

**EFFECTIVENESS OF HOME-BASED DIRECTLY OBSERVED  
TREATMENT FOR TUBERCULOSIS IN KWENENG WEST SUBDISTRICT,  
BOTSWANA.**

**Researcher: Dr Diulu Kabongo**

**Supervisor: Prof Bob Mash**

**A research assignment submitted in partial fulfillment of the requirements for  
the MFamMed Degree in the Division of Family Medicine and Primary Care,  
Faculty of Health Sciences, University of Stellenbosch**

**Declaration**

I, the undersigned, hereby declare that the work contained in this thesis is my own work and that I have not previously submitted it to any other university for degree purpose.

**Signature:****Dr D Kabongo**

## **ABSTRACT**

### **Introduction:**

Tuberculosis and HIV are major public health problems in Botswana. The Botswana National Tuberculosis Control Programme (BNTP) was established in 1975. Short course chemotherapy was introduced in 1986 and the Directly Observed Treatment (DOT) Strategy was adopted in 1993. In the face of growing TB notification rates, a low country average cure rate, human resource constraints in health facilities and sometimes poor accessibility to health facilities by weak patients and those living far away, Botswana decided to offer home-based care using volunteers or family members.

### **Setting:**

Kweneng West Subdistrict, a rural area in Botswana

### **Aim and objectives:**

The aim of this study was to assess the success of home-based DOT in the management of tuberculosis compared to facility-based DOT in Kweneng West Subdistrict, Botswana and to explore the acceptability of home-based DOT among TB patients, TB treatment supervisors and health workers. Objectives:

- To compare treatment outcomes for patients receiving home-based DOT and those receiving facility-based DOT through the following criteria:
- To compare patient contact(s) tracing efforts among home-based providers and facility-based providers
- To establish TB patient's, TB treatment supervisor's and health worker's perceptions about home-based DOT

### **Methods:**

A quantitative, observational study combined with qualitative in-depth interviews. Participants were selected from TB patients who attended treatment from January 2006 till June 2008 at all main clinics of Kweneng West Subdistrict, Botswana. The interview purposively selected health care workers, TB patients and community supervisors to establish their thoughts about HB DOT. A framework approach was used to analyse interviews.

### **Results:**

Treatment outcomes and, particularly, the cure rates were not statistically different between FB DOT, HB DOT and MX DOT. However there was a surprisingly difference in contact tracing, with FB DOT performing better than other DOT types. Interviews revealed that patients were happy with their choice of DOT types. Among reasons to choose HB DOT was the need to shorten distances for DOT. Among reasons to choose FB DOT were the needs to ensure safety through supervision by nurses as opposed to lay people (community supervisors) and to obtain injections that no community supervisor is allowed to administer. A mix of HB DOT and FB DOT was generally adopted to allow flexibility in the administration of DOT for few patients. Overall cure rate was 78.5% and successful treatment rate was 83%.

**Conclusion:**

The introduction of HB DOT and the option given to choose this DOT type is supported. Indeed allowing patient's preference of DOT type may impact positively on patients' satisfaction and adherence to medication. On the other hand, issues were still raised by all stakeholders to help improve the flexibility and sustainability of HB DOT. Further studies may be needed to understand the better performance of FB DOT in contact tracing.

## **I- INTRODUCTION, BACKGROUND AND MOTIVATION**

Although seen as a global emergency since 1993, tuberculosis (TB) still resulted in 9 million new cases and 2 million deaths in 2004, of which 95% and 98% respectively happened in developing countries. (1, 2) The economically active 15-50 year old age group is the worst affected. (2, 3)

Presently Botswana has one of the highest notification rates in the world despite a previous decline in rates between 1975 and 1989. (2, 3) The 1990s have seen a constant rise in notification rates, blamed mainly on the HIV (human immunodeficiency virus) scourge. (2, 3) Notification rates show more than 509 cases per 100000 people annually since 2000. (2) Multidrug resistant (MDR)-TB cases are also on the rise. (2, 3)

The Botswana National Tuberculosis Control Programme (BNTP) was established in 1975. (2) Short course chemotherapy was introduced in 1986 and the Directly Observed Treatment (DOT) Strategy was adopted in 1993. (2) Supervision of the entire treatment course is offered. (3)

In the face of growing TB notification rates, a low country average cure rate, human resource constraints in health facilities and sometimes poor accessibility to health facilities by weak patients and those living far away, Botswana decided to offer home-based care using volunteers or family members. (3)

Many studies conducted in different countries support the usefulness of a community-based TB programme. (3) In Botswana only a pilot study assessed the cost-effectiveness of this programme.

This study, therefore, focuses on determining the actual effectiveness of home-based DOT in Botswana, in order to contribute to the debate concerning how to strengthen the DOT approach.

## **II- OVERVIEW OF LITERATURE**

### **A- Aetiology, mode of transmission and epidemiology of tuberculosis**

Tuberculosis is one of the oldest diseases affecting humans. (1) Its causal agents belong to the Mycobacterium tuberculosis complex. (1, 2) Mycobacterium tuberculosis remains the most frequent and important agent to cause human disease. (1) However the complex also includes Mycobacterium bovis, Mycobacterium africanum and Mycobacterium microti. (1, 2)

Other Mycobacterial species that are gaining importance with the advent of HIV/AIDS (human immunodeficiency virus/acquired immunodeficiency syndrome) are labelled as Mycobacterium Other Than Tuberculosis (MOTT) infections. (1, 2)

Tuberculosis (TB) primarily spreads through droplets expelled by an infectious patient who coughs and/or sneezes. (2) Infectious individuals are those with acid and alcohol fast bacilli (AAFB) smear positive sputum. (1, 2)

After infection (contact) the host immune system response usually restrains the Mycobacterium and therefore prevents the occurrence of the disease. (1, 2) Asymptomatic dormant or latent bacilli may remain in the host body. (1) Latent bacilli may be reactivated later on and produce a disease in individuals with a poor immune system response. (1)

Disease is usually pulmonary but may affect any organ or may be disseminated. (1) Pulmonary tuberculosis with AAFB in the sputum is the sole infectious form. (2)

As HIV depresses the immune system response, it fuels the development of the disease “tuberculosis”. (1, 2) Other factors that influence progression from infection to disease are: malnutrition, alcohol, diabetes mellitus, silicosis, smoking and some malignancies. (2) However HIV infection remains the most powerful factor and it triples, to 30-50%, the lifetime risk of acquiring TB. (2, 3, 4)

Despite the impact of HIV infection on the course of the TB epidemic, TB can eventually be controlled because:

