

**COST- EFFECTIVENESS OF COMMUNITY-BASED (DOT) AND  
SELF-SUPERVISED TREATMENT OF TUBERCULOSIS IN  
MARACHA ARUA, UGANDA**

A dissertation submitted to the faculty of health sciences of the  
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### LIST OF ACRONYMS

|        |  |
|--------|--|
| AFB    | Acid fast bacilli                              |
| AIDS   | Acquired immune deficiency syndrome            |
| C/E    | Cost-effectiveness ratio                       |
| CB-DOT | Community-based directly observed TB treatment |
| CDC    | Centre for Disease Control                     |
| CEA    | Cost-effective Analysis                        |

|        |   |
|--------|---|
| CHW    | Community Health Worker                                   |
| CXR    | Chest X-Ray   |
| DOT    | Directly observed treatment                               |
| DOTS   | Directly observed treatment-short course                  |
| DR     | Democratic Republic                                       |
| FY     | Financial year  |
| HIV    | Human immunodeficiency virus                              |
| HMIS   | Health Management Information System                      |
| HSD    | Health sub-district                                       |
| HSSP   | Health Sector Strategic Plan                              |
| IMF    | International Monetary Fund                               |
| IUATLD | International Union Against Tuberculosis and Lung Disease |
| KABP   | Knowledge, Attitude, Behaviour and Practice               |
| KNCV   | Royal Netherlands Tuberculosis Association                |
| NGO    | Non-Governmental Organization                             |
| NMS    | National Medical Stores                                   |
| NTP    | National TB Control Programme                             |
| OPD    | Out-patient Department                                    |
| SCHW   | Sub-county Health Worker                                  |
| TB     | Tuberculosis  |
| UCT    | University of Cape Town                                   |
| UNAIDS | United Nations Acquired Immune Deficiency Syndrome        |
| UNHCR  | United Nations High Commission for Refugees               |
| US     | United States   |
| USAID  | United States Association for International Development   |
| VVW    | Village Volunteer Worker                                  |
| WHA    | World Health Assembly                                     |
| WHO    | World Health Organization                                 |

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## ABSTRACT

Tuberculosis is the leading infectious killer of people living with HIV/AIDS. Millions of tuberculosis deaths could be prevented by the widespread use of the less expensive strategy of directly observed treatment (DOT). The cost-effectiveness of DOT however varies with its method of supervision. This study evaluated the cost-effectiveness of community-based and self-supervision strategies of DOT in Maracha, Arua District, Uganda. Patients', community's and health system's costs were obtained through interviews and expenditure statements. For effectiveness measures, historical follow-up of the cohort belonging to each the TB treatment supervision strategy was done. Systematic random sampling was done to identify the 20 patients from each treatment strategy for interviews to estimate their treatment costs. Due to low number of patients in the available TB registers, all the 129 patients were enrolled for the study. The findings showed that community-based supervision of DOT was a more cost-effective TB treatment supervision option than that by self-supervision and was therefore recommended to Maracha HSD and Arua District for more support and expansion. However, the accuracy of this study was limited by method used and generalizability of the results could be affected by the small sample size.

## Chapter One

### Background

#### 1. 1 Introduction

**1.1.1 Tuberculosis (TB):** TB is one of the largest infectious killer diseases in the world today and thirty million people especially youths and adults could die from TB in the next 10 years (World Health Organization, 2000). Someone is infected with tuberculosis every second, and in 1999 alone 8 million people (World Health Organization, 2000) were sick from TB. TB creates more orphans than any other infectious disease. It causes 3 million deaths every year with South East Asia and Africa the worst affected regions (Marchant, 2000). Every country is vulnerable to the consequences of poor TB treatment practices in other countries. In sub-Saharan alone, about 1.5 million new cases arise each year (BMJ Editorial, 1997).

Uganda was one of the top ten countries with the highest case notification rates (150/100,000) in Africa by 1998 (WHO, 2001). The situation in Arua, a district in North Western Uganda, and which borders the Democratic Republic of Congo and Sudan, has been exacerbated by influx of refugees from Southern Sudan. This was compounded by the fact that Uganda has a high HIV/AIDS prevalence rate of about 5%, and 60% of HIV in the country is associated with TB (Health Management Information System of Uganda, 1999).

**1.1.2 Tuberculosis and HIV/AIDS:** TB is also the leading infectious killer of people living with human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) of which more than 50% is found in sub-Saharan Africa (WHO, 2000).

However the epidemic of tuberculosis is associated with HIV in sub-Saharan Africa in such a way that hospital based care is no longer feasible. The caseload in Malawi hospitals increased from 5,334 in 1985 to 19,195 in 1995 (BMJ Editorial, 1997). Over the same period the cure rate for smear positive cases decreased from 90% to 63%, and bed occupancy reached 400% in cities (BMJ Editorial, 1997). Crowded wards are also likely to deter admission and adherence.

**1.1.3 TB prevention and DOTS:** Millions of TB deaths could be prevented through the widespread use of directly observed treatment short-course (DOTS), a less expensive strategy for detection and treatment of TB (World Health Assembly, 2000). The strategy can detect and cure more TB cases even in the poorest countries. In 1997, the average success rate worldwide was almost 80%. However, less than 25% TB are treated through the DOTS strategy (World Health Assembly, 2000). In Uganda ever-since the adoption of the DOT strategy in 1993, TB case notification has been increasing at a rate of 8%. This increase in TB notification could be attributed to the effect of HIV/AIDS or to an improvement in the capacity of the health services to detect TB cases or both (Uganda annual health sector performance report FY 2000/2001). Arua is one of the 14 districts currently implementing the community-based-directly observed treatment (CB-DOT). Successful treatment of TB cases could lead to reduction in transmission of TB and ultimately to reduction in the number of TB cases notified. However for Maracha HSD, CB-DOT had not yet been evaluated and there was need for this cost effectiveness evaluation so that appropriate decisions for more support and expansion of this treatment programme in the district could be made.

**1.1.4 Cost-effectiveness evaluation:** In this cost-effectiveness evaluation study, the costs of DOTS treatment in OPD (after intensive phase of DOTS) using two supervision

options was compared. In one supervision option i.e. CB-DOT, the TB patients after intensive phase of treatment go back to their homes but get continuation drug treatment from lay-health workers in their villages for a period of 6 months. The patients in this group come to the OPD clinic for only follow-up diagnostic tests. In the second method of supervision of out-patient treatment, self-supervision, the patients also go home after intensive phase of treatment but have to come every month for follow-up tests and collect fresh supplies of drugs which they swallow from home without supervision of a second party.

**1.1.5 Study area:** The study was conducted in Maracha, Arua District, in West Nile Zone, Uganda. Arua District is situated in North Western part of Uganda. The District had poor socio-economic indicators, and local revenue accounted for only 29% of its annual budgetary estimates (District Development Plan, 2001/2002). Arua had one of the worst infectious diseases profiles and HIV/AIDS constituted 60% of the burden of disease in the district. The District had high caseload of TB patients (956, 814 and 914 registered cases in 1998, 1999 and 2000 respectively). This was especially in Maracha, one of the Health Sub-District (HSD) in Arua, which harbors refugee camps from areas bordering both Sudan and DR Congo (District Annual reports 1998-2000). Maracha runs an integrated curative and preventive health services for the refugees and its peoples.

## **1.2 Research problem**

With today's evidence-based push, it makes sense that the costs and effectiveness/benefits of healthcare interventions are measured. With this cost effectiveness evaluation reports, then policy and decision makers can have a more informed dialogue about which option of DOT supervision to adopt. This research will

therefore address the question: "From the health system, patients and community perspectives, is it more cost-effective to supervise DOT treatment of tuberculosis through CB-DOT or by self-supervision.

After patients were discharged from active treatment phase, compliance to further treatment and the costs incurred by patients, health system and community varied with the DOT supervision option. This study compared the cost effectiveness of two supervision options of DOTS after initial active treatment phase in Maracha hospital. The research identified the more efficient DOT supervision option and the one with greater patient's treatment compliance.

HIV/AIDS has no known cure and yet it is associated with TB, and so increasing cumulative prevalence of HIV/AIDS meant there was increasing number of individuals who were immunosuppressed and more likely to get active TB infection. The situation is usually worsened by malnutrition, intercurrent/multiple infections and overcrowding in peri-urban and poor rural communities like in Maracha.

Preventive measures which raise community awareness leading to improvement in knowledge, attitude, behaviour and practice (KABP) could lead to more TB treatment compliance, increased cure rate and reduction in transmissibility. This then could lead to reduction in TB incidence and eventually prevalence and then eventual eradication. CB-DOT involves creating or improving community awareness, so when combined could reduce incidence of both TB and HIV/AIDS. Less expensive intervention measures which raise awareness with resultant positive Knowledge, Attitude, Behaviour and Practice (KAPB) could lead to improved compliance to TB treatment, increased cure rate and eventual reduction in transmissibility and incidence.

This was an efficiency evaluation in which each supervision outcome was the number of TB patients who completed treatment after the 6-8 month period. Negative outcomes such as patients' reactions to anti-TB drugs were ignored. The more efficient and effective DOT supervision option could have increased case detection and treatment rates, reduced suffering of patients and also reduced treatment costs to both patients and the health system. The results and recommendations of this cost effectiveness study could therefore be used by Arua district for choosing and adopting the best option for supervision of DOT.

### **1.3 Aim and objectives**

To identify whether community-based supervision of directly observed TB treatment was more cost-effective than the option of self-supervision of DOT in Arua, Uganda.

