Science Journal of Public Health
2016; 4(4): 352-358
http://www.sciencepublishinggroup.com/j/sjph
doi: 10.11648/j.sjph.20160404.23
ISSN: 2328-7942 (Print); ISSN: 2328-7950 (Online)

Methodology Article

FAST Strategy - A Sustainable Administrative TB Infection Control Measure in Nigeria: Reducing Time to TB Diagnosis and Enrolment to Treatment

Useni Sani[1], Gidado Mustapha[1], Onazi Jumoke[1], Eneogu Rupert[1], Chukwueme Nkemdilim[1], Ubochioma Emperor[2], Akang Gabriel[2], Obot Valerie[3], Omoniyi Amos[4]

[1]KNCV Tuberculosis Foundation, Abuja, Nigeria

[2]National Tuberculosis and Leprosy Control Program, Federal Ministry of Health, Abuja, Nigeria

[3]Akwa Ibom State Tuberculosis and Leprosy Control Program, Akwa Ibom State Ministry of Health, Uyo, Nigeria

[4]World Health Organization, Abuja, Nigeria

Email address:

useni.sani@kncvtbc.org (S. Useni), mustapha.gidado@kncvtbc.org (M. Gidado), jumoke.onazi@kncvtbc.org (J. Onazi), emperorubochi@yahoo.com (E. Ubochioma), valerie_obot@yahoo.com (O. Valerie), omoniyifadare@yahoo.com (O. Amos), rupert.eneogu@kncvtbc.org (R. Eneogu), nkem.chukwueme@kncvtbc.org (C. Nkemdilim), gabrielakang@yahoo.com (A. Gabriel)

To cite this article:

Useni Sani, Gidado Mustapha, Onazi Jumoke, Eneogu Rupert, Chukwueme Nkemdilim, Ubochioma Emperor, Akang Gabriel, Obot Valerie, Omoniyi Amos. *FAST* Strategy - A Sustainable Administrative TB Infection Control Measure in Nigeria: Reducing Time to TB Diagnosis and Enrolment to Treatment. *Science Journal of Public Health*. Vol. 4, No. 4, 2016 pp. 352-358. doi: 10.11648/j.sjph.20160404.23

Received: March 1, 2016; **Accepted**: March 18, 2016; **Published**: July 28, 2016

Abstract: *FAST* stands for Finding, Actively, Separating, and Treating. *FAST* focus health care workers on the most important administrative Tuberculosis (TB) transmission control intervention: effective TB treatment reduces TB spread rapidly, even before sputum smear and culture turn negative. General outpatient department (GOPD) and inpatient clinics in most public and some private health institutions are overcrowded with long waiting times to access health care services. This has led to an increasing importance to ensure effective TB prevention and control especially in settings were Presumptive TB cases, confirmed TB cases and People living with HIV (PLHIV) are seen. This study is aimed at describing the process of *FAST* implementation and its effect on reduction of time to diagnosis of TB and enrolment for care at tertiary Health care facilities. A prospective study in 12 facilities of 6 states with high TB and HIV burden; adapted guidelines, standard operating procedures (SOPs) and training materials for *FAST* strategy; trained pool of facilitators; field tested tools; advocacy visits to health facilities; collected base line data that preceded facility level sensitization of *FAST* implementation. Diagnosis of TB and DR-TB was in line with the national guidelines with the use of Acid Fast Bacilli (AFB) light microscopy and GeneXpert MTB/RIF technology. Follow-up evaluations were conducted monthly by State Tuberculosis and Leprosy Control Program (STBLCP) and quarterly by National TBL Control Program (NTBLCP). Data was analyzed using Stata 13 version 1 for paired t-test (mean comparison test). Average time to diagnosis of susceptible TB using 3 sputa samples reduced from a baseline of 2.9 days in April 2014 to 1.9 days by end of September 2014. Time to treatment of susceptible TB cases diagnosed either by AFB microscopy or Xpert reduced from a baseline of 3.9 days to 1.1 days. Similarly, average time for DR-TB cases diagnosed (including patients receiving their results) reduced from 2.3 days to 1 day. Proportion of TB cases diagnosed and started on treatment increased by up to 14-56% range among different facilities. Integrating *FAST* into health care delivery improves early diagnosis and enrolment to care at minimal cost; facilitate TB infection control in clinic waiting areas especially in low income countries like Nigeria. *FAST* also has additional advantage of increasing TB case notification.

