`ORIGINAL RESEARCH ARTICLE

Predictors of treatment outcomes of childhood tuberculosis among patients attending the TB clinic at Mbagathi County Hospital, Nairobi County

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Abstract

Background: Globally, tuberculosis (TB) is the leading cause of death by a single infectious agent. An estimated one million children develop tuberculosis disease, and an estimated 233,000 die from its complications worldwide each year. Kenya is among the 30 high TB burden countries which accounted for 87% of the world's cases. In 2019, 86,385 TB cases were notified in Kenya among which 8,393 were children aged below 15 years. Unlike studies on TB in adults, there is limited published data for the predictors of treatment outcomes in children. The aim of TB treatment policy is to cure patients and therefore alleviate suffering and prevent death from the disease. It's also aimed at preventing long-term complications arising from the disease and prevent relapse. Treatment is also aimed at preventing the transmission of the infection and development of drug resistance. Outcomes of treatment is a good indicator of the performance of the TB program.

Objectives: To determine the predictors of treatment outcomes of childhood tuberculosis among patients attending the TB clinic at Mbagathi County Hospital, Nairobi County

Design: A three-year retrospective study.

Setting: Tuberculosis clinic at Mbagathi County Hospital, Nairobi

Subjects: Files of patients aged below 15 years registered for treatment of TB at Mbagathi County Hospital between 1st January, 2018 and 31st December, 2020.

Results: The findings of the study showed the proportion of males and females were comparable at 62 (49.2%) and 64 (50.8%), respectively. Of these children, 64 (50.8%) were aged < 1 year and 47 (37.3%) had severe acute malnutrition. Of all the study subjects, 80 (63.5%) had pulmonary TB, 39 (31.0%) had extra-pulmonary TB and 4 (3.2%) had miliary TB.

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The HIV testing rate was 115 (91.2%) with the HIV positivity rate of 28 (22.2%). Genexpert test was done in 54 (42.9%) children out of which 30 (55.6%) had Mycobacterium tuberculosis (MTB) detected. Good/favourable treatment outcomes were observed in 68 (53.9%) of respondents. Among the 19 children aged between 1 year and < 5 years, 13 (68.4%) had good treatment outcomes and was highest compared to the other age groups. Age was significantly associated with treatment outcome (Fishers Exact test, $p<0.05$). Out of 116 children whose DOT supporter was a household member, 63 (54.4%) had good treatment outcomes and was significantly associated with treatment outcome (Fishers Exact test, $p<0.05$). Among 82 children who had pulmonary tuberculosis, 50 (61.0%) compared to 18 (43.9%) of 41 children with EPTB had good treatment outcome. On binary logistic regression, the type of TB was the only variable that significantly contributed to the model.

Conclusion: Children below one year of age contributed the highest TB burden and malnutrition being a very important factor associated with TB disease. Pulmonary TB remained the predominant type of the disease and HIV positivity rate was double the national scale. Most children were self-referrals and those whose treatment outcomes were not evaluated contributed a high proportion of poor treatment outcomes.
Recommendation: A better referral framework should be implemented so as capture data particularly for treatment outcomes. Multi-centre research that is more representative is also recommended.

1.0 Introduction

Tuberculosis (TB) is a severe communicable disease that is a major cause of ill health and among the top 10 causes of death worldwide (Belay & Wubneh, 2020). TB remains the leading global cause of death by a single infectious agent; it caused approximately 1.6 million deaths in 2017 (Torres *et al.*, 2019). It is caused by Mycobacterium tuberculosis and is almost exclusively a droplet infection transmitted from a person with active pulmonary tuberculosis (Azit *et al.*, 2019; Huerga *et al.*, 2019; Sharma *et al.*, 2018). Although TB is preventable and treatable, it remains one of the major causes of death among children. Approximately one million children develop tuberculosis disease, and an estimated 233,000 die from complications of TB each year, corresponding to about 23 deaths every hour (Wobudeya *et al.*, 2019). According to WHO, majority of the patients who developed TB in 2019 were in the WHO region of South-East Asia (44%) with Africa contributing 25% of the total burden. Although globally the TB incidence rate is falling, it is not fast enough to attain the 2020 milestone of a 20% reduction between 2015 and 2030. The African region has progressed relatively well with a reduction of about 16% (*Global Tuberculosis Report 2020*).