**The objectives of the study were:**

1. To identify, quantify and value (in US\$) the inputs/resources used by the health system, the community and patients under the CB-DOT and Self-Supervised TB treatment options in Arua
2. To identify and quantify outcomes of the two TB treatment options in Arua
3. To estimate the cost-effectiveness of the two TB treatment supervision options
4. To perform a sensitivity for assumption and estimates of inputs

### **1.4 Justification**

It was necessary to identify the most efficient DOT supervision option because of the high TB prevalence in Arua, and the fact that the case detection rate in Uganda was

below WHO standards. Uganda belonged to the group of the least developed countries by World Bank/IMF standards and could not have afforded the high cost of in-patient treatment of the ever-rising number of TB cases.

There was an urgent need to identify a cheaper approach to TB treatment, which was independent of hospitalization, and had a high patients' compliance (for this society that belongs to one of the least developed nations). DOTS was the standard approach to care in countries like the US and China (WHO, 2001) and the most cost-effective method of its supervision when identified was even more relevant in a country like Uganda.

The economic evaluation method that was used in this study had already been tested in South Africa and Bangladesh and found to be robust (Floyd et al, 1997; Akramul, 1998).

## **Chapter Two**

### **Literature Review**

#### **2.1 Cost-effectiveness analysis (CEA)**

Because of its relative simplicity, cost effective analysis (CEA) is the most common form of economic evaluation in health care. It requires effectiveness to be valued in natural terms. It requires that outcomes of the two intervention options being compared to be the same. CEA deals with technical efficiency and seeks to answer the question "Given that it has been decided that a goal has to be achieved, what is the best way of doing so?" or "What is the best way of spending a given budget to achieve a certain outcome?" Thus, CEA always involves comparison of at least two options with the same goal (Donaldson et al, 1997).

Cost-effectiveness evaluation is used to inform decisions about which interventions provide the greatest amount of specific desired outcomes per dollar spent. Decisions about technical efficiency can then be made. The cost-effectiveness ratio produced for each alternative is therefore, a measure of "cost per unit of health effect". The alternative with the lowest cost-effectiveness ratio is better (Donaldson et al, 1997).

#### **2.2 TB and HIV/AIDS epidemics**

TB is a global problem, but in Africa HIV/AIDS has formed a deadly alliance that is fueling TB epidemics and creating untold obstacles to TB control programme. Some 23.3 million Africans are estimated (UNAIDS/WHO, 1999) to have HIV/AIDS. The African region also has the highest TB incidence rate in the world (259/100,000 persons). Africa has so far the highest fraction of persons with TB and HIV co-infection

(1.2%). It also has the highest fraction (32%) of TB cases that are HIV-positive (Davis, 1998). Because of this co-infection, 8 African countries belong to a group of 22 countries in the world, with 80% of the global TB burden (Davis, 1998). Uganda, and its neighbors Kenya, Tanzania and DR Congo belong to this group of high TB burden African countries. These countries except Kenya also belong to the so-called Great Lakes region. It is an area of political turmoil with internal and across-the-border displacements of its peoples. Uganda and Tanzania belong also to the group of the least developed countries according to International Monetary Fund (IMF) ratings. TB and HIV are associated with low socio-economic status. TB thrives in a place like Arua which had in the recent past overcrowded camps of displaced people from DR Congo and Southern Sudan.

Tuberculosis continues with its alarming worldwide spread despite the existence of a highly cost-effective intervention strategy known as DOTS. Bringing the prevalence and spread of TB down in Arua means quick actions in this fluidy border district. There is need to stop transmission by increasing treatment coverage and completion. The ratio of annual rate of infection (ARI) decreases as TB declines because case detection and prompt treatment shortens the duration of infectiousness, and ARI falls faster than incidence (Dye Christopher et al, 1998). This can be achieved by community-based supervision of DOT which has been shown to be cost-effective in South Africa (Floyd et al, 1997).

Clearly the goal of all TB programmes is to deliver services as close to the community as possible. Therefore WHO in collaboration with UNAIDS, the IUATLD, the Royal Netherlands Tuberculosis Association (KNCV), CDC/Atlanta and USAID have developed a project that aims to assess the feasibility, acceptability and cost-effectiveness of

community contribution to TB care (BMJ Editorial, 1997). Under these projects, treatment supervision in the community is offered as an alternative to the standard treatment supervision offered by regular health facilities (Davis, 1998). Eight projects in five countries (Botswana, Malawi, South Africa, Uganda and Zambia) are testing different community mechanisms to deliver TB care, involving community health workers, “guardians” and traditional healers. The 8 projects are at various points of implementation and encouraging results are emerging from them. In Uganda, piloting was completed and DOTS was in its expansion phase (Uganda annual health sector performance report FY 2000/2001). Maracha was now in the expansion phase of DOTS, and with both CB-DOT and self-supervision of TB treatment.

It is important to treat TB in people with HIV. With DOTS, TB patients can be cured of active TB, relieved of suffering, and TB transmission within the community checked (ZAMNET, 1997). Even in settings where anti-retroviral drugs such as AZT are unavailable or inaccessible, it is still vital that the health system offers HIV-infected individuals the simple antibiotics needed for DOTS because HIV/AIDS itself does not kill but co-infections like TB does. Treatment can essentially be carried out for patients at home, and health workers should also consider offering preventive therapy with isoniazid to HIV-infected patients who are at high risk of developing TB (such as TB carriers or those living in communities with very high incidence of TB) [ZAMNET, 1997].

### **2.3 Directly observed treatment (DOT)**

There is also evidence that for both patients and the health system, hospital-based treatment is three times more expensive than DOT (BMJ Editorial, 1997). DOT, not hospitalization is advocated as the World Health Organization’s (WHO’s) current global tuberculosis control strategy to promote adherence. In New York, the introduction of

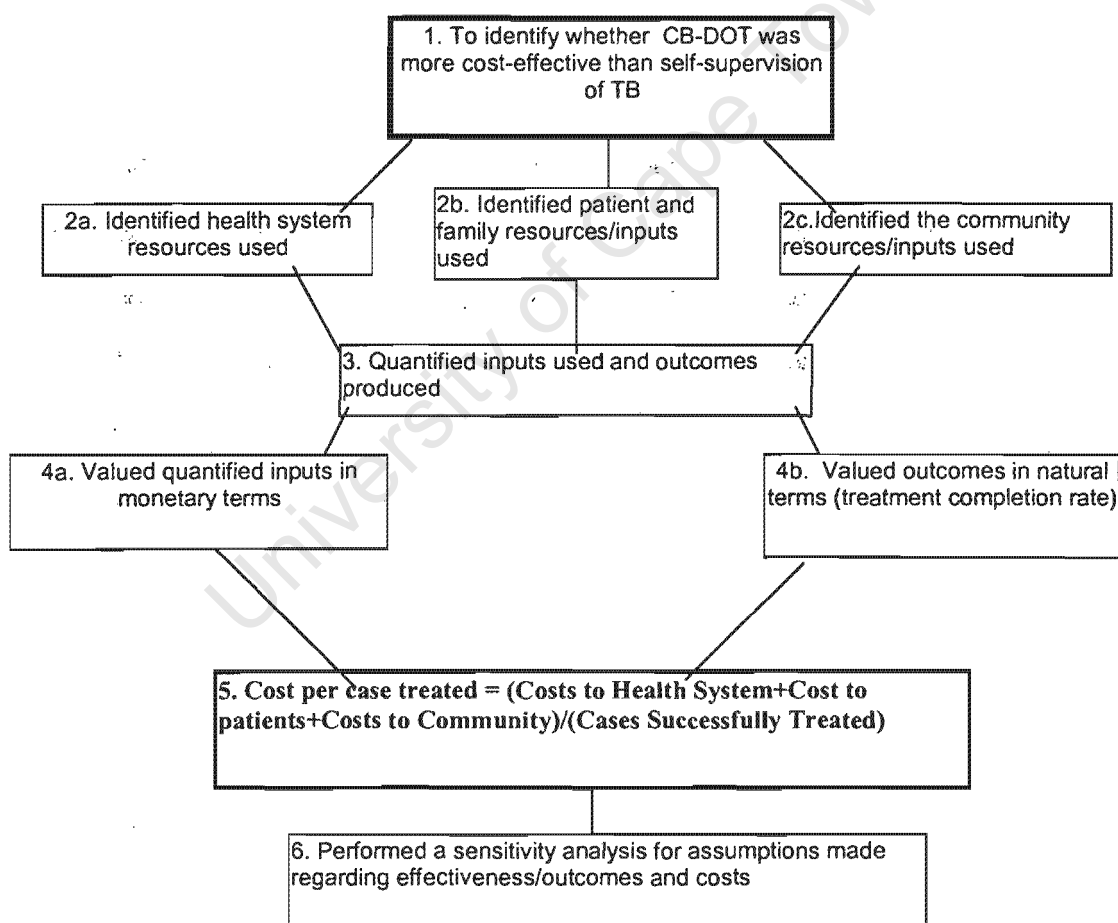
directly observed treatment has been associated with sustained reduction in the number of new cases and cases of multi-drug resistance (BMJ Editorial, 1997). Poor patient compliance is a major contributory factor to multiple drug resistance that increases cost of TB treatment by 100 times. Therefore new treatment options should address both costs and compliance (cost-effectiveness). Until recently the World Health Organization (WHO) and the International Union Against Tuberculosis and Lung Disease (IUATLD) advocated a strategy of admission to hospital for at least the first 2 months of treatment as a way of ensuring adherence. DOT was with other elements of the control programme, highly effective (BMJ Editorial, 1997).