Keywords: TB Infection Control, Intensified Case Finding, Health System Delay

1. Background and Introduction

According to the 2015 Global TB report, Tuberculosis remains a major global health problem while 9.6 million people developed TB and 1.5 million died from the disease. In sub-Saharan Africa, Tuberculosis (TB) is still a great challenge to public health. Nigeria remains one of the 22 high burden countries (HBC) that accounts about 80% of the world's TB cases. From the National TB Prevalence Survey 2012, the prevalence and incidence rates of all forms of TB in 2012 are much higher than previously estimated by World Health Organization (WHO) for the same year. While "the prevalence rate now stands at 322 per 100,000 populations; the incidence rate is 338 per 100,000 populations, indicating an actual rate of TB case detection in Nigeria at approximately 17%. [1]" Similarly, "the National survey on KAP showed ≤ 29% awareness of TB in the population. [2]" "The 2010 National DR-TB prevalence survey report also revealed a prevalence of 2.9% among new cases of TB and 14.3% among previously treated cases. [3]" "In 2005, Federal Ministry of Health (FMOH) estimated a total of 23,640 health facilities in Nigeria of which 85.8% are primary health care facilities, 14% secondary and 0.2% tertiary. 38% of these facilities are owned by the private sector, which provides 60% of health care in the country. By the end of 2013, Nigeria has an estimated population of 167 million with 5,389 directly observation of treatment (DOT) centers, 1,602 AFB microscopy Laboratories, 87 GeneXpert MTB/RIF sites and 1,004 Anti-Retroviral Therapy (ART) centers across the country. [4]"

"Most TB transmissions occur between the onset of coughing and initiation of treatment [5]". Early diagnosis and prompt effective therapy represent the key elements in controlling the disease. Thus "diagnosis and treatment delay of TB is significant to disease prognosis and may result in more extensive disease and more complications, which leads to an increased period of infectivity in the community and higher mortality [6], [7]".

Despite the adoption of "WHO policy document on TB infection control by Nigeria in 2008 that describes the managerial, administrative, environmental and respiratory protection controls in healthcare facilities [8]", there is "weak implementation of specific recommendations for TB-IC at most TB and HIV care settings [9]". Cases of "susceptible TB and multidrug-resistant tuberculosis (MDR-TB) are being generated by transmission in overcrowded and poorly ventilated clinic waiting areas [10]". Many "HIV-co-infected clients in high-burden settings are also at risk for infection and re-infection, in addition to other patients' relatives, health care workers and staff of other facilities [11]".

As part of efforts to reduce health system delays, the NTBLCP in 2014 adopted and piloted the implementation of the *FAST* strategy at selected healthcare facilities with a focused approach to reducing TB or DR-TB transmission in outpatient and inpatient healthcare settings. *FAST* stands for Finding, Actively, Separating, and Treating. *FAST* focuses health care workers on the most important administrative TB transmission control intervention: effective TB treatment reduces TB spread rapidly, even before sputum smear and culture turn negative.

Implementing *FAST* will also contribute to intensified case findings at General medical settings (Outpatient departments, HIV/ ART clinics) where the focus is finding patients with unsuspected infectious TB and at TB settings where patients are already diagnosed with TB and the focus is finding patients with drug resistant TB in order to provide effective therapy and rapidly stop spread.

This study is aimed at describing the process of *FAST* implementation and its effect on reduction of time to diagnosis of TB and enrollment for care at tertiary Health care facilities.

2. Methodology

Based on State specific TB and HIV burden, convenient sampling was used to select 1 state from each of the 6 geo-political zones of the Federation (Abia, Akwa-Ibom, Benue, Kaduna, Taraba and Osun). Two facilities that provide TB, HIV/ART care services from each of these 6 states were then included to implement the pilot *FAST* strategy.

