International Journal of TROPICAL DISEASE & Health
10(2): 1-9, 2015, Article no.IJTDH.19933
ISSN: 2278–1005

SCIENCEDOMAIN *international*
www.sciencedomain.org

Treatment Outcomes of Tuberculosis Patients Managed at the Public and Private Dots Facilities in Lagos Nigeria

Olusola Adedeji Adejumo[1*], Olusoji James Daniel[2], Esther Ngozi Adejumo[3], Esther Oluwakemi Oluwole[1] and Odusanya O. Olumuyiwa[1]

[1]Department of Community Health and Primary Health Care, Lagos State University Teaching Hospital, Ikeja Lagos, Nigeria.
[2]Department of Community Medicine and Primary Care, Olabisi Onabanjo University Teaching Hospital Sagamu, Ogun State, Nigeria.
[3]Department of Medical Laboratory Science, Babcock University, Ilisan –Remo, Ogun State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author OAA conceived the study, involved with data collection, data analysis and discusssion. Author OJD wrote the methodology and was involved in the writing process, author ENA was involved in data collection and proof reading the manuscript. Author EOO was involved with data collection and literature search while author OOO supervised the research. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2015/19933
Editor(s):
(1) Giuseppe Murdaca, Clinical Immunology Unit, Department of Internal Medicine, University of Genoa, Italy.
Reviewers:
(1) Elvis Enowbeyang Tarkang, University of health and Allied sciences (UHAS), Ho, Ghana.
(2) D. G. Dambhare, Maharashtra University of Health Sciences, India.
(3) Humaira Zafar, Department of Microbiology, Al Nafees Medical College, Islamabad, Pakistan.
(4) Mausumi Basu, IPGMER and SSKM Hospital, Kolkata, India.
Complete Peer review History: http://sciencedomain.org/review-history/10447

Original Research Article

Received 3rd July 2015
Accepted 17th July 2015
Published 8th August 2015

ABSTRACT

Setting: Public and private tuberculosis (TB) treatment facilities in Lagos State, Nigeria.
Objective: This study compares the treatment outcomes of tuberculosis (TB) patients managed at the public and private treatment facilities in Lagos Nigeria.
Methods: A descriptive comparative cross-sectional study. Four hundred and seventy smear positive adults TB patients were consecutively recruited from 23 public and 11 private directly

**Corresponding author: Email: drolus_adejumo@yahoo.com;*

observed treatment short course (DOTS) facilities and followed up till completion of treatment after which their treatment outcomes were compared.
Results: The prevalence of TB/HIV co-infection among patients managed at the public and private DOTS facilities was 10.0% and 10.7% respectively (P = 0.68). There was no significant difference in the treatment success and defaulter rates of TB patients managed at the public and private DOTS facilities (P > 0.05). Supervision of treatment by a treatment supporter (OR 2.98, 95%CI 1.59 – 5.56) and not interrupting treatment (OR 21.27 95% 8.86 - 51.07) were predictors of treatment success.
Conclusion: Treatment outcomes of TB patients treated at the public and private DOTS facilities were comparable. There is need for strategies to effectively track patients lost to follow up.

Keywords: PPM DOTS; treatment outcomes; TB; Nigeria.

1. INTRODUCTION

Health care providers in the private sector have increasingly become a significant part of the health care system providing health care services in many developing countries [1]. The private medical sector varies within and between countries in terms of size, composition, types of services delivered level of organization and socio economic groups served [2]. In the last few decades, the private sector has grown considerably in some resource poor settings [3,4] to become an important source of care for the poor even where public services are widely available [5]. These private health care providers (PHPs) out number public health care providers and usually were the first point of care by a large proportion of patients seeking care including TB patients. Although they offer better geographical access and more personalized care than the public facilities, they frequently do not often follow the national treatment guidelines for the management of TB patients, hence some of the TB patients they serve are usually deprived of the benefits of standard and rational treatment [1].

To ensure that all patients receive quality assured TB services, the World Health Organization (WHO) as part of the global response to TB control introduced the STOP TB strategy in 2006. One of the core elements of the strategy is the engagement of all care providers in TB control [6]. The public-private mix (PPM) links all healthcare providers within the private and public sectors to the national tuberculosis programme for the implementation of directly observed treatment short-course (DOTS) activities [7]. The involvement of the private providers in the TB case notification and management is expected to increase case detection, reduce diagnostic and treatment delay and also enhance patient's access and acceptance of DOTS treatment. It is expected that this approach will result in reduction in disease transmission, improve treatment outcomes and reduce the workload on the public sector [8]. Published report of public-private mix projects in Asia however has shown that the approach is feasible and effective [9].