A recent study in South Africa has shown that DOTS was 3 times cheaper than conventional treatment (Floyd et al, 1997). DOT was also 2 to 4 times more cost effective than conventional treatment. Admission to the hospital was the most costly item for TB treatment; accounting for 75% of health system costs, 76% of patients' costs, and 75% of overall costs. The contribution of lay-workers in supervision of DOT had reduced the total costs of DOTS by 26% from health systems' perspective, 53% from the patient's perspective, and by 31% overall in comparison with health clinics supervision. The community costs are minimized because supervision of drug intake takes place at the convenience of both patients and lay-workers. The opportunity costs of patients/lay-workers are thus reduced.

## 2.4 Conceptual framework (adapted from Drummond et al, 1987)

To find out the most cost-effective supervision option, costs and effects of each alternative were identified, and measured in appropriate physical terms. Costs were valued in monetary terms (after discounting for time) and outcomes in natural terms (treatment completion). The cost per number of TB treatment completed was the indicator of efficiency (see the scheme below).

Figure 1: Conceptual Framework



## Chapter Three

### Field methodology

#### 3.1 Study design

This was a cost effectiveness study in which community-based DOT was compared with self-supervision of TB treatment from March 2000 to March 2001. The costing was done from the health system, patients and community perspectives. It was assumed that the community contribution was equal to the opportunity costs incurred during the time they supervise drug intakes. Initially the CB-DOT was to be compared to clinic-based DOT, but because of withdrawal of the support from MALTESER, and international NGO based in Arua and affiliated to United Nations High Commission for Refugees (UNHCR), from end of 1999 Maracha health sub-district had reduced its DOT (field) activities (no clinic-based DOT in satellite health units). However with support from District Health Office, the HSD still ran community-based DOT in 3 sub-counties (Kijomoro, Oluvu and Oleba). The two other sub-counties (Nyadri and Yivu) then had mostly self-supervised TB treatment programme.

Data was collected using historical cohort epidemiological method. TB patients (129) treated in the health sub-district Maracha hospital in March 2000-March 2001 was identified from TB registers. The patients were assigned to two follow-up groups: a) the group (31 patients) supervised by community health workers and, b) and the group (98 patients) of self-supervision. The first group, after the intensive phase (2-4 weeks) of treatment from Maracha hospital, returned to their homes. From here they continued getting anti-TB drugs from VVWs' homes for the next 6 months. After the intensive phase, the patients of the second group also went home but with a month-long supply of anti-TB drugs, which they continue to take without community supervision. They

however had to go to Maracha every month to replenish their stock and for other health advice and medical attention.

Each patient in the two arms was then followed up by direct interviews and record reviews for resources used from diagnosis to treatment completion. Interviews were conducted with the 20 patients from each supervision option to determine their opportunity costs for tuberculosis treatment. Capital and recurrent costs for TB treatment for one year was estimated for both options.

**Community costs:** these were taken as opportunity costs during the time of supervision of drug intakes. It was estimated from the average monthly income of the local community of Maracha as ascertained from patients' interviews. The length of time the community spent on DOT was assumed to be the same as that taken by CB-DOT patients to access drugs from VVW homes. The other costs of community participation during monthly village meetings were already met by the health system in terms of out-of-pocket allowances and meals provided.

Treatment outcomes were measured using national guidelines as recommended by WHO. Because of poor records especially on follow-up laboratory investigations (sputum smears at 5<sup>th</sup> and 8<sup>th</sup> months), treatment completion rate, transfers, defaulter and death rates were the only available indices of treatment outcome (TB registers, Maracha, 2000-2001).

### 3.2 Setting

The study was conducted in Maracha, Arua District, in West Nile Zone, Uganda. Arua District is situated in North Western part of Uganda. It is bordered by the Republic of

Sudan in the North, Democratic Republic of Congo in the West, Nebbi District in the South, Moyo and Adjumani Districts in the East and Gulu District in the South East. The District headquarters is 520 kilometers from Kampala City. The total land area is 7595 square kilometers and had a mid year projected population of 709,603 inhabitants by 2000. Out of this, 141,805 people lived in Maracha HSD catchment area (District Development Plan, 2001/2002).

The District was prone to outbreaks of pyogenic meningitis, measles, plague etc. Despite these, Arua had to absorb problems associated with refugees from Sudan and the Democratic Republic of Congo. Maracha HSD integrated curative and preventive health services for the refugees and its peoples. The District had high caseload of TB patients (956, 814 and 914 registered cases in 1998, 1999 and 2000 respectively) and especially Maracha HSD which bordered refugee camps from areas bordering both Sudan and DR Congo (District Annual reports 1998-2000).

### **3.3 Site characteristics**

Arua District had poor socio-economic indicators, and local revenue accounted for only 29% of its annual budgetary estimates (District Development Plan, 2001/2002). Arua had one of the worst infectious diseases profiles: apart from the major causes of morbidity and mortality like malaria, acute respiratory infections, HIV/AIDS which constituted 60% of the burden of disease in the district, Arua had also other preventable diseases like tuberculosis, under-nutrition, anaemia, helminthiasis, trauma/accidents, skin infections, mental health, cardiovascular diseases, immunisable diseases with considerable morbidity (District Development Plan, 2001/2002).

Basic socio-demographics like: Child Mortality Rate (240/1,000; National 203/1,000 live births), female literacy rate (28%; National 46%), fully immunized infants (23%; National 47%), and stunting (47%; National 38%) were poor (District Development Plan 2001/2002)

In Maracha HSD the top 5 diseases were; malaria, ARI and TB, worms, trauma and gastroenteritis. Though the number of TB patients was low compared to other diseases but the TB ward had one of the longest occupancy rate (74%, 2001) compared to the other general medical cases (58%, 2001) [Maracha Annual report, 2000/2001]. It also had the longest average length of stay (61 days). Because of this long stay, successful in-patient treatment of TB cases should have been expensive compared to other causes of admissions. CB-DOT could have reduced these costs in Maracha.

The poor indicators meant Arua district had to thrive to improve health services coverage within HSDs, reduce costs of access to health-care for patients by instituting appropriate treatment options like CB-DOT. Maracha HSD (Maracha county) has 5 sub counties but also served some patients from neighboring counties of Koboko, Ayivu, Terego and Aringa; plus refugees from Southern Sudan and Eastern DR Congo.

The Roman Catholic Church ran Maracha hospital, and the 200-bed hospital was in-charge of the TB control programme for the HSD. All peripheral health units in the HSD were under the responsibility of the Maracha hospital Medical Superintendent. A team consisting of medical officer, clinical officers, registered midwife, public health nurse, health assistant, dispenser and a community-based health worker were involved in the supervision of health services. The coordinator of Medicus Mundi Navarra, an NGO

affiliated to the Roman Catholic Church assisted them (Maracha Annual report, 2000-2001).

### **3.4 Sample size and sampling technique**

The sample size was determined by convenience. Patients were selected by the systematic random sampling technique. From the TB register, the first patient number was determined randomly from random number tables. Subsequent patients were then every 3<sup>rd</sup> number. The process was repeated until 20 patients were identified for determination of patients' costs. They were then traced to their residents by the assistance of SCHWs and VVWs for administration of interviews.

Since the registers revealed only 129 patients (98 under self-supervision and 31 under CB-DOTS), all patients were enrolled for the follow-up study on treatment outcome. On the short arm were 31 patients of CB-DOT patients and 98 patients of self-supervision on the long arm.

### **3.5 Data collection method**

The costs of treatment and their outcomes were determined by observation of staff activities, interviews and record reviews.

#### **3.5.1 Health system costs**

Since the inpatient and outpatient department (OPD) were integrated for many programmes, there were both shared costs and fixed costs incurred for TB treatment in 2000-2001. Shared costs were estimated through observation and interviews of health staff in different cost centers within OPD (clinic, laboratory, x-ray, pharmacy etc) to determine the relative share of their time by programme activities. The health staffs

were asked using a simple questionnaire to list their activities and identify which proportion was for TB. An inventory survey for furniture, equipment, vehicles and rooms used for the TB programme directly, or shared, was conducted. Costs were also derived from accounting books, expenditure files and financial reports, and for those items whose cost were not available, market prices of 2000 were used.

Recurrent costs such as salary, transportation, repairs and maintenance, stationery and meetings were sought from records and the proportion for TB estimated according to the time and cost-share of TB programme. An inventory of drugs and diagnostic tests used for TB was prepared according to official records. Prices were calculated based on the price list from the National TB programme stores.

### **3.5.2 Patients' costs**

Interviews using a standard questionnaire were conducted in order to determine costs for diagnosis and treatment of patients from each supervision option. Time and travel costs during visits to the health centre in the first phase (for diagnosis and treatment), and to CHWs homes in the later part of the directly observed treatment were estimated. Costs of follow-up tests were included. For each group of supervision option, patients' time and travel costs to the health unit were ascertained. Average direct costs to patients (money spent on transport and treatment) and average indirect costs to patients (time spent on traveling and treatment) were estimated. Indirect costs were converted into money form using average monthly income as determined from patients' interviews.

### **3.5.3 Community costs**

This was assumed to be the opportunity costs of the time patients spent with VVWs during the swallowing of drugs. This time was determined by interviews of patients and

later converted into monetary terms considering the community's average monthly incomes, also determined from the interview.

#### **3.5.4 Effectiveness**

Data on programme achievements was collected by review of 2000/2001 TB records. A standard reporting form was used for data collection. Treatment outcomes indicators like number of patients cured, completed treatment, defaulted, died, failure and transferred were determined as defined by WHO/NTP. There were three broad categories of patients: a) those who completed full treatment course and became sputum negative by 5<sup>th</sup> and 8<sup>th</sup> month was defined as cured; b) patients who completed full treatment course but sputum results at 5<sup>th</sup> and 8<sup>th</sup> month not available were defined as completed treatment; c) the third category were patients who stopped treatment anytime during the treatment course for more than 2 months and were defined as defaulter or; patients who died of any cause during the treatment course and defined as failure or; patients who were referred/transferred to another hospital and treatment outcome unknown and defined as referred/transferred (Akramul, 1999). Only patients in the first two categories were interviewed for estimation of outcome. The measure of effectiveness in this study was successful TB treatment rate. The number of patients in the 1<sup>st</sup> two categories (a+b) was expressed as a ratio (percentage) of all patients treated (categories a+b+c)

#### **3.6 Data analysis plans**

Raw data was entered in the Microsoft Excel spreadsheets for analysis.

