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Point of diagnosis and patient retention in HIV care in western Kenya

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Abstract

Background—Home-based counseling and testing (HBCT) achieves earlier HIV diagnosis than other testing modalities; however, retention in care for these healthier patients is unknown. The objective of this study was to determine the association between point of HIV testing and retention in care and mortality.

Setting—AMPATH (Academic Model Providing Access to Healthcare) has provided HIV care in western Kenya since 2001.

Methods—AMPATH initiated HBCT in 2007. This retrospective analysis included individuals 13 years, enrolled in care between January 2008–September 2016, with data on point of testing. Discrete time multi-state models were used to estimate the probability of transition between the following states: engaged, disengaged, transfer, and death, and the association between point of diagnosis and transition probabilities.

Results—Among 77,358 patients, 67% female, median age: 35 years and median baseline CD4: 248 cells/mm³. Adjusted results demonstrated that patients from HBCT were less likely to disengage (relative risk ratio (RRR)=0.87, 95% CI:0.83-0.91) and die (RRR=0.65, 95% CI:

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0.55-0.75), while those diagnosed via provider-initiated counseling and testing were more likely to disengage (RRR=1.09, 95% CI:1.07-1.12) and die (RRR=1.13, 95% CI:1.06-1.20), compared to patients from voluntary counseling and testing (VCT). Once disengaged, patients from HBCT were less likely to remain disengaged, compared with patients from VCT.

Conclusion—Patients entering care from different HIV testing programs demonstrate differences in retention in HIV care over time beyond disease severity. Additional research is needed to understand the patient and system level factors that may explain the associations between testing program, retention and mortality.

Keywords

retention; HIV care; HIV testing; HIV diagnosis; sub-Saharan Africa

Introduction

Kenya's comprehensive strategy for achieving the ambitious goal of eliminating incident HIV infections by 2030 includes ensuring widespread access to different modes of HIV counseling and testing, while improving and facilitating retention in care following HIV diagnosis.¹ Recent national data from the Kenyan AIDS Indicator Survey (KAIS) showed that in Kenya, however, 53% of people living with HIV were unaware of their status,² while data specific to western Kenya showed that 39% were unaware of their infection at the time of diagnosis.³ Towards the goal of universal access to HIV testing and treatment, several strategies including home-based counseling and testing (HBCT), provider-initiated testing and counseling (PITC) and voluntary counseling and testing (VCT) have expanded in the previous decade across sub-Saharan Africa. HBCT has been shown to successfully diagnose HIV earlier than PITC and VCT in western Kenya and elsewhere in sub-Saharan Africa.⁴⁻⁶

Early diagnosis, timely initiation of antiretroviral therapy (ART), and retention in HIV care over time are all critical elements of the HIV care continuum, maximizing health outcomes for PLWH and conferring prevention benefits to the population. However, once PLWH enroll in care following diagnosis, it is unknown whether patients entering care from different HIV testing programs have comparable retention in care over time. In particular those not yet eligible for ART have historically been less likely to be retained in care,^{7,8} and it is likely that there are a greater number of pre-ART patients diagnosed in HBCT compared to other testing programs. Understanding the differential engagement in the care continuum and associated risks of mortality for PLWH entering care from different testing programs will enable targeted interventions tied to testing programs in order to enhance both linkage and retention in care over time.

The objective of this study, therefore, was to determine the association between point of diagnosis (i.e., HIV testing program) and retention in HIV care among patients enrolling in HIV care in western Kenya using data from the Academic Model for Promoting Access to Healthcare (AMPATH) program. AMPATH, a partnership between Moi University, Moi Teaching and Referral Hospital and a consortium of North American institutions, has provided HIV treatment and care in western Kenya since 2001.⁹ AMPATH has also been offering widespread HBCT in the region since 2007.¹⁰ Because of the analytic challenges of

examining retention in care presented by patients moving in and out of care over time,¹¹ as well as the competing risks from deaths, dropping out of care, and transferring care using traditional survival models, we used multi-state models to examine the transitions between engagement and disengagement from care, transfer, and death.¹²