Even though there is increased awareness that tuberculosis is a major cause of morbidity and mortality in young children in tuberculosis-endemic areas (Marais *et al.*, 2014; Wang *et al.*, 2020), childhood TB usually has lower priority compared to adult disease since in the latter, cases are usually few, largely non-infectious and an assumption that controlling adult TB

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prevents childhood illness (Satyanarayana *et al*., 2010; Onyango *et al*., 2018)). Important to note is the latest TB prevalence survey in Kenya whose target population comprised of all persons (males and females) aged 15 years and above but not children (Enos *et al*., 2018). In reference to diagnosis, management and reporting of TB cases, the World Health Organization (WHO) defines children as those below the age of 15 years (Brooks *et al*., 2021) while patients aged 15 years and above are considered as adults (Enos *et al*., 2018). This has been adopted globally in TB programmes and management.

Gaps in reporting for childhood TB exist even at the global scene with 19 countries out of the 30 high TB burden countries provided data on the overall treatment success rate for children aged 0–14 years in 2018 while the rest did not. Such scenario among others have prompted to start initiative such as Catalysing Paediatric Tuberculosis Innovations (CaP TB) that being implemented in nine sub-Saharan African countries (including Kenya) and India whose aim is to increase the uptake of innovative approaches to TB diagnosis, treatment, and care in children and adolescents aged 14 years or under (Organizat, 2021). All this is against the backdrop of the Childhood TB Roadmap, with a goal of zero TB deaths in children and highlights the importance of identifying strategies to support children and their families to improve treatment completion percentages and prevent loss to follow-up (Brooks *et al*., 2021).
Kenya is among the 30 high TB burden countries which combined accounts for approximately 87% of the world's TB cases (Ngari *et al.*, 2023). In Kenya, 8,393 children aged between 0- less than 15 years with TB were notified which constituted 9.7% of all reported TB cases in 2019 (Ronoak, 2021). In 2020, the TB case notification rate was 154 per 100,000 population and among 72,942 total cases notified to the TB program the same year, 5,663 (8%) were children. The treatment success rate was 88.6% among children aged 0 – less than 15 years for the 2019 cohort. Therefore, poor treatment outcomes accounted for 11.4% with 4.8% death rate included (Ronoak, 2021). Childhood TB should be a priority area of focus for the national TB control program, because infection with *M. tuberculosis* rapidly progresses to disease in young children and are also predisposed to severe or disseminated forms of TB (Onyango *et al*., 2018).

According to Kenya TB report (2019), bacteriological diagnosis among children was 5% out of which 30% had GeneXpert results while 18% had an initial smear test done. HIV co-infection rate among the children was 14.4% with ART uptake of 96.3%. During the same period, an estimated 24% of children were severely malnourished while 9% were moderately malnourished. In the year 2018, childhood treatment cure rate was 87%, death rate 5% and loss to follow-up was 3.9%. Children are infected either directly from an index adult case or from reactivation of latent TB (DNTLDP_Annual Report 2018_Final.Pdf, n.d.). Similarly, the 2019 childhood TB cohort, treatment success rate was about 89% and cure rate at 66%. Death rate and loss to follow-up among these children each was 4% (Ronoak, 2021).