### 3.6.1 Costing

Capital costs were annualized using discount rate of 7% (recommended rate in Uganda, 2000). Replacement values were used to calculate equivalent annual costs of buildings, furniture, vehicles and equipment, at a discount rate of 7%. Useful life of buildings was 20 years; that of vehicles 10; motor cycle, equipment and furniture, 5 years. Generator and X-ray machine 15 years and bicycles 2 years. Sources of data included hospital records, inventories and National Medical Stores (NMS) price list as per 2000, Commissioner Health Engineering office and Regional Equipment Maintenance unit.

Joint clinic costs were allocated to tuberculosis on the basis of the proportion of total visits for which TB patients accounted, and then to different types of visits (diagnosis, for drugs) on the basis of interviews with staff (number of each type of visit made). Some observations were also made to determine (corroborate) the OPD staff time spent on each visit. The costs of drugs were allocated between the two options according to the proportion of patients in each group. Since during the continuation phase of DOTS no patients of CB-DOT took drugs in clinic, and also no Self-Supervised patients took drugs from VVWS, then the clinic costs of drugs was equivalent to the proportion consumed by Self-Supervised patients and that consumed by CB-DOT patients constituted field supervised costs of drugs.

Average costs were calculated for each treatment item separately in Uganda Shillings (1750 = 1 US \$) by 2000. Drugs, laboratory chemicals and logistics, X-ray films (costs of drugs and diagnosis) were based on hospital records and hospital stores inventory and quotes by NMS. An ingredient approach was used for other recurrent costs during health clinic visits, overall hospital costs and supervision of community-based treatment.

### **3.6.2 Ingredient approach**

For each item, the quantities of all resources used were established and multiplied by their unit prices, summed, and then divided by the relevant number of units of output (number of hospital visits or number of VVWs visits over the 6-8 months and number of patients managed in both groups). This then gave us the cost per unit of output (per visit).

The total cost of each treatment option was ascertained by: multiplying the average cost of each care component (average cost of clinic visit; average cost of field visit; average costs of patient's visits to the clinic or VVWs and average costs of community time) by the total number of times they were incurred, and then summing up the totals.

### **3.6.3 Summary of costing**

- The total equivalent annual capital costs + total recurrent costs = total health system cost
- This was divided by total number of patients visits to get an average cost per visit to the provider
- For each supervision option, the average cost per DOT visit met by a patient added to the average cost of each patient's visit met by the provider to form the combined average patient's cost per each DOT visit
- This combined cost per each DOT visit was multiplied by the average number of a patient's visits to give cost per patient treated
- This cost was then divided by successful TB treatment rate to estimate cost-effectiveness ratio

#### **3.6.4 Choice of effectiveness measure and source of effectiveness data**

Treatment completion rate was used as an outcome measure. The first choice of effectiveness measure was cure rate as per sputum smear results at 5<sup>th</sup> and 8<sup>th</sup> month of treatment. Because of inadequate records and failure of patients to come for sputum smear control tests, cure rate was not in this case a very appropriate measure of treatment successful rate. Treatment successful rate was then measured by proportion of patients from each arm of follow-up which completed treatment (whether cure confirmed or not) during the 6-8 month period, using TB register.

#### **3.6.5 Cost effectiveness analysis**

Cost-effectiveness was calculated based on the cost for each patient treatment completion. These calculations were based on average costs. In each option, the cost per patient treated (from diagnosis to end of treatment) was divided by proportion of patients who completed the treatment course. A cost-effectiveness ratio was then obtained. The option with the smaller ratio is more cost-effective and was to be recommended to Arua District for considerations.

#### **3.6.6 Incremental cost-effectiveness analysis**

The additional cost and effectiveness of CB-DOT was compared to that of self-supervision. Essentially the costs of field supervision service activities by health workers, SCHWs and VVWs constituted additional health system's costs. The costs of access of drugs and health messages by patients from VVWs were taken as additional patient's costs. These additional costs during treatment of one TB patient to completion and the additional effectiveness (over that of self-supervision) were expressed as additional cost per unit of additional effectiveness, or incremental cost-effectiveness.

### **3.7 Sensitivity analysis**

Because of Uganda's weak but labile economic strength, cost-effectiveness ratios for the 2 options were tested using changed interest rates. Sensitivity analysis was also done to test the cost-effectiveness of these two options if Uganda achieved its vision of reaching treatment success rate of 85% by end of 2005 as in the Government 5-year Health Plan (2000-2005).

#### **3.7.1 Costs**

A sensitivity analysis was performed to test the robustness of the cost-effectiveness to changes in discount rates for capital costs at  $\pm 3$  of the present interest rates of 7% (i.e. at 4% and 10%).

#### **3.7.2 Effectiveness**

There were uncertainties in the treatment successful treatment rate; the awareness of the community and patients in these sub-counties (until 1999 all sub-counties in Maracha had CB-DOT) could have influenced the compliance of self-supervised patients in a positive manner thereby raising the percentage of treatment completion rate in the follow-up group in the long arm. The cost-effectiveness of both options were tested by the overall national target for TB treatment successful rate of 85% (Uganda Annual Health Sector Performance Report, FY 2000/2001)

### **3.8 Design limitations**

There was no credible proof of treatment and supervision effectiveness from the historical cohort method. This study depended on data from patients' registers and records, which were incomplete, unreliable and inaccurate.

Time spent by health workers and patients was not an accurate way of estimating shared and opportunity costs of the health system and patient respectively. Time spent on TB duties varies from day to day; when the clinic is very busy during some months health workers are very busy and some days you find no patients in the clinic. The small sample size affected representativeness of the findings.

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## Chapter Four

### Results

#### 4.1 Presentations

The results of this cost-effectiveness study consisted of: the costing of the different inputs (capital and current costs) for treatment and supervision of each supervision option for TB patients in the OPD of Maracha hospital, the effectiveness of the each supervision option (chapter 9.3) and then cost-effective ratio and cost-effectiveness. Incremental cost-effectiveness was calculated with field supervision taken as additional service for DOT. Sensitivity analyses were done after annualization of capital inputs at changed discount rates (4% and 10%). Finally the cost-effectiveness ratios were tested by changing the effectiveness of treatment options to the national target of 85%. The costs were converted to US \$ as per end of 2000 rates (Uganda Shillings 1750 = 1 US \$).

#### 4.2 Cost results

##### 4.2.1 Health system costs

These consisted of capital and recurrent costs for both supervision options, and an additional cost item for CB-DOT i.e. cost of field supervision.

##### 4.2.1.1 Capital costs

The capital costs were annualized using the 2000 interest of 7% and useful lives of the various items. From shared capital costs, the replacement value for TB capital costs were computed from the proportion of their utilization by OPD TB activities. In OPD, capital costs were the same for both TB supervision options (see Table 4.1).

**Table 4.1: Replacement values of Capital costs and their annual values (US \$)**

| Item  | Total replacement value | TB share (%) | Replacement value for TB | Useful life (years) | Annuity factor | Annual value           |
|---|-------------------------|--------------|--------------------------|---------------------|----------------|------------------------|
| Building  | 17,143                  | 100          | 17,143                   | 20                  | 10.594         | 1,618                  |
| Vehicle   | 14,286                  | 15           | 2,143                    | 10                  | 7.024          | 305                    |
| X-ray   | 8,571                   | 13           | 1,071                    | 15                  | 9.108          | 118                    |
| Equipment                                       | 1,429                   | 13           | 179                      | 5                   | 4.100          | 44                     |
| Generator                                       | 14,286                  | 13           | 1,786                    | 15                  | 9.108          | 196                    |
| Furniture                                       | 251                     | 100          | 251                      | 5                   | 4.100          | 61                     |
| <b>Total annual value capital inputs</b>        |                         |              |                          |                     |                | <b>2,342</b>           |
| <b>Total value of capital costs in 6 months</b> |                         |              |                          |                     |                | <b>2,342/2 = 1,171</b> |

**4.2.1.2 Recurrent costs:** For shared recurrent costs, the total cost of each item consumed in the hospital for financial year 2000/2001 was ascertained from records. This was then multiplied by proportion (%) of that item used by TB to give its annual recurrent cost for TB. This was divided by 12 to convert it to monthly costs. Since OPD TB treatment was for 6 months, the monthly costs were multiplied by 6 to estimate the costs for complete DOT OPD treatment. The proportion of health staff time spent in OPD for TB patients (as ascertained from the interviews) were multiplied by their monthly salaries to give monthly cost of each staff time for TB. All these costs were then also multiplied by 6 to get total recurrent costs for personnel for an average OPD TB treatment time of 6 months. The following health staff (and share of time in OPD) worked in OPD TB clinic: clinical officer (15%), enrolled nurse (13%), nursing assistants (63%), radiographer (20%), laboratory assistant (22%), laboratory attendant (22%) and driver (15%). The recurrent costs were the same for both options. It was estimated that

normally health staff in Uganda worked 8 hours a day, 5 days a week, and 20 days a month (see Table 4.2).