Methods

Study setting

AMPATH has been described in detail elsewhere.^{9,13} Briefly, AMPATH is headquartered in Eldoret, Kenya (about 350 km northwest of Nairobi) and has enrolled over 160,000 HIV-infected patients in Ministry of Health facilities around western Kenya. All HIV and tuberculosis (TB)-related care and treatment are free at the point of service for patients. The HIV clinical care protocols used by AMPATH are consistent with WHO guidelines. Care is supported and data are managed via the AMPATH electronic medical record system (AMRS), which has been adopted for use in more than 50 countries.^{14,15} AMPATH has also offered widespread HBCT in the region since 2007. Ministry of Health certified counselors have offered door-to-door testing and counseling in 12 medium and high HIV burden sub-counties of the AMPATH catchment. HBCT is offered alongside traditional facility-based VCT and PITC in the region.¹⁰

Study sample

This retrospective analysis was restricted to 77,358 patients 13 years of age who newly enrolled in care at an AMPATH site between January 2008 and September 2016. We excluded 14,857 patients who did not have information regarding point of HIV diagnosis in their medical record.

Definition of states

To define patient retention in HIV care over time, we began by partitioning time into fixed 200-day intervals starting from the date of enrollment in HIV care. Expected return dates by AMPATH protocol are 3 months for patients on ART and 6 months for patients not on ART. We allowed 14 additional days beyond these guidelines; accordingly, patients were expected to have at least one clinic visit record at every 197 days ($=30.5 \text{ days} \times 6 \text{ months (if not on ART)} + 14 \text{ days}$) regardless of their ART status to be defined as engaged and disengaged, unless they had transferred or died. To simplify, we set 200-day intervals to ascertain patient status over time. Patient status at each interval end point was described using 6 mutually exclusive states (Figure 1): Engaged in care (state=1), missed one expected visit (disengaged for one interval; state=2), missed two visits (disengaged for two intervals; state = 3), missed three or more visits (disengaged for three or more intervals; state = 4), transferred out of care (state=5), and deceased (state=6). Each of the six states represents transitions related to retention in care. For example, transitions within the first state represent retention, while transitions from the disengaged states to the engaged state represent re-entry into care (Figure 1). While patients could pass in and out of the engaged and disengaged states, transfer and death were considered absorbing states.

Statistical analysis

We employed descriptive statistics to describe the baseline demographic and clinical characteristics of the sample. We used Pearson chi-squared and Wilcoxon rank sum tests to examine differences in baseline characteristics comparing patients from different points of diagnosis.

Discrete time multi-state models (DMM; i.e., multinomial regression models) were used to estimate the probability of transitioning from engaged in care to remaining engaged in care (state 1), missed one visit (state 2), transferred (state 3) and deceased (state 4). Similarly a separate model estimated the probability of transition from one to two missed visits (state 2), or death; and for each successive missed visit state. Transfer-out, and deceased were absorbing states and thus a patient did not contribute to the estimation once they transitioned into one of these states.

The state transition rates were defined as $p_{jk}(t) = \Pr(\text{in state } k \text{ at time } t \mid \text{in state } j \text{ at time } t - 1) = \Pr(\text{transition from state } j \text{ to state } k \text{ at time } t)$. For example, $p_{12}(t)$ is the probability of transition from engaged to disengaged; $p_{21}(t)$ is the probability of transition from disengaged to re-entry into care, and $p_{11}(t)$ is probability of retention in care (i.e., engaged to engaged).

We estimated the association between point of diagnosis and specific state transition rates through DMM. Technical details and application of the DMM approach can be found elsewhere.¹² We use *engagement in care* as the reference state although model fits are equivalent with other reference categories.

