

## The Effectiveness of Family-Based DOTS versus Professional-Family Mix DOTS in Treating Smears Positive Tuberculosis

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### ABSTRACT

**Background:** The present study compared the effectiveness of Family-Based DOTS (FB-DOTS) versus Professional-Family Mix DOTS (PFM-DOTS) in smear positive tuberculosis (TB) patients.

**Methods:** This semi-experimental study was performed in Tuberculosis and Lung Diseases Research Center of Tabriz in 2011-2012, among 57 TB patients recruited into either FB-DOTS or PFM-DOTS groups. At the baseline of the study, knowledge of both patients and their supervisors were assessed while at the end point, smear and culture of sputum, quality of life, knowledge and satisfaction of the patients along with the knowledge and satisfaction of their supervisors were assessed.

**Results:** The difference for sputum smear negative (culture) was 16.2 (4.8%) and 7.7(6.9%) for the PFM-DOTS in comparison with FB DOTS by the end of the second and forth months of treatment, respectively. A significant difference was observed between the two groups in relation to knowledge, satisfaction (patients and supervisors) and all four domains of quality of life: physical health ( $P=0.036$ ), psychological health ( $P<0.001$ ), social relations ( $P=0.026$ ) and environmental health ( $P<0.001$ ).

**Conclusion:** The PFM-DOTS treatment strategy in which health experts follow the patients in their homes seems to be among most appropriate strategies in treating TB.

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## Introduction

Pulmonary tuberculosis (TB) is a lower respiratory tract infection which accounts for 85% of all TB cases.<sup>1</sup> The smear positive type is transferable through airways<sup>2</sup> and is detectable by sputum tests.<sup>3</sup> Though less prevalent in developed countries, this disease

is still spreading in developing countries<sup>4,5</sup> and so is a most important health and social concern in these regions. Thirty million patients are affected by the disease worldwide now which is predicted to kill more than 40 million people in the upcoming 15 years, if

sufficient efforts are not made to efficiently control the disease.<sup>6,7</sup> Therefore, it is crucial that treatments be commenced as soon as diagnosis with the disease is made.<sup>8,9</sup> There are factors contributing to delayed recovery and multi-drug resistance (MDR) including incompletion to the prescribed treatment protocol,<sup>10</sup> improper dietary modifications, inappropriate treatments, delayed provision, and distribution of drugs and no supervision upon timely and correct use of medications.<sup>11-13</sup>

Technological developments in modern world, population growth, and increasing medical costs<sup>14</sup> and critical role of patients' education in treatment of diseases,<sup>15,16</sup> along with importance of suitable relationship with patients to have a better treatment outcome,<sup>13</sup> all highlight the crucial role of attention that needs to be paid to adoption of treatment strategies that are not only cost effective<sup>17</sup> but also take into account the influence of good relation with the patients and proper supervision in the treatment process. Considering all these, WHO has recommended the DOT (Directly Observed Treatment Short-course therapy) strategy for the treatment of TB.<sup>18,19</sup>

Studies conducted in Iran indicate a decreasing trend in incidence of smear positive pulmonary TB and the success rate of treatments<sup>11</sup> in Tabriz and East Azerbaijan, Iran. This rate has been reported to be 94% and 87%, respectively.<sup>20</sup> Studies from all over the world have shown that implementation of DOTS can result in a success rate of at least 90-95%.<sup>6,20</sup> Even in the developed countries and among highly educated patients, it was indicated that after feeling of improvement, the treatment process has been left incomplete and the medications have been put aside, while in the DOTS strategy medication intake is closely supervised by a health expert or trained individual.<sup>6</sup> In Golestan Province, Iran, the rate of treatment failure in the group under direct supervision was 1.7% at the beginning of the fifth month; this number was 7.3% for the control group which indicated a significant correlation be-

tween the treatment strategy and failure rate.<sup>21</sup>

Due to lack of enough work force and limited financial sources, daily supervision of TB patients in their homes is not performed at this stage. Investigation of various treatment strategies of TB has led to selection and implementation of the most appropriate strategy in terms of quality, effectiveness, and efficacy, which in turn has resulted in efficient universal control of the disease. Undoubtedly, this can aid to proper development and distribution of governmental and non-governmental funds and to reach goals that were set for better control of TB, especially in the developing countries. The aim of the present study was to investigate the effectiveness of two different treatment strategies: Family-based DOTS and Professional-Family Mix DOTS, and report effectiveness of the two strategies in treatment of sputum positive pulmonary TB.