**Table 4.2: Recurrent costs (see appendix 3) of TB OPD treatment activities (US \$)**

| Recurrent inputs  | OPD total | TB share (%)               | TB costs     |
|---|-----------|----------------------------|--------------|
| Fuel  | 566       | 100                        | 566          |
| Repairs   | 4,371     | 38                         | 1,639        |
| Electricity   | 3,086     | 20                         | 617          |
| Water   | 2,308     | 13                         | 300          |
| Stationery  | 286       | 50                         | 143          |
| Lab. Chemicals  | 222       | 100                        | 222          |
| Lab. Logistics  | 311       | 100                        | 311          |
| X-ray   | 429       | 100                        | 429          |
| Salaries  | 3,521     | For details see appendix 3 | 708          |
| <b>Total clinic recurrent costs for CB-DOT (without drugs)</b>                                |           |                            | <b>4,935</b> |
| <b>Total all clinic-recurrent costs for Self-Supervised patients (with drugs)</b>             |           |                            | <b>6,021</b> |
| NB: Total costs of drugs for Self-Supervision patients (98) = $1,429 \times 98 / 129 = 1,086$ |           |                            |              |
| Total costs of drugs for CB-DOT patients (in the field only) = $1,429 \times 31 / 129 = 343$  |           |                            |              |

#### 4.2.1.3 Field supervision costs

These consisted of both capital and recurrent costs (see Tables 4.3 & 4.4). Summary of health systems cost for both supervision options is give in Table 4.5.

**Table 4.3: Capital costs of field supervision (US \$)**

| Item                         | Total replacement value | Share field supervision (%) | Replacement value for TB | Use life (years) | Annuity factor | Annual value       |
|------------------------------|-------------------------|-----------------------------|--------------------------|------------------|----------------|--------------------|
| M/cycle                      | 1,429                   | 100                         | 1,429                    | 5                | 4.100          | 349                |
| Bicycle                      | 86                      | 100                         | 86                       | 2                | 1.808          | 47                 |
| <b>Sub-total (annual)</b>    |                         |                             |                          |                  |                | <b>396</b>         |
| <b>Sub-total (6- months)</b> |                         |                             |                          |                  |                | <b>396/2 = 198</b> |

**Table 4.4: Recurrent cost field supervision (US \$)**

| Recurrent inputs   | Monthly costs | Costs in 6 months |
|--|---------------|-------------------|
| Allowance for SCHWs  | 51            | 309               |
| Allowance for VVWs   | 34            | 206               |
| Fuel for facilitators  | 26            | 154               |
| Facilitators allowance   | 17            | 103               |
| Stationery   | 11            | 69                |
| Maintenance & repairs  |               | 569               |
| Meals  | 34            | 206               |
| <b>Subtotal</b>  |               | <b>1,616</b>      |
| <b>Recurrent costs drugs</b>   |               | <b>343</b>        |
| <b>Total costs field supervision (Capital + drugs &amp; other recurrent costs)</b> |               | <b>2,157</b>      |

**Table 4.5: Summary of health system costs (in 6 months) for both supervision options (US \$)**

| <b>Cost item</b>                                       | <b>Community-based supervision</b> | <b>Self-supervision</b> |
|--|------------------------------------|-------------------------|
|  | <b>Total costs</b>                 | <b>Total costs</b>      |
| Clinic capital costs                                   | 1,171                              | 1,171                   |
| Recurrent clinic costs                                 | 4,935                              | 6,021                   |
| Capital costs field                                    | 198                                | -                       |
| Recurrent costs of field supervision (including drugs) | 1,959                              | -                       |
| <b>Health system costs</b>                             | <b>8,263</b>                       | <b>7,192</b>            |

Total health system costs less drug costs were the same in OPD clinic. Total health system for CB-DOT was 1.2 times more than that of self-supervision. The difference in health system costs for the two options was due to costs of drugs and that of field supervision. Capital inputs were 16%, and recurrent costs 84% of total health system costs for self-supervision; for CB-DOT capital costs were 17%, and recurrent costs were 83% of total health system costs. The ratio of recurrent to capital costs was 5 in both CB-DOT and Self-Supervision.

#### **4.2.1.4 Average health system costs**

This was equal to total of average costs: cost of each clinic visit plus cost of drugs per patient for self-supervision, and plus cost of field supervision per CB-DOT patient (see Table 4.6). Therefore total costs of clinic visit (capital +recurrent), was divided by total number of clinic visits for all patients (129) = 779 total visits [31 CB-DOT patients \* 3 visits (93 visits) plus 98 self-supervision patients \* 7 (686 visits)]. For field supervision, the total costs of field activities were divided by the total of all patients' visits (31\*72 = 2232).

**Table 4.6 Average health systems costs (US \$)**

| Costs (US \$)   | Community-based supervision | Self-supervision |
|---|-----------------------------|------------------|
| a. Average of capital + Recurrent costs (per clinic visit) =<br>total capital & total recurrent costs /total clinic visits (all OPD visits) | 6,105/ (779) = 8.0          | 7192/(779) = 9   |
| c. Average costs of field supervision = costs all inputs/no. visits<br>(Total costs field supervision/31*72 supervision visits)             | 2157/ 2232) = 1.0           | -                |

Average health system costs of the two options were almost equal (1.1:1).

#### 4.2.2 Community contributions/costs

The costs (allowances and meals) of the monthly meetings attended by village/community volunteers were virtually all met by the health system (see appendix c). The proportion of the monthly income of community supervisors of CB-DOT spent during the time TB patients take drugs at their homes, was taken as their contribution to the TB programme. These were derived from the total length of time taken during VVWS during patients visits to VVWs homes and the community's average monthly incomes as from the questionnaires.

#### 4.2.3 Patient's costs

A total of 40 patients were interviewed using standard tested questionnaires. Half of these belonged to the group of self-supervision and the other 20 patients were those supervised by the VVWs. They were asked questions during the interview to establish their total monthly income, time costs for access to care in the OPD and from VVWs for community-based DOT patients. Questions were also asked about other costs during travel or access to care like for hotel, accommodation and transport fares. Sixty-five percent (26 patients) interviewed were females and only 35% (14 patients) were males.

The average age of these patients was 28 years (95% CI: 24-32 years; SD: 20 years). These former TB patients were selected by systematic random sampling from the patients' registers in Maracha. The nearest patient of the same sex, and belonging to the same treatment group replaced any missing patient, or non-response. Sixty-five percent (26) of patients interviewed were farmers; 20% (8) were children below five years and 15% (6) were students. Their average income was US \$11 (95% CI: 7-15). The average total time of travel was 4 hours return for clinic visit and 15 minutes for visiting VVW for DOT. A patient's costs of access to care other than time (transport/hotel) were US \$0.35 (95%CI:0.30-0.40). The total cost per patient's visit to clinic was US \$0.46 (95% CI:0.36-0.56). The average cost per clinic visit is the same in both options. The difference in total costs to clinic visits was due to difference in total clinic visit per patient in both options (3 for CB-DOT; 7 for self-supervision). The cost of visit to VVWs homes was an additional traveling cost for the patients under community-based supervision (see Table 4.7).

**Table 4.7: Costs of a TB patient's complete treatment (US \$)**

| <b>Cost item</b>                               | <b>Community-based supervision</b> | <b>Self-supervision</b> |
|--|------------------------------------|-------------------------|
| Cost per visit to clinic                       | 0.46 (a)                           | 0.46 (a)                |
| Cost per visit to VVWs                         | 0.01 (b)                           | -                       |
| Number of visits to clinic                     | 3 (c)                              | 7 (c)                   |
| Number of visits to VVWs                       | 72 (d)                             | -                       |
| Total costs of clinic visits per patient       | 1.4 (a*c)                          | 3.2 (a*c)               |
| Total costs of VVWs visits per patient         | 0.72 (b*d)                         | -                       |
| <b>Total costs of a patient's visits (all)</b> | <b>2 {(a*c)+(b*d)}</b>             | <b>3 (a*c)</b>          |

#### 4.2.4 Cost of one patient treatment to completion

This was the total costs of each patient's (one) visit to the health clinic multiplied by total number of clinic visits for self-supervision, or, plus total cost of a patient's visit to the

VVWs multiplied by total number of visits to VVWs for CB-DOT (see Table 4.8). The self-supervised patient made 7 visits to the OPD clinic. The CB-DOT patient made 3 visits to the OPD clinic but 72 visits to the VVWs. This was likely to increase his/her total cost of treatment.

**Table 4.8: Costs of treatment completion (US \$)**

| COSTS  | COMMUNITY BASED SUPERVISION |               |              | SELF-SUPERVISION |               |              |
|--|-----------------------------|---------------|--------------|------------------|---------------|--------------|
|  | Average costs               | No. of visits | Total amount | Average costs    | No. of visits | Total amount |
| Total health system costs during a patient's clinic visits       | 8                           | 3             | 24           | 9                | 7             | 63           |
| Health systems costs of field supervision for a patient's visits | 1.0                         | 72            | 72           | -                | -             | -            |
| A patient's total cost of visits to a clinic                     | 0.46                        | 3             | 1.4          | 0.46             | 7             | 3.22         |
| Community costs during all VVW visits per patient                | 0.01                        | 72            | 0.72         | -                | -             | -            |
| A patient's costs of total VVW visits                            | 0.01                        | 72            | 0.72         | -                | -             | -            |
| <b>Total cost of one TB patient treatment</b>                    |                             |               | <b>99</b>    |                  |               | <b>66</b>    |

The cost of TB treatment for CB-DOT patient was more than that of a self-supervised patient by US \$33. Therefore the cost of complete OPD TB treatment by CB-DOT supervision is 1.5 times more than that in self-supervision.

