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Vikela Ekhaya: A Novel, Community-based, Tuberculosis Contact Management Program in a High Burden Setting

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Background. The prevention of tuberculosis (TB) in child contacts of TB cases and people living with human immunodeficiency virus (HIV) is a public health priority, but global access to TB preventive therapy (TPT) remains low. In 2019, we implemented Vikela Ekhaya, a novel community-based TB contact management program in Eswatini designed to reduce barriers to accessing TPT.

Methods. Vikela Ekhaya offered differentiated TB and HIV testing for household contacts of TB cases by using mobile contact management teams to screen contacts, assess their TPT eligibility, and initiate and monitor TPT adherence in participants' homes.

Results. In total, 945 contacts from 244 households were screened for TB symptoms; 72 (8%) contacts reported TB symptoms, and 5 contacts (0.5%) were diagnosed with prevalent TB. A total of 322 of 330 (98%) eligible asymptomatic household contacts initiated TPT. Of 322 contacts initiating TPT, 248 children initiated 3 months of isoniazid and rifampicin and 74 children and adults living with HIV initiated 6 months of isoniazid; 298 (93%) completed TPT. In clustered logistic regression analyses, unknown HIV status (adjusted odds ratio [aOR] 5.7, $P = .023$), positive HIV status (aOR 21.1, $P = .001$), urban setting (aOR 5.6, $P = .006$), and low income (aOR 5.9, $P = .001$) predicted loss from the cascade of care among TPT-eligible contacts.

Conclusion. Vikela Ekhaya demonstrated that community-based TB household contact management is a feasible, acceptable, and successful strategy for TB screening and TPT delivery. The results of this study support the development of novel, differentiated, community-based interventions for TB prevention and control.

Keywords. contact tracing; global health; HIV; prevention and control; tuberculosis.

Tuberculosis preventive therapy (TPT) for high-risk household contacts of tuberculosis (TB) patients has been recommended since 2006 by the World Health Organization (WHO) [1, 2]. Until recently, however, this important intervention was largely neglected, with TB programs focusing primarily on TB case management. Several factors have invoked a renewed interest in TB contact management and TPT delivery. First, in 2016, the WHO began reporting national TB program data on TPT initiation in children < 5 years of age with household TB exposure [3]. The mandatory reporting in itself is thought to have increased attention and resource allocation for this important intervention. Second, an objective for 4 million children to receive TPT by 2022 emerged from the September 2019 United Nations high-level meeting [4]. Finally, modeling studies suggest that End TB targets will not be met without extensive increases in TPT delivery, and that TPT in child household contacts is a highly effective and cost-effective strategy for preventing TB-related mortality [5-7].

This renewed TPT commitment has been fueled not only by evidence outlining its effectiveness but also by innovative, shorter TPT regimens. Data from randomized controlled trials [8-10] and observational studies [11, 12] indicate higher TPT initiation and completion rates when shorter regimens are used. The shorter regimens complement work done to reduce structural barriers to TPT delivery; this work has demonstrated that TPT can be delivered safely to asymptomatic children without the need for tuberculin skin testing or chest radiographs [13-15]. However, structural barriers continue to result in steep losses of contacts at most steps of the cascade even with shorter TPT regimen use [16]. Structural barriers in high-burden settings include the cost of clinical visits [17], TB-related stigma, and limited mechanisms for TPT documentation within health systems [18]. Efforts to overcome these barriers through provision of transport support [19] and decentralization of services [20] have been associated with decreased losses along the contact management cascade.

Despite gains driven by increased attention and new preventive regimens, only 33% of eligible children globally

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initiate TPT and TPT completion data remains sparse. In Eswatini, only 12% of eligible children initiated TPT following household exposure to TB in 2018, increasing to 32% in 2019 [21, 22]. These suboptimal initiation rates persist despite the introduction of a contact tracing register in 2017, inclusion of TB contact management in national healthcare worker trainings, and introduction of community TB active case finders [23]. However, there are very few data regarding the efficacy of administering TPT in the community. Therefore, we implemented Vikela Ekhaya, a novel contact management program designed to assess the feasibility, acceptability, and potential impact of differentiated, community-based services for TPT delivery in a TB-human immunodeficiency virus (HIV) high-burden setting.

