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Timing and Determinants of Tuberculosis Treatment Interruption in Nairobi County, Kenya

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ABSTRACT

Tuberculosis (TB) treatment is a key pillar in the management and control of TB. Service delivery within the treatment facilities plays an important role in ensuring treatment adherence by TB patients. A prospective cohort study involving 25 health facilities, 25 facility in-charge officers and 291 patients diagnosed as new sputum smear positive (SM+) between December 2014 and July 2015 was undertaken. The aim of the study was to estimate the median time to treatment interruption, associated factors and overall predictors of non-adherence to TB treatment. A total of 19 (6.5%) treatment interruptions were observed. The median time to default was 56 [95% CI, 36-105] days. Treatment in a non-public facility [AOR=0.210, 95% CI (0.046-0.952)] and facilities perceived to have adequate number of health care workers to offer Directly Observed Therapy (DOT) [AOR=0.195, 95% CI (0.068-0.56)] showed a lower odds of treatment interruption whereas attainment of secondary level education [AOR=5.28, 95% CI (1.18-23.59)] indicated a higher odds of treatment interruption. Non-clinical aspects of health care service delivery influence patient adherence to TB treatment. Health seeking behavior of groups considered to be high risk for treatment interruption should be incorporated into the design and delivery of TB treatment.

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1. INTRODUCTION

Tuberculosis (TB) is one of the infectious diseases of public health concern globally. According to WHO Global TB report (2016) there was an estimated 10.4 million new (incident) TB cases worldwide including 480,000 new cases of multidrug-resistant TB (MDR-TB) and an additional 100,000 people with rifampicin-resistant TB (RR-TB) [1]. Kenya is currently ranked among the top 20 countries with high TB, high TB/HIV and high MDR-TB burden, accounting for 84%, 87% and 84% of the global burden respectively. In 2015 the Kenya Division of Leprosy, Tuberculosis and Lung Disease (DLTLD) notified a total number of 81,518 of which 74,742 were new cases while 6,776 were previously treated cases. Nairobi County notified the highest number of cases at 12,385 [2].

With correct management treatment success rates are high. If left untreated, TB has a high mortality rate. Poor adherence to anti-TB drugs can lead to emergence of drug resistant TB. Resistance to single drugs has been reported in every country and resistance to all of the major anti-tuberculosis drugs has now emerged [3]. Over the years, despite the decline in case finding for drug sensitive TB, Kenya has seen a gradual increase in DR-TB case notification from 112 cases in 2010 to 433 in 2015. Notably, there was a 50% increase in 2015, compared to 288 cases in 2014.

Availability of resources for TB care and prevention is one of the components in the implementation of WHO END TB strategy [4]. There is inadequate number of health care workers (HCWs) and skills across all cadres of human resources for health in Kenya. According to Kenya Service Availability and Readiness Assessment Mapping [5], the doctor-population ratio is less than one (<1) per 10,000 population. The nurse population-ratio was established as 3 per 10,000 people and for registered clinical officers 1 per 10,000. All other cadres of HCWs accounted for less than one (<1) per 10,000. This is very low compared to the WHO recommended standards of 23 doctors, nurses and midwives per 10,000 persons in a population. Significant workforce gaps are complicated by unequitable distribution of HCWs. The Health Sector-Human Resource Strategy (HS:HRS) 2014-2018 [6] projects that by the year 2030 there will be a challenge in filling general practitioner and nurses gaps in the country. Kenya has a total of 8,405 health facilities of which 49% are operated by the government (public). Of these 5,840 offer TB treatment services [5].

The loss to follow up during tuberculosis (TB) treatment contributes to low treatment success rates and possible development of drug resistant TB (DR-TB). Kenya has seen an increase in cases of DR-TB case notification which is of great concern as is poses a threat to the gains made in reducing TB burden in the country. Successful treatment of drug sensitive TB is of utmost importance in ensuring that the chances of developing DR-TB are minimized. Adherence to the six month treatment regimen for all newly diagnosed patients cannot be overemphasized in the efforts to halt further increase in reported cases of MDR TB. In 2015, Kenya recorded 4.3% treatment interruption rate amongst new pulmonary TB patients [2]. Factors that contribute to non-adherence should be addressed immediately to increase treatment success rates of drug susceptible TB and stop the surge in incidences DR-TB. Treatment interruption is defined as a patient being off- treatment for two consecutive months.