In March 2014, coordination meetings held to adapt guidelines, SOPs and training materials for *FAST* strategy; training of pool of facilitators from the 6 states and field testing of tools at NTBLTC Zaria for practical demonstration. This was followed with advocacy visits to health facilities, collection of base line data that preceded facility level sensitization of *FAST* implementation in April 2014. Diagnosis of TB and DR-TB was in line with the National Guidelines with the use of AFB light microscopy and GeneXpert MTB/RIF technology. Follow-up evaluations were conducted monthly by State TBL control program and quarterly by National TBL control Program.

At each of the clinics (GOPD, ART, DOTS, STI), a mechanism was established for referral and follow up of clients with symptoms of cough through organized cough surveillance. This involved a daily assigned health worker actively looking for otherwise unsuspected TB patients with current cough at waiting clinic areas. Identified coughers are fast tracked, further screened for symptoms suggestive of TB (fever, weight loss, night sweats) and separated from other clients to a designated well ventilated areas; sputum of those with presumptive TB promptly collected for laboratory investigations, including rapid molecular testing, as per national guidelines; and are educated on respiratory hygiene/ cough etiquettes to prevent further spread of TB.

Monthly data and information were obtained by adjusting existing national TB laboratory and clinic registers to compute average time to diagnosis and average time to treatment:

a) Time to Diagnosis: The number of days from the date of patient presentation on which sputum was collected (column: *Date of collection*) to the date the lab result was received (column: *Date result released*) as recorded in the clinic presumptive TB register.

For DR-TB, the date the laboratory result was received

(column: *Comments)* as recorded in the presumptive DR-TB register.

b) Time to Treatment: The number of days from the date on which the lab result was received (column: *Date registered*) to the date treatment was initiated (column: *Date treatment started*) as recorded in the TB register.

For DR-TB, the date the lab result was received recorded in the *Comments* column and the date of treatment recorded in the *Treatment facility referred to* column.

Monthly data on "time to diagnosis" and "time to treatment" obtained were recorded in a 2 by 2 table for baseline January to December 2013 and intervention period from April to September 2014. A period of longer than 7 days was defined as a diagnosis delay and a period of longer than 2 days as a treatment delay. The time from the first consultation to the date of diagnosis was defined as '*health system's delay'*. Data was collated using Microsoft excel 2013, expressed as simple percentages and proportions; pre and post intervention was analysed using Stata 13 version 1 for paired t-test (mean comparison test).

Approval to publish data used in this pilot was obtained from the ethics committee of the Federal Ministry of Health.

3. Results

Facilities where *FAST* strategy was implemented (Pilot) had reduction in average time to diagnosis from a baseline of 2.9 days with a steady decline to 1.9 days by end of September 2014 (table 1). Similarly in table 5, there was reduction in average time to treatment at pilot facilities (1.9 ± 0.8 days) compared to (3.9 ± 2.9 days) at baseline; a statistically significant reduction of 2.1 days (95%CI, 0.4387 to 3.7612 days), t(11)= 2.7823, P>0.05.

Table 1. *Average time (days) to diagnosis and treatment for susceptible TB cases.*

INDICATOR-TB	Baseline Q1 - Q4 2013 (monthly average)	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Apr. - Sept. 2014 (monthly average)
Average time to diagnosis (days)	2.9	2.4	2.9	2.7	2.0	2.3	1.9	2.0
Average time to treatment (days)	3.9	2.7	2.3	2.1	1.4	1.3	1.1	2.0
Total number of presumptive TB cases	10,427 (869)	909	958	1,147	519	581	481	4,595 (766)
Total number of TB patients started on treatment	2,212 (185)	230	189	176	95	110	84	884 (147)