METHODS

In 2018, Baylor College of Medicine—in partnership with the Eswatini National TB Control Program and the Baylor College of Medicine Children's Foundation-Eswatini (Baylor-Eswatini)—received funding from the Stop TB Partnership's TB Reach Wave 6 to explore novel approaches to improve TB contact management cascade completion rates. The program was named Vikela Ekhaya, or "protect the home" in SiSwati, and enrolled index cases and household contacts from April 2019 through March 2020 with follow-up of contacts on TPT through September 2020. The program was implemented at 19 public sector Basic Management Units, clinical sites approved to provide TB services, throughout the Hhohho region. The program offered a community-based option for contact management for families of TB index cases identified at these Basic Management Units that included 13 rural health clinics, 3 referral clinics, 1 district hospital, and 1 national referral hospital.

Nurses registered and offered participation in the Vikela Ekhaya program to eligible index cases. Following completion of informed consent, index cases were offered the choice of returning with their household members to the facility for evaluation or being visited at home by the community management team. Once registered, index cases who chose community-based care were assigned to 1 of 2 mobile contact management teams that comprised a TB nurse and a screening officer. Households were eligible for community-based care if (1) located within the Hhohho region, (2) linked to either an index case with pulmonary TB confirmed by Xpert Ultra or clinically determined pulmonary TB, and (3) included high-risk contacts younger than age 5 years.

At community and facility visits, household contacts of infectious patients with TB completed symptom screening for TB and other illnesses. Children with symptoms were either referred to a facility for clinical examination and care or reevaluated in the community at a 2-week follow-up visit, based on the severity and duration of symptoms and assessment by the study nurse. Patients who were able to expectorate provided sputum on-site. Specimens were returned to the laboratory for Xpert Ultra testing. HIV testing and counseling was offered to all household contacts without known HIV status, or for adolescents and adults without testing in the prior year in accordance with national guidelines. Community visits also included maternal child health interventions such as deworming and vitamin A administration, assessments of nutritional and vaccination status, and assessment and treatment of common health ailments.

Community- and facility-based teams offered immediate TPT initiation to eligible contacts. Eligible contacts were asymptomatic, or had had TB excluded, and were either children younger than age 5 years or people living with HIV; adults living with HIV were eligible for TPT if they had not received isoniazid in the prior 2 years. Contacts eligible for TPT had no cough, fever, weight loss or failure to thrive, or night sweats and were otherwise acting well. Eligible child contacts younger than 5 years of age were offered a 3-month course of rifampicin and isoniazid (3HR). In accordance with national guidelines, eligible people living with HIV of all ages were offered a 6-month course of isoniazid (6H). If indicated, TPT was dispensed at the home and monitoring visits were completed in the home at 6 weeks and 3 months for 3HR and 3 months and 6 months for 6H. Patients on 6H had complementary visits for HIV care in between these home visits. Completion of TPT was defined in accordance with WHO definitions [24]. Nurses determined on-time completion if patients took at least 90% of dispensed doses (76 doses for 3HR and 164 doses for 6H) within 4 months for 3HR and 9 months for 6H. Late completion was defined as completion of the dispensed doses outside of the time windows described.

All patient encounters were documented through the CareQuest application (Global Mobility Lab, Singapore), a secure healthcare delivery application that was customized for TB contact management. Data entry into the CareQuest application was accompanied by completion of TPT management cards, developed by the Vikela Ekhaya team in partnership with the Eswatini National TB Control Program. Deidentified program data was analyzed using Stata 16 (StataCorp LP, College Station, Houston, TX, USA). All clinical investigation supporting the reporting of these findings was conducted according to the principles expressed in the Declaration of Helsinki. All participants gave verbal consent for participation in the Vikela Ekhaya program. Approval was obtained from all necessary ethical bodies including the Baylor College of Medicine Children's Foundation Eswatini (00013367), the Eswatini National Health Research Review Board (24047712/24045469), and the Baylor College of Medicine Institutional Review Board (H-35028), Houston, TX, USA.