The main exposure of interest in this analysis was point of HIV diagnosis and the categories included: (1) VCT/mobile voluntary counseling and testing (reference), (2) HBCT, (3) PITC and antenatal testing, (4) testing in the tuberculosis clinic (TB) or in an inpatient setting, and (4) other testing venues. Point of diagnosis was self-reported at the time of enrollment in HIV care and was documented in the patient medical record. We chose VCT/MVCT as the reference category because our main research question was to determine how patients enrolling in care following diagnosis via HBCT compared with those from VCT, since patients from VCT sought out testing and were likely the most motivated to stay in care following diagnosis. PITC was defined as all provider-initiated testing and included inpatient and diagnostic testing performed by a clinician, testing in outpatient units, and prenatal testing. Adjusted models included the following potential confounders: sex (male vs. female), age (≥ 35 vs. <35 years), CD4 count (≥ 350, <350 cells/mm³, or never measured), ART use (yes/no), calendar year, and time in care. The definition of ART varied depending on whether or not the initial state was engaged or disengaged. For those engaged in care, ART was defined as ART status in the prior time interval, while for those in the disengaged state, ART was defined as ART use at last known status (e.g., last clinical visit prior to disengaging from care). Bootstrapping with 1000 samples was used to calculate 95% confidence intervals to account for the correlation from repeated measures among individual patients.

Coefficients in the DMM are log relative risk ratios (RRR), therefore we present results from models as RRR. Adjusted results are presented as adjusted RRR, representing the

association between the covariate and the transition from one state to another relative to the transition to the reference state.

Role of the funding source

The funding sources had no role in the design of the study, interpretation of the data, writing of the report, or decision to submit for publication.

Results

Characteristics of the study sample

Table 1 presents the baseline demographic and clinical characteristics of the 77,358 patients included in the analysis. Sixty-seven percent were female, with median age of 35 years, median CD4 count at baseline of 248 cells/mm³ and 12% transferred in on ART or were initiated ART at baseline. Fifty-one percent of the sample was diagnosed through PITC, 28% percent through VCT and 7% through HBCT. Approximately one-quarter were married or living with a partner at baseline. The median time from enrollment in care to database closure was 5.2 years. Patients entering care from HBCT had the highest median CD4 count at baseline (323 cells/mm³), while patients entering via TB/inpatient care had the lowest CD4 count (131 cells/mm³).

Average transition probabilities

Overall the average probability of being retained in care (i.e., remaining in the engaged state once engaged in care) was 0.85, while the probability of disengaging from care was 0.13 (data not shown). Once disengaged, the average probability of remaining disengaged was 0.88 and becoming reengaged in care as 0.11 (data not shown).

Associations between point of testing and state transitions

Table 2 presents the adjusted RRR of the associations between point of testing and transitions from the engaged state, accounting for patient demographic and clinical characteristics. Adjusted results demonstrated that among those engaged in care, diagnosis via HBCT was associated with lower probability of disengaging from care (RRR=0.87, 95% CI: 0.83-0.91), transferring-out (RRR=0.67, 95% CI: 0.52-0.82) and death (RRR=0.65, 95% CI: 0.55-0.75), compared to VCT. Testing and diagnosis in PITC was associated with higher rates of disengagement in care (RRR=1.09, 95% CI: 1.07-1.12) and higher mortality rates (RRR=1.13, 95% CI: 1.06-1.20) compared to entering care via VCT, with similar and slightly stronger results observed for testing and diagnosis via TB clinics or other inpatient settings.

Transitions out of care were related to CD4 count and ART use. Once engaged in care, compared with those with low CD4 count (<350) who were not on ART, all other CD4/ART groups were less likely to disengage from care, transfer or die, except for those who had no information regarding their CD4 count and were not on ART which had higher probability of disengagement in care (RRR=1.60, 95% CI: 1.54-1.67). Age and sex were also related to retention in HIV care. Once engaged in care, older age (≥ 35 years) was associated with lower rates of disengagement (RRR=0.64, 95% CI: 0.63-0.66) and transferring care

(RRR=0.55, 95% CI: 0.50-0.61), and higher rates of death (RRR=1.15, 95% CI: 1.08-1.22), compared with younger age. Males who were engaged in care were more likely to disengage from care (RRR=1.09, 95% CI: 1.06-1.11) and die (RRR=1.15, 95% CI: 1.08-1.22), compared to females.