### 4.3 Effectiveness

The effectiveness measure was the treatment completion rate and the patients' register was the source of data. Though in the earlier design of the study effectiveness was expected to be the cure rate, but the available records could not allow for ascertainment

of sputum smear results for most open lung TB cases to confirm cure. There were 129 patients recorded as treated for TB in Maracha between March 2000 and March 2001. Since this was a small number of patients, all were enrolled for this study. The patients were divided into two groups for follow-up. There were 31 patients for CB-DOT supervision and 98 patients for self-supervision. In total there were 69 (58%) males to 60 (42%) females. Their average age was 30 years (95% CI: 26-34 years). Only 3 sub-counties have community-based DOT.

There was almost an equal distribution of patients amongst the 3 sub-counties i.e. Kijomoro 11 patients (34%); Oleba 11 patients (34) and Oluvu 10 patients (32%). Fifty-three (41%) patients had open lung TB; 16 had extra-pulmonary TB (12%) and 60 (47%) with closed lung TB. Of the open lung TB 23 (43%) had smear examination done at 8<sup>th</sup> month and results recorded. Thirty (57%) had no smear done or recorded at 8<sup>th</sup> month. Forty eight (37%) patients had no smear done and never completed treatment. This last group of patients was not followed up and could have spread TB without constraints. DOT should reduce this scenario. Table 4.9 shows the outcome of TB treatment .

**Table 4.9: Outcome of TB treatment in Maracha, 2000-2001**

| Outcome measures                      | Total    | Community-based<br>DOT | Self-supervision |
|---------------------------------------|----------|------------------------|------------------|
| Smear at 8 <sup>th</sup> month        |          |                        |                  |
| Treatment completed                   | 80 (62%) | 26 (84%)               | 54 (55%)         |
| Reasons for treatment<br>incompletion |          |                        |                  |
| Transfer                              | 18 (14%) | 0                      | 18 (18%)         |
| Death                                 | 15 (12%) | 0                      | 15 (15%)         |
| Defaulted                             | 16 (12%) | 5 (16%)                | 11 (12%)         |

Total number of patients who completed TB treatment was 80 (62%). Fifty-four (54) were patients of self-supervision (98), and 26 from CB-DOT (31) giving treatment completion rate of 55% (54/98) and 84% (26/31) respectively. No patients of CB-DOT supervision option was transferred or died but 5 (16%) defaulted. Eighteen patients (18%) of self-supervision option were transferred to other health units. No reasons for the transfers were given in the available records. Fifteen died (15%) and 11 (12%) defaulted from the self-supervision group.

**4.4 Cost-effectiveness**

This was derived from cost-effectiveness (C/E) ratio. The C/E ratio = Cost of TB treatment to completion divided by TB treatment completion success (%). The option with the smaller C/E ratio was more cost-effective (see Table 4.10).

**Table 4.10: Cost-effectiveness ratio**

|   | TB treatment option |                               |
|---|---------------------|-------------------------------|
|   | Community-based DOT | Self-supervision TB treatment |
| Cost of one TB patient treatment (US \$)      | 99                  | 66                            |
| Effectiveness of treatment of TB patients (%) | 84                  | 55                            |
| <b>Cost-effectiveness ratio</b>               | <b>117</b>          | <b>120</b>                    |

Cost-effectiveness ratio of community-based DOT (117) was smaller than that of self-supervision option (120). CB-DOT was therefore more-cost-effective. Successful treatment of a TB patient's costs less in CB-DOT (US \$117) compared to that of self-supervision (US \$120).

#### 4.5 Incremental cost-effectiveness analysis

This was the cost-effectiveness of the additional service of field supervision. It was the difference between a patient's costs of TB treatment to completion in CB-DOT and self-supervision, divided by difference in their treatment effectiveness (see Table 4.11).

**Table 4.11 Additional costs and effectiveness of CB-DOT (US \$)**

|   |            |
|---|------------|
| Additional costs of CB-DOT supervision (a patient's full TB treatment)<br>(Costs a patient's full treatment by CB-DOT- Cost a patient's full treatment by self supervision) | 99-66 = 33 |
| Additional effectiveness (effectiveness CB-DOT-effectiveness self supervision) [%]  | 84-55 = 29 |
| <b>Incremental cost-effectiveness</b>   | <b>113</b> |

CB-DOT had additional service added (field supervision) for supervision of patients in the community. This additional service needed additional US \$ 113 to treat a TB patient to completion. This increased effectiveness of TB treatment from 55% (self-supervision) to 84% (CB-DOT).

#### 4.6 The results of sensitivity analysis

Two sensitivity analyses were performed: a sensitivity analysis using different discount rate, and a sensitivity analysis of changed TB treatment success rate.

**4.6.1 Sensitivity analysis using different discount rates:** For the uncertainties in Uganda's economy, the cost-effectiveness of both treatment options was tested by changing interest rate (discount rate) to a lower limit of 4% (best economic scenario in Uganda) and an upper limit of 10% (worst economic scenario in Uganda) (see Table 4.12 below).

**Table 4.12: Sensitivity analysis at 4% and 10% discount rates (US \$)**

| Description of item                       | Community-based TB supervision | Self-supervision of TB treatment |
|---|--------------------------------|----------------------------------|
| Cost of a TB patient treatment completion | 95 (107)                       | 65 (70)                          |
| Treatment success rate (%)                | 84                             | 55                               |
| <b>Cost-effectiveness ratio</b>           | <b>113 (127)</b>               | <b>118 (127)</b>                 |

The Cost-effectiveness ratio of community-based DOT was 113 and that of self-supervision option was 118 at 4%, and at 10%, the cost-effectiveness ratios of the two options were the same (127) 10%. There was no change in ranking of cost-effectiveness ratio at 4% (lower than current rate of 7%; better economic scenario than current). But at discount rate of 10% (more than current rate of 7%; poorer economic scenario for Uganda), the cost-effectiveness is the same.

#### 4.6.3 Sensitivity analysis of changed TB treatment success rates

This was done using the overall national target of TB treatment rate of 85% (see Table 4.13).

**Table 4.13: Sensitivity analysis of treatment successful rate at 85%**

|   | Community-based TB supervision | Self-supervision |
|---|--------------------------------|------------------|
| Costs of complete treatment of a TB patient (US \$) | 99                             | 66               |
| TB successful treatment rate (%)                    | 85                             | 85               |
| <b>Cost-effectiveness ratio</b>                     | <b>116</b>                     | <b>78</b>        |

The cost-effectiveness ratio (116) of community-based supervision was this time more than that of self-supervision (78) by 38. However this situation when costs of treatment of a patient could have remained the same for a wide range of success rates in self-supervision of TB treatment is very unlikely in Uganda.

## Chapter Five

### Discussions

The study results were discussed based on the objectives of the study, the findings, TB treatment policy issues in Uganda and limitations of the method.

The total health system costs less drugs (capital & recurrent) for the two options were the same (6,106 US \$) at the point of OPD clinic service consumption. The total health system costs less drugs in OPD was equal because all patients received the same inputs (capital +recurrent) in OPD. Self-Supervised but not CB-DOT patients took drugs from OPD during this time of continuation phase. However, the additional field activities increased the total health system costs for CB-DOT by 2,157 US \$ (26% of total). In the study by Floyd K, 1997, the costs of different drug regimens, management and audit were the same; and organization of supervision and supervision of supervisors were 5% of total DOT strategy. The recurrent costs of field supervision in Maracha (23%) could have been reduced if supervision and monthly meetings were entirely done by the HSD staff rather than supervisors from the District Health Office. Distance traveled by HSD staff would have been shorter, with resultant reduced total cost of field supervision and costs for complete treatment of one patient, and then eventually would have improved further the cost-effectiveness ratio of CB-DOT.

The average health system clinic costs (per visit) were US \$8 for CB-DOT, and US \$9 for self-supervision. Field supervision increased total average health system costs per visit by US \$1. However, the average field supervision costs per visit was only 11% of total average health system costs per visit in CB-DOT, and yet the difference in effectiveness of the two options was 29% (CB-DOT 84%, self-supervision 55%).

Considering that the community of Maracha is poor socio-economically, the health system (Government, NGOs etc.) in a cost-effective option should meet more of the TB treatment costs than patients, and probably the additional 11% or more costs in Maracha was fair. In the Malawian evaluation of DOT study, the average supervision cost per patient was only 3% of non in-patient activities (Wilkinson et al, 1997). The average cost per CB-DOT visit to the health system was US \$1.6 (in Maracha, US \$1) in Hlabisa, South Africa, 1997 (Floyd K et al, 1997), compared to US \$6.4 and US \$17 for visits to the health clinic and OPD respectively. The Maracha supervision costs were therefore very close to that of other African countries. It was encouraging that it was cheaper since Uganda is a poor country.

The patient's total costs of access to care in all visits to OPD in CB-DOT (US \$1.4) was less than that of self-supervision (US \$3.2) despite average cost of a clinic visit by a patient being the same for both. This was because self-supervision patients visited the OPD more times (7) than that of CB-DOT (3). CB-DOT reduces patients' costs of travel to the OPD clinic (by 56%) and was more likely to be favoured by patients. In the evaluation study of DOT in Kiboga and Masindi, Uganda, 98% of respondents from the community acknowledged that CB-DOT had a lower cost for them and made treatment more accessible (WHO, 2000). The total costs of VVW visits by a patient (US \$0.72) was small, and so was the total cost of all visits (clinic+VVWs) by a patient of CB-DOT (US \$2) compared to total costs of self-supervision visits (US \$3). And therefore, despite a high number of times (72), the total VVW visits increased a patient's total costs of all visits by only 36% in CB-DOT. The high number of contacts between patients and VVWs didn't increase a patient's costs substantially and yet could have instead led to increased DOT supervision time and therefore more patients' compliance. This then

eventually led to more effectiveness of TB treatment supervised by the community (84%) than that of self-supervision (55%).