2. METHOD

2.1. Operational definitions

Treatment interruption according, to the WHO and International Union against *Tuberculosis* and Lung Disease *(*IUATLD*)* guidelines is defined as TB patient who did not start treatment or whose treatment was interrupted for two consecutive months or more [7].

Smear positive PTB was defined as a patient with at least one sputum smear examination positive for acid fast bacilli. Alternatively, patients whose two samples turned smear negative, were given antibiotics and on repeat diagnosis one sample turned positive for *Mycobacterium tuberculosis* bacilli, were also classified as SM+ [8].

Treatment was administered according to the WHO/IUATLD guidelines [9]. The patients received a standardized Short-Course Chemotherapy (SCC) following the Directly Observed Therapy (DOTS) for treatment of TB strategy. The recommended regiment for treatment for new SM+ adults entailed two months of intensive phase treatment with four drugs consisting of Isoniazid (H), Rifampicin (R), Pyrazinamide (Z) and Ethambutol (E). This was then followed by a continuation phase of Rifampicin and Isoniazid (RH) for four months.

2.2. Study site

This study was conducted in Nairobi County which reports the highest CNR of SM+ PTB in the country [2]. A total of 25 facilities offering TB treatment within Nairobi County were included in the study. The facilities were selected based on the high number of TB patients receiving TB treatment. The sample size per facility was allocated proportionally based on the number of SM+ TB patients treated in 2013.

2.3. Study design

A prospective cohort study of patients diagnosed between December 2014 and July 2015 was undertaken. The patients were interviewed twice during the treatment period. The first interview was administered within the first three weeks of being diagnosed as SM+. The second interview was administered after 12 weeks of treatment. The facility in-charges were interviewed once within the study period. After six months of treatment, TB registers were reviewed to collect data on treatment outcomes.

2.4. Study population

The study participants constituted new SM+ PTB patients in Nairobi County. Only patients above 15 years were included in the study for ease of sputum collection for confirmation as SM+ status. Patients who had been on treatment for more than three weeks were not included in the study. An informed consent was sought from each participant before data collection. Facility-in-charges from all participating facilities were included in the study. The hypothesis for the sample size calculation was based on an expected adverse treatment outcome of 12% in new smear positive TB cases and an absolute precision of 0.03. Furthermore

the sample size was increased by 20% for expected losses due to patients diagnosed as smear-positive who did not return for treatment. In total, 291(92% response rate) new SM+ TB patients and 25 (100% response rate) facility in charges were interviewed.

2.5. Data collection

Two data sources were used in the study. Structured Questionnaires were administered to the study participants within three weeks of starting treatment and once during the continuation phase to collect socio-demographic and patient characteristics. Facility in-charge were interviewed to collect data on institutional characteristics. Treatment outcome(s) were extracted from the TB register at the end of the treatment period. The data collection tools were pretested to ensure that the questions were consistent. Data verification was carried out to ensure data validity. On receipt of questionnaires, internal and external consistency checks were carried out. A double entry procedure was adopted in data entry for all the data. The two image data files were compared for consistency. Discrepant values were checked against the original data file and values and inconsistencies were corrected. This led to the eventual creation of the final data base for safe keeping and analysis.

2.6. Data analysis

The computed descriptive statistics were used to describe data characteristics in terms of means and proportions. In bivariate analysis, Chi-square was used to test for association between the independent variables and treatment interruption. Kaplan-Meier failure estimates and log rank test were used to estimate average failure time, corresponding level of risk and difference in patient average time. Treatment interruption for reasons other than factor under analysis was censored in the Kaplan-Meier survival analysis. Cumulative risk of treatment interruption during the entire treatment period was determined. Cox regression hazard analysis was used to determine predictors of treatment interruption. Statistical significance was determined by considering nominal p-value of less than 5% ($p< 0.05$) with a 95% confidence level. Data was analyzed using Stata Corp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.

3. RESULTS

3.1. Socio demographic characteristics

Of the 291 respondents, 215 (74%) were male. The TB patients had an average age of 32.3 (22.3-42.3) years. Majority of the patients 147 (51.7%) had attained a secondary level of education, 99 (35%) primary level and 38 (13.3 %) post-secondary education. A large proportion of the study participants 212 (74%) had a source of income of which 117 (55 %) were self-employed while 95 (45%) were employed by a third party. Persons employed by third parties were further segregated and clustered into groups based on the frequency of payment, 64 (64 %) received payment on a monthly basis, 16 (16%) on a weekly basis and 19(19%) were paid on a daily basis. The patient socio-demographic characteristics were cross tabulated against TB treatment interruption shown in Table 1.