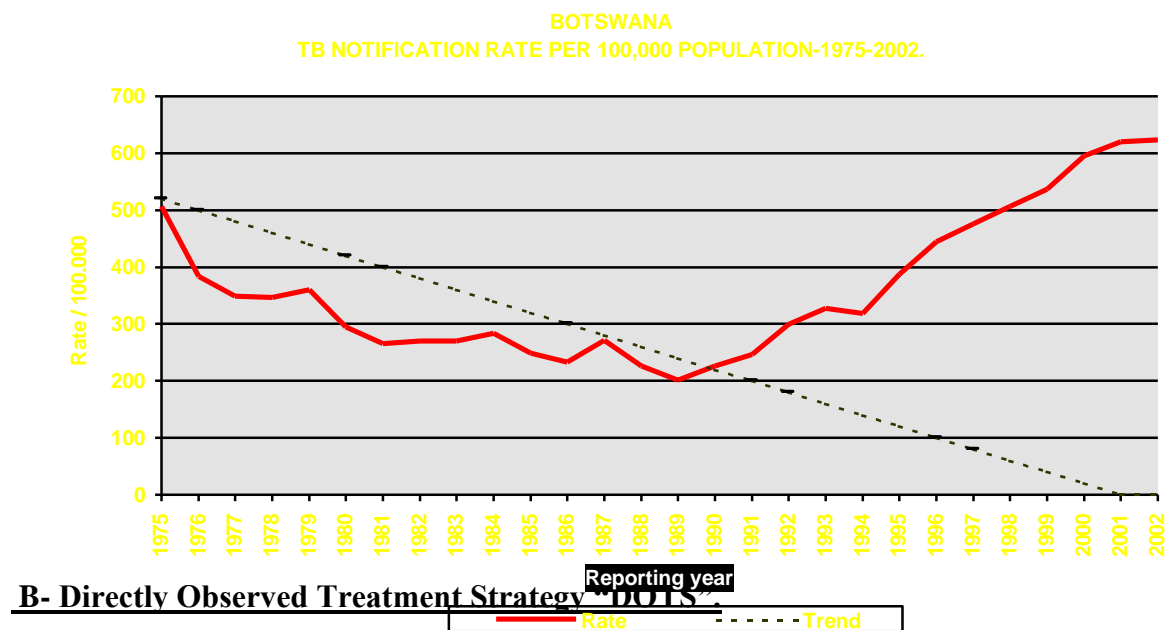
- Human beings are the sole reservoir of Mycobacterium tuberculosis. They are the source of infections and patients can easily be identified. (2)

- Proper treatment can limit transmission. (2)
- Response to TB therapy in HIV positive individuals is similar to the response in HIV negative individuals. (4)

Meanwhile figure 1 shows that the trends of notification in Botswana are still worrisome, like in many countries with high HIV prevalence. (2, 4)

In Botswana, 60-86% of TB patients are co-infected by HIV. Young adults who are mostly affected by HIV are therefore also carrying the burden of TB over the past 10-20 years.

Figure 1: Trends of notification (3)



Different broad strategies are needed to control TB. (4) Presently three mechanisms summarize these options (4):

- reducing transmission of TB
- reducing reactivation of latent TB infection
- reducing HIV transmission

Detecting infectious TB individuals is at the centre of controlling transmission. (4)

DOTS strategy emphasises the need to find infectious cases and to ensure that they are cured from TB. (4) DOTS strategy finds its rationale in decreasing the possibility of relapses as it offers high standard care. (25) The World Health Organisation (WHO) recommends the DOTS strategy to National TB Programmes of all countries. (4, 6)

The whole DOTS strategy comprises the following elements (2):

- Political commitment with increased and sustained financing: Treatment of TB is provided free of charge to all patients in Botswana and the government of Botswana participates actively in national and international activities related to TB.
- Case detection through quality assured bacteriology: Many laboratory facilities are scattered around Botswana. Two referral laboratories perform Mycobacterium cultures. Case detection may be hampered by the health seeking behaviour of people. (22) Indeed many patients will delay to seek medical attention. (22,23) However trends show better knowledge of TB and its cause, but more efforts need to be made in terms of community education and cooperation between modern and traditional medicines. (22,23)
- Standardized treatment with supervision and patient support (directly observed treatment: DOT): Botswana uses a 6-month course for new patients. Supervision is provided throughout the entire course of treatment. (see Table 2 for treatment regimens) Other countries such as Zambia and Tanzania use Rifampicin only during initial phase (2 first months) and have therefore a 8-month course. (9)(10)(11)(14)
- Uninterrupted supply of quality-assured drugs
- Monitoring and evaluation system and impact measurement: The Botswana National Tuberculosis Programme (BNTP) has established clear recording and monitoring tools. Health facilities use paper-based recording registers and districts levels use both paper-based and electronic TB registers for easy data analysis.
- 
- DOTS-Plus strategy was instead introduced in 1998 to include requirements related to the management of MDR-TB. (26) MDR-TB, and even extensively drug resistance TB (XDR-TB), are a growing health problem in Botswana. (2)



Kweneng East sub-district that is next to Kweneng West sub-district (study location) is leading in Botswana in terms of number of MDR-TB cases. (27)

Treatment is provided according to a specific categorisation adopted by BNTP.

Following recommendations by the WHO, Botswana defines TB cases as follows (2):

- New: A patient who has never had treatment for TB or who had previously taken anti-tuberculosis treatment for less than 1 month
- Relapse: A patient previously treated for TB who has been declared cured or treatment completed, and is diagnosed with sputum smear-positive or culture-positive TB
- Treatment after failure: A patient who is started on a re-treatment regimen after having failed previous treatment, i.e., sputum positive after 5 months of treatment. This is also a patient who was initially smear negative and becomes smear positive at the end of the first two months treatment
- Treatment after default: A patient who returns to treatment following interruption of treatment for 2 or more **consecutive** months, with smear or culture positive TB (sometimes smear-negative but still with active TB as judged on clinical and radiological assessment)
- Chronic case: A patient who is sputum-positive at the end of a fully supervised re-treatment regimen.

For clear analysis of data, end of treatment outcomes are classified as follows (2):

- Cured patient: patient was initially sputum AAFB positive, but is smear negative in the last month of treatment and on at least one previous occasion
- Treatment completed: treatment has been completed, but patient does not meet the criteria to be classified cured or failure.
- Treatment success: the sum of cured patients and those that have completed treatment.
- Death: patients who die for any reason during the course of TB treatment.
- Failure of treatment: patient who is sputum smear-positive at 5 months or later during treatment. Also patient who was smear-negative before initiating treatment but turned smear-positive after the initial phase
- Treatment interruption: patient who misses treatment. Those who miss treatment for 2 consecutive months or more are considered defaulters.

- Treatment outcomes for MDR-TB use different criteria that are not specified here.

**Table 1: Recommended Treatment Regimens in Botswana (2)**

TB Diagnostic Category	TB Patients	TB Treatment Regimens	
		Initial Phase (daily)	Continuation Phase (daily)
<b>I</b>	All new adult cases of TB regardless of site, bacteriology or severity of disease, and severe TB in children	2HRZE	4HR
<b>II</b>	Previously treated cases of TB: - Retreatment after relapse - Retreatment after default -Retreatment after treatment failure	2HRZE /1HRZE	5HRE
<b>III</b>	Less severe cases of TB in children	2HRZ	6HE
<b>IV</b>	Chronic and MDR-TB cases (still sputum-positive after supervised re-treatment)	Specially-designed standardized or individualized regimens are recommended	

Legend: H: Isoniazid, R: Rifampicin, Z: Pyrazinamide, E: Ethambutol, S: Streptomycin.