Nigeria launched the DOTS strategy for the management of TB in 1993 through the National Tuberculosis and Leprosy Control Programme (NTBLCP) [10]. The targets of the national TB programme are: to detect at least 70% of the estimated smear positive TB cases, to achieve at least 85% cure rate of the smear positives, to halve by 2015 the prevalence and the mortality due to TB relative to 1990 levels and to eliminate TB as a public health problem by 2050 in line with the global targets [10].

So far TB case detection rate, treatment success rate and cure rate in Nigeria is 43%, 84% and 72% respectively [11] which are below the global targets. However, failure to expand DOTS service to the private sector has been identified as one of the reasons militating against the attainment of global targets [11]. In order to address the potential of the private sector which constitute about 60% of health service provision in Nigeria [10], the National TB and Leprosy Control Programme (NTBLCP) initiated the systematic engagement of private sector through the public–private mix to ensure effective and efficient delivery of TB services to the general population.

The Lagos state PPM steering committee was inaugurated shortly after the state had a consensus building /stakeholders meeting in 2008. The private health providers (PHP) who were interested in partnering with the LSTBLCP were enlisted for training according to National TB and Leprosy Control guidelines. Based on

their capacity and interest, the private health provider (PHP) was assigned to any of the three schemes for collaboration. In Scheme one known as **"referral of patients suspected of having TB**", the PHP refer patients or send sputum of patients suspected of having TB to a NTBLCP approved treatment/microscopy center. Those engaged under scheme two known as **'Provision of Directly Observed treatment"**, provide DOTS to patients as per the NTBLCP guidelines. Those under scheme three can either serve as an approved microscopy center under NTBLCP **(Microscopy center only)** or as **treatment and microscopy center**. The PHP were provided with recording and reporting materials, drugs and other consumables to commence TB services in their facilities. At the end of 2011, The LSTBLCP had 130 TB treatment facilities offering directly observed treatment short course (DOTS). There were 99 public, 31 private health care facilities (20 private for profit (PFP) and 11 private not for profit (PNFP). Of the 11 PNFP health facilities only 2 participated in TB treatment prior to 2008.

The TB patients attending PHP facilities do not pay for anti-TB drugs supplied by the National TB programme but the patient were required to pay for consultation fee. In addition, PHP that have laboratory services were allowed to charge an agreed fee for sputum AFB because the reagents and consumables for sputum AFB are freely supplied by the LSTBLCP. The PHP were also allowed to charge patients for other investigations required by the attending physician such as chest x-ray, ESR, etc especially in smear negative TB patients. Smear microscopy was used to diagnose TB and in the event of smear negative result, chest x ray was used to diagnose TB. The HIV rapid test kit used to diagnose HIV was Determine (determine HIV-1/2 Alere Determine™, Japan 2012) and Uni-Gold™ (Trinity Biotech PLC, Wicklow, Ireland 2013). The duration of treatment was eight months. The treatment regimen consisted of two months intensive phase of Rifampicin, Isoniazid, Pyrazinamide and Ethambutol as fixed dose combination and six months continuation phase of Rifampicin and Isonizid as fixed dose combination.

Despite the engagement of the private sector in TB management, there has been concern if the treatment outcomes of patients managed at the private and public DOTS facilities are comparable [12]. This study compared the treatment outcomes of TB patients managed at the public and private DOTS facilities in Lagos Nigeria.

2. METHODS

A descriptive comparative cross sectional study was conducted to evaluate treatment outcomes of TB patients managed at the public and private DOTS facilities in Lagos state.

2.1 Sampling Technique

A sampling frame of 130 DOTS facilities provided by the Lagos state programme officer (99 public and 31 private DOTS facilities) was used to select, 34 DOTS facilities (23 from public and 11 private) that served as both microscopy and treatment centers and were involved in the DOTS programme for at least 2 years. Using the sample size formula for comparing proportions, statistical power of 95%, cure rates of 87% (public DOTS facilities) and 60.9% (private DOTS facilities) from previous studies [13,14] and attrition rate of 25%, a sample size of 100 was obtained for each group. All consenting new smear positive TB patients aged 15 years and above were consecutively recruited between October 1 to December 31 2012 from the selected public and private DOTS facilities respectively.