Table 2. *Average time (days) to diagnosis and treatment for DR - TB cases.*

INDICATOR- DR TB	Baseline Q1 - Q4 2013 (monthly average)	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Apr. - Sept. 2014 (monthly average)
Average time to diagnosis (days)	2.3	2.1	1.9	0.9	1.5	1.1	1.0	1
Average time to treatment (days)	2.0	0.9	0.1	4.3	4.3	4.3	2.0	3
Total number of presumptive DR-TB cases	1,678 (140)	124	149	290	191	261	105	1,120 (93)
Total number of Rifampicin resistant TB enrolled for treatment	83 (7)	5	11	4	3	5	3	31 (5)

Table 3. *Average time (days) treatment for susceptible TB cases.*

S/No.	Susceptible TB	Number of Presumptive TB cases (monthly average)		Average time to treatment (days) - Presumptive TB cases		GeneXpert machine available
		Baseline	Pilot	Baseline	Pilot	
1	IDH &ABSUTH	3.2	2.1	5.3	3.3	No
2	FEDERAL MEDICAL CENTER UMUAHIA	3.3	2.5	11.8	2.2	Yes
3	UUTH, UYO	2.1	2.0	4.8	1.3	No
4	General Hospital, Iquita, Oron	2.8	2.1	2.1	1.0	Yes
5	BSUTH	3.0	2.2	3.8	2.7	Yes
6	FMC, makurdi	4.1	3.8	3.9	2.5	Yes
7	NTBLTC ZARIA	1.0	2.0	1.0	1.0	Yes
8	44 Military Hospital	2.0	1.7	2.0	1.7	Yes
9	STATE HOSPITAL ASUBIARO	3.0	1.9	5.0	2.4	Yes
10	STATE HOSPITAL, IKIRUN	7.0	4.0	5.0	2.2	No
11	Federal Medical Centre Jalingo	2.0	1.7	2.0	1.2	No
12	First Referral Hospital Mutum/biyu	2.0	2.0	1.0	1.0	No

Table 4. *Health facilities showing average TB cases notified and started on treatment through intensified case finding (ICF).*

		Baseline		Intervention Period	
S/No.	**Name of Health Facility**	**Presumptive TB cases (monthly average)**	**Number of TB cases started on treatment (monthly average)**	**Presumptive TB cases (monthly average)**	**Number of TB cases started on treatment (monthly average)**
1	IDH &ABSUTH	74	19	85 (14.8%)	21 (6.8%)
2	FEDERAL MEDICAL CENTER UMUAHIA	114	13	165 (45.0%)	5
3	UUTH, UYO	26	18	24	11
4	General Hospital, Iquita, Oron	51	31	81 (57.6%)	28
5	BSUTH	9	6	10 (16%)	2
6	FMC, makurdi	81	13	57	7
7	NTBLTC ZARIA	204	16	142	88
8	STATE HOSPITAL ASUBIARO	90	10	63	5
9	STATE HOSPITAL, IKIRUN	27	5	21	4
10	Federal Medical Centre Jalingo	105	33	49	19
11	First Referral Hospital Mutum/biyu	79	11	67	8
12	44 Military Hospital	10	8	64 (566.0%)	29 (247.4%)