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Once children are diagnosed with drug sensitive TB, they are put on a standard 6 months regimen as per the national treatment guidelines. This consists of the intensive phase for the first 2 months with 4 drugs namely rifampicin, isoniazid, pyrazinamide and ethambutol followed by 4 months continuation phase with isoniazid and rifampicin. The exceptional treatment regimen is for tuberculous meningitis and osteo-articular TB where the continuous phase lasts for 10 months. At the end of treatment, outcomes are declared as whether cured, treatment completed, treatment failure, died, lost to follow up and not evaluated. All children initiated on treatment are also tested for HIV per the national TB treatment guidelines and those found to be positive initiated on ART immediately (*Revised Paedeatric Guidelines – National Tuberculosis, Leprosy and Lung Disease Program*, n.d.). Ensuring that children register good treatment outcomes is in tandem with the WHO's End TB Strategy and the United Nations Sustainable Development Goals (SDGs) Health Goal No.3 that aims to ensure healthy lives and promote well-being for all at all ages. Target No. 3.3 aims to, 'End the epidemics of AIDS, tuberculosis, malaria among other diseases. Translated into numerical targets this means that TB incidence and death rates should be reduced by 80% and 90%, respectively (Lönnroth & Raviglione, 2016; Teferi *et al*., 2021).

Several risk factors are associated with the success of treatment. Malnutrition is well known as a strong risk factor for progression from TB infection to disease and account for about 26% of TB incident globally (Bhat et al., 2013). Identifying under-nutrition during TB diagnosis helps to establish baseline nutritional indicators for monitoring the response to treatment (WHO | Nutritional Care and Support for Patients with Tuberculosis, 2019). Malnutrition is also associated with a delay in treatment completion. HIV co-infection is also an important risk factor for poor drugs adherence in both adults and children. Known risk factors for unfavourable TB treatment outcomes in children are being less than five years of age, being HIV positive, smear positivity, having low body weight, (Lopez-Varela *et al*., 2017) as well as the site of TB disease (Hamid et al., 2019). Other independent risk factors for TB mortality include sex of patient and history of prior TB treatment (Adamu *et al*., 2017).

The WHO recommends greater prioritization for quality of TB notification data for children, as well as consistency of case definitions and higher-level coverage of reporting (Organizat, 2021). The key responsibility for successful TB treatment is assigned to the health-care provider, not the patient and the TB control program should assist the health-care professional and community health volunteers in evaluating patient barriers to adherence and make timely recommendations through the use of a strategy referred to as case management. The strategy's goal is to provide patient-centred care aimed to ensure all public health activities related to stopping TB transmission are completed and that the patient completes treatment. This form of care ensure successful treatment outcomes as it emphasizes tailoring treatment to address both the patient's social and clinical concerns (*Self-Study Modules on Tuberculosis Module 6 Managing Tuberculosis Patients and Improving Adherence*, n.d.)

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Patients suffering from TB have the responsibility to follow the prescribed treatment plan and to conscientiously comply with the instructions given to protect their health and that of others. They are responsible for informing the health providers of any problems or difficulties with following treatment as agreed. The complex relationship between the patient and health care workers is an important determinant of the outcome of TB treatment. A positive relationship or interaction leads to good outcome of treatment and vice versa. At the health care worker level, this interaction is affected by their knowledge on the disease and treatment protocol, skills on patients counselling and education and their attitude towards the patients. Poorly counselled or educated patient on TB and its treatment may end up with poor outcomes; similarly a negative attitude of the health care workers towards the patients will cause them to stop or interrupt the treatment (Ibrahim *et al*., 2014).

2.0 Materials and methods

The retrospective descriptive cross-sectional study design was applied using secondary data that was routinely collected during treatment for children diagnosed with TB in the three-year period between 1st January, 2018 and 31st December, 2020 at Mbagathi County Hospital, Nairobi. The facility was purposely selected as the study centre for being the single largest high volume referral TB diagnostic and treatment facility in Kenya. The total entries of 126 patients under the age of fifteen years registered in the Facility TB Register (MoH TB_4) during the study period were included in the study. Several variables were recorded that included the patient's demographic information, the DOT supporter during the intensive phase of treatment, the type of TB, types of investigations that were done and their results, the treatment regimen given and results of HIV test. Also included was whether the patients were given nutritional support and if they had any co-morbidity. For the HIV positive patients, whether they were put on cotrimoxazole preventive therapy (CPT) and anti-retroviral therapy was recorded. Finally, the outcome of treatment is recorded. All the TB_4 files for the three-year period were identified and verified that that none was missing. A pre-coded data abstraction tool was used to systematically collect the data. Quantitative data was entered on the Statistical Package for Social Science (SPSS)version 21 for analysis. Descriptive statistics, Fishers exact test and logistic regression were carried out. Data was presented in form of texts, tables and charts. Results were considered significant if $p<0.05$. Ethical approvals were received from Kenya, National Commission for Science, Technology and Innovation (NACOSTI) and Jomo Kenyatta University of Agriculture and Technology (JKUAT) institutional ethical review committee (IERC). Permission to use patient's files was grantedby the department of Health, Nairobi County. Anonymity and confidentiality were maintained.