The number in front of the regimens determines the duration of the course of TB treatment in months

### **C- Community TB Programme**

Though accessibility to health facilities is good in Botswana, the burden of the TB epidemic is beginning to overstretch human resources. (2, 3) Other approaches need to complement the DOTS strategy in order to yield good result in the management of TB. (3) Many suggest the use of community members to help in one or another area of the TB programme. (3, 6,24)

In Africa there is a tradition of communities, and especially women, taking care of family members. (3) The WHO, through its Stop TB strategy, recognizes community participation as one of the principles of the Primary Health Care approach. (3,24)

Already communities are successfully supporting the health care system in community home based care (CHBC) and support groups for people living with HIV/AIDS.(3)

In the case of TB possible community contributions may be (3, 18):

- supporting patients throughout the entire treatment (general support or DOT)
- patient, family and community education on TB (to help reduce stigmatization)
- case finding and case detection (allow screening of TB contacts, submit sputum for examination and collect results)
- recognition of adverse effects leading to defaults

Countries that have well functioning National TB programmes can also benefit from community based approaches as this may help them maintain their standards in the face of growing deficiencies in human resources. (6) Community involvement in dispensing anti-tuberculosis treatment has been tried in urban African (6, 9, 14, 17) and Asian (7, 16, 19) settings as well as rural areas. (10, 11)

Furthermore studies have used different community members to help administer TB treatment such as family members (8, 15, 19), volunteers (10, 11, 17), previous TB patients or established community home based care programme (9) with encouraging results.

Community TB care seems also to be well accepted by patients as it helps improve the TB knowledge of patients and the community at large and therefore reduces stigmatization. (5, 11, 18)

Finally community TB care helps to improve the affordability and cost effectiveness of the TB treatment (12), though there remains an issue of incentives for volunteers to help sustain the programme. (3, 13)

### **III- PROJECT AIMS AND OBJECTIVES**

#### **A- AIM OF THE STUDY**

The aim of this study is to assess the success of home-based DOT in the management of tuberculosis compared to facility-based DOT in Kweneng West sub-district, Botswana and to explore the acceptability of home-based DOT among TB patients, TB treatment supervisors and health workers.

#### **B- OBJECTIVES OF THE STUDY**

1- To compare treatment outcomes for patients receiving home-based DOT and those receiving facility-based DOT through the following criteria:

- Cure rate
- Treatment completion rate
- Treatment success rate
- Mortality
- Treatment failure rate
- Treatment interruption rate

2- To compare patients contact(s) tracing efforts among home-based providers and facility-based providers

3- To establish TB patient's, TB treatment supervisor's and health worker's perceptions about home-based DOT

### **IV- STUDY DESIGN AND METHODOLOGY**

#### **A- Study setting**

Botswana is currently scaling up a community based TB programme. This programme aims to allow dispensing of medication to TB patients at their respective homes (Home-based DOT). It equates to the usual daily supervision of TB treatment at

health facilities (Facility-based DOT). Home-based DOT is made possible by the use of community volunteers. After consultation with community representatives in their respective catchment areas, health facilities select local volunteers. All volunteers are trained in TB treatment supervision. At the onset of TB treatment, patients are introduced to both concepts (home-based and facility-based DOT) and are expected to choose which mode they prefer. (3) Community volunteers (supervisors) are allocated duties according to their readiness and patients and supervisors location.

Community volunteers dispense TB medication in the community for a given number of patients. Community volunteers are supervised in their respective catchment area by clinic nurses. They are given weekly TB medication for their patients and they are expected to report back their activities to the clinic nurses once per week. (3)

Generally nurses have the responsibility of managing records, supervising medication intake and guiding the community volunteers. (2) They are supported by health education assistants (HEA). HEA are community members that have received a short training to allow them to support the link between health facilities and communities. (2) They are particularly involved in child welfare clinic and the TB programme. They help health facilities to trace defaulters and they record all non-institutional deaths that occur in their respective communities. (2)

Medical doctors initiate TB treatment and offer monthly follow up of all TB patients. (2)

TB programme data are captured on two tools at health facilities (the health facility TB register and individual TB patient cards: see annexes 1 and 2) and two tools at district level (the manual TB register and electronic TB register: ETR). (2) District records include data from all health facilities in the specific district. (2)

Research will be conducted in Kweneng West Subdistrict, which is a rural area with approximately 40000 inhabitants. Kweneng West Subdistrict comprises 23 health facilities with 8 main clinics run by the Local Government. It also has a primary hospital run by the Boswana Defense Forces (BDF). All health facilities offer TB treatment.

## **B- Methodology for objectives 1, 2**

*Study design:* To achieve these objectives the study utilised an observational, retrospective study design. Data was collected from routinely pre-filled TB registers and individual patient TB cards and three groups of patients were identified according to their choice of home-based DOT or facility-based DOT or a mix of the two. Comparison of treatment outcomes was made between these arms to assess the effectiveness of the home-based DOT relative to the usual facility-based approach.

The choice of this kind of study design stems from its advantages: less expensive and less time consuming, it helps demonstrate effectiveness and usually enrolls a large sample that carries a greater chance to show statistical significance. This is despite its disadvantages that include reliance on an accurately maintained database and no randomisation of individuals. Lack of randomisation may lead to bias, especially the inability to assess all potential confounding factors that may provide alternative explanations for differences in outcomes between the groups. Owing to these disadvantages, efforts were made to measure as many known confounding factors as possible and account for them during analysis (see below).

*Study population:* TB patients registered in the main clinics of Kweneng West Subdistrict from June 2006 to June 2008 were considered for this study. Exclusion criteria included: MDR/XDR TB cases and patients who were transferred in/out whilst on TB treatment. Using a 5 % precision with 95 % confidence interval, the sample size required was estimated to be at least 381 respondents.

*Study procedures:* After a short training on data capturing and issues of ethics, research assistants collected and captured data manually on pre-made forms (see annex 3). Forms were then sent to the main researcher to enter them in an electronic database (data sheet in MS Excel) to allow easy data analysis. Research assistants were community TB volunteers as they were already acquainted with the TB programme and issues of ethics. A small financial incentive was offered to them for their assistance.

Variables captured from the TB registers at the clinic level were:

- Outcome of TB treatment
- Type of DOT provided (facility-based, home-based, mixed, undetermined)
- Age
- Sex
- HIV status
- HAART (Highly active anti-retroviral therapy)
- Type of TB (new/re-treatment, pulmonary/extra-pulmonary)

However some confounding factors that may be considered interesting (and of great importance), may be difficult to measure as the present TB registers in Botswana do not capture data about them. For example the general clinical condition of patients (bedridden/weak/still able to walk), WHO HIV clinical staging or CD4 count.

*Pilot study:* After training, research assistants were given an opportunity to capture data for 5 patients in the presence of the main researcher who gave them feedback and clarified any problems. The main researcher also ran the data sheet in MS Excel using any imaginary data to assess its efficiency.

*Analysis:* Data was collated in Excel and submitted for analysis to the Centre for Statistical Consultation (University of Stellenbosch). The analysis looked for any association between the type of DOT and TB outcomes while accounting for any other measured confounding factors.