2.2 Study Procedure

On recruitment into the study, a structured questionnaire was administered on all the patients after written informed consent was obtained. The weight, sputum and HIV test results were recorded at baseline, before patients were commenced on eight months anti-TB regimen. The decision to have treatment supervised either by the health worker at the DOTS facilities or treatment supporter was made by the patients. For patients with no treatment supporter, drug use was directly observed during the intensive phase by a health worker, however during the continuation phase; patients were given one month appointment. For patients with treatment supporter, drugs were given to cover for two weeks to the patient or the treatment supporter who supervised the treatment at home and charted the drug intake on a card which was presented with empty drug blisters before drug refill.

Health facility record of the patient was updated from the treatment supporter card. Sputum AFB

test results and weight measurements done at the second, fifth and seventh month of treatment by health workers were recorded on a proforma. The treatment outcomes of TB patients managed at the public and private DOTS facilities were compared after completion of treatment. The study tools used were: structured questionnaire, a proforma to monitor patient's treatment and patient's treatment card. Study variables were cure rate, treatment completed rate, defaulter rate, treatment failure rate, transferred out rate, treatment success rate, proportion with treatment interruption and proportion with TB/HIV.

2.3 Evaluation of Treatment Outcome

The treatment outcome was divided into six categories according to the WHO and NTBLCP guidelines [15].

- Cured: Defined as the number of patients among smear positive patients that complete treatment and had at least two negative smears with an interval of at least one month, one of which should be obtained at the end of treatment.
- Treatment completed: This is the number of patients that complete treatment but sputum examination results are not available.
- Treatment failure: This is the number of patients who are still sputum smear positive at five months or more after the start of chemotherapy, or who interrupted treatment for more than 2 months after completing one month of chemotherapy, returned to treatment and are found to be smear positive.
- Defaulter: This is the number of patients that did not take drugs for two consecutive months or more.
- Transferred out. This is the number recorded that moved out of the health facility catchment area.
- Treatment success. Defined as the sum of the cases that were cured and that completed treatment.

2.4 Data Analysis

Data was analysed using the Statistical Package for Social Sciences (SPSS) IBM version 19. Mean and standard deviation were calculated for numerical data while percentages were calculated for both numerical and categorical data. Chi square was used to compare categorical data. Logistic regression was used to assess predictors of treatment success. Variables significantly associated with treatment success on bivariate analysis were entered at once into the regression model as predictors. The confidence interval was set at 95% for all statistical tests.

2.5 Ethical Approval

The study was approved by the Health Research Ethics Committee of the Lagos State University Teaching Hospital. Written Informed consent was obtained from all respondents before recruitment into the study.

3. RESULTS

Four hundred and seventy new smear TB positive patients were recruited. Out of which 358 (76.2%) and 112 (23.8%) were from the public and private DOTS facilities respectively. The mean age of TB patients treated at the public and private DOTS facilities was respectively 33.5±12.1 years and 31.2±10.1 years. The male:female ratio of TB patients managed at the public and private DOTS facilities was respectively 1:0.7 and 1:0.6. The proportion of patients with TB/HIV co-infection was 10% at the public and 10.7% private DOTS facilities (P = 0.68) as shown in Table 1.

There was no significant difference in the treatment outcomes of patients managed at the public and private DOTS facilities. The cured, treatment completed, treatment success and defaulter rates of patients managed at the public and private DOTS facilities was 65.4% vs 63.4%, 21.8% vs 22.3%, 87.2% vs 85.7% and 9.7% and 13.4% respectively as shown in Table 2.

The type of person that supervised treatment and non-interruption of treatment were associated with treatment success. (P = 0.05) is shown in Tables 3 and 4. The odd that a TB patient supervised by a treatment supporter will have treatment success was about three fold higher than if the treatment was supervised by a health worker (OR 2.98, 95% CI 1.59 – 5.56). In addition, the likelihood of having treatment success was 21 times higher among patients that did not interrupt treatment compared with patients that interrupted treatment (OR 21.27, 95%CI 8.86 – 51.07).