3.0 Results

Out of 126 children registered for TB treatment during the period of study, the proportion of males and females was comparable 62 (49.2%) and 64 (50.8%), respectively and 64 (50.8%) were < 1 year of age. In addition, 47 (37.3%) of the children enrolled for treatment had severe acute malnutrition while 1 (0.8% child was overweight. Out of the 126 children, 84 (66.6%) had

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pulmonary TB and 39 (31.0%) had extra-pulmonary tuberculosis. Out of the 39 cases of extra-pulmonary TB, pleural effusion was disproportionately (19/39; 48.7%) the most frequent sub-type. In total, 115 (91.2%) children were tested for HIV and had a HIV positivity rate of (28/115; 24.3%) (Table 1).

Table 1: Description of Patient-Level Factors among Children Treated for TB

Variable	Frequency	Percent
Sex		
Male	62	49.2
Female	64	50.8
Age		
<1 year	64	50.8
1 < 5 years	19	15.1
5 <15 years	43	34.1
Nutritional status		
Severe Acute Malnutrition	47	37.3
Moderate Acute Malnutrition	18	14.3
Mild malnutrition	16	12.7
Normal	32	25.4
Overweight	1	0.8
Not calculable	12	9.5
Type of TB		
Pulmonary	84	66.6
Extra-pulmonary	39	31.0
Not indicated	3	2.4
EPTB sub-type		
TB Lymphadenopathy	9	7.1
TB Pleural Effusion	19	15.1
Not case of EPTB	80	63.5
Not recorded	8	6.3
Miliary TB	4	3.2
TB Pericarditis	1	0.8
TB Meningitis	5	4.0
HIV status		
Positive	28	22.2
Negative	87	69.1
Not recorded	11	8.7

Out of 126 children, 116 (92.1%) had a household member as the treatment supporters during the intensive phase of treatment. Out of the 28 children who were HIV positive, (22/28; 78.6%) were on highly active ant-retroviral therapy (HAART) and (23/28; 82.1%) were on cotrimoxazole preventive therapy (CPT). Out of 126 children, 89 (77.8%) were self-referrals to the hospital for treatment while 97 (77.0%) were indicated to be referred to the TB clinic (Table 2).

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Table 2: Description of Clinical-Level Factors among Children Treated for TB

Variable	Frequency	Percent
DOT supporter in intensive phase		
Health care worker	1	0.8
Household member	116	92.1
Community health volunteer	2	1.6
No DOT supporter	7	5.5
Cotrimoxazole Preventive Therapy		
Yes	23	18.2
Not recorded	5	4.0
Not HIV positive	98	77.8
ARV's		
Yes	22	17.4
Not recorded	6	4.8
Not HIV positive	98	77.8
Patient Referred 'From'		
HIV Comprehensive Care Clinic (HCC)	1	0.8
Private center (PS)	7	5.6
Self-referral (SR)	89	70.6
Contact invitation (CI^2)	1	0.8
Community Health Volunteer (CHV)	2	1.6
Ward	19	15.0
Other	7	5.6
Patient Referred 'To'		
VCT Center (VCT)	2	1.6
HIV Comprehensive Care Unit (HCC)	2	1.6
Nutrition Clinic (Nut C)	23	18.2
TB Clinic (TBC)	97	77.0
Not indicated	2	1.6

Out of the 126 children, 54 (42.9%) had Genexpert test done on diagnosis; out of which, 28 (51.9%) of the results were positive for TB but no resistance to rifampicin. In addition, 6 (4.8%) children had sputum smear microscopy done on diagnosis and had a positivity rate of 1 (16.7%). Out of 126 children who were done a chest X-ray on diagnosis, 92 (76.0%) had radiological findings suggestive for TB while in 29 (24.0%) had bacteriologically positive results from Genexpert test or sputum microscopy (Table 3).