ANALYTIC APPROACH

Loss from the cascade of care was assessed for index cases and household contacts at several time points. Index cases were determined to be "lost" if they were eligible but declined participation in the program or consented to participation but subsequently declined to schedule household or clinic evaluations (Figure 1A). Index cases who chose clinic-based contact management and received follow-up were "retained" in the cascade of care. Household contacts were determined to be "lost" to the cascade of care if they were symptom-screen positive but did not receive follow-up evaluations for TB or did not receive either a TB diagnosis or a "TB-excluded" clinical determination (Figure 1B). Household contacts were additionally determined to be "lost" to the cascade of care if they were TPT-eligible but refused TPT or initiated but did not complete their TPT regimen (Figure 1C).

Demographic and clinical data were reported as frequencies and proportions for categorical variables and as median and interquartile range (IQR) for continuous variables. Difference across groups were compared using the χ^2 or Fisher exact tests for categorical variables. Generalized estimating equations were used to compensate for correlation within households. Univariate and multivariable logistic regression modeling were performed to determine the characteristics associated with the risk of loss from the cascade of care. Variable selection for the logistic regression models was purposeful. A P value < .05 was considered statistically significant.

RESULTS

Study staff approached 371 index cases presenting for TB treatment for participation in the Vikela Ekhaya program: 244 (66%) consented to participate in household contact management, 36 (10%) were ineligible for participation, 36 (10%) declined participation (of these, only 1 listed concern about stigma as the primary reason), and 55 (15%) initially consented but then declined to schedule a household or clinic evaluation (Table 1). Of the 36 patients with TB deemed ineligible, 9 reported no household contacts, 5 were diagnosed with drug-resistant TB, and 22 were diagnosed with extrapulmonary TB. Most index cases were approached within 4 weeks of TB diagnosis, 287 (77%) were new TB cases, and 207 (56%) reported cough for ≥ 2 weeks. Index cases who consented to participate overwhelmingly chose community-based contact management, with only 5 families choosing to come to the clinic to be evaluated.

In total, Vikela Ekhaya evaluated 945 household contacts of 244 TB index cases; 8 contacts were evaluated at a TB facility, whereas 937 were evaluated in their homes (Figure 1). Contacts were 59% female, 22% were 4–15 years old, and 30% were younger than 5 years old; 90% were aware of their HIV status, and 124 (13%) were living with HIV (Table 2). Evaluated households were predominately rural (73.4%) and within an hour of a TB clinic (91%). Household size varied widely, and was inclusive of all occupied buildings in the homestead, with 1–14 contacts evaluated per household. Of 286 evaluated contacts younger than 5 years of age, 4 (1%) were living with HIV, and 83% were up to date on maternal and child health indicators including vitamin A supplementation, immunizations, and deworming (Table 3). All 945 contacts were screened for TB symptoms; 72 (8%) contacts reported at least 1 TB symptom, and 4 contacts who reported TB symptoms were eventually diagnosed with prevalent TB. One additional child contact did not have symptoms at the initial evaluation. TPT was not initiated because of an abbreviated home visit as there was police activity in the area. The infant developed symptoms before scheduled follow-up of her symptomatic caregiver 2 weeks later and both were diagnosed with TB. Of the 5 contacts diagnosed with TB, 3 were children, and 1 was living with HIV (Table 4). Cough was the most common TB symptom reported, and 45 (4.6%) contacts reported experiencing coughing for ≥ 2 weeks. Additionally, 821/945 (87%) responded to follow-up calls at study completion (median follow-up time: 257 days; IQR: 208–309 days), resulting in identification of 2 additional TB cases. One was an HIV-negative child younger than 5 years who had completed 3HR TPT before being diagnosed with clinical TB 6 months after completion. The child successfully completed treatment for drug-susceptible TB, and it is possible the child was reinfected with TB after TPT. The other was an adult living with HIV who had declined TPT and was later diagnosed with culture and Xpert-confirmed TB.