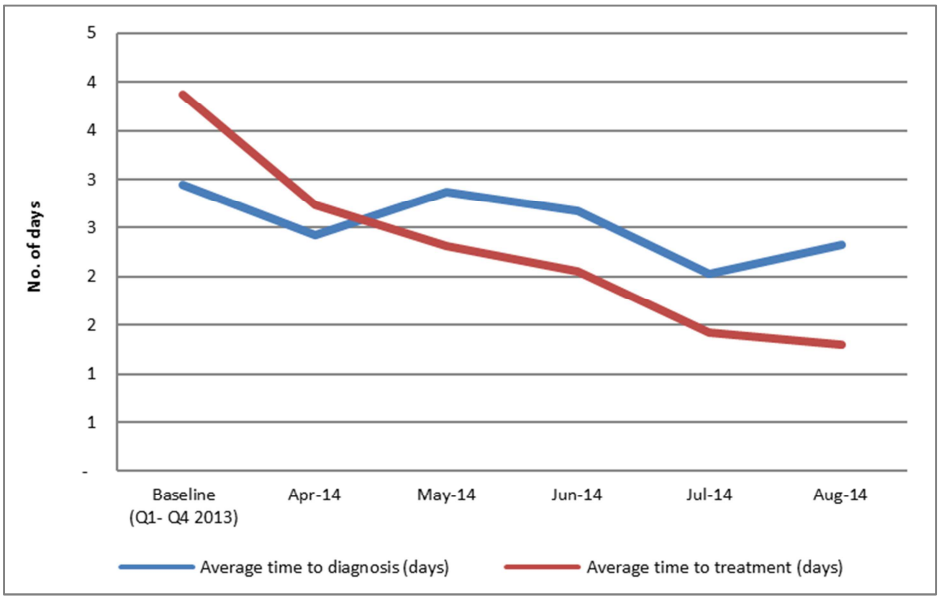

Figure 1. *Average time (days) to susceptible TB diagnosis and treatment.*

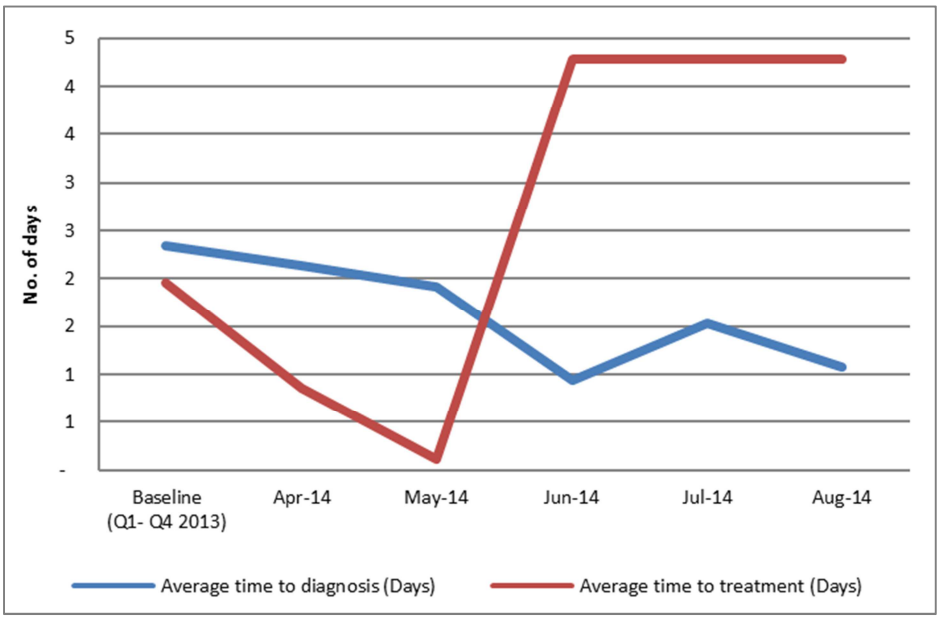

Figure 2. *Average time (days) to DR-TB diagnosis and treatment.*

DR-TB cases diagnosed using 1 sputum sample test with Xpert MTB/RIF in line with the national guidelines reduced from a baseline of 2.3 days to 1 day by end of September 2014 (figure 2); though the average time to treatment for diagnosed DR-TB cases remained 2 days for the same period. At pilot facilities with Xpert machines (table 6), there was no statistically significant reduction in time to treatment for susceptible TB cases (1.9 ± .0.7 days) compared to facilities with no Xpert (1.8 ± 0.9 days). (95%CI, -1.1928 to 0.9356 days), t(10) = -0.2692, p>0.05.