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Table 3: Diagnostic Methods Used Among Children Treated for TB at Mbagathi County Hospital

Type of test	Frequency	TB positive (%)	TB negative (%)
Genexpert	54	28 (51.9)	26 (48.1)
Sputum smear	6	1 (16.7)	5 (83.3)
Chest X-ray	121	92 (76.0)	29 (24.0)

Out of 126 respondents, 68 (53.9%) had good treatment outcomes. Among 62 male and 64 female respondents, 35 (56.4%) and 34 (41.6%) respectively had successful treatment outcome. In 19 children aged between 1 year and < 5 years, 13 (68.4%) had good treatment outcomes and was highest compared to the other age groups. Age was significantly associated with treatment outcome (Fishers Exact test, $p<0.05$). Out of 47 children with severe acute malnutrition, 29 (61.7%) got good treatment outcome. Among 84 children who had pulmonary tuberculosis, 51 (60.7%) compared to 17 (43.6%) of 39 children who had EPTB got good treatment outcome. Out of 19 children with pleural effusion, 10 (58.8%) had successful treatment outcome and the highest among the other extra-pulmonary TB sub-types. The type of TB was significantly associated with treatment outcome (Fishers Exact test, $p<0.05$). In 28 HIV positive children, treatment success was 19 (68.8%) and 41 (47.7%) among 87 HIV negative children respectively (Table 4). Outcomes registered as cured and treatment completed denoted good/favourable TB treatment outcomes while died and unknown outcome denoted poor/unfavourable TB treatment outcomes.

Table 4: Comparison between Patient-Level Factors and Treatment Outcomes

	Treatment Outcome					Fisher's Exact Test		
Variable	Cured (C)	Treatment Completed (TC)	Died (D)	Unknown outcome	Total	Value	*df*	Exact sig. (2-sided) (p-value)
Sex								
Male	3 4.8%	32 51.6%	2 3.2%	25 40.3%	62	2.986	3	0.422
Female	7 10.9%	26 40.6%	1 1.6%	30 46.9%	64			
Age								
< 1 year	0 0.0%	31 48.4%	1 1.6%	32 50.0%	64			
1 < 5 years	2 10.5%	11 57.9%	2 10.5%	4 21.1%	19	21.283	10	<0.001
5 < 15 years	8 18.6%	16 37.2%	0 0.0%	19 44.2%	43			
Nutritional status								
Severe Acute Malnutrition	6 12.8%	23 48.9%	1 2.1%	17 36.2%	47			
	1	4	0	13	18			