## **Materials and Methods**

### ***Study design***

The present study was a semi-experimental study with the aim of determining the effectiveness of two treatment strategies of FB-DOTS versus PFM-DOTS in smear positive pulmonary TB patients, performed in 2011-2012.

### ***Participants, Setting, and Sampling***

The study population was TB patients diagnosed as TB in Tuberculosis and Lung Diseases Research Center of Tabriz in 2011. This center is affiliated by the Tabriz University of Medical Sciences and covers all patients who are diagnosed with TB in East Azerbaijan Province located in North West of Iran. Smear positive patients referred to this center, if meeting the inclusion criteria, were randomly entered into one of the two groups. The other patients entered the treatment groups by random allocation. Totally, 57 patients were diagnosed with TB in 2011, out of which 24 and 33 subjects entered the PFM-DOTS group and FB-DOTS group, respectively.

Inclusion criteria of the study were: 1) having a minimum of two sputum smear positive tests for acid-fast bacilli, 2) having only one sputum smear positive tests for acid-fast bacilli and confirmed disease based on the reported radiographic changes of the thorax by a radiologist and 3) having only one sputum smear positive tests for acid-fast bacilli and one positive sputum culture for acid-fast bacilli. The exclusion criteria were: 1) sputum smears negative patients, 2) non-pulmonary TB and 3) patients on a retreatment for the disease.

### ***Procedures***

Data on satisfaction and knowledge of the patients was collected by a self-designed questionnaire and the standard questionnaire by WHO was employed to assess Quality of Life. This standard questionnaire has four domains including; Physical health, Psychological health, Social relations, and Environmental health. Validity of the self-designed questionnaire was assessed and confirmed by a panel of eight experts in the field of infectious and pulmonary diseases. Reliability for the four domains of quality of life (physical health ( $\alpha=0.77$ ), psychological health ( $\alpha=0.724$ ), social relations ( $\alpha=0.718$ ), environmental health ( $\alpha=0.66$ ), as well as knowledge ( $\alpha=0.78$ ) and satisfaction ( $\alpha=0.77$ ) was checked by Cronbach's Alpha test.

### ***Data collection***

In the FB-DOTS group, a family member was selected as the supervisor and the patients took their medications at home. A health expert followed the treatment process monthly. In the PFM-DOTS group, a health expert, after primary arrangements visited the patient at home weekly for the first two months of treatment (a total of 8 visits), every other week for the next two months (a total of 4 visits) and monthly for the last two months (a total of 2 visits). He checked the treatment process according to the patients' treatment cards and provided necessary explanations on the importance of timely use of medications and hygiene. Moreover, the health expert contacted the patient every

tertian (once in every three days) for the first two months of treatment (a total of 20 calls), weekly for the next two months (a total of 8 calls) and monthly for the last two months (a total of 2 calls) to check for the timely use of medications and provision of necessary recommendations to the patients and their home supervisors.

At baseline, knowledge of patients and their families (home supervisors), and also patient's life quality were assessed on separate interviews. At the endpoint of the study, knowledge and satisfaction indices of the patients and their families (home supervisors) were assessed separately. Sputum negative subjects were assessed at the end of the second, fourth and sixth month; if the Sputum result was positive, the first assessment was performed at the end of the third month. Recurrence of the disease and the patients quality of life, as effectiveness indices, and direct and indirect costs (based on the information available from the medical record) as cost indices were assessed at the endpoint of the study; cost effectiveness was evaluated accordingly and compared for the two treatment strategies.

Sputum smear, sputum culture, satisfaction score, knowledge score and life quality score were the primary outcomes investigated in the present study. Smears becoming negative and sputum culture were the main indices assessed after 2, 4 and 6 months of intervention. Knowledge, quality of life and satisfaction after 6 months of treatment were secondary indices of the study.

To evaluate the recovery process of TB patients, two sputum samples were collected every other month and were sent to the laboratory to be tested. If the smear was positive at the end of month two, the samples were collected monthly. Smear and culture results were provided by the Laboratory of Tuberculosis and Lung Diseases Research Center, Tabriz University of Medical Sciences.