Table 1. Cross Tabulation of Patient Socio-demographic Characteristics Against TB Treatment Interruption

Socio-demographic characteristics		TB Treatment Outcome	
		No. Censored	Treatment Interruption
Gender	Male	199(92.99%)	15(7.01%)
	Female	71(95.95%)	3(4.05%)
Age	15-24	47(88.68%)	6(11.32%)
	25-34	127(93.38%)	9(6.62%)
	35-44	59(93.65%)	4(6.35%)
	45 plus	35(100%)	0(0.00%)
Level of education	Primary	95(96.94%)	3(3.06%)
	Secondary	132(89.8%)	15(10.2%)
	Post-Secondary	38(100%)	0(0.00%)
Have Source of income	Yes	196(92.89%)	15(7.11%)
	No	71(94.67%)	4(5.33%)
Type of source of income	Self employed	110(94.02%)	7(5.98%)
	Employed	86(91.46%	8(8.51%)
Frequency of Wage payment	Daily	16(84.21%)	3(15.79%)
	Weekly	12 (80.00%)	3(20.00%)
	Monthly	62(95.38%)	3(4.62%)

3.2. Patient characteristics

At recruitment, 136 (46.7%) of the patients reported a history of smoking. The smokers were further clustered, based on the last time they smoked. The findings showed that majority of the patients, 75 (58.7%) had smoked within 8 weeks or less to the day of the interview. During the continuation phase, majority of the respondents 65 (88.9%), were not smoking. History of alcohol consumption was reported by 168 (58.3%) of the study participants on recruitment into the study. Majority had consumed alcohol within 8 weeks and less to the study point. During the continuation phase, most patients 85(89%) were not consuming alcohol. Most of the participants 253(94%) are spent one hour or less travelling to access a health facility. The mean travel time to the facility reported by the participants was 1.07 ± 0.3 hrs. From our findings, 87 (31%) of the participants suffered adverse reaction to TB treatment within the first three weeks of treatment. Skin irritation was the most common 33(37.9 %), side effect reported, During the continuation phase, the reported adverse reaction frequency among the study participants dropped to 49 (19%) of which skin irritation, 17(43%) was the most common. Within the first three weeks of treatment, relief on TB symptoms was reported by 157 (72%) of the study participants, Most of them 75(51%), noted a reduction in coughing. The study participants reported presence of other chronic infections 51(18%) of which HIV/AIDS was the most common 36 (83. 8%).

3.3. Institutional characteristics

A total of 25 facilities were included in the study. Public facilities accounted for 68% of the facilities while faith based and private institutions accounted for 24% and 8 % respectively. Majority of the facilities, 12 (48%) were level III (health centres), 10 (40%) level II (dispensaries) and 3 (12 %) level IV (district and sub district hospitals). Diagnostic and treatment services were offered in 21 (84%) of the facilities while 4 (16%) offered only treatment services. Among the institutions offering diagnosis, 20 (95%) indicated that their lab staff had been trained specifically on TB diagnosis protocols. Availability of a specific TB clinic room was reported in 21 (84 %) of the facilities with 21 (80%) indicating that specific HCWs had been allocated to offer TB services. A further 21 (80%) facilities indicated that HCWs had been trained on TB management. Continuous counselling was offered to patients in 23 (96%) of these institutions throughout the treatment period while 19 (79%) reporting that they had enough HCWs to offer DOT support to patients.

