	0.94	6,992.00
completed	45	35	9	1120	288	1.00	0.94	1,520.00
failed		41	0	761	0	1.00	0.94	837.10
defaulted		17	20	206	416	1.00	0.94	642.60
died		16	3	215	63	1.00	0.94	299.50
tr. Out		1	0	7	0	1.00	0.94	7.70
Total travel cost	357	225	124	5989	3711	1.00	0.94	10,299.00
Opp. cost				5989	3711	0.61	0.49	5,471.70

Note: Opp. - Opportunity cost, including unskilled workers salary as of 2010. Unskilled workers salary = 108,000.00 MNT with exclusion of patients, who underwent DOTS in prison.

Table D.4 Calculation for travel times in the city during category 1 treatment

Cat 1 travel	City	Rural	N, travel city	N, travel rural	Unit cost City (USD)	Unit cost Rural (USD)	Cost of travel (USD)
cured	115	92	3680	2944	1.0	0.94	6,992.00
completed	35	9	1120	288	1.0	0.94	1,520.00
failed	41	0	761	0	1.0	0.94	837.10
defaulted	17	20	206	416	1.0	0.94	642.60
died	16	3	215	63	1.0	0.94	299.50
tr. Out	1	0	7	0	1.0	0.94	7.70
Total travel	225	124	5989	3711	1.0	0.94	10,299.00
Opp. Cost			5989	3711	0.61	0.49	54,717.00

APPENDIX E: Calculation of Labor Cost

Table E.1 Allocating labor cost for each DOTS intervention

Category	Total (Dispensary)	MATA
Nurses	160.00	2.00
Doctors	68.00	12.00
Cohorts	1,427.00	630.00
Total treated patients with TB	4,163.00	742.00
Average nurses' wage	6,653,280.00	3,326,640.00
Average doctors' wage	8,267,760.00	4,133,880.00
Total Salary	813,366,240.00	56,259,840.00
Salary after allocation	237,756.87	75,821.89
Training cost (US$)	47,982,700.40	3,049.00
Currency exchange rate	1,357.06	1,357.06
Salary after allocation per head(US$)	202.89	60.98
Total program allocation (US$)	289,529.09	38,418.44

BIOGRAPHY

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