### ***Ethnical consideration***

Approval for the study was obtained from the Ethics Committee, Tabriz Univer-

sity of Medical Science and Tuberculosis and Lung Disease Research Center. Participants were explained about their anonymity and the possibility to withdraw from the study even after they signed the informed consent form.

### **Data analysis**

Results for sputum smear and culture were reported as frequency (percent) for each of the groups at the end of the second, third fourth, and the last months of the study. Chi-square test was used to compare these results. Scores for quality of life, satisfaction of the patients, and their supervisors with health services as well as their knowledge about TB were reported as mean (SD) for each group. To compare the FB-DOTS and PFM-DOTS groups for knowledge, satisfaction, and quality of life, independent samples *t* test was performed at baseline.<sup>22</sup> The confounding variables including demographic characteristics (age, occupation, gender), smear results (1+, 2+ or 3+) and thorax radiography results (None (Normal), Less (moderate influence by microbe), More (high influence on lungs)<sup>6</sup> were assessed through the study course. Since the patients had not been matched for these factors at baseline, covariance analysis was applied to adjust the results for the probable differences of the two groups for these variables. In all the analyses performed,  $P < 0.05$  was considered as significant result.<sup>23-25</sup> SPSS version 11.5 was used for the analyses.

### **Results**

Fifty seven TB patients (out of 118 subjects diagnosed with TB in 2011-2012) met the inclusion criteria and entered the study after signing an informed consent form. Thirty-three patients entered the FB-DOTS group together with their home supervisors and 24 patients entered PFM-DOTS group with their home supervisors. Treatment results, knowledge about the disease, satisfaction with the provided services and quality of life data were analyzed for all the 57 patients. There were no significant differences

in age, education and occupation among the patients and their home supervisors in the two groups. In PFM-DOTS group, three men and in FB-DOTS group one man and two women died through the study course and were excluded from the final analyses; data about 51 patients were analyzed at the endpoint of the study.

All the 21 patients (100%) in the PFM-DOTS group took their medications regularly and timely. In the FB-DOTS group, 26 patients (86.6%) took their medications as prescribed while the other 4 patients (13.3%) did not follow the treatment protocol and reported a 10-60 days of discontinuation of their treatment.

Sputum smear negative results at the end of the second and fourth months of the intervention and end of the study were 76.2%, 90.5% and 100.0% in the PFM-DOTS group respectively; the results were 60.0%, 82.8% and 100.0% for the FB-DOTS group (Table 1). Although there was a difference of 16.2% and 7.7% for the sputum smear negative results between the two groups at the end of the second and fourth months of intervention, this difference was not statistically significant ( $P=0.366$ ).

To confirm the sputum smear negative results reported by the laboratory, the samples were cultured in Lowenstein-Jensen medium for two months. The sputum negative culture results were 95.2%, 100.0% and 100.0% at the end of the second and fourth months of the intervention and at the end of the study in the PFM-DOTS group, respectively (Table 2). These results were 90%, 93.1% and 100% in the FB-DOTS respectively. As for the sputum smears, results from sputum cultures indicated a non-significant difference ( $P=0.634$ ) of 4.8% at the end of the second month and 6.9% in the last day of month four, between the two treatment groups.

Patients and their supervisors were separately analyzed for knowledge scores. The results were justified for the baseline knowledge by covariance analysis. There was a significant difference in knowledge scores between the FB-DOTS and PFM-DOTS

groups for both patients and their supervisors ( $P < 0.001$ ). The analysis of knowledge score differences between the baseline and end of the study in each of the treatment groups showed that in both groups, patients as well as their supervisors had significantly increased knowledge scores at the last month of the study compared to baseline; the increase was greater in PFM-DOTS group than FB-DOTS group. At baseline, no significant differences were seen in knowledge scores between the two intervention groups, neither in patients nor their supervisors (patients ( $P = 0.816$ ), supervisors ( $P = 0.523$ )).

Comparing the two treatment groups for life quality at the end of the study duration, adjusted for baseline measures, revealed a significant difference between the groups in all four aspects: physical health ( $P = 0.036$ ), psychological health ( $P < 0.001$ ), social relations ( $P = 0.026$ ) and environmental health ( $P < 0.001$ ) in favor of the PFM-DOTS group.