All contacts were assessed for TPT eligibility in accordance with national guidelines. Of 330 contacts eligible for TPT, 248 (75%) children younger than 15 years of age agreed to initiate 3HR, and 74 (22%) children and adults living with HIV agreed to initiate 6H. Contacts initiated TPT a median of 6 days (IQR 2–10 days) from index case TB treatment initiation. Only 10 contacts from 8 households chose to have their TPT managed in a facility; the other 312 (97%) chose community-based TPT management. Of the 322 total contacts who initiated TPT, 298 (93%) completed TPT in accordance with WHO definitions and 9 completed late (Figure 1C). Among those not completing TPT, 5 contacts chose to stop TPT, 9 contacts were lost to follow-up, and 1 contact stopped TPT after being diagnosed with TB. In clustered logistic regression analyses, unknown HIV status and positive HIV status were independent predictors of loss from the cascade of care among TPT eligible contacts (adjusted odds ratio [aOR]: 5.7, P = .023 and aOR: 21.1, P = .001, respectively) (Table 5). Additionally, monthly household income of Emalangeni 500–1000 (USD 34–69) and urban setting were risk factors for loss from the cascade of care, compared with monthly household income greater than Emalangeni 1000 and rural setting, respectively (aOR: 5.6, P = .006; aOR: 5.9, P = .001).