Table 5. *Paired t test for average time to treatment (days) for Susceptible TB.*

Variable |	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
baseline |	12	3.975	.8475567	2.936022	2.10954	5.84046
pilot |	12	1.875	.2253365	.7805884	1.379038	2.370962
diff |	12	2.1	.7547827	2.614644	.4387344	3.761266

mean (diff) = mean (baseline - pilot) t = 2.7823
Ho: mean (diff) = 0 degrees of freedom = 11
Ha: mean (diff) < 0 Ha: mean (diff) != 0 Ha: mean (diff) > 0
Pr(T < t) = 0.9911 Pr(|T| > |t|) = 0.0178 Pr(T > t) = 0.0089

Table 6. *Paired t test for average time to treatment (days) for Susceptible TB at facilities with Xpert.*

Group |	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
no |	5	1.8	.427785	.9565563	.6122785	2.987722
yes |	7	1.928571	.2670066	.706433	1.27523	2.581913
combined |	12	1.875	.2253365	.7805884	1.379038	2.370962
diff |		-.1285715	.4776473		-1.192836	.935693

diff = mean(no) - mean(yes) t = -0.2692
Ho: diff = 0 degrees of freedom = 10
Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.3966 Pr(|T| > |t|) = 0.7933 Pr(T > t) = 0.6034

During the pilot period, 5 out of 12 facilities (41.7%) showed an increase in average monthly Presumptive TB cases while 1.7% of pilot facilities had increase in proportion of diagnosed TB cases started treatment. Difference in average monthly Presumptive TB cases of 0.6 (table 7), was not statistically significant; at baseline (2.9±1.5 cases) compared to pilot (2.3 ± 0.9 cases), (95%CI, 0.0258 to 1.2241), t(11)= 2.2958, p<0.05

Table 7. *Paired t test for difference in average monthly notified Susceptible TB cases started on treatment.*

Variable |	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
baseline |	12	2.958333	.4366641	1.512649	1.997242	3.919424
pilot |	12	2.333333	.2203074	.7631672	1.84844	2.818227
diff |	12	.625	.2722312	.9430367	.0258231	1.224177

mean(diff) = mean(baseline - pilot) t = 2.2958
Ho: mean(diff) = 0 degrees of freedom = 11
Ha: mean(diff) < 0 Ha: mean(diff) != 0 Ha: mean(diff) > 0
Pr(T < t) = 0.9788 Pr(|T| > |t|) = 0.0423 Pr(T > t) = 0.0212

4. Discussion

Delay in identification, diagnosis and start of tuberculosis (TB) treatment increases the risk of morbidity and mortality at the individual level as well as increase in the risk of transmission at community level.

An "estimate of 10 persons become infected annually by a patient with untreated smear-positive pulmonary TB and over 20 during the natural course of untreated disease until death [12]". "In both high and low TB prevalence countries, delay in the start of TB treatment is relatively common [13], [14]".

Delays are divided into patient delay, health care system delay and total delay. Total delay was defined as the sum of the patient delay and the health care system delay. While Patient delay was defined as the period from onset of symptoms related to TB to the date when the patient first contacted health services for those symptoms, Health care system delay was defined from the date of the patient's first contact with the health services for those symptoms to the date of the start of TB treatment. "The health care system delay is assumed to be a larger problem than patient delay [15]".

Several studies that described the problem of "delay in the start of TB treatment indicated a low index of suspicion

among health care providers for diagnosing TB [16], [17], [18]". Despite symptoms such as cough, weight loss and night sweat, health care providers only initiated specific TB examination after unsuccessful antibiotics treatment.

Though this study was conducted in tertiary and referral hospitals, there was a low health system delay similar to findings with mean diagnosis interval of 3.3 days and mean initiation of treatment interval of 1.4 days [19] This is contrary to findings expected at tertiary and referral hospitals with longer patient and health system delays.

The adoption of *FAST* strategy in this study has contributed to low health service delay due to a high degree of alertness on the side of the health workers to suspect and diagnose tuberculosis which was attributable to "the basic triaging, effective separation and fast tracking to access prompt diagnosis and early treatment [20], [21]".