3.4. Socio demographic, patient and institutional characteristics association with treatment interruption

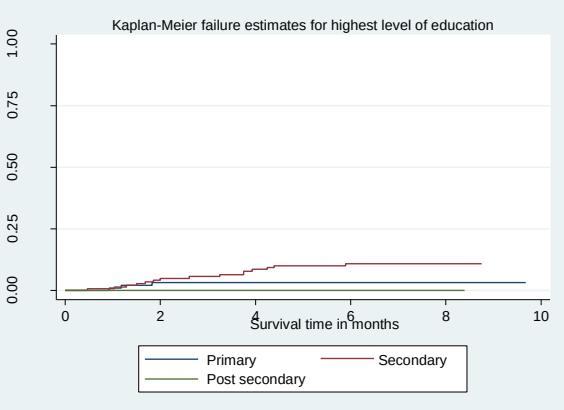
Highest level of education reported by the participants showed statistically significant association with treatment interruption, χ^2 (1, 243) =4.523, ($p<0.033$). Continued use of alcohol during treatment displayed a statistically significant association, χ^2 (1, N=95) =5.732, ($p<0.017$). Amongst the institutional variables, statistically significant associations were observed between perceived availability of adequate HCWs to offer DOT support, χ^2 (1, 275) =8.0005, ($p<0.005$ and nature of facility offering treatment, χ^2 (1, 92) =4.0350, ($p<0.045$). The other socio-demographic, patient and institutional variables did not exhibit statistically significant associations with treatment interruption. The socio-demographic, patient and institutional characteristics that that showed statistically significant association with TB treatment interruption are shown in Table 2.

Table 2. Association Between Socio-demographic, Patient and Institutional Characteristics with TB Treatment Interruption

Characteristics		TB Treatment Outcome		χ^2
		Number censored	Treatment interruption	(P-value)
Education level	Primary	95(96.14%)	3(3.06%)	4.5(0.033)
	Secondary	130(89.66)	14(10.34%)	
Alcohol on treatment	Yes	8(72.73%)	3(27.27%)	5.7(0.017)
	No	79(94.05%)	5(5.95%)	
Sufficient staff for DOT	Yes	227(95.8%)	10 (4.2%)	8.0(0.005)
	No	32(84.2%)	6(14.8%)	
Nature of facility	Public	184(91.5%)	17(8.5%)	4.0(0.045)
	Non-public	89(97.8%)	2(2.2%)	

3.5. Survival analysis

Out of the 291 patients, 19 (6.5%) interrupted their treatment. The median time to treatment interruption was 56 [95% CI, 36-105] days. Nine (47%) of the treatment interruptions occurred within the first two months of treatment. Kaplan-Meier failure estimate according to highest level of education (log rank test; P<0.018) and alcohol use during treatment (log rank test; P<0.017) displayed a significant difference shown in Figure 1. Of the institutional factors, perceived availability of adequate HCWs to offer DOT (log rank test; P<0.004) and nature of facility offering the treatment (log rank test; P<0.047), similarly displayed a statistically significant difference shown in Figure 2.



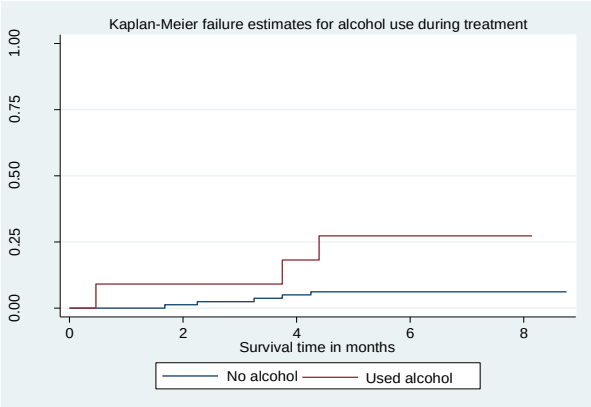
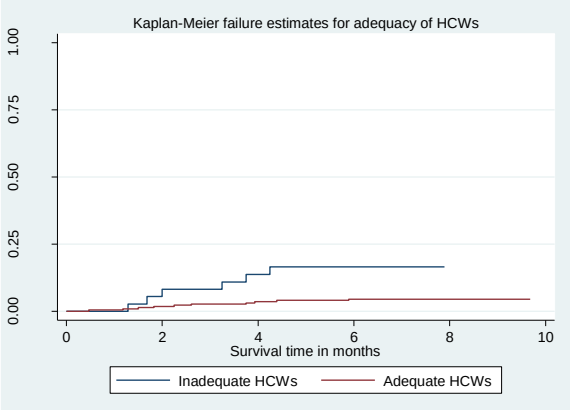


Figure 1. Kaplan-Meier failure estimates for socio-demographic and patient characteristics that showed significant association with TB treatment interruption