### **C- Methodology for objective 3**

*Study design:* A qualitative study was utilised to complement the results obtained during the quantitative study for the 2 previous objectives. This type of study is more suitable to assess the beliefs and attitudes of individuals towards a subject. The qualitative study was conducted by in-depth interviewing of TB patients, TB treatment supervisors (community volunteers) and health workers (nurses and health education assistants) who are involved in the home-based DOT and facility-based DOT programme.

*Study population:* Study participants were chosen purposefully in the same areas where data was collected for objectives 1 and 2. Study participants were people who

are actively involved in the TB programme at the time of research. Study participants were chosen as followed:

- 5 TB patients under home-based DOT
- 5 TB patients under facility-based DOT
- 5 TB treatment supervisors
- 5 health workers (3 nurses and 2 health education assistants).

Selection of TB patients included all age-groups, both genders and if possible both unemployed and working individuals.

*Piloting:* Main researcher who conducted all interviews had to perform few pilot interviews to ascertain the ability of community volunteers to translate. In addition, research assistants were trained in the communication skills required for an in-depth interview and their role during interviews.

*Data collection:* The focus of interviews and topics were based on previous research findings (5) and other topics have been added considering the particularity of the study setting. The in-depth interviews focused differently for each type of interviewee:

For TB patients under home-based DOT and facility-based DOT, the interview was introduced by the following question:

“Can you please describe your experience of TB treatment (the type of DOT you chose) and how you now feel about receiving the TB treatment in this way?” The interview then covered the following topics:

- Advantages and disadvantages of the DOT style
- Initial reasons for choosing home or facility DOT and reflection now
- Experience of volunteer: relationship and attitude
- Access to medication and convenience of taking medication
- How easy is (was) it to keep to the TB treatment (adherence)?
- What made taking the TB treatment easier or harder?
- The impact on recovery from TB and the quality of life
- What would have made your experience better?
- Did you experience any discrimination or stigmatization?



For TB treatment supervisors, the opening question was: “Can you please describe your experience of supervising medication for a TB patient?” The interview then covered the following topics:

- How difficult or easy is it to supervise people on TB treatment?
- What type of patient benefits from home-based DOT
- What challenges do you face in supervising TB treatment?
- What suggestions would you make to improve the home-based DOT programme?
- What is your experience of working with the staff at the health facility?
- What reaction do you get from the broader community towards your work?

For health workers, the opening question was: “Can you describe the impact of home-based DOT on the TB treatment programme in your facility?” The interview then covered the following topics:

- How does home-based DOT help or hinder health workers to manage TB?
- How easy or difficult is it to supervise volunteers?
- What are the advantages and disadvantages of home-based DOT and facility-based DOT?
- What type of patient should receive home-based DOT?
- How sustainable is the home-based DOT programme?
- What suggestions would you make to improve the home-based DOT programme?

Main researcher was fluent in English and research assistants were fluent in English and Seswana. Either language was used during interviews according to the choice of each person. Interviews were recorded on tapes.

*Analysis:* The tapes were listened to by the main research and a research assistant for interpretation. Transcripts of the translated tapes were prepared in English. Qualitative data analysis using the framework approach was then performed by the main researcher.

- Familiarisation: Immersing oneself in the data by reading the transcripts and listening to the tapes
- Creating thematic index: During the familiarisation process the key themes and sub-themes that emerge from the data were collated and re-organised into an index of themes and sub-themes

- Indexing: The transcripts were then re-read and coded throughout using the index created above
- Charting: Data from the transcripts which has received the same index code were collated together in a chart so that all qualitative materials on the same or similar themes can be juxtaposed
- Mapping and interpretation: New concepts and theories emerging from the analysis were defined, potential associations between themes explored, range and strengths of different opinions mapped and the meaning of the findings discussed.

## **V- ETHICAL CONSIDERATION**

### *1- Retrospective study using database*

Debates about obtaining informed consent from all patients whose records were used remain philosophical. Practically it is impossible to meet all the patients and such a move may perversely erode confidentiality by encouraging the correlation of individuals and their respective data. As only routinely collected data were to be used in the analysis and without any patient identifiers it was not proposed to obtain consent from each patient. Permission was obtained from the district health services to collect and analyse the data. The data collectors were trained to respect confidentiality of patients when they collected the data from the TB register or personal health records. Data were captured first of all on a pre-made form, using only reference numbers as codes. A master list of folder numbers corresponding to these codes was kept separately by the main researcher. No patient identifiers were used in the analysis or reporting. Access to the data files was only allowed by the use of a password known to the main researcher.

### *2- Interviews:*

Written, informed consents (see annex 4) were obtained from all study participants before undergoing the in-depth interview. Interviewers (main and assistants) were encouraged to uphold confidentiality as they were privy to patients' feelings about community TB programme.

Interviews were recorded on tapes and no name was linked to data on tapes.

Interviewers started every interview by only introducing the participant reference number. A paper-based database captured demographic information under every corresponding reference number. This database included elements such as: type of respondent (TB patient under home-based DOT, TB patient under facility-based DOT, TB treatment supervisor or health worker), sex and age. Consent forms were produced in both English and Seswana.

Ethical approval was received from the University of Stellenbosch Committee on Human Research, as well as from the Ministry of Health and the Ministry of Local Government of the Government of Botswana.

## VI- STUDY RESULTS

### A- QUANTITATIVE STUDY RESULTS

The study included 405 TB patients whose characteristics are shown in Table II and age distribution in Figure 2.

Table II: Study participants' characteristics in different DOT types

<b>Variables</b>		<b>All N=405</b>	<b>FB DOT N=279</b>	<b>HB DOT N=95</b>	<b>MX DOT N=31</b>	<b>P value</b>
Mean age (years)		36.5	36.5	35.3	40.3	0.52
Gender	Male n (%)	220 (54)	160 (57)	46 (48)	14 (45)	0.18
	Female n (%)	185 (46)	119 (43)	49 (52)	17 (55)	
HIV status	Positive n (%)	191 (47)	131 (47)	43 (45)	17 (55)	0.13
	Negative n (%)	171 (42)	124 (44)	35 (37)	12 (39)	
	Unknown n (%)	43 (11)	24 (9)	17 (18)	2 (6)	
On HAART*	Yes n (%)	75 (39)	48 (37)	19 (44)	8 (47)	0.26
	No n (%)	68 (36)	52 (40)	11 (26)	5 (29)	
	Unknown n (%)	48 (25)	31 (23)	13 (30)	4 (24)	
Location of TB	Pulmonary n (%)	322 (80)	216 (77)	82 (86)	24 (77)	0.15