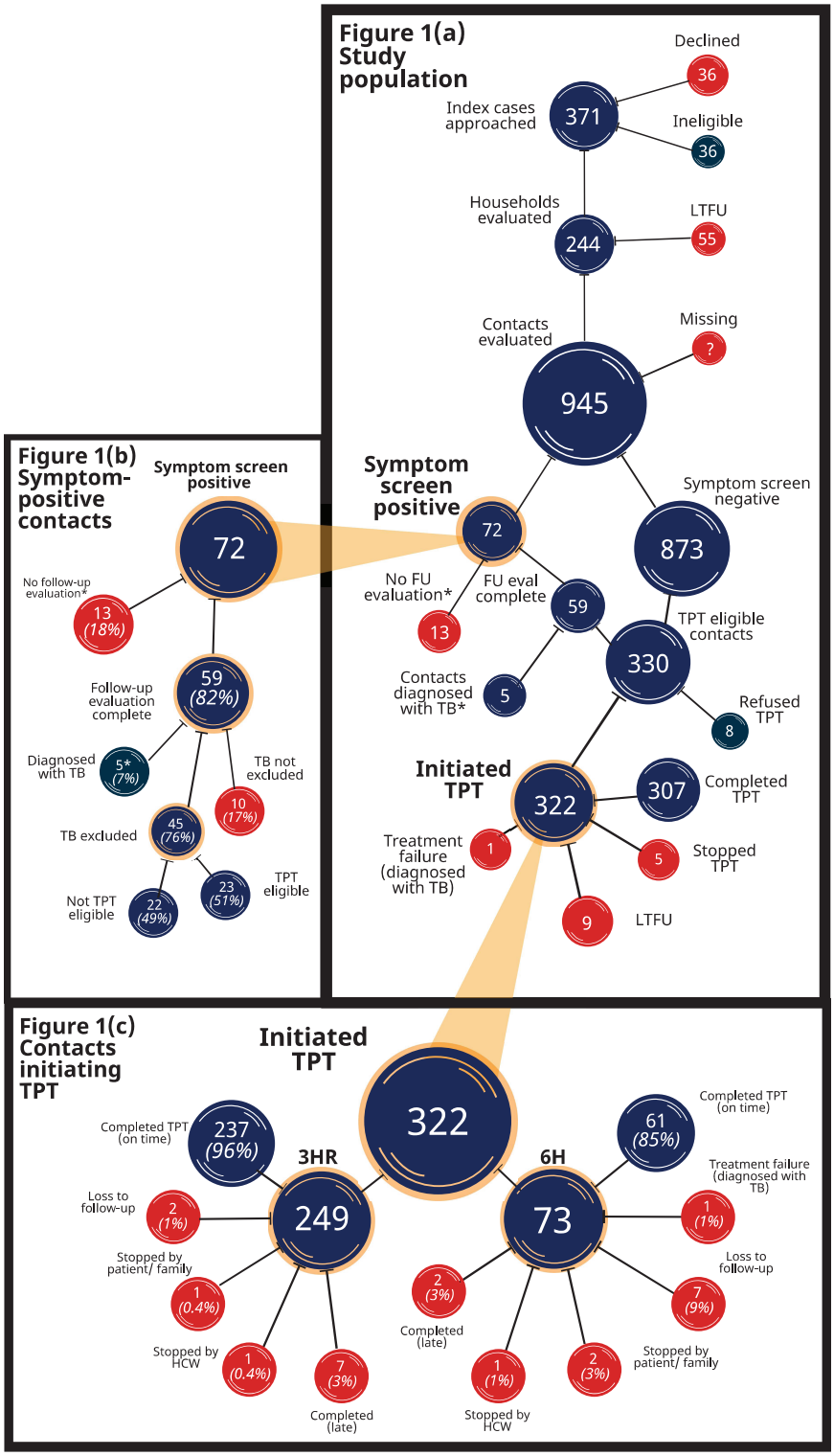

Figure 1. Flow of participants through the program. FU, follow-up; LTFU, loss to follow-up; HCW: healthcare worker; TB, tuberculosis; TPT, tuberculosis preventive therapy. *Follow-up evaluation included 2-week symptom follow-up, clinical examination, and/or diagnostic testing. **One contact initially reported no symptoms but was later diagnosed with TB.

DISCUSSION

Despite a renewed commitment to TPT and newly available shorter regimens, TPT initiation rates remain suboptimal. Further, there are little to no data regarding TPT completion rates or community approaches to support TPT delivery. Our novel contact management program, Vikela Ekhaya, not only

Table 1. Characteristics of Index Cases by Retention in the CoC

	Total	Retained in CoC	Lost to CoC	Fisher Exact Test
	N = 371	N = 244[a]	N = 91[a]	*P* Value
Sex				
Female	136 (36.7%)	90 (36.9%)	31 (34.1%)	.7
Male	235 (63.3%)	154 (63.1%)	60 (65.9%)	
HIV status				.77
Nonreactive	152 (41.1%)	99 (40.6%)	41 (45.6%)	
Reactive	214 (57.8%)	142 (58.2%)	48 (53.3%)	
Unknown	4 (1.1%)	3 (1.2%)	1 (1.1%)	
Time from TB diagnosis				.18
<1 wk	193 (52.0%)	120 (49.2%)	49 (53.8%)	
1–4 wk	112 (30.2%)	80 (32.8%)	24 (26.4%)	
>4 wk	52 (14.0%)	30 (12.3%)	18 (19.8%)	
Missing	14 (3.8%)	14 (5.7%)	0 (0.0%)	
Index case Xpert results				.05
Negative	77 (20.8%)	32 (13.1%)	23 (25.3%)	
Positive	237 (63.9%)	161 (66.0%)	62 (68.1%)	
Missing	57 (15.4%)	51 (20.9%)	6 (6.6%)	
New case				.56
New	287 (77.4%)	176 (72.1%)	80 (87.9%)	
Retreatment	33 (8.9%)	21 (8.6%)	7 (7.7%)	
Unknown	2 (0.5%)	1 (0.4%)	1 (1.1%)	
Missing	49 (13.2%)	46 (18.9%)	3 (3.3%)	
Cough				.35
No cough	148 (39.9%)	97 (39.8%)	29 (31.9%)	
<2 wk	16 (4.3%)	8 (3.3%)	6 (6.6%)	
2–8 wk	161 (43.4%)	109 (44.7%)	43 (47.3%)	
>8 wk	46 (12.4%)	30 (12.3%)	13 (14.3%)	
Fever				.92
None	338 (91.1%)	230 (94.3%)	85 (93.4%)	
<2 wk	9 (2.4%)	5 (2.0%)	2 (2.2%)	
≥2 wk	24 (6.5%)	9 (3.7%)	4 (4.4%)	
Night sweats	93 (25.1%)	51 (20.9%)	24 (26.4%)	.3
Weight loss	101 (27.2%)	55 (22.5%)	30 (33.0%)	.066

Index cases were determined to be "lost" to the cascade of care if they were (1) eligible for participation in the program and (2) declined participation in the program or consented to participation in the program but subsequently declined to schedule household or clinic evaluations. Participants who chose clinic-based contact management and received follow-up were "retained" in the CoC.