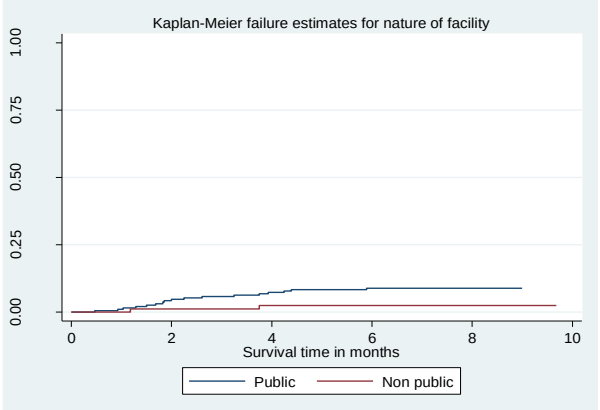
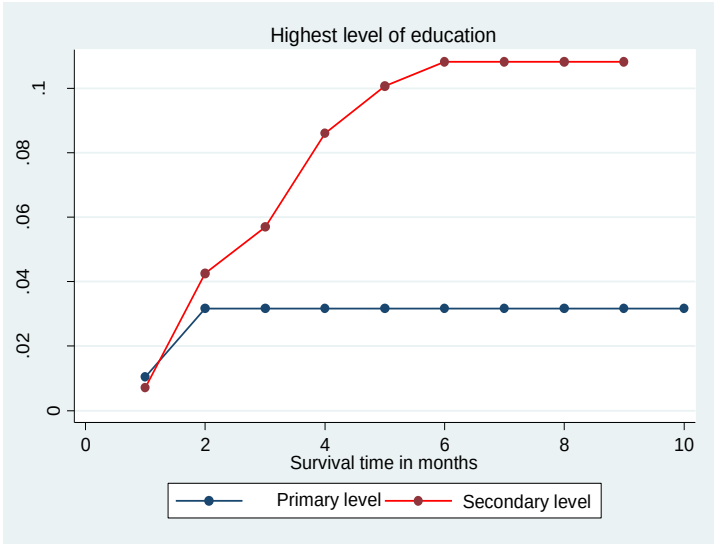


Figure 2. Kaplan-Meier failure estimates for institutional characteristics that showed significant association with TB treatment interruption

3.6. Risk of treatment interruption

3.6.1. Socio-demographic, Patient Characteristics and Risk of Treatment Interruption

During the entire treatment period, a 3.38 increase in risk for treatment interruption was observed amongst patients with secondary level education when compared to those with primary level education. Similarly, continued use of alcohol during treatment increased risk for treatment interruption by 4.04 fold compared to those who did not consume alcohol during treatment. The proportion of patients that interrupted TB treatment during the follow-up period clustered according to highest level of education and alcohol consumption during treatment is shown in Figure 3.



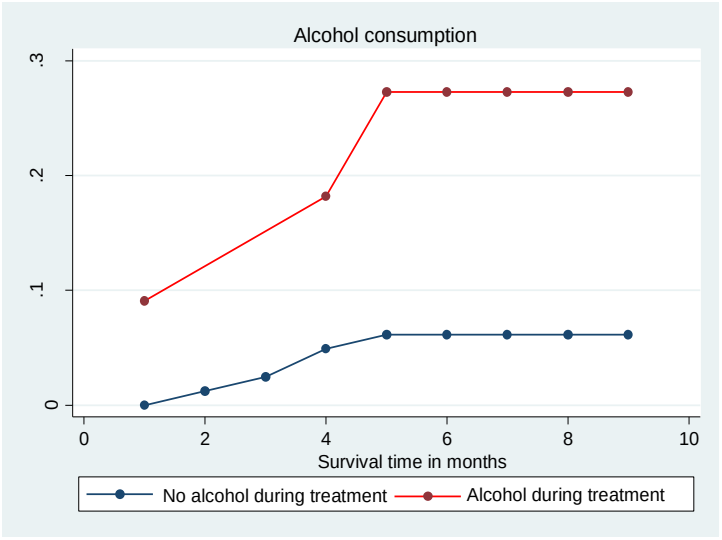


Figure 3. Proportion of treatment interruption during the follow-up period grouped according to highest level of education attained and alcohol consumption during TB treatment

3.6.2. Institutional factors and risk for treatment interruption

Facilities perceived to have inadequate staff to offer DOT support showed a 3.69 increase in risk for treatment interruption when compared to facilities that were perceive to have adequate staff. Additionally, public facilities had a 3.83 increase in risk for treatment interruption when compared to patients treated in private or faith based facilities. The proportion of patients that interrupted TB treatment during the follow-up period clustered according to perceived adequacy of HCWs in the treatment center and nature of the facility offering TB treatment is shown in Figure 4.