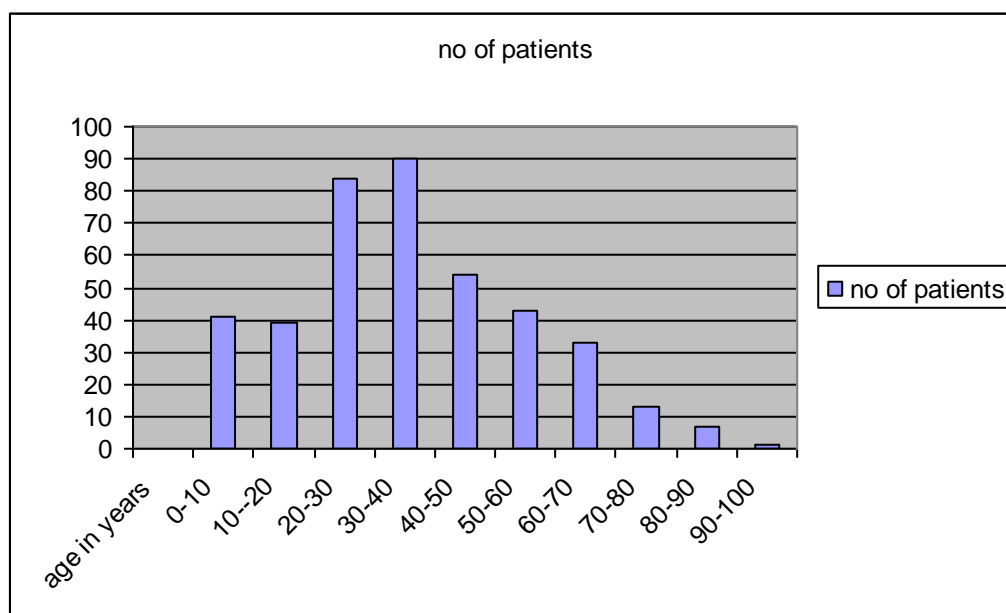
	Extra pulmonary n (%)	83 (20)	63 (23)	13 (14)	7 (23)	
Initial AAFB**	Positive n (%)	121 (38)	92 (43)	24 (29)	5 (21)	0.14
	Negative n (%)	94 (29)	63 (29)	21 (26)	10 (42)	
	Not done n (%)	107 (33)	61 (28)	37 (45)	9 (37)	
ATT category	New n (%)	350 (86)	214 (86)	95 (100)	14 (45)	<0.01
	Retreatment n (%)	55 (14)	38 (14)	0 (0)	17 (55)	

\* n = Only patients who are HIV positive

\*\* n = Only patients with pulmonary TB

ATT = Anti-Tuberculosis Treatment

Figure 2: Age distribution



Subsequent to HIV testing, TB patients who are HIV positive are eligible to start HAART regardless of their CD4 counts. However the initiation of HAART is determined by clinicians who consider the patient's general condition and their level of immuno-suppression. Generally, the onset of HAART is delayed and concomitant initiation of HAART and TB treatment is avoided. If the general condition of a patient is poor, clinicians may need to introduce HAART as early as 2 weeks after the

initiation of TB treatment. Otherwise HAART initiation may wait until the end of the intensive phase or the completion of TB treatment.

The Botswana National TB programme encourages health workers to perform smear testing for the presence of AAFBs in case of pulmonary TB. In so doing clinicians would avoid excessive reliance on chest radiography for TB diagnosis. In this study, there were 322 patients with pulmonary TB, among whom 215 (66.8%) had an initial AAFB result at the onset of TB treatment.

Table II also compares the study participants' characteristics in terms of the different types of DOT that they experienced. In Botswana, TB patients are free to choose between facility-based DOT and home-based DOT. In particular situations, some patients may start TB treatment under FB-DOT and end up in HB-DOT or vice versa; hence a third mixed group (MX-DOT) has been considered in this study. The late introduction of HB-DOT in some areas of the sub-district may have contributed to the uneven enrolment among the different DOT. Indeed some areas started HB-DOT only in early 2008.

The groups receiving different DOT types did not differ statistically in any of the characteristics except the category of TB treatment. None of the re-treatment patients (n=55) was considered for exclusive home-based DOT and 38 (69%) received exclusive facility-based DOT, while 17 (31%) were mixed. The main reason for this difference is the need for re-treatment patients to receive streptomycin injections during the intensive phase of treatment.

Table III compares the outcome of TB treatment between the three types of DOT and the efforts to trace TB contacts. Overall the successful treatment rate (sum of cured and completed cases) was 83%.

Table III: Comparison of overall outcome of TB treatment and contact tracing efforts among the different DOT types

Variables		All N=405 N (%)	FB DOT N=279 N (%)	HB DOT N=95 N (%)	MX DOT N=31 N (%)	P value
Treatment Outcome	Cure	95 (23)	71 (25)	19 (20)	5 (16)	0.45
	Complete	244 (60)	164 (59)	58 (61)	22 (71)	
	Died	52 (13)	34 (12)	15 (16)	3 (10)	
	Interrupted	9 (2)	8 (3)	1 (1)	0 (0)	
	Failure	5 (1)	2 (1)	2 (2)	1 (3)	
Contact tracing	Yes	245 (60.5)	190 (68)	48 (50.5)	7 (22.5)	<0.01
	No	160 (39.5)	89 (32)	47 (49.5)	24 (77.5)	

The outcome of treatment did not differ significantly between any of the three groups. However health workers in FB-DOT group fared better in efforts to trace contacts of TB patients. Community volunteers in HB-DOT did contact tracing in fewer TB patients, and the MX-DOT group was worst in its attempts to trace contacts of TB patients.

Table IV shows the cure rate in terms of the total number of patients who had an initial positive AAFB (smear positive pulmonary TB patients) as opposed to all registered patients. Again there was no significant difference between the DOT types

Table IV: Comparison of cure rates for smear positive pulmonary TB patients among different DOT types

	All N= 121	FBDOT N= 92	HBDOT N= 24	MXDOT N= 5	P value
Number of cured patients (cure rate)	95 (78.5%)	71 (77.2%)	19 (79.2%)	5 (100%)	0.48

## B- QUALITATIVE INTERVIEW RESULTS

### Advantages of facility based DOT

Some patients believed that the stricter environment of the clinic was more likely to ensure their ongoing adherence to TB treatment:

*“Because I feared getting tired of taking tablets and therefore become tempted to hide them or throw them instead of taking them. At clinics I took them in the presence of the health care worker” Patient*

*“It is just too serious at clinics as one takes tablets in front of the nurses” Patient*

While others felt more secure knowing that more highly trained staff were theoretically more available to them:

*“I feel safe when I know the doctor is nearby and can intervene anytime if something goes wrong” Patient*

Health care workers also felt that problems were more likely to be detected early in FB-DOT:

*“On-going counselling, direct supervision by highly trained health workers, daily assessment of patients and therefore early detection of toxicity and side effects signs are of great importance” Health worker*

### **Disadvantages of facility based DOT**

Patients and community volunteers recognised that the disadvantages of facility based DOT included longer travel time and distances and longer waiting times for treatment at the clinic. The effort and time needed therefore to obtain treatment at clinics might adversely affect adherence:

*“Weekly or fortnightly supply may help their experience be better. Having extra manpower over weekends at clinics may reduce the nightmare faced by a single nurse and all patients” Patient*

*“Patients may choose to stay home and not go late to far away health facilities” Volunteer*

*“Waking up early in the morning to queue at the clinics is difficult and inconveniencing, we don’t get enough rest”*

### **Advantages of home based DOT**

Obtaining treatment from a community volunteer was less stressful as it required less effort and a convenient more flexible time could be negotiated.