The cost per VVW visit was US \$0.01 and this was even cheaper than the average patient's cost (US \$0.45) per CB-DOT visit in Hlabisa, South African (Floyd et al, 1997). The homogenous settlement in Maracha and with community solidarity probably made identification of CB-DOT supervisor simpler compared to Hlabisa, a poor metropolitan township. CB-DOT supervisors in Maracha were also probably more likely to have been readily available, dedicated and immediately attended to patients thereby reducing patient's visit costs. Community's solidarity, KABP and community motivation play the biggest role in success of CB-DOT. Therefore insights into all these factors should precede selection and design of CB-DOT supervision for any community (geographic area).

The community costs was small (\$0.72) because patients visits were done at convenient times, when VVWs were most available. The time of engagement between them was also small (15 minutes). However the costs could rise if this increases due to lack of cooperation and solidarity amongst the community.

The cost of completion of a TB patient's treatment was higher in CB-DOT (US\$ 99) compared to that of self-supervision (US\$ 66) by 50%. The high cost item for CB-DOT was cost of field supervision of one patient (US \$73). It was 74% of all costs of a patient treatment to completion. This was followed by total health system costs for a patient's all clinic visits (US\$ 24). This was 24% of all costs of a patient treatment to completion. Items for cost savings in CB-DOT was first of all, costs cuts in field supervision and then secondly reduced patients' visits to clinics. And for Maracha, this meant allocating

resources to HSD for DOT supervision rather than it (supervision) being done by District health Office staff: Allowances for supervisors and fuel costs would have reduced since HSD staff would then travel less distance. Or even at the same costs, supervisors could have visited the field more times to increase effectiveness of DOT. In absolute terms US \$73 for field supervision of a CB-DOT patient was not very expensive to the health system compared to transferring more costs to TB patients (who are very likely poorest in these communities) by increasing the number of their clinic visits like in self-supervision.

For self-supervision, the most costly item for the health systems during full TB patient treatment was clinic visits (US \$63). This was 95% of its one patient full treatment costs. These costs was highest because of the many times self-supervised patients had to travel to OPD and engage the health system for services. In other studies, clinic visits by patients was also a source of high TB treatment costs per patient and poor compliance in conventional TB treatment and as also in clinic-supervised DOT (Floyd et al, 1997; Zwarenstein et al, 2000; WHO, 2000). Therefore reducing patient's visits to OPD clinic and substituting it with VVW visits as in CB-DOT would have reduced costs further for self-supervision.

A patient's visit to a VVW did not require any monetary expenditure and time loss when converted to normal income lost was small (USUS \$ 0.01) compared to that of a clinic visit (USUS \$0.46). With increased clinic visits in self-supervision, travel costs and time loss from work increased. Total clinic visits costs was 4 times more than the cost of a patient visits to a VVW. This was a big inconvenience (monetary/time loss) to patients (especially to poor patients and who need more time for subsistence farming like in Maracha). In Hlabisa by 1994, costs of visits to a local clinic and hospital were

respectively 4 and 42 times more than that to VVW (Wilkinson, 1997). So the only cost saving alternative for clinic visits in DOT was probably DOT supervision by lay health workers (Zwarenstein et al, 2000). This effective supervision option was also a financial relief to the patients in this socio-economically disadvantaged area of Uganda.

Effectiveness was to be measured by number of TB patients cured but due to incomplete cure records, the proportion of patients who completed treatment (taking drugs up to 6-8 months) after the intensive phase was taken as an indicator of effectiveness (compliance). CB-DOT was a more effective (84%) method of supervision compared to self-supervision (55%). This has also been shown by studies in other African countries. In Cape Metropolitan Clinics in Elsies River, South Africa, Zwarenstein et al, 2000 showed that new TB patients supervised by lay health workers (LHW) had more benefits compared to those supervised by both clinic nurse (24%, 95% CI 6-43%) and self-supervision (39%, CI 18-60%). Earlier study results had shown that self-supervision (60%) was more effective than DOT (42%) in Khayelitsha, Cape Town (Zwarenstein, 1998). But that study was limited by size and the fact that the number of re-treatment patients was high (30%) meant there were other factors for treatment failures that could not have been controlled by supervision method alone (Zwarenstein, 1998).

Defaulter rates were almost equal in the 2 follow-up groups; 16% in CB-DOT and 11% in self-supervision. This was possible with CB-DOT in Maracha because the fluidy border situation here (borders DR Congo which is at war) could have made follow up of patients more difficult. Unsuccessful TB patient treatment incompleation was mainly caused by defaulting in CB-DOT. No patients from CB-DOT was transferred or died compared to 18% and 15% who were transferred and died respectively with self-supervision probably because patients in fair clinical conditions were outright selected (management problem)

for CB-DOT, or because of poor compliance, self-supervised patients were more likely to develop complications (supervision method problem) and needed transfers or died. Other studies in Uganda, Malawi and South Africa and Ethiopia have shown that CB-DOT was more effective than other TB treatment and treatment supervision strategies (WHO, 2000; Wilkinson, 1997).

CB-DOT was more cost-effective (C/E ratio = 117) than self-supervision (C/E ratio = 120) of TB treatment. Despite the high costs of one patient treatment to completion in CB-DOT (US \$99) compared to self-supervision (US \$66), but in CB-DOT the number of patients completing treatment was high (84% compared to 55% in self-supervision). Because of cost convenience, community supervision and follow up, CB-DOT patients are more likely to come for DOT in VVW homes. Self-supervised patients had to develop their own initiatives to swallow drugs (on their own) from their homes (private) without any second party to authenticate. Self-supervision depended on personal initiatives, and to swallow TB drugs is cumbersome and patients might have not appreciated long-term benefits of TB treatment; patients were therefore less likely to swallow TB drugs on their own. This could have led to more complications of TB resulting in the many transfers and deaths in self-supervision option compared to CB-DOT patients in this study. The cost-effectiveness of DOT have been shown to be more with CB-DOT compared to self-supervision in studies of other African Countries (WHO, 2000; Zwarenstein, 2000; Wilkinson, 1997). The incremental analysis showed that compared to self-supervision, more US \$114 was needed to successfully treat a TB patient to completion in CB-DOT. However this additional expenditure incurred during additional service (field supervision) improved effectiveness of the TB treatment programme by 29%. More decentralization of responsibilities and resources from

central government units (District) to lower levels of implementation (HSD) would not only have improved the budget of the HSD but also reduced the cost of field supervision.

The cost-effectiveness ratios were robust even with changed annual capital costs by changing interest rate to 4% but the same if it's increased to 10%. This means the overall economic performance in Uganda can affect the technical efficiency of the management options chosen in Uganda. It's pertinent that DOT evaluation be done under different/changing economic status of a country.

With the government Uganda's targeted overall effectiveness of TB treatment of 85% by end of 2005, self-supervision was more cost-effective (assuming no additional costs). This meant a big improvement in compliance of self-supervised patient at no additional costs (activities). It therefore meant that for Uganda to raise overall effectiveness of TB treatment even with self-supervision, universal awareness has to be created and sustained at no costs. This was not realistic. The method already tested for increasing KAPB for TB treatment and HIV control programme was community-based programme activities. This required additional activities/costs and therefore additional expenditures but was still more cost-effective. To increase coverage, compliance and cost-effectiveness of TB treatment, the strategy to be adopted by all HSDs and districts is therefore CB-DOT.

## Chapter Six

### Conclusions and recommendations

#### 6.1 Conclusions

Tuberculosis was one of the causes of high burden of diseases in Maracha, Arua. Maracha was poor socio-economically but also received patients from DR Congo and Southern Sudan. The situation has been fueled by HIV/AIDS and therefore the need to reduce incidence by reducing transmissibility and eventually prevalence by prompt and successful treatment of cases. In this context the more cost-effective method for supervision of DOT helped to reduce costs and burden of disease.

The results of this cost-effectiveness evaluation of CB-DOT in comparison with self-supervision showed that CB-DOT was more cost-effective. Costing of capital and recurrent inputs from both health system and patients were done and their summary measures compared to each option's effectiveness. The major cost item for self-supervision was the many visits to the clinic. The total and cost of treatment of a patient to completion in CB-DOT was higher than that of self-supervision because of additional field supervision activities. However VVW visits reduced patients' costs in CB-DOT. Since CB-DOT and community-based awareness creation created more compliance and many VVWs visits by patients did not greatly increase costs, then more additional field activities was still cost-effective. However there was need to reduce costs further by decentralization of resources and management of monthly community meetings from District Health Office to the HSD.

The Cost-effectiveness of DOT supervision option in Maracha however varied with interest rates and may change in favour of Self-Supervision if its effectiveness reaches

the Uganda's target of 84% at the present costs. This is however very unlikely in the present Uganda's economic status or in the near future.

The study however was subject to limitations due to lack of credible proof for effectiveness. The data from the registers and records were incomplete, unreliable and inaccurate. Because of the small sample size, and fact that success of community-based programmes varies under different settings, generalizability of this results has to be considered carefully: studies should be designed for peculiar settings and existing results used in very similar situations (self-supervision was more cost effective in Khayelitsha and Elsies clinics, Cape Town)

## **6.2 Recommendations**

From the cost-effectiveness ratios, Maracha and Arua District should reconsider expansion of community-based supervision of DOT to all sub-counties of Maracha and other HSDs of Arua. Other cost-saving strategies could be by further decentralization of resources and responsibilities for community monthly meetings on CB-DOT from District to HSDs.

Since HIV/AIDS and tuberculosis epidemic are related and community-based awareness activities has worked for both DOT and HIV/AIDS prevention and control programmes in Uganda, a combined community awareness programme could be designed for this double tragedy and would even further reduce costs (cost-cuts by integration).