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	Treatment Outcome					Fisher's Exact Test			
Variable	Cured (C)	Treatment Completed (TC)	Died (D)	Unknown outcome	Total	Value	*df*	Exact sig. (2-sided) (p-value)	
Moderate Acute Malnutrition	5.6%	22.2%	0.0%	72.2%					
Mild malnutrition	1 6.2%	8 50.0%	1 6.2%	6 37.5%	16	15.372	15	0.447	
Normal	1 3.1%	15 46.9%	1 3.1%	15 46.9%	32				
Overweight	0 0.0%	1 100.0%	0 0.0%	0 0.0%	1				
Not calculable	1 8.3%	7 58.3%	0 0.0%	4 33.3%	12				
Type of TB									
Pulmonary	10 11.9%	41 48.8%	1 1.2%	32 38.1%	84				
Extra-pulmonary	0 0.0%	17 43.6%	2 5.1%	20 51.3%	39	12.263	6	0.034	
Not indicated	0 0.0%	0 0.0%	0 0.0%	3 100.0%	3				
EPTB sub-type									
TB adenitis	0 0.0%	3 33.3%	0 0.0%	6 66.7%	9				
TB Pleural Effusion	0 0.0%	10 58.8%	0 0.0%	9 41.2%	19				
Not a case of EPTB	10 12.5%	38 47.5%	1 1.3%	31 38.8%	80				
Not indicated	0 0.0%	1 28.6%	2 28.6%	5 42.9%	8	22.575	18	0.176	
Miliary TB	0 0%	3 75.0%	0 0%	1 25.0%	4				
TB Pericarditis	0 0.0%	1 100.0%	0 0.0%	0 0.0%	1				
TB Meningitis	0 0.0%	2 40.0%	0 0.0%	3 60.0%	5				
HIV status									
Positive	3 11.7%	16 57.1%	2 7.1%	7 25.0%	28				
Negative	6 6.8%	35 40.9%	1 1.1%	45 51.1%	87	10.223	6	0.077	
Not recorded	1 9.1%	7 63.6%	0 0.0%	3 27.3%	11				

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Out of 116 children whose DOT supporter was a household member, 63 (54.4%) had good treatment outcomes. Treatment supporter in the intensive phase of treatment was significantly associated with treatment outcome (Fishers Exact test, $p<0.05$). Among 30 children whose test was positive on Genexpert at diagnosis, 20 (66.7%) had good treatment outcomes while in 24 children who were Genexpert negative, 10 (41.7%) had successful treatment outcome. Genexpert test results were significantly associated with treatment outcome (Fishers Exact test, $p<0.05$) (Table 5). Outcomes registered as cured and treatment completed denoted good/favourable TB treatment outcomes while died and unknown outcome denoted poor/unfavourable TB treatment outcomes.

Table 5: Relationship between clinical factors and treatment outcomes

	Treatment Outcome				Total	Fisher's Exact Test		
Variable	Cured	Treatment Completed	Died	Unknown outcome		Value	*df*	Exact sig. (2-sided) (p-value)
DOT supporter								
Health Care Worker	1	0	0	0	1			
	100.0%	0.0%	0.0%	0.0%				
Household member, Friend	9	54	2	51	116			
or Relative	7.8%	46.6%	1.7%	44.0%		16.898	9	0.040
Community Health Volunteer	0	2	0	0	2			
	0.0%	100.0%	0.0%	0.0%				
No DOT supporter	1	1	1	4	7			
	14.3%	14.3%	14.3%	57.1%				
Genexpert results								
Positive and no rifampicin	9	11	0	10	30			
resistance	30.0%	36.7%	0.0%	33.3%				
Negative	0	10	1	13	24			
	0.0%	41.7%	4.2%	54.2%		21.176	6	<.001
Not applicable	1	37	2	32	72			
	1.4%	51.4%	2.8%	44.4%				

Binary logistic regression was used to determine whether the patient level predictors were associated with the likelihood of having favourable/good TB treatment outcome. A preliminary analysis suggested that the assumption of multicollinearity was met (tolerance=0.97). An inspection of standard residual values revealed that there was no outlier in Case-wise list and therefore the database was retained. The model was not scientifically significant, χ^2 =7.80, df=6, p=0.253 suggesting that it could not distinguish those with good and those with poor treatment outcomes. The model explained between 6.0% (Cox & Snell R square) and 8.0% (Nagelkerke R square) of the variance in the dependent variable and correctly classified 62.7%. Type of TB and no other variable significantly contributed to the model. The type of TB odds ratio of 0.40 suggests that for each type of TB, there was .40 times less likely to have a good treatment outcome (Table 6). Although the model showed that type of TB was the only

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scientifically significant variable, every factor has a clinical importance aimed at improving the treatment outcome of the study subjects.