*“[HBDOT] allows us to rest enough and does not stress us as we would have usually agreed with volunteers about a specific time to meet.” Patient*

Home based DOT was also an advantage for those too sick to travel every day to the facility and for those who struggled to eat before taking medication at the clinics. Not being able to eat might lead to more side effects and reduced adherence.

*“Community TB programme has come on time to help us. At times we are too sick to walk to the clinics everyday. Clinics advise us to eat before medication intake but by the time we take tablets at clinics, the food would have dissolved in the stomach. At home the volunteer deals with few people and gives time to patients to eat some porridge in the morning before medication” Patient*

*“[The feeling] we have of helping sick people in our own community, people who are very weak or who stay far from health facilities” Volunteer*

*“We are helping sick people in our own community, people who are very weak or who stay far from health facilities” Volunteer*

Home based DOT allows patients to engage more fully in other aspects of their lives:

*“HB DOT is well designed to help workers or non-workers to take tablets at an agreed time with their community supervisors. Patients may then have time to take care of other businesses instead of staying at clinics the entire day.”*



Nurses also saw these advantages and in addition perceived that their workload was reduced and the need for them to do home visits. They also recognised that attending the facility might place an additional financial burden on the patient.

*“Of course HBDOT reduces the travelling distance to clinics for patients, it reduces workload for nurses, it reduces the daily transport cost of very ill patients to/fro clinics for medication or the need for home visits by nurses and the disturbance of visiting patients at home when they are still asleep” Nurse*

Home based DOT is also an advantage on weekends when clinics may be closed:

*“HBDOT is of incredible help during weekends when health posts close” Nurse*

*“HB DOT is helpful during weekends when health posts are closed.” Patient*

### **Disadvantages of home based DOT**

Patients had fears about taking TB treatment under HB-DOT that could affect their adherence to medication.

*“We are however sometimes worried about our own safety as volunteers are perceived to be not fully knowledgeable about doses and side effects of medication for instance”. Patient*

*“I feel it is safe to take treatment at clinics, though I feel tired some days or I have painful legs. The health workers have been taught details about how to give these tablets.” Patient*

Health care workers concurred with these fears and the possibility that volunteers were not sufficiently knowledgeable:

*“Patients may also have little trust in volunteers”. Health worker*

*“HBDOT unfortunately involves volunteers that are not perfect about TB management and may still have problems with some aspects of TB management. There are also concerns about the change of time of medication intake”. Health worker*

It is therefore understandable why volunteers suggested to health workers to pay regular visits to communities where they (health workers) could continue health education and re-enforce what volunteers had taught:

*“Nurses need not abandon us with the patients during the entire course of treatment. They (nurses) need to meet TB patients and communities regularly to re-enforce our education. It may even increase confidence of patients in us as nurses would confirm what we usually say”. Volunteers*

Health workers also worried that community volunteers may not always supervise strictly in the long term:

*“Patients may relax and volunteers may be lenient to members of their community”. Health worker*

A further problem is that there is sometimes no substitute when community volunteers are not available:

*“No back up plan when volunteers have funerals or are ill”.*

### **Organisational issues**

Interviews with patients on FB DOT frequently revealed that they had incomplete knowledge about the existence of HB DOT. Sometimes they didn't know they were free to choose to take tablets from home or from health facilities. Below is a conversation with some patients:

*Interviewer: “Did you know that at home you would take TB tablets in the presence of the community volunteers”?*

*Patient 1: “Is it? I didn't know. I thought I would just get a supply for few days and then swallow them at my own time”*

Problem patients on HB DOT may be referred back to the facility when supervision is difficult:

*“It is discouraging to look after patients who refuse to take medicines (hide them or throw them) or patients who still take alcohol. Fortunately, stubborn patients may be referred back to health facilities for follow up” Volunteer*

In addition to visiting patients at home, volunteers may also supervise patients in their own home, which makes supervision more time efficient for them:

*“Patients walking to our places (volunteer’s house) for medication has made supervision very easy and gives us time to finish this work and deal with our personal activities”.*

Though not specifically allowed by the national TB programme, the provision of such flexibility that allows combination of facility, home and even school based supervision can support adherence and quality of life:

*“I felt that taking TB tablets was disturbing my school attendance, hence I allowed my teacher to keep my tablets and issue them to me daily. During weekends I instead take medication from the clinic. I think this arrangement is advantageous to me”  
School boy on TB treatment*

The need for greater flexibility was still an issue for some patients:

*“How can I go to plough the field some 25km away from here if everyday I have to take the TB tablets in the presence of a supervisor? What am I going to eat this year? Why don’t they allow farmers to go back to their work when they feel a bit better?”*

Although relying on unpaid volunteers renders HB DOT cost effective, its long term sustainability seems threatened:

*“HB DOT requires only few resources”.*

*“HBDOT won’t be sustainable as there is high turnover of volunteers due to no incentive. National TB programme should tackle this issue urgently”*

Despite this issue, community volunteers perceive the community TB programme to be acceptable to patients:

*“It may go a long way if few problems are managed as communities have generally accepted us and take us like nurses”.*

They appreciate the privileged position that their role in HB DOT allows them to attain in the community, but they need some form of identification. Indeed identification and other clothing / equipment will ease their movement and encourage them:

*“Do you know that sometimes even clinic staff fails to identify us. We need uniform and some form of sticker to write our names on to help people identify us”*

*“People take us as nurses and that inspires respect, why then not have identification?”*

*“We need umbrellas and other protective cloths/boots to wear when it is raining, cold or very hot”.*

Health workers think that the National TB programme has to take some bold decisions before HB DOT collapses. Among their recommendations for improvement, one can note the need for:

- financial incentives for volunteers
- training of additional volunteers to help cover more areas
- organisation of regular refresher workshops for volunteers to assist them to maintain their standards and acquire more knowledge
- the district TB coordinator, local government and ministry of health officials to pay regular supportive visits to volunteers (not only clinic staff). It may encourage them and make them feel appreciated

- constant availability of data capturing/monitoring tools (forms)
- reliable transportation to allow daily home visits of TB patients by health workers.

## **VII- DISCUSSION**

### **A- Main findings of the study**

No difference in TB treatment outcomes was found between facility-based, home-based and mixed types of offering DOT. It would appear therefore that home-based DOT is as good as facility-based treatment. The choice of DOT may be flexible based on the need for injections, patient preference and availability of different DOT options. It is likely that providing greater choice and matching the treatment plan more closely with patient preferences will lead to greater satisfaction and adherence to treatment. Indeed despite many disadvantages raised about HB-DOT, outcome of ATT remained comparable to the one in FB DOT; this shows at least the commitment of patients to their choice of DOT.