Abbreviations: CoC, cascade of care; HIV, human immunodeficiency virus; TB, tuberculosis.
[a]36 index cases were ineligible for participation in the program (included in total), and were excluded from CoC analysis.

Table 2. Characteristics of Household Contacts and Households Evaluated for Vikela Ekhaya

Contact Characteristics		N = 945
Sex	Female	555 (58.7%)
	Male	390 (41.3%)
Age	Adult (>15 y)	453 (47.9%)
	Child (5–15 y)	206 (21.8%)
	Infant (<5 y)	286 (30.3%)
Knowledge of HIV status[a]	Known	853 (90.3%)
	Unknown	92 (9.7%)
HIV status[b]	Nonreactive	799 (84.6%)
	Reactive	124 (13.1%)
	Unknown	22 (2.3%)
Location of evaluation	Health facility	8 (0.8%)
	Household/community	937 (99.2%)
Contacts evaluated (per household)	1–3 contacts	245 (25.9%)
	4–6 contacts	393 (41.6%)
	7–9 contacts	181 (19.2%)
	10+ contacts	126 (13.3%)
TB history	No	912 (96.5%)
	Unsure	6 (0.6%)
	Yes	27 (2.9%)
Household characteristics		N = 244
Any smoker in home	No	219 (90.0%)
	Yes	17 (7.0%)
	Missing	8 (3.3%)
Transport time to clinic	0–30 min	160 (65.6%)
	30 min–1 h	61 (25.0%)
	1–2 h	15 (6.1%)
	2+ h	1 (0.4%)
	Missing	8 (3.3%)
Monthly household income	E0–500	16 (6.6%)
	E500–1000	51 (20.9%)
	E1000–10 000	150 (61.5%)
	E10 000+	18 (7.4%)
	Missing	10 (4.1%)
Household setting	Rural	179 (73.4%)
	Urban	58 (23.8%)
	Missing	8 (3.3%)
Home type	Homestead	158 (64.8%)
	Rented	20 (8.2%)
	Single house	59 (24.2%)
	Missing	8 (3.3%)

Abbreviation: HIV, human immunodeficiency virus.
[a]Knowledge of HIV status at beginning of contact evaluation. All participants with "unknown" status were offered immediate HIV testing and counseling.
[b]Final HIV status after completion of contact evaluation.

demonstrated the feasibility and acceptability of differentiated, community-based TPT delivery in a TB-HIV high-burden setting, but also highlighted its potential impact on TPT delivery. The WHO estimates that 875–1050 children younger than 5 years of age were eligible for TPT in Eswatini in 2019 [22]. Through our intervention, which was supported by 2 mobile clinic nurses, 248 children < 5 years initiated TPT and 237 completed TPT within 4 months of initiation. Hence, this intervention in the Hhohho region, which covers approximately 25% of the population, appears to have achieved near-complete coverage of eligible children.

This report adds to a small but growing body of literature that community-based approaches supporting TPT for drug-resistant and drug-susceptible TB result in higher rates of completion than has typically been reported using facility-based approaches [25]. It also expands on research suggesting that household engagement and symptom-based TPT delivery are effective strategies for reducing TB prevalence and providing TPT in high burden settings [13, 15, 26, 27]. Building on this work, this report is among the first descriptions of a fully decentralized contact management program where screening, prevention, and follow-up took place at patient homes. This approach essentially collapses the contact management cascade

Table 3. Characteristics of Child Household Contacts (<5 Y) Evaluated for Vikela Ekhaya

	Characteristics
	N = 286
Sex	
Female	148 (51.7%)
Male	138 (48.3%)
HIV status[a]	
Nonreactive	282 (98.6%)
Reactive	4 (1.4%)
Unknown	0 (0.0%)
Maternal Child Health interventions up to date[b]	
Not up to date	17 (5.9%)
Up to date	237 (82.9%)
Missing	32 (11.2%)
Nutrition in infants < 6 mo	N = 28
Breastfeeding only	17 (61%)
Formula feeding only	3 (11%)
Breastfeeding and formula	5 (18%)
Missing	3 (10%)
Nutrition in infants 6–12 mo	N = 29
Breastfeeding only	5 (17%)
Breastfeeding and formula	14 (48%)
Mixed feeding	9 (31%)
Missing	1 (3%)
Symptom screen	
Negative	257 (89.9%)
Positive	29 (10.1%)
Symptom duration (n = 29)	
Symptoms ≥ 2 wk	16 (5.6%)
Symptoms < 2 wk	13 (4.5%)

Abbreviation: HIV, human immunodeficiency virus.