Table 1. Socio demographic characteristics of new smear positive TB patients attending the DOTS facilities

Variable	Public	Private	X2	p
	(n = 358) Freq (%)	(n = 112) Freq (%)		
Age Group in yrs				
< 20	41 (11.5)	14 (12.5)	3.23	0.5199
20 – 29	116 (32.4)	39 (34.8)		
30 – 39	108 (30.2)	36 (32.1)		
40 – 49	49 (13.7)	16 (14.3)		
>50	44 (12.3)	7 (6.3)		
Mean age	33.5±12.0	31.2±10.1		
Gender				
Male	211 (58.9)	69 (61.6)	0.25	0.6154
Female	147 (41.1)	43 (38.4)		
Educational Qualification				
None	20 (5.6)	9 (8.1)	3.09	0.3783
Primary	68 (19.0)	16 (14.3)		
Secondary	196 (54.7)	58 (51.8)		
Tertiary	74 (20.7)	29 (25.9)		
Alcohol Intake				
Yes	45 (12.6)	11 (9.8)	0.61	0.4332
No	313 (87.4)	101 (90.8)		
Cigarette smoking				
Yes	25 (7.0)	4 (3.6)	1.72	0.1903
No	333 (93.0)	108 (96.4)		
HIV Status				
Positive	36 (10.0)	12(10.7)	0.17	0.680
Negative	306 (85.5)	88 (75.6)		
Not Done[#]	16 (4.5)	12 (13.7)		
Who supervised treatment				
Treatment supporter	194 (54.2)	40 (35.7)	11.65	**0.001**
Health worker	164 (45.8)	72 (64.3)		
Treatment interruption				
Yes	128 (35.8)	58 (51.8)	9.196	**0.002**
No	230 (64.2)	54 (48.2)		

Table 2. Treatment outcomes of TB patients attending the DOTS facilities

Variable	Public	Private	χ^2	p
	(n = 358) Freq (%)	(n = 112) Freq (%)		
Cured	234 (65.4)	71(63.4)	0.15	0.703
Treatment completed	78 (21.8)	25(22.3)	0.01	0.905
Defaulted	35 (9.7)	15(13.4)	1.39	0.239
Died	3 (0.8)	0.0 (0.0)	0.94	0.441^x
Transferred out	3 (0.8)	0.0 (0.0)	0.94	0.441^x
Treatment failure	5 (1.4)	1(0.9)	0.17	0.561^x
Treatment success	312 (87.2)	96 (85.7)	0.154	0.695

NB: x = Fisher's exact

Treatment success was defined as the sum of the cases that were cured and that completed treatment

Table 3. Factors associated with treatment success at the DOTS facilities

Variable	Treatment Success		X2	p
	Yes n = 408 (%)	No n = 62 (%)		
Age group				
< 20 years	45(11.1)	10 (16.1)	2.435	0.656
20 – 29	135 (33.1)	20 (32.3)		
30 – 39	126 (30.9)	18 (29.0)		
40 – 49	59 (14.5)	6 (9.7)		
50 yrs and above	43(10.5)	8 (12.9)		
Mean±SD	33.1±11.5	32.1±12.8		
Gender				
Male	249 (61.0)	31 (50.0)	2.719	**0.099**
Female	159 (39.0)	31 (50.0)		
Alcohol intake				
Yes	48 (11.8)	8 (12.9)	0.066	**0.797**
No	360 (88.2)	54 (87.1)		
Cigarette smoking				
Yes	22 (5.4)	7 (11.3)	3.234	0.072
No	386 (94.6)	55 (88.7)		
Who supervised treatment?				
Health worker	191 (46.8)	43 (69.4)	10.939	**0.001**
Treatment supporter	217 (53.2)	19 (30.6)		
Treatment interruption				
Yes	130 (31.9)	56 (90.3)	76.919	**<0.001**
No	278 (68.1)	6 (9.7)		
HIV status	**n = 385**	**n = 57**		
Positive	40 (10.4)	8 (14.0)	0.68	0.409
Negative	345 (89.6)	49 (86.0)		
On ARV	**n = 40**	**n = 8**		
Yes	21 (52.5)	1 (12.5)	4.297	0.055[x]
No	19 (47.5)	7 (87.5)		

NB: x = Fisher's exact

Table 4. Predictors of treatment success among Tb patients in DOTS facilities

Predictors	B	Wald	p	Odds ratio	95%CI
Treatment supervised by treatment supporter	1.090	11.716	0.001	2.976	1.594 – 5.556
No treatment interruption	3.057	46.806	<0.001	21.269	8.859 – 51.07