In this study, instant referrals for diagnosis of a presumptive TB case in line with national algorithm that incorporates use of rapid diagnostic tests (Xpert MTB/RIF technology) and an effective mechanism for prompt release of laboratory results also played significant roles. "By ensuring prompt TB laboratory analysis and diagnosis, multiple clinic and follow up visits were reduced [22]". This on the long term contributes to reduction in the total delay. Proportion of TB cases diagnosed and started on treatment increased by up to 14-56% at some pilot facilities (table 4). A well implemented *FAST* strategy in addition to "intensified case detection has a great impact on improving TB infection control by reducing the waiting time in the facility [23], [24]".

As TB is the common cause of morbidity and mortality among PLHIVs, the National TBLCP integrated DOTS services in HIV/ART clinics to facilitate "one stop" service management of co-infected persons. The adoption of *FAST* strategy at these HIV/ART clinic waiting areas has also immensely reduced the spread of TB and simultaneously ensured prompt treatment of both conditions.

Some challenges encountered during the implementation of FAST strategy included constraints of space for separation, so clients had to be fast- tracked at some facilities. Only 7 out of 12 facilities had GeneXpert machines which resulted in establishing effective linkage and referral system for sputum transportation. Coordination and supervision by state and national level was sub-optimal which necessitated regular phone calls, follow-up e-mails to access data and monitor progress of implementation. The intended gains of this strategy were deeply affected due to prolonged strike action by government health care workers for 3 out of the 6 months pilot period.

5. Conclusion

FAST strategy when scaled up to other facilities by improving health systems delay can contribute significantly to TB intensified case finding. *FAST* as an administrative TB Infection control intervention in health care facilities requires minimal resources and can be easily implemented.

Abbreviations

AFB	- Acid Fast Bacilli
ART	- Anti-Retroviral Therapy
FAST	- Finding, Actively, Separating, and Treating
FMOH	- Federal Ministry of Health
GOPD	- General outpatient department
HBC	- High burden countries
HIV	- Human Immuno-Deficiency Virus
ICF	- Intensified case finding
MDR-TB	- Multi-Drug Resistance TB
NTBLCP	- National Tuberculosis and Leprosy Control Program
PLHIV	- People living with HIV
STBLCP	- State Tuberculosis and Leprosy Control Program
STI	- Sexually transmitted infection
TB	- Tuberculosis
TB-IC	- TB infection control
USAID	- States Agency for International Development
WHO	- World Health Organization
XDR-TB	- Extensively Drug Resistant-TB

Acknowledgment

Special thanks to Dr. Max Meis from KNCV Tuberculosis Foundation, who provided technical assistance in developing, updating the *FAST* guide and during the entire process of implementation of the pilot.

This pilot project is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of TB CARE 1 project and do not necessarily reflect the views of USAID or the United States Government.

Authors' Contribution

S. U. - searched literature and contributed to the development of the article and facilitated the training of facility staff and data collectors in the field

M. G. - made inputs for revision and coordination of the research work and reviewed the article

E. U, V. O. & A. O. – supervised, monitored the field work and reviewed the article

J. O. & N. C. –analyzed the data and reviewed the article

R. E & G. A - reviewed the article and made inputs for article's finalization

References

[1] Federal Ministry of Health, Department of Public Health. *National TB Prevalence survey* 2012.

[2] Association for Reproductive and Family Health, Nigeria: *Global Fund to Fight AIDs, Tuberculosis and Malaria Phase 1 recipient*. Knowledge, Attitude and Practice of TB in Nigeria 2012.

[3] Federal Ministry of Health, Department of Public Health. *National DR-TB Prevalence survey* 2010.

[4] Federal Ministry of Health, Department of Public Health. *National tuberculosis and leprosy control programme Annual report* 2013.

[5] World Health Organization. *Global TB report* WHO/HTM/TB/2013.11.

[6] WHO: WHO Policy on TB Infection Control in Health-Care Facilities, Congregate Settings and Households 2010.

[7] STOP TB Partnership. *Global Plan to Stop TB* 2011 – 2015

[8] Federal Ministry of Health, Department of Public Health. *National guidelines for TB Infection Control* 2008.