Table 6: Results of Bivariate Analysis for Patient Level Predictors and Outcome Variables

Variables in the Equation

							95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Sex of Child	-.111	.372	.089	1	.765	.895	.432	1.854
	Age of Child	.197	.218	.814	1	.367	1.218	.794	1.868
	Nutrition Status of Child	.029	.101	.081	1	.776	1.029	.844	1.255
	Type of TB	-.907	.371	5.961	1	.015	.404	.195	.836
	Extra-pulmonary TB Sub-type	.035	.165	.045	1	.832	1.036	.749	1.432
	Child's HIV Status	-.176	.358	.242	1	.623	.838	.416	1.691
	Constant	.406	.658	.381	1	.537	1.501		

Binary logistic regression was used to determine whether the clinical level predictors were associated with the likelihood of having favourable/good TB treatment outcome. A preliminary analysis suggested that the assumption of multicollinearity was met (tolerance=.921-.950). An inspection of standard residual values revealed that there was no outlier in Case-wise list and therefore the database was retained. The model was not scientifically significant, χ^2 =9.39, df=6, *p*=.153 suggesting that it could not adequately distinguish those with good and those with poor treatment outcomes. The model explained between 7.2% (Cox & Snell R square) and 9.6% (Nagelkerke R square) of the variance in the dependent variable and correctly classified 58.7% of cases as shown in Table 7. There was no variable that significantly contributed to the model. Although the model was not scientifically significant, every variable has a clinical importance aimed at improving the treatment outcome of the subjects.

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Table 7: Results of Bivariate Analysis for Clinical Level Predictors and Outcome Variable

Variables in the Equation									
								95% C.I. for Exp(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Who is DOT Supporter in Intensive Phase of Treatment?	-.417	.408	1.045	1	.307	.659	.296	1.466
	What was the Genexpert Results?	-.142	.094	2.271	1	.132	.868	.721	1.044
	Sputum Smear Results at 0 month (Diagnosis)	-1.398	1.136	1.515	1	.218	.247	.027	2.290
	Was Patient put on ARV's?	-.210	.174	1.451	1	.228	.811	.576	1.141
	Patient Referred 'By' or 'From'	.133	.087	2.346	1	.126	1.142	.964	1.353
	Type of Nutritional Support	.035	.105	.108	1	.742	1.035	.843	1.272
	Constant	3.504	2.324	2.274	1	.132	33.242		

4.0 Discussion

Our study found that children below the one year constituted more than half of the children registered for treatment. This was different from a study by Adejumo *et al.,* (2016) and Satyanarayana *et al.,* (2010) which had children aged between 5 < 15 years being the majority but similar to one by Moon *et al.*, (2019). This can be attributed to the premature immunity in young children that increases the risk for TB disease. More than half (51.6%) of the study subjects had severe to moderate acute malnutrition which could be explained to be due to the fact that TB is a debilitating disease and a delay in making a TB diagnosis leads to deterioration of the general health of the children. This can be due to poor health seeking behaviour of patients or a low index of suspicion for TB by the health care providers. The high number of children with a household member as the DOT supporter in the intensive phase of can be explained by the fact that TB treatment and care in Kenya is community-based where TB services are decentralized and are implemented in settings where patients live, work, and receive education (Zhang *et al.*, 2016). That majority of respondents (66.7%) had pulmonary TB was similar to studies by Moon *et al.*, (2019) but contrasted with studies by Satyanarayana *et al*., (2010) and Mirutse *et al*., (2019) who had EPTB as the predominant form of TB. This can be explained by the fact that diagnosis of EPTB in children is more challenging since it affects all organs of the body and unlike in PTB which has molecular tests such as Genexpert, EPTB lack appropriate diagnostic tools. This can also be attributed to their wider spectrum of clinical manifestation and involvement of inaccessible sites among other reasons as noted by Arega *et al*., (2020). TB pleural effusion was the most predominant form of EPTB and unlike in the study by Ohene *et al*., (2019) and Satyanarayana *et al*., (2010) which found TB lymphadenopathy as the commonest sub-type. HIV screening and testing was higher (91.2%) compared to studies

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by Mirutse *et al*., (2019)) and Adejumo *et al*., (2016)with the positivity rate of 28.0% which was higher than the average national HIV positivity rate of 14.0%.