Note: B = Logistic regression coefficient
Wald = Chi Square

4. DISCUSSION

This study found that the cured, treatment completed and treatment success rates of patients managed at the public and private DOTS facilities were comparable. Similar finding was obtained in studies conducted in India and Kenya [16-18]. However other studies conducted in Nigeria, Thailand and Vietnam [13,14,19,20] showed that cure rates were higher in patients managed at the public DOTS facilities compared with those managed at the private DOTS facilities. This finding may be because of the affordable cost of TB treatment at the private DOTS facilities. TB patients attending private DOTS facilities do not pay for anti-TB drugs supplied by the national TB Programme. However, they are required to pay a token as service charge for sputum AFB. A study from Vietnam attributed the better cure rates observed in patients managed at the public DOTS facilities to the cost of treatment [20]. While treatment at

the public DOTS facilities were funded by the NTP, patients attending the private DOTS facilities pay the full cost of treatment [20]. Generally, the proportion of patients lost to follow up at the public and private DOTS facilities in this study was high. However, this proportion is higher at the private DOTS facilities compared with the public DOTS facilities (P = 0.24).The long duration of treatment may be responsible for this finding. The findings from this study are consistent with those from studies conducted in Thailand, Vietnam and India [19-21]. Private DOTS providers unlike the public DOTS providers do not have effective mechanism to track TB patients lost to follow up [21]. A study showed that payment for services at the private DOTS facilities may be responsible for the higher proportion of patients lost to follow up [20].

In this study non-interruption of treatment and supervision of treatment by treatment supporters were associated with treatment success. A significantly high proportion of TB patients managed at the private DOTS facilities were not adherent to treatment (P <0.001). This finding is similar to what was obtained in a study from Russia which reported that treatment failure rate was high among TB patients who had treatment interruption especially during the intensive phase [22]. This may be because the LSTBLCP did not provide the private DOTS providers the necessary logistics to effectively track patients lost to follow up.

Another factor associated with treatment success in this study was the supervision of patient's treatment by treatment supporters. The objectives of the supervision of TB treatment by treatment supporters are to improve adherence of TB patients to treatment and reduce the proportion of patients lost to follow up. A significantly higher proportion of patients whose treatment were supervised by treatment supporters had successful treatment compared with those supervised by the health workers (P < 0.001). The conventional DOTS approach which patients obliged to attend the health facility each day to obtain medication was difficult for patients because of their poor physical condition, distance and lack of funds to pay for travel [23]. The patient centred approach allows TB patients choose where TB drugs intake is supervised and by who. Supervision could be undertaken either by a health worker at a health facility or at home by a supporter of the patient's choice. This approach could positively impact treatment adherence. Studies have shown that adherence to treatment and treatment success was higher with treatment supporters than the conventional health facility based DOTS [24-26].

5. CONCLUSION

Treatment outcomes of TB patients managed at the public and private DOTS facilities were comparable. Effort should be made to track patients lost to follow up especially those managed at the private DOTS facilities.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the Lagos State TB control officer, TB focal persons, LGA TB supervisors and the Lagos State Ministry of Health for their support.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. World Health Organization. Public- Private Mix for TB care and control. A tool for National situation assessment; 2007. WHO/HTM/TB/2007.391.Geneva. Available:http://whqlibdoc.who.int/hq/2007/WHO_HTM_TB_2007.391eng.pdf Accessed April 2015.
2. Uplekar M, Pathania V, Raviglione M. Private practioners and public health: weak links in tuberculosis control. Lancet. 2001; 358:912-916.
3. Satyanarayana S, Nair SA, Chadha SS, Shivashankar R, Sharma G, Yadav S, et al. From where are tuberculosis patients accessing treatment in India? Results from a cross-sectional community based survey of 30 districts. PLoS One. 2011;(6):9.
4. Xun L, Qin L, Erin E, Johane P, Hang Z, Yang W, et al. Public-Private Mix for tuberculosis care and control: A systematic review. Int J infect Dis. 2015;34:20-32.
5. World Health Organization. World Health Organization: DOTS. Geneva: WHO; 2012. Available:http://who.int/tb/dots/en/ (Accessed November, 2014)
6. World Health Organization. STOP TB Partnership: DOTS Expansion Working