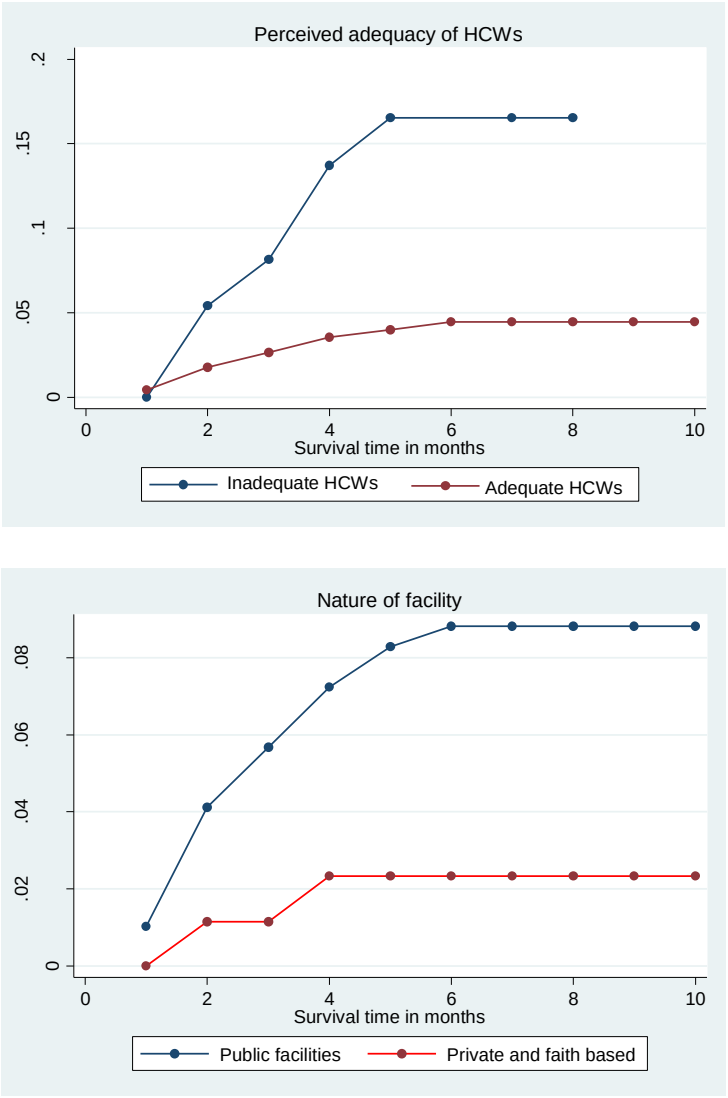


Figure 4. Proportion of treatment interruption during the follow-up grouped according to perceived adequacy of HCWs to offer DOT support and nature of facility offering TB treatment

3.6.3. Cox proportional hazard

Alcohol use during treatment, HR= 4.821 (95% CI 1.152-20.178) and perceived availability of adequate HCWs to offer DOT support HR = .253 (95% CI .092 - .697) showed significant association with treatment outcome on univariate analysis shown in Table 3.

Table 3. Univariate Cox Proportional Hazard Analysis of Factors Associated with TB Treatment Interruption

Variable	Univariate		
	Hazard Ratio (95% CI)	Z-Stat	p>|z| Value
Public vs. non-public	.253 (.055-1.097)	-1.84	0.066
Adequate vs Inadequate HCWs	.253 (.092-.697)	-2.66	0.008
Primary vs Secondary	3.42 (.99-11.814)	1.94	0.052
Alcohol use during treatment	4.82 (1.15-20.18)	2.15	0.031

Nature of facility, adequacy of HCWs and highest level of education were included in the multivariate analysis. Alcohol use during treatment was excluded from the model due to low patients consuming alcohol during treatment. The three factors showed statistically significant associations with treatment default, χ^2 (3,226) =17.37, (p<0.0006) shown in Table 4.