[9] Ogbonnaya L. U, Chukwu J. N, Uwakwe K. A, Oyibo P. G, Ndukwe C. D. The status of tuberculosis infection control measures in health care facilities rendering joint TB/HIV services in "German Leprosy and Tuberculosis Relief Association" supported states in Nigeria. *Niger J Clin Pract.* 2011 Jul-Sep; 14 (3): 270-5. doi: 10.4103/1119-3077.86765.

[10] Alonso-Echanove J, Granich RM, Laszlo A, Chu G, Borja N, et al.: Occupational transmission of Mycobacterium tuberculosis to health care workers in a university hospital in Lima, Peru Clin Infect Dis 2001, 33: 589-596.

[11] Gandhi NR, Moll A, Sturm AW, Pawinski R, Govender T, et al.: Extensively drug-resistant tuberculosis as a cause of death in patients co-infected with tuberculosis and HIV in a rural area of South Africa Lancet 2006, 368: 1575-1580.

[12] Lawn SD, Afful B, Acheampong JW: Pulmonary tuberculosis: Diagnostic delay in Ghanaian adults. Int J Tuberc Lung Dis 1998, 2: 635-640.

[13] Counsell SR, Tan JS, Dittus RS: Unsuspected pulmonary tuberculosis in a community teaching hospital. Arch Intern Med 1989, 149: 1274-1278.

[14] Heldal E: Notification of tuberculosis in Norway [in Norwegian]. Norsk Epidemiologi 1995, 5: 15-17.

[15] World Health Organization: Tuberculosis Handbook. Geneva, Switzerland: WHO; 1998.

[16] Steen TW, Mazonde GN: Pulmonary tuberculosis in Kweneng District, Botswana: delay in diagnosis in 212 smear-positive patients. Int J Tuberc Lung Dis 1998, 2: 627-634.

[17] Sherman LF, Fujiwara PI, Cook SV, Bazerman LB, Frieden TR: Patient and health care system delays in the diagnosis and treatment of tuberculosis. Int J Tuberc Lung Dis 1999, 3: 1088-1095.

[18] Beyers N, Gie RP, Schaaf HS, van Zyl S, Nel ED, Talent JM, Donald PR: Delay in the diagnosis, notification and initiation of treatment and compliance in children with tuberculosis. Tuber Lung Dis 1994, 75: 260-265.

[19] Güneylioglu D, Yilmaz A, Bilgin S, Bayram U, Akkaya E. Factors affecting delays in diagnosis and treatment of pulmonary tuberculosis in a tertiary care hospital in Istanbul, Turkey. *Med Sci Monit.* 2004 Feb; 10 (2): CR62-7.

[20] Nardell E. and Dharmadhikari A. Turning off the spigot: reducing drug-resistant tuberculosis transmission in resource-limited settings. *Int J Tuberc Lung Dis*. Oct 2010; 14 (10): 1233–1243.

[21] Reid M. J, Saito S, Nash D, Scardigli A, Casalini C, Howard A. A. implementation of tuberculosis infection control measures at HIV care and treatment sites in sub-Saharan Africa. *Int J Tuberc Lung Dis*. 2012 Dec; 16 (12): 1605-12. doi: 10.5588/ijtld.12.0033

[22] Finnie RK, Khoza LB, van den Borne B, Mabunda T, Abotchie P, Mullen PD: Factors associated with patient and health care system delay in diagnosis and treatment for TB in sub-Saharan African countries with high burdens of TB and HIV. *Trop Med Int Health* 2011, 16 (4): 394-411.

[23] Guang Xue He, Susan van den Hof, Marieke J van der Werf, Guo Jie Wang, Shi Wen Ma, Dong Yang Zhao, Yuan Lian Hu, Shi Cheng Yu and Martien W Borgdorff: Infection control and the burden of tuberculosis infection and disease in health care workers in china: a cross-sectional study. *BMC Infectious Diseases* 2010, 10: 313 doi: 10.1186/1471-2334-10-313.

[24] A. Roderick Escombe, David A. Moore, Robert Gilman, William Pan: The Infectiousness of Tuberculosis Patients Co-infected with HIV. DOI: 10.1371/*journal.pmed*.0050188.