Also, daily administration of ATT under supervision seems to bother some TB patients. In some of these patients, mixing different DOT types appears to be necessary to allow patients the flexibility they need for other priorities. This is why a school boy enjoyed mixing HB DOT and FB DOT to avoid missing classes; and farmers, particularly, find it difficult to stay next to clinics for the entire course of ATT. For the latter category of patients, the much needed flexibility of DOT may still be elusive. Many other patients also mixed FB-DOT and HB-DOT, either concomitantly or consecutively. Some patients under MX DOT are those who started ATT under FBDOT and found it more flexible to move to HBDOT once they became clinically stable and could return to work. Other patients under MX DOT are those on re-treatment regimen who needed streptomycin during the initial phase of TB treatment. Community volunteers are not allowed to inject patients but they would give oral medication to patients whilst nurses would inject them. The latter situation was observed in a few instances where nurses went against the national TB programme inclusion criteria into HB-DOT by enrolling re-treatment TB patients to HB-DOT. These apparent innovations saved several desperate situations and need to be formalised with clear distribution of roles among the different caregivers as indeed

almost 8 % (35 out of 405) of all study participants found themselves in MX-DOT. In support of formalisation of MX DOT is its outcome of ATT performance that remained non-statistically significantly different to FB-DOT and HB-DOT.

Overall cure rate was 78.5%, which is below the WHO target as well as the Botswana National TB programme target of 85%.

The successful treatment rate was 83%, which is close to the WHO target of 85% and above the Botswana National TB programme target of 75%.

Facility-based health workers were found to be more proactive in contact tracing than the home-based volunteers. Given the volunteers' greater engagement and involvement in the community, this was an unexpected finding. Is this poor performance a reflection of the lack of trust in the relationship between patients and community volunteers or a lack of knowledge of community volunteers about some aspects of TB management? This situation requires further analysis but in case of the latter option the national TB programme would need to revise the curriculum offered to community volunteers during their training and include discussions emphasising the importance of contact tracing. Such curriculum would move the responsibility of community volunteers beyond dispensing only to include activities related to early detection of TB, specifically contact tracing. Considering their performance in other aspects of treatment outcome, it is more plausible that community volunteers may perform well concerning contact tracing if they are educated about it and are diligently allowed to be involved. Patients with MXDOT did even worse in contact tracing as probably no single caretaker took the responsibility of screening close contacts to TB patients.

#### B- Relation of findings to literature

The findings of this study concur with those obtained for community based DOT from more ideal situations offered in clinical trials (6,14) . Also its results join those concerning treatment outcome from several other observational studies conducted in different settings (7,10, 20), making its implementation a likely complementary intervention to support the traditional FB-DOT.

On the other hand this study did not demonstrate that outcomes from HB-DOT can be better than FB-DOT (9,11). Many other studies did so. A study in Zambia (9) was conducted in an urban area at a time when HIV had emerged and many TB patients were interrupting ATT due to weakness and inability to walk to health facilities. This study was also in an environment where ATT was offered for 8 months to new patients and strict DOT implemented only during the initial phase. In its HB DOT initiative, this TB programme allowed community volunteers to provide DOT at home. HB DOT showed a better completion rate, and later, when volunteers became more involved in collection of follow up sputum, even cure rates became better. However it is not clear if TB patients under HB DOT received any HAART. Also, another study in Uganda (11) was conducted in rural area and compared two periods, one without HB DOT and the other one with HB DOT option. At the difference with Botswana, DOT was traditionally offered during the first two months of ATT and no DOT afterwards. During the period of introduction of HB DOT, patients would be admitted for two weeks initially and would carry on with HB DOT until the end of treatment. The introduction of HB DOT had a tremendous positive impact as it avoided defaulting ATT.

An attempt to assess the use of family members as treatment supervisors in industrialised countries showed worse adherence to ATT in the HB-DOT group. In this study, TB patients were randomly allocated to FB DOT or HB DOT. TB patients under HB DOT freely chose a family member to supervise them. Analysis was carried per intention-to-treat and saw many picked family members not committed. Also, where they accepted to help supervision, they were swayed by emotions and therefore not reliable for compliance (8). But same type of study conducted in a developing country yielded results that showed better adherence to ATT in patients under HB-DOT (15). The latter results and present study results demonstrate the reliability to HB DOT, at least in developing countries.

Finally, a qualitative study conducted as focus group discussions in Tanzania (5) showed similar perceptions to present study about HB DOT among TB patients, community volunteers and health workers; though this study was using previous TB patients as treatment supervisors. Among reasons cited by this study to support the introduction of HB DOT, relief of overcrowding in clinics and cost effectiveness and

easy time management came up clearly. Also volunteers requested to be regularly visited by health workers. And the different stakeholders expressed concerns about the sustainability of HB DOT as community volunteers may need to find other jobs or activities to financially support their respective families. Another qualitative study in Uganda (11) using an assessment of knowledge, attitudes and beliefs also supports the link between patients' own choice of DOT type and their commitment to complete ATT. It also shows that many TB patients had chosen HB DOT due to its cost effectiveness (patients travel short distance) and its flexibility as patients and community volunteers agree on what time to meet.

### C- Strengths and weaknesses of study

A particular strength is the combination of quantitative, analytical methods with exploratory qualitative interviews, which captured a more complete picture of the process as well as the outcome of care. This study also reports results from the actual health care setting rather than from the more ideal conditions created by a randomised clinical trial. During the period considered for the present study, the Subdistrict TB programme registered 706 TB patients. Considering the exclusion criteria, 405 TB patients were recruited as study participants. However the MX-DOT as a special arrangement was not expected and was allowed by the TB programme only for few patients whose analysis was therefore affected by its small sample size.

Another weakness is the potential effect of measured and unmeasured confounding factors on outcomes between the different groups. In this study only confounding factors registered in the TB registers were considered. Other confounding factors that may have been relevant were not available such as CD4 count, WHO HIV clinical staging and other co-morbidities.

In terms of interviews, it is important to recall their subjectivity and the potential for mis-interpretation of meaning through the process of translation and analysis. However main researcher conducted all interviews, accompanied by assistants that are fluent in the local language.

### D- Need for future research and recommendations for the health system



Future studies that may assist with the further evaluation of HB DOT are:

- Investigation of the surprising difference in contact tracing efforts
- Investigation of programmes that may give more flexibility and choice to patients
- Re-evaluation of the community TB programme following the implementation of recommendations given in this study.

Present study results will be shared with local managers, health workers and communities to highlight the equal performance of the different DOT types in terms of TB management outcomes. There is a need to continue educating patients and communities regarding the availability and potential benefits of HB-DOT. And in this regard, one may point to the benefits offered by a more flexible DOT tailored to patients' circumstances and preferences.

It is worth noting some factors that explain the choice of the different DOT types as obtained from interviews:

Reasons to choose facility based DOT	Reasons to choose home based DOT
<ol style="list-style-type: none"> <li>1. Need to obtain injections</li> <li>2. Feel more secure being treated by a nurse than a volunteer</li> <li>3. Live close to a clinic</li> <li>4. Not too weak to travel</li> </ol>	<ol style="list-style-type: none"> <li>1. Live very far from clinic</li> <li>2. Too weak to travel</li> <li>3. Can't afford to travel to clinic</li> <li>4. Easier to eat at home before taking treatment</li> <li>5. Flexible for workers/students</li> </ol>

HBDOT may be improved and strengthened by consideration of the following issues:

- Regular talks with TB patients by health care workers to reinforce on-going counselling by community volunteers

- Continuing professional development and education of volunteers to ensure they are competent and up-to-date
- Education and support for contact tracing by community volunteers
- Uniform and some form of identification for community volunteers
- Financial incentives for community volunteers, though challenging needs to be considered critically.