Group Strategic Plan 2006-2015. Geneva: WHO; 2006.
Available:http://www.stoptb.org/wg/dots_expansion/en/ (Accessed January, 2015)
7. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors: Systematic analysis of population health data. Lancet. 2006;367:1747-1757.
8. Nwell JN, Pande SB, Baral C, Ban DS, Malla P. Control of tuberculosis in urban setting in Nepal: Public- Private partnership. Bull World Health Organ. 2004;82:92-98.
9. World Health Organization. Public-private mix for DOTS: reports of the second meeting of the PPM subgroup for DOTS expansion, Geneva: WHO; 2004. Report NoWHO/HTM/TB/2004.338.
Available:http://whqlibdoc.who.int/hq/2004/WHO_HTM_TB_29_94.338.pdf (Accessed April 2015)
10. Federal Ministry of Health. Public-Private Mix in Tuberculosis Control: implementation guidelines. FMOH. Abuja; 2007.
11. World Health Organization. Global tuberculosis control, surveillance, planning and financing. WHO Report. Geneva; 2007.
Available:http://www.who.int/tb/publications/global_report/2007/pdf/full.pdf
(Accessed April 2015)
12. Okeke TA, Aguwa EN. Evaluation of the implementation of directly observed treatment short course by private medical practitioners in the management of tuberculosis in Enugu, Nigeria. Tanzania Health Research Bulletin. 2006;8:86-89.
13. Gidado M, Ejembi CL. Tuberculosis case management and treatment outcome: assessment of the effectiveness of Public-Private Mix of tuberculosis programme in Kaduna State, Nigeria. Ann Afr Med. 2009;8(1):25-31.
14. Quy HT, Lönnroth K, Lan TN, Buu TN. Treatment results among tuberculosis patients treated by private lung specialists involved in a public-private mix project in Vietnam. Int J Tuberc Lung Dis. 2003; 7:1139-1146.
15. Federal Ministry of Health. National Tuberculosis and Leprosy Control programme. Models for training of general health care workers on tuberculosis control 4th edition. Abuja: Sounasprints. 2012: 8-51.
16. Puneet KD, Lal SS, Lonnroth K, Wares F, Uplekar M, Sahu S, et al. Improving tuberculosis control through public-private collaboration in India: Literature review. BMJ. 2006;332:574–578.
17. Obermeyer Z, Abbott-Klafter J, Christopher J. Murray L. Has the DOTS Strategy Improved Case Finding or Treatment Success? An Empirical Assessment. PLoS ONE. 2008;3:e1721.
18. Chakaya J, Upleker M, Mansoer J, Kutwa A, Karanja G, Omleka V, et al. Public – private mix for control of tuberculosis and TB- HIV in Nairobi, Kenya: outcomes, opportunities and obstacles . Int J Tuberc Lung Dis. 2008;12:1274-1278.
19. Chengsorn N, Bloss E, Anekvorapong R, Anuwatnonthakate A, Wattanaamornkiat W, Komsakorn S, et al. Tuberculosis services and treatment outcomes in private and public health care facilities in Thailand, 2004–2006. Int J Tuberc Lung Dis. 2009; 13:888-894.
20. Lönnroth K, Thuong LM, Lambregts K, Quy HT, Diwan VK. Private tuberculosis care provision associated with poor treatment outcome: Comparative study of a semi-private lung clinic and the NTP in two urban districts in Ho Chi Minh City, Vietnam. Int J Tuberc Lung Dis. 2003;7:165–171.
21. Krishman A, Kapoor SK. Involvement of private practitioners in TB control in Ballabgarh, Northern India. Int J tuberc Lung Dis. 2006;10:601-6.
22. Jakubowiak W, Bogorodskaya E, Bonsov E, Donilova I, Konibalova E. Treatment interruption and duration associated with defaults among new patients with tuberculosis in six regions of Russia. Int J Infect Dis. 2009;13:362-368.
23. Egwaga S, Range N, Lwilla F, Mkopi A, Barongo V, Mtenga S, et al. Assessment of patient preference in allocation and observation of anti-tuberculosis medication in three districts in Tanzania. Patient prefer Adherence. 2008;2:1-6.
24. Egwaga S, Mkopi A, Range N, Haag-Afbenz V, Baraka A, Grewal P et al. Patient- centered tuberculosis treatment delivery under pragmatic condition in Tanzania: A cohort study. BMC Med. 2009;7:80-84.
25. Newell JN, Baral SC, Pande SB, Bam DS, Malla P. Family member DOTS and community DOTS for tuberculosis as

control in Nepal: Cluster randomized controlled trial. Lancet. 2006;367:903-909.

26. Brust JC, Shah NS, Scott M, Chaiyachati K, Lygizos M, Van der Merwe TL, et al. Intergrated home based treatment for MDR-TB and HIV in rural South Africa: an alternative model of care. Int J Tuberc Lung Dis. 2012;16:998-1004.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/10447