The study found that 42.9% of the children had Genexpert test done on diagnosis. The current policy on TB diagnosis encourages Genexpert as the first test in suspected TB since it is more sensitive than sputum smear test, fast to perform and other specimens such as stool, gastric contents and nasopharyngeal aspirates other than sputum can be tested. Young children are not able to cough out sputum and therefore, bacteriological confirmation for TB has been a challenge. Among all respondents, only 1.6% and 0.8% of patients were referred for treatment by the community health volunteers and through contact invitation respectively. These findings may suggest inadequate implementation of policy on intensified TB case finding through contact invitation.

Out of 62 children who had poor treatment outcomes, 55(88.7%) were patients whose treatment outcome was not evaluated either because they transferred out and/or their outcome is unknown. This is despite TB treatment services being decentralized to peripheral health facilities near where patients reside. The facility in which this study was carried is a major TB diagnostic centre and proper follow-up of the patients who have transferred out to continue treatment in other health facilities was critical. To be able to capture all patient's treatment outcomes need both passive and active approaches that ensure that records are correctly and promptly updated.

Children with moderate acute malnutrition had the lowest treatment success rate. Treatment success rate was higher in children with pulmonary TB (61.3%) than those with EPTB (46.2%). Among 30 patients who were Genexpert test positive on diagnosis, a third got cured and the other third got treatment complete. All new patients with Genexpert test positive on diagnosis should have scheduled sputum smear follow-ups at the 2^{nd}, 5^{th} and 6^{th} month of treatment. More than 90% of the children had a chest X-ray requested on diagnosis. HIV seropositive patients had a higher proportion of favourable treatment outcome (67.9%) than the HIV negative patients. On bivariate analysis, it was found that the nutritional status of the patient and the results of Genexpert test were a significantly associated ($p< 0.05$) with TB treatment outcome at 95% confidence interval.

This research, however, is subject to several limitations. Since this study was retrospective in nature, we relied only on the data that was recorded in the source registers thereby limiting access to information that would have been important in influencing TB treatment outcomes that would be got from the health care providers among others. The study is also limited to the fact that the results cannot be generalized to other TB treatment centres.

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5.0 Conclusion

i. The age of respondent and type of TB disease were significant patient-level factors that were predictors of treatment outcomes. But although the nutrition status of the patient was not significantly associated with the treatment outcome, it is a factor of valuable importance since more than 50% of the respondents had between moderate to severe malnutrition.
ii. The treatment supporter in the intensive phase of treatment and Genexpert test results were significant clinical-level factors that were predictors of treatment outcomes. There were very few patients who had a community health volunteer as the treatment supporter that indicate insufficient community-based treatment support that enhances active TB case finding.
iii. Chest X-ray was the most common diagnostic method requested although it should be limited to those patients who could not do a bacteriological test or one in which the test is negative and there is high suspicion for TB.
iv. Poor treatment outcomes were largely contributed by patients who could not be evaluated (88.7%) since data about their treatment outcome was not available as there was no correspondence about the patients who were transferred out and continued treatment in other health facilities.

6.0 Recommendations

i. Activities to counter malnutrition should be enhanced so as to promote the nutritional status of children aged below 15 years.
ii. There is need to improve on the active case finding policy whereby more patients are referred for TB treatment such as by community health promoters (CHP's) rather than self-referrals.
iii. There is a great need to develop and/or improve on a sustainable frame-work that will ensure smooth referral of patients and backward flow of information about their management. This will enhance tracking of patients on treatment and eventual recording of their treatment outcome.
iv. A multi-centre study that is more representative and which would include input from patients, health care providers and managers of the TB program is recommended so as to ascertain the actual performance of the national TB program.

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7.2 General acknowledgement

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7.3 Declaration of interest
None

7.4 Ethical clearance
Indicate the reference number or the clearance number

7.5 Conflict of interest
None

7.6 Data availability statement
None

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