## VIII- REFERENCES

- 1- Braunwald E, Fauci AS, Kasper DL, Hauser SL, Longo DL, Jameson JL. Harrison's Principles of Internal Medicine. 15<sup>th</sup> Edition. USA: McGraw-Hill Medical Publishing Division; 2001; vol 1: 1024-1035
- 2- Ministry of Health (Botswana). National Tuberculosis Programme Manual. 2<sup>nd</sup> Edition. Gaborone: Ministry of Health; 2007
- 3- Botswana National tuberculosis Programme. Community TB Care: Training Guide for Health Workers. Gaborone: Ministry of Health; 2007
- 4- Godfrey-Faussett P, Ayles H. Can we control Tuberculosis in High HIV Prevalence Settings?. Tuberculosis. 2003; 83: 68.76
- 5- Wandwalo E, Makundi E, Hasler T, Morkve O. Acceptability of community and health facility-based directly observed treatment of tuberculosis in Tanzanian urban setting. Health Policy. 2006 Oct;78(2-3):284-94.
- 6- Wandwalo E, Kapalata N, Egwaga S, Morkve O. Effectiveness of Community-Based Directly Observed treatment for Tuberculosis in Urban Setting in Tanzania: A Randomised Controlled Trial. International Journal Tubercle and Lung Disease. 2004;8:1248-54
- 7- Singh AA, Parasher D, Shekhavat GS, Sahu S, Wares DF, Granich R. Effectiveness of Urban community Volunteers in Directly Observed Treatment of Tuberculosis

Patients: A Field Report from Haryana, North India. *International Journal of Tubercle and Lung Disease*. 2004 Jun;8(6):800-2.

8- MacIntyre CR, Goebel K, Brown GV, Skull S, Starr M, Fullinaw RO. A Randomised Controlled Trial of the efficacy of Family-Based Directly Observation of Anti-Tuberculosis Treatment in an Urban, Developed-Country Setting. *International Journal of Tubercle and Lung Disease* 2003 Sep;7(9):848-54

9- Miti S, Mfungwe V, Reijer P, Mahers D. Integration of Tuberculosis Treatment in a Community-Based Home Care for Persons Living with HIV/AIDS in Ndola, Zambia. *International Journal of Tubercle and Lung Disease*. 2003 Sep;7(9 Suppl 1):S92-8.

10- Kangangi JK, Kibuga D, Muli J, Maher D, Billo N, N'gang'a L, Ngugi E, Kimani V. Decentralisation of Tuberculosis Treatment from the Main Hospitals to the peripheral Health Units and in the Community within Machakos District, Kenya. *International Journal of Tubercle and Lung Disease*. 2003 Sep;7(9 Suppl 1):S5-13

11- Adatu F, Odeke R, Mugenyi M, Gargioni G, McCray E, Schnelder E, Mahert D. Implementation of the DOTS Strategy for Tuberculosis Control in Rural Kiboga District, Uganda, Offering Patients the Option of Treatment Supervision in the Community, 1998-1999. *International Journal of Tubercle and Lung Disease*. 2003 Sep;7(9 Suppl 1):S63-71.

12- Sinanovic E, Floyd K, Dudley L, Azevedo V, Grant R, Maher R. Cost and Cost Effectiveness of Community-Based Care for Tuberculosis in Cape Town, South Africa. *International Journal of Tubercle and Lung Disease*. 2003 Sep;7(9 Suppl 1):S56-62

13- Dudley L, Azevedo V, Grant R, Schoeman H, Dikeveni L, Maher R. Evaluation of Community Contribution to Tuberculosis Control in Cape Town, South Africa. *International Journal of Tubercle and Lung Disease*. 2003 Sep;7(9 Suppl 1):S48-55.

14- Lwila F, Scellenberg D, Masanja H, Acosta C, Galindo C, Aponte J, Egwaga S, Njako B, Ascaso C, Tanner M, Alonso P . Evaluation of Efficacy of Community Based vs Institutional based Direct observed Short-course Treatment for the Control of Tuberculosis in Kilombero District, Tanzania. *Tropical Medicine and International health*. 2003 Mar;8(3):204-10

15- Manders AJ, Banerjee A, van den Borne HW, Harries AD, Kok GJ, Salaniponi FM. Can Guardians Supervise TB Treatment as well as Health workers ? A study on Adherence during the Intensive Phase. *International Journal of Tubercle and Lung Disease*. 2001 Sep;5(9):838-42

16- Ngamvithayapong J, Yanai H, Winkvist A, Saisorn S, Diwan V. Feasibility of Home Based and Health Centre Based DOT: Perspectives of TB care Providers and Clients in an HIV-endemic Area of Thailand. *International Journal of Tubercle and Lung Disease*. 2001 Aug;5(8):741-5.

17. Zwarenstein M, Schoeman JH, Vundule C, Lombard CJ, Tatley M. A randomized Controlled Trial of Lay health Workers as Direct observers for treatment of Tuberculosis. *International Journal of Tubercle and Lung Disease*. 2000 Jun;4(6):550-4.

18- Maher D. The Role of the Community in the Control of tuberculosis. *Tuberculosis (Edinb)*. 2003;83(1-3):177-82

19- Akkslip S, Rasmithat S, Maher D, Sawert H. Direct observation of tuberculosis treatment by Supervised family members in Yasothorn Province, Thailand. *International Journal of Tubercle and Lung Disease*. 1999 Dec;3(12):1061-5.

20- S. Kironde, M. Meintjies. Tuberculosis treatment delivery in high burden setting: does patient choice of supervision matter? *International Journal of Tubercle and Lung Disease*. 2002: 6(7): 599-608

21- Francis Omaswa. The “community TB care in Africa” project. *International Journal of Tubercle and Lung Disease*. 2003: 7(9): 51

- 22- Steen TW, Mazonde GN. Ngaka ya setswana, ngaka ya sekgoa or both? Health seeking behaviour in Batswana with pulmonary tuberculosis. *Social Science & Medicine* 1999; 48(2):163-172
- 23- Steen TW, Mazonde GN. Pulmonary tuberculosis in Kweneng District, Botswana: delays in diagnosis in 212 smear-positive patients. *Int J Tuberc Lung Dis*. 1998;2(8):627-34
- 24- World Health Organisation. The Stop TB strategy: building on and enhancing DOTS to meet the TB-related Millenium Development Goals. Geneva, World Health organisation (WHO/HTM/STB/2006.37)
- 25- Elzinga G. Scale up: meeting targets in global tuberculosis control. *Lancet*. 2004
- 26- A DOTS-plus handbook: guide to the community-based treatment of MDR-TB. Boston, Partners In Health. 2002
- 27- Kweneng East leads in MDR-TB cases. *BOPA News*. 2009 Apr 01.