Table 4. Multivariate Cox Proportional Hazard Analysis of Factors Associated with TB Treatment Interruption

Variable	Multivariate		
	Adjusted Hazard Ratio (95% CI)	Z-Stat	p>|z| Value
Public vs. non-public	.210 (.046-.952)	-2.02	0.043
Adequate vs Inadequate HCWs	.195 (.068-.0.56)	-3.03	0.002
Primary vs Secondary	5.28 (1.18-23.59)	2.18	0.029

4. DISCUSSION

4.1. Treatment Interruption

In this study 6.5% of the new SM+ TB patients interrupted their treatment. In Kenya, treatment interruption rates of 4.5% and 8.5% have been reported amongst new and retreatment TB patients' respectively [10]. According to DLTLD 2015 report, the country's treatment interruption rates were 4.3% and 3.4 % for the two groups' respectively [2]. Other studies reported treatment interruption rates of 7.2 % among PTB patients in South Africa [11] and 8.9% in Ethiopia [12]. When all forms of TB are considered, reported treatment interruption rates included 11.1% [13] in Ethiopia, 7.4 % in India [14] and 11.5% in Kuwait [15]. There is a variation in treatment interruption rates between and within countries. These variations could be attributed to the status of TB control programs within the study regions in-country and between countries.

4.2. Time to Treatment Interruption

The median time to default was 56 days with majority of the patients defaulting during the transitory phase between intensive and continuation phase of treatment. The results were consistent with reported increase in hazard for treatment interruption during intensive phase in Kenya [10]. Similar results have been observed in India where up to 40% of default cases occurred during the same period [14]. In Kuwait 56% of treatment interruption were observed within the first two months of treatment [15]. In Moldova, the median time to default was 110 days and the highest risk was observed in the month immediately after intensive phase of treatment [16]. There is need to address individual and health system changes occurring during the transition phase of treatment in order to institute appropriate measures that would reduce loss to follow up during this period. These measures should be put in place immediately the patients begin TB treatment as the risk for interruption is highest within the first two months.

4.3. Risk Factors

4.3.1. Highest Level of Education

There was a significant association between highest level of education attained by the patients and TB treatment interruption. A 3.38 increase in risk for TB treatment interruption was observed amongst patients with secondary level education when compared to those with primary level education. The findings in this study therefore present a possible presence of a high risk group previously not considered. Further investigation into attitudes and health seeking behaviors in this category of patients need to be evaluated to understand the reason for increased risk in this group.

4.3.2. Alcohol use During Treatment

A statistically significant association was observed between continued alcohol use and treatment outcome. Patients who continued alcohol use during treatment had a 4.04 increase in risk for treatment interruption compared to those who did not consume alcohol. New cases with alcoholism and drug addiction have been shown to have an increased hazard of defaulting [16],[17]. In this study majority of study participants with a history of alcohol use, stopped alcohol consumption during TB treatment. Alcohol use impairs mental capability and this interferes with decision making capacity including adherence to TB treatment. There has been a call to action to address alcohol use and abuse to achieve optimal results in TB prevent and treatment [18]. Patients who continue use of alcohol during TB treatment should be considered high risk for treatment interruption.

4.3.3. Availability of Adequate Health Care Workers

Perceived inadequate availability of HCWs to offer DOT was identified as a risk factor for treatment interruption. There was a 3.69 f increase in risk for treatment interruption among patients treated in facilities that were perceived to have inadequate HCWs to offer DOT. A functional health system requires sufficient health workers, equitably distributed to improve coverage and accessibility. The need for adequate healthcare workers with the right skills cannot be overemphasized as a requirement to achieving health goals in a

population. There is limited literature published pertaining to HCW staffing levels and TB treatment outcomes. There is an urgent need to rigorously evaluate the importance of adequate staffing to provide evidence in designing optimal TB treatment guidelines. The results are supportive of the highlighted need for strategies to transform health workforce capabilities in order to achieve the target to end TB [19].

4.3.4. Nature of Facility

Tuberculosis treatment is offered in public and non-public facilities in Kenya. The nature of facility offering treatment showed a statistically significant association to treatment interruption. Patients who received treatment in public facilities had a 3.83 increase in risk for treatment interruption when compared to those who received treatment in non-public facilities. Similar results were reported in Nigeria where receiving treatment at a public facility was a predictor of unsuccessful treatment outcomes [20]. While there has been no evidence to show that there is better clinical services in non-public facilities, patients in private facilities reported better interpersonal satisfaction attributed to longer consultations times and higher chances of receiving counselling [21],[22]. In Kenya, public health facilities are known to be well stocked with TB tracer commodities to provide TB services [5]. There is need to determine whether patient interpersonal satisfaction over and above sufficient clinical services is a risk factor to TB treatment interruption.