[a]Knowledge of HIV status at beginning of contact evaluation. All participants with "unknown" status were offered immediate HIV testing and counseling.
[b]Maternal and child health indicators included: Vitamin A supplement, immunizations, deworming

Table 4. Characteristics of Contacts by TB Diagnosis

Characteristics	No TB Case	TB Case	
	n = 940	n = 5	*P* Value
Sex			.390
Female	553 (58.8%)	2 (40.0%)	
Male	387 (41.2%)	3 (60.0%)	
Age			.88
Adult (>15 y)	451 (48.0%)	2 (40.0%)	
Child (5-15 y)	208 (22.1%)	1 (20.0%)	
Infant (<5 y)	281 (29.9%)	2 (40.0%)	
Knowledge of HIV status[a]			<.001
Known	851 (90.5%)	2 (40.0%)	
Unknown	89 (9.5%)	3 (60.0%)	
HIV status[b]			.86
Reactive	123 (13.1%)	1 (20.0%)	
Nonreactive	795 (84.6%)	4 (80.0%)	
Unknown	22 (2.3%)	0 (0.0%)	
Symptom screen			<.001
Negative	872 (92.8%)	1 (20.0%)	
Positive	68 (7.2%)	4 (80.0%)	
Symptom positive contacts	n = 68	n = 4	
Symptom duration			.086
≥2 wk	46 (72%)	1 (25%)	
<2 wk	18 (28%)	3 (75%)	
Cough			.092
≥2 wk	44 (65%)	1 (25%)	
<2 wk	17 (25%)	3 (75%)	
None	7 (10%)	0 (0%)	
Fever			.82
≥2 wk	3 (4%)	0 (0%)	
<2 wk	3 (4%)	0 (0%)	
None	62 (91%)	4 (100%)	
Weight loss/failure to thrive			.62
No	64 (94%)	4 (100%)	
Yes	4 (6%)	0 (0%)	
Night sweats[b]			.87
≥2 wk	3 (4%)	0 (0%)	
<2 wk	2 (3%)	0 (0%)	
None	25 (37%)	3 (75%)	
Missing	37 (54%)	1 (25%)	

Abbreviations: TB, tuberculosis; HIV, human immunodeficiency virus.

[a]Knowledge of HIV status at beginning of contact evaluation. All participants with "unknown" status were offered immediate HIV testing and counseling.
[b]Final HIV status after completion of contact evaluation.

and nearly eliminates structural barriers for patients to access care. Although in this study nurses dispensed TPT and provided follow-up assessments, next steps could include provision and monitoring of TPT by community health workers to further increase feasibility and reduce costs. eHealth mobile tools similar to that implemented in this project can help to support data collection and reporting from community health workers without access to paper registers at facilities.

Our findings suggest that rural and HIV-unaffected households were more likely to be retained in the cascade of care. Community care may be most appropriate for populations that are not engaged in chronic HIV care, and live in rural homesteads with less ready access to medical services. Although stigma was not perceived as a barrier for the majority of participants receiving community visits, experience from this project suggests that these families may be less concerned with potential stigma associated with health worker community visits than families in more congested and less private urban environments, and may have less experience with HIV-associated stigma. A flexible and varied facility and community approach to contact management is most likely to meet the needs of all families battling household TB exposure.