Satisfaction scores were significantly higher in PFM-DOTS compared to FB-DOTS group in both patients ( $P < 0.001$ ) and their supervisors ( $P = 0.037$ ).

## **Discussion**

The results of the present study confirmed the advantages of PFM-DOTS strategy over FB-DOTS in terms of avoiding delayed recovery from the disease, knowledge improvement, increased quality of life as well as satisfaction with the provided health services, in both the patients and their supervisors. Although in both treatment groups, 100% of the patients recovered from TB, 13.3% of the participants in FB-DOTS group took their medications irregularly which due to the contagious nature of the disease, can increase the probability of transmission of TB to others and cause multi drug resistance (MDR); which requires great attention. On the other hand, TB is more prevalent among the poor. Thus, it is crucial to closely supervise the regular and timely intake of drugs at their homes.

In both treatment strategies applied in the present study, patients were treated at their homes and both strategies were based on DOTS and resulted in a 100% recovery from the disease. These results were in agreement with those studies conducted by Steffen et al. in Brazil in 2007-2008<sup>26</sup> and the study by Abbasi and Arabi in Golestan, Iran.<sup>21</sup> All these three studies have shown the effectiveness of DOTS strategy in recovery of the TB patients from the disease. Moreover, our results were similar to the results of the study led by Datiko et al. in Southern Ethiopia in 2008; cost effectiveness and recovery rate of the patients in Community Based DOTS (CB-DOTS) were greater than Health Facility Based DOTS (HF-DOTS), which was a strategy similar to FB-DOTS and PFM-DOTS adopted in our study, and treatment costs were 2.6 times greater in HF-DOTS compared to CB-DOTS group.<sup>27</sup> In India in 1998-2002, three treatment strategies: Public-Private Mix Directly Observed Treatment Short-course therapy (PPM-DOTS), Public sector Directly Observed Treatment Short-course therapy (P-DOT), and Non-Directly Observed Treatment Short-course therapy in the private sector (Non DOTS Private) were assessed for cost effectiveness. Recovery rate was 1.5 times greater in groups treated by DOTS strategy, than the other two methods.<sup>28</sup> In DOTS groups which also had a home supervisor, cost effectiveness was increased; this was confirmed by the results of studies conducted in Nepal, Southern Ethiopia and Tanzania in which CB-DOTS was compared to FB-DOTS, HF-DOTS and PFM-DOTS treatment strategies.<sup>27,29,30</sup> In the present study, PFM-DOTS was more cost effective than FB-DOTS which is predominant due to the decreased number of visits to the TB clinics by the patients.<sup>30</sup> CB-DOTS strategy has also been reported to increase cost effectiveness in Tanzania, Malawi and Kenya by 35%, 50% and 60% respectively.<sup>31,32</sup> In Nepal, CB-DOTS were revealed to be more cost effective in comparison to FB-DOTS while in Pakistan, where

two strategies were compared, FB-DOTS were more cost effective.<sup>29,33</sup>

In Haiti in two time sections, 1982-2000 and 2003, Directly Observed Treatment short-course therapy-strategy expansion was compared to inpatient service in terms of reduction in incidences, decrease in mortality and treatment costs. In DOTS-strategy expansion, patients took their medications under the supervision of a health expert and in inpatient strategy; patients were treated in hospital, and receive their care in hospitalization period. Implementation of DOTS strategy resulted in a significant decrease in incidence and mortality rate of TB in the study population, in 2003. Moreover, governmental costs were decreased and 131 million dollars were saved. Before using the DOTS strategy, 76% of a Haitian Patients' income was spent on TB treatment.<sup>34</sup> these results are consistent with the findings of this study regarding home based health services and DOTS strategy adoption which resulted in faster recovery of the patients.