5. CONCLUSION

Eliminating TB treatment interruption is a key factor in the fight against TB. Precautionary measures need to be put in place for patients who continue alcohol and drug use during TB treatment to prevent treatment interruption. Health system management changes occurring during the transition between intensive and continuation phase of treatment need to be evaluated to determine the reason for increased treatment interruption during that period of treatment. This study highlights the need to look at the human resource components in health facilities and the non-clinical institutional variables that are contributing to adverse treatment outcomes. Patient perception and attitude on quality and treatment approach, should to be integrated into all health facilities offering TB treatment.

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REFERENCES

[1] WHO, "Global Tuberculosis Report 2016," World Health Organization, 2016.
[2] Division of Leprosy, "Tuberculosis and Lung Disease," DLTLD Kenya Annual Report, 2015.
[3] WHO, "Tuberculosis Factsheet No. 104," World Health Organization, 2012.
[4] WHO, "Implementing END TB strategy: THE ESSENTIALS," WHO, 2015.
[5] "Kenya Service Availability and Readiness Assessment Mapping (SARAM)," 2013.
[6] Kenya Health Sector, "Human Resources Strategy 2014-2018," 2016.
[7] WHO, "Definitions and reporting–7 framework for tuberculosis," 2013.
[8] Division of Leprosy, "Tuberculosis and Lung Disease," DLTLD Guidelines on management of Leprosy and Tuberculosis, 2013.
[9] WHO, "Treatment of tuberculosis: guidelines–4th ed, WHO, 2010.
[10] E. O. Masini, *et al.*, "Using Survival Analysis to Identify Risk Factors for Treatment Interruption among New and Retreatment Tuberculosis Patients in Kenya," *Plos One,* vol/issue: 11(10), 2016.
[11] G. Kigozi, *et al.*, "Factors influencing treatment default among tuberculosis patients in a high burden province of South Africa," *International Journal of Infectious Diseases,* vol. 54, pp. 95-102, 2017.
[12] T. Zenebe and E. Tefera, "Tuberculosis treatment outcome and associated factors among smear-positive pulmonary tuberculosis patients in Afar, Eastern Ethiopia: a retrospective study," *The Brazilian Journal of Infectious Diseases,* vol/issue: 20(6), pp. 635-36, 2016.
[13] G. Gebrezgabiher, *et al.*, "Treatment Outcome of Tuberculosis Patients under Directly Observed Treatment Short Course and Factors Affecting Outcome in Southern Ethiopia: A Five-Year Retrospective Study," *Plos One,* vol/issue: 11(2), 2016.
[14] K. Vasudevan, *et al*., "Smear Conversion, Treatment Outcomes and the Time of Default in Registered Tuberculosis Patients on RNTCP DOTS in Puducherry, Southern India," *Journal Of Clinical And Diagnostic Research,* vol/issue: 8(10), 2014.
[15] Q. Zhang, *et al.*, "Determinants of Default from Pulmonary Tuberculosis Treatment in Kuwait," *The Scientific World Journal,* vol. 2014, 2014.

[16] H. E. Jenkins, *et al*., "Risk factors and timing of default from treatment for non-multidrug-resistant tuberculosis in Moldova," *The International Journal of Tuberculosis and Lung Disease*, vol/issue: 17(3), pp. 373-80, 2013.
[17] Raviglione M. and Poznyak V., "Targeting harmful use of alcohol for prevention and treatment of tuberculosis: a call for action," *European Respiratory Journal*, vol/issue: 50(1), 2017.
[18] A. Finlay, *et al*., "Patient-and provider-level risk factors associated with default from tuberculosis treatment, South Africa, 2002: a case-control study," *BMC Public Health*, vol/issue: 12(1), 2012.
[19] WHO, "Global strategy on human resources for health: Workforce 2030," World Health Organization, 2016.
[20] K. N. Ukwaja, *et al.*, "Profile and determinants of unsuccessful tuberculosis outcome in rural Nigeria: Implications for tuberculosis control," *World Journal of Methodology*, vol/issue: 6(1), pp. 118-125, 2016.
[21] I. Hazarika, "Role of private sector in providing tuberculosis care: Evidence from a population-based survey in India," *Journal of Global Infectious Diseases*, vol/issue: 3(1), pp. 19-24, 2011.
[22] P. R. Eliya, *et al.*, "The quality of outpatient primary care in public and private sectors in Sri Lanka--how well do patient perceptions match reality and what are the implications?" *Health Policy and Planning*, vol/issue: 30(1), pp. 59-74, 2015.