Since cost-effectiveness of DOT varies with its various methods of supervision, therefore before DOT supervision option is selected for and area, adequate considerations (after

operational research) should be made to rule out other factors which makes them work or not, without just globalization of findings elsewhere.

Therefore District managers need to know the right ingredients necessary for DOT to work in their own settings before just replicating results from elsewhere. Results from somewhere else could work only in similar settings and an appropriate operational research is recommended for different settings.

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## Appendix A. Table of costs from provider's and patient's viewpoints

| Costs                    | Source   |
|--------------------------|--|
|                          | <b>Provider's costs</b>  |
| Capital                  | Review of records from Maracha hospital, Ministry of Health, NTP, and District offices. Data for field health programme activities will be obtained from the hospital's community health department. |
| Building                 |  |
| Equipment                |  |
| Vehicle, motor-cycles    |  |
| Bicycles                 |  |
| Generator, X-ray machine |  |
| Recurrent                |  |
| Salaries                 |  |
| Transport                |  |
| Repairs                  |  |
| Electricity              |  |
| Water                    |  |
| Laboratory chemicals     |  |
| Drugs                    |  |
| Stationery               |  |
| Other costs              |  |
|                          | <b>Patients costs</b>  |
| Transport                | Questionnaires survey  |
| Time                     | "  |
| Hotel                    | "  |
| Incidentals              | "  |

### Cost-effectiveness analysis:

Provider's Cost per DOT visit = (recurrent+annuitised capital cost) ÷ number of visits

Patient's cost per DOT visit = (cost during clinic visit + cost during VVW's visit) ÷ total number of visits (for self-supervision there was only cost of clinic visit)

Total cost per DOT option visit = Provider's Cost per DOT visit + Patient's cost per DOT visit

Cost per patient treated = total cost per DOT option visit \* total number of visits

Cost effectiveness (C/E) ratio = Cost per patient treated ÷ successful TB treatment rate

## Appendix B QUESTIONNAIRES FOR PATIENT'S COST

Date: -----Name of data collector-----

**Supervision type ( )** S, for self-supervision; C, for community-based

### A. General information

1. Name of respondent-----
2. Registration number (TB)----- (from patient's card if any)
3. Place      Subcounty----- Parish-----Village-----
4. Gender [   ] M = male and F = Female
5. Age ----- (Children to nearest year)
6. Marital status (tick):
  - a. Single    b. Married    c. Divorced    d. Separated    e. Widowed
7. Employment status (tick):
  - a. Employed    b. unemployed    c. peasant farmer    d. Student    e. Refugee    f) others  
(specify)

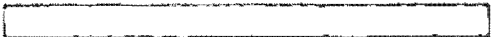
### B. Cost information

8. Classify your monthly income (UShs). Tick as appropriate.
  - a. Under 10.000 UShs
  - b. Between UShs 10,000 and UShs 25,000
  - c. Between UShs 26.000 and UShs 50.000
  - d. Between UShs 51,000 and UShs 75,000
  - e. Between UShs 76,000 and UShs 100,000
  - f. Between UShs 101,000 and UShs 125,000
  - g. Between UShs 126 and UShs 150,000
  - i. Between UShs 151,000 and UShs 175,000
  - h. Above UShs 175,000
9. Which year where you treated for TB-----
10. In which health facility where you treated-----
11. How do you usually travel to the health facility (tick)

- a. Walk
  - b. Public transport
  - c. Private transport (specify)
12. How long did it take to walk/ride to the health facility/VVW's home (estimate hours)
- a. Below one hour (state in fractions)
  - b. Between 1 and 2 hours
  - c. Between 2 and 4 hours
  - d. Between 4 and 6 hours
  - e. Between 6 and 12 hours
13. How long did you spend in the health facility/VVW's home before attention (medical)
- a. less than one hour
  - b. Between 1 and 2 hours
  - c. Between 2 and 3 hours
  - d. Between 3 and 5 hours
  - e. Between 6 and 12 hours
14. Were you levied any fees for medical attention/services received
- a. Yes.
  - b. No
15. If yes specify amount-----
16. How much do you pay for public transport (if any) return (state the amount)-----
17. How long did it take you to walk back (estimate in hours)
18. Apart from time, transport & medical, what other costs did you meet (specify costs and estimate amount spent)
17. When did you return home
- a. That very day
  - b. If not specify any costs incurred-----

**Thank you, for your attention!**

**Appendix C: Costs**



**A. Capital costs (US\$)**

| Cost items                                   | Replacement Value | Share by TB (%) | TB replacement value | Years of useful life | Annuity Factor | Equivalent cost | 6-month costs   |
|--|-------------------|-----------------|----------------------|----------------------|----------------|-----------------|-----------------|
| Building                                     | 17,142.86         | 100             | 17,142.86            | 20                   | 10.594         | 1,618.17        | 809.08          |
| Vehicle                                      | 14,285.71         | 15              | 2,142.86             | 10                   | 7.0236         | 305.09          | 152.55          |
| X-ray  | 8,571.43          | 12.5            | 1,071.43             | 15                   | 9.1079         | 117.64          | 58.82           |
| Equipment                                    | 1,428.57          | 12.5            | 178.57               | 5                    | 4.1002         | 43.55           | 21.78           |
| Generator                                    | 14,285.71         | 12.5            | 1,785.71             | 15                   | 9.1079         | 196.06          | 98.03           |
| Furniture                                    | 251.43            | 100             | 251.43               | 5                    | 4.1002         | 61.32           | 30.66           |
| <b>Total capital costs for clinic visits</b> |                   |                 |                      |                      |                | <b>2,341.83</b> | <b>1,170.92</b> |

**B. Provider's capital costs for field supervision**

| Capital costs   | Replacement Value | Share by TB (%) | TB replacement value | Years of useful life | Annuity Factor | Equivalent cost | 6-month costs |
|-----------------|-------------------|-----------------|----------------------|----------------------|----------------|-----------------|---------------|
| M/cycle         | 1,428.57          | 100             | 1,428.57             | 5                    | 4.1002         | 348.42          | 174.21        |
| Bicycle (3)     | 85.71             | 100             | 85.71                | 2                    | 1.808          | 47.41           | 23.70         |
| <b>Subtotal</b> |                   |                 |                      |                      |                | <b>395.82</b>   | <b>197.91</b> |

**C. Clinic recurrent costs**

| 1. Salaries               | Full monthly costs | TB time (%) | Monthly TB costs | Total costs (6 months) |
|---------------------------|--------------------|-------------|------------------|------------------------|
| Clinical Officer          | 126.2857143        | 15          | 18.94285714      | 113.6571429            |
| Nursing Assistant         | 22.85714286        | 63          | 14.4             | 86.4                   |
| Enrolled Nurse            | 65.14285714        | 13          | 8.468571429      | 50.81142857            |
| Radiographer              | 126.2857143        | 20          | 25.25714286      | 151.5428571            |
| Laboratory Assistant      | 118.2857143        | 22          | 26.02285714      | 156.1371429            |
| Laboratory Attendant      | 82.28571429        | 22          | 18.10285714      | 108.6171429            |
| Driver                    | 45.71428571        | 15          | 6.857142857      | 41.14285714            |
| <b>Sub-total Salaries</b> |                    |             |                  | <b>708.3085714</b>     |

**D. Other clinic recurrent costs**

|   |             |     |             |                 |
|---|-------------|-----|-------------|-----------------|
| 2. Transport (fuel)                             | 94.28571429 | 100 | 94.28571429 | 565.71          |
| 3. Repairs                                      | 1821.433333 | 15  | 273.215     | 1,639.29        |
| 4. Electricity                                  | 514.2857143 | 20  | 102.8571429 | 617.14          |
| 5. Water  | 384.6153846 | 13  | 50          | 300.00          |
| 6. Stationery                                   | 23.80952381 | 100 | 23.80952381 | 142.86          |
| <b>Subtotal</b>                                 |             |     |             | <b>3,265.00</b> |
| <b>Total salaries and other recurrent costs</b> |             |     |             | <b>3,973.31</b> |

**E. Drugs and diagnosis**

| Cost items       | Full monthly costs | % TB | Monthly TB costs | Total costs (6 months) |
|------------------|--------------------|------|------------------|------------------------|
| 7. Lab Chemical  | 37                 | 100  | 37               | 222.17                 |
| 8. Lab logistics | 51.86              | 100  | 51.86            | 311.14                 |
| 9. X-ray films   | 71.428             | 100  | 71.428           | 428.57                 |
| 10. Drugs        |                    |      |                  | 1,428.57               |

**F. Total drugs & diagnosis**

**Total costs clinic OPD (capital+recurrent) 8,705.60**

**G. Recurrent costs for field supervision**

| Cost items   | Full monthly costs | % TB | Monthly TB costs | Total in 6 months |
|--|--------------------|------|------------------|-------------------|
| 1. Allowance for SCHWs                                   | 51                 | 100  | 51               | 308.5714286       |
| 2. " " Voluntee  | 34                 | 100  | 34               | 205.7142857       |
| 3. Fuel for facilitators                                 | 26                 | 100  | 26               | 154.2857143       |
| 4. Facilitators Allowance                                | 17                 | 100  | 17               | 102.8571429       |
| 5. Stationery  | 11.43              | 100  | 11.43            | 68.57142857       |
| 6. Meals   | 34                 | 100  | 34               | 205.7142857       |
| 7. Repairs/maintenance                                   |                    |      |                  | 569.29            |
| <b>Total recurrent costs (field supervision)</b>         |                    |      |                  | <b>1,615.00</b>   |
| <b>Total costs field supervision (capital+recurrent)</b> |                    |      |                  | <b>2,010.83</b>   |

**H. Patient cost per unit visit**

0.46

**I. Patient cost per VVW visit**

0.01

**J. One VVW's (Community) cost per visit**

0.01