In Nepal in 2001-2002, cost effectiveness of CB-DOTS was compared to that of FB-DOTS; in CB-DOTS, a community health volunteer directly supervised medication intake by the patient while in FB-DOTS, a family member did the task. DOTS strategy applied in both treatment groups had clinical results greater than 80%. However, CB-DOTS were reported to be more cost effective than FB-DOTS.,<sup>35</sup> this finding confirmed our results. In both studies, FB-DOTS were found to be less cost effective compared to the other strategy.<sup>29</sup>

In Tanzania treatment costs of HF-DOTS were 1.5 times greater than CB-DOTS, which was attributed to less number of visits to the TB clinics, resulted in more cost effectiveness of CB-DOTS compared to HF-DOTS. CB-DOTS strategy implementation increased cost effectiveness by 44% in smear positive patients.<sup>30</sup> The results of our study were in agreement with the study by Wandwalo et al.,<sup>30</sup> in that in both studies patients who took their medications under the supervision of a family member had a recovery rate of one hundred percent.

To the best of our knowledge, in no studies health experts have supervised the patients at home (PFM-DOTS) so far.

### ***Limitations***

Main limitation of this study was presence of a negative attitude towards TB amongst the study participant due to social stigma they feel in relation to being recognized with TB. In addition, families were not willing to accept the study staff at their homes. We tried to respond these concerns by explanation of benefits of the home based service provision and thus increase their compliance with the study. While a standard and structured data collection tool was used for data collection, due to financial limitations, we were not able to apply different observers and questioners in the Professional-Family Mix strategy group to decrease probability of observer bias. Small sample size could potentially be another source of bias in this study and consequently findings of the study must be interpreted carefully. A future larger scale study will help greatly to answer all these methodological considerations.

### ***Recommendations***

It is recommended that the effectiveness of PFM-DOTS method in treating TB patients compared to the currently practiced FB-DOTS method be assessed in governmental, non-governmental and collaborated settings in the future studies to create scientific basis for decision makers in the health networks.

### ***Practical recommendations***

Considering the emphasis of WHO on close supervision of the TB patients and based on the results of the present study, which confirmed higher effectiveness of supervision by a health expert in treatment of TB patients, it is recommended that PFM-DOTS method be considered as a efficient alternative method in treating TB patients at least until the sputum smear and culture negative results are achieved.

**Table 1: Frequency and percent of sputum smear results at the end of second and fourth month of treatment and the endpoint of the study**

Patient Group		Smear 2		Smear 4		Smear 6		Total
		Positive	Negative	Positive	Negative	Positive	Negative	
PFM-DOTS	Patient Count	5	16	2	19	0	21	21
	% within Group	23.8	76.2	9.5	90.5	0.0	100.0	100.0
F-B-DOTS	Patient Count	12	18	5	24	0	30	30
	% within Group	40.0	60.0	17.2	82.8	0.0	100.0	100.0
Total	Patient Count	17	34	7	43	0	51	51
	% within Group	33.3	66.7	14.0	86.0	0.0	100.0	100.0

**Table 2: Frequency and percent of sputum culture results at the end of second and fourth month of treatment and the endpoint of the study**

Patient Group		Culture 2		Culture 4		Culture 6		Total
		Positive	Negative	Positive	Negative	Positive	Negative	
PFM-DOTS	Patient Count	1	20	0	21	0	21	21
	% within Group	4.8	95.2	0.0	100.0	0.0	100.0	100.0
F-B-DOTS	Patient Count	3	27	2	27	0	30	30
	% within Group	10.0	90.0	6.9	93.1	0.0	100.0	100.0
Total	Patient Count	4	47	2	48	0	51	51
	% within Group	7.8	92.2	4.0	96.0	0.0	100.0	100.0

## Conclusion

WHO has recommended that TB should be treated in the living place of the patients under the supervision of health care providers.<sup>6</sup> However, financial sources are limited and the recommended strategy by WHO could be costly. On the other hand, patients are not generally willing to accept a daily visit by the health care provider due to fear of being recognized with TB and social misjudgments about their disease. Despite all these concerns, since TB is a contagious disease and irregular taking of medications can cause drug resistance, supervised use of medications is essential. PFM-DOTS strategy, in which the experts visited the patients only weekly, was found to be a more effective treatment option compared to HF-DOTS. This method can lead to reach main goals of TB patients' treatment that is more negative results in smear and culture of sputum. Other benefit of the PFM-DOTS will be rapid treatment of TB patients. In addition, a significant increase in patients' satisfaction with health services, enhanced quality of life and better knowledge of the disease in both patients and their families will be other advan-

tages. Therefore, PFM-DOTS can be regarded as one of the efficient strategies for the treatment of TB.

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## Competing interests

The authors declare no conflict of interests.

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