The high rates of TPT acceptance and completion among eligible children in this project may be attributed to the availability of the shorter 3HR preventive treatment option, as has been observed previously [11]. Shorter preventive therapy options also made community follow-up more manageable, allowing for just 1 additional visit 4–6 weeks after therapy initiation and a visit at treatment completion. Importantly, this regimen is available as a child-friendly formulation, further reducing

Table 5. Clustered Logistic Regression: Risk Factors for Loss From the CoC Among TPT-eligible Household Contacts of TB Cases

Outcome: Loss From the CoC, n = 23		Univariable Analysis N = 330		Multivariable Analysis N = 305	
		OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Gender	Female	REF		REF	…
	Male	0.8 (0.3–1.8)	.567	…	…
Age	Adult (>15 y)	REF		REF	…
	Child (5–15 y)	…	…	…	…
	Infant (<5 y)	0.3 (0.1–0.6)	.002	3.2 (0.6–16.6)	.164
Knowledge of HIV status[a]	Known	REF	…	REF	…
	Unknown	4.2 (1.2–14.5)	.023	5.7 (1.3–25.9)	.023
HIV Status[b]	Nonreactive	REF	…	REF	…
	Reactive	4.5 (1.9–10.5)	.001	21.1 (3.6–122.2)	.001
Household characteristics					
Monthly household income	E0–500	1.6 (0.2–11.0)	.647	1.8 (0.3–11.1)	.55
	E500–1000	3.3 (1.1–9.9)	.033	5.6 (1.6–19.3)	.006
	E1000+	REF	…	REF	…
	Missing	1.7 (0.2–17.6)	.641	3.8 (0.0–351.2)	.56
Household setting	Rural	REF	…	REF	…
	Urban	6.3 (2.4–16.4)	<.001	5.9 (2.0–17.2)	.001
	Missing	1.9 (0.2–17.2)	.578	0.8 (0.0–69.6)	.914

Abbreviations: 3HR, 3-month course of rifampicin and isoniazid; 6H, 6-month course of isoniazid; CoC, cascade of care; REF, reference value; TPT, tuberculosis preventive therapy.

[a]Knowledge of HIV status at beginning of contact evaluation. All participants with "unknown" status were offered immediate HIV testing and counseling.

[b]Final HIV status after completion of contact evaluation. TPT eligible contacts were determined to be "lost" to the cascade of care if they (1) refused TPT or (2) initiated but did not complete assigned TPT regimen. Contacts who completed TPT late (>4 mo for 3HR or > 9 months for 6H) were retained in the CoC.

barriers associated with the use of adult formulations. Our program focused primarily on the highest risk household contacts; however, recent recommendations have suggested expansion of TPT to all household contacts [24]. This expanded access increases the efficiency of community programs such as Vikela Ekhaya by increasing the patients eligible to benefit from TPT at each household.

Even with the inclusion of incident cases identified up to a year following our intervention, we identified TB in < 1% of contacts. This low TB detection rate is consistent with recent evidence from an active case finding study in rural South Africa [28], but less than has been typically observed in studies investigating child household TB contacts [29]. On average, children initiated TPT less than 1 week after index case treatment initiation. Hence, this low TB detection rate may reflect the efficacy of TPT when delivered rapidly with good adherence.

Despite demonstrating a successful model for community-based TB contact management, TPT delivery, and maternal child health care, this program has some important limitations. First, because Vikela Ekhaya was conceived and implemented as a pragmatic intervention, our evaluation is limited to post hoc and operational research questions. Second, although the program would have benefitted from integrated tests of infection for asymptomatic household contacts, this was not financially or logistically reasonable, as is the case in many low-resource settings. Third, because participants were offered free choice of community- or facility-based contact management, the study population was not balanced across exposure groups. Fourth, we were unable to offer TPT to household contacts of drug-resistant TB patients and referred these patients for management within the drug-resistant TB program. Finally, the overwhelming success of our program to improve TPT completion rates may have limited our ability to detect risk factors associated with nonadherence.

In conclusion, by analyzing a TB prevention and control program from identification of at-risk contacts to completion of appropriate TPT or TB treatment, we identified barriers to retention in the cascade of care. This study provides evidence to inform public health practice and the development of novel community-based interventions aimed at improving retention of TB contacts within the cascade of care. Differentiated, community-based, and integrated TB/HIV prevention and control programs can reduce barriers to completion of the contact management cascade of care and lower the risk of TB disease in children exposed to TB.

Notes

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Potential conflicts of interest. R. H. S. is a paid monitoring and evaluation consultant for the Stop TB Partnership and worked with us on this project. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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