Table 3 presents the adjusted RRR of the associations between point of testing and disengagement in care, accounting for patient demographic and clinical characteristics. Following one 200-day interval with no visit, diagnosis via HBCT was associated with lower probabilities of having subsequent 1, 2, or 3 or more 200-day intervals without a visit (RRR=0.82, 95% CI: 0.71-0.92; RRR=0.74, 95% CI: 0.62-0.90; RRR=0.55, 95% CI: 0.48-0.66, respectively), compared to re-engaging in care, while diagnosis from PITC was associated with a greater risk of subsequent 1, 2 or 3 or more 200-day intervals without a visit (RRR=1.14, 95% CI: 1.06-1.23; RRR=1.24, 95% CI: 1.10-1.40; RRR=1.16, 95% CI: 1.06-1.27, respectively). There were no differences in mortality rates following disengagement from care that were associated with diagnosis via HBCT vs. VCT.

Similar to transitions out of care, once disengaged for one 200-day interval, all CD4 and ART use groups had lower probabilities of having an additional 200-day period without a visit and death, compared with CD4 count ≥ 350 and no ART use, except for those without CD4 information who reported no ART use, where risk for continued disengagement and death was higher. Age and sex were also related to continued disengagement from care once disengaged for one interval. Older age (≥ 35 years) was associated with a subsequent period of being disengaged following the initial 200-day period with no visit (RRR=0.91, 95% CI: 0.84-0.96), compared with younger age, but not with having 2, 3 or more periods without a visit (RRR=1.00, 95% CI: 0.90-1.10; RRR=0.98, 95% CI: 0.91-1.07). Once disengaged, males were more likely to remain disengaged over time (RRR=0.90, 95% CI: 0.84-0.96; RRR=0.89, 95% CI: 0.79-0.99; RRR=0.81, 95% CI: 0.74-0.88), compared with females.

Discussion

The main finding of this study is that, among those who initiate care, diagnosis via HBCT was associated with higher retention in care and lower mortality compared to diagnosis via VCT. At the same time, once disengaged from care, diagnosis via HBCT was associated with lower rates of further disengagement from care and lower rates of death, compared to diagnosis from VCT. These associations were observed after adjusting for severity of disease progression as measured by CD4 counts, and ART use. Patients who entered care from PITC, TB/inpatient and other testing programs were more likely to disengage from care, compared with those who enrolled following VCT. Patients who disengaged from care were more likely to remain disengaged if they were diagnosed via PITC or in the TB clinic/inpatient testing compared to patients who entered care after VCT.

Home-based counseling and testing is an effective strategy to expand HIV testing in rural areas of sub-Saharan Africa and identify people living with HIV in a timely manner, with higher CD4 counts, compared with facility-based testing venues.^{4-6,16-19} Patients who initiate ART with higher CD4 cell counts benefit from improved clinical outcomes. However, it was not previously known whether patients diagnosed with HIV via HBCT, who

are healthier in general than those receiving diagnoses from other testing venues, would be as likely to be retained in care once enrolled due to research demonstrating lower pre-ART retention in other settings.^{7,8} That patients who entered care following HBCT were less likely to disengage from care compared to those who tested via VCT provides evidence that not only can HBCT successfully identify individuals earlier in the course of HIV disease progression, but that individuals who entered care from HBCT may be more likely to stay in care over time. Beyond retention in care, patients who entered care from HBCT had lower mortality rates than those who tested via VCT. Again, this finding supports earlier research indicating that HBCT can achieve earlier diagnosis than other testing programs, adding to the potential impact on patient outcomes and effectiveness of HBCT programs overall.

It is unknown precisely how the HIV testing and diagnosis platform impacts retention and patient outcomes beyond differences in clinical disease stage and severity at the time of diagnosis. As a testing strategy HBCT removes many barriers related to convenience, distance, travel, and opportunity costs associated with accessing testing at facilities, as well as reducing fears of HIV-related stigma that may be associated with being seen at testing venues.²⁰ The removal of these barriers at the testing phase may result in motivation toward higher adherence to clinic appointments later on for patients diagnosed with HIV at home. It is also possible that differences in the administration of counseling, offer and acceptance of testing, and venue of testing may contribute to improved patient health-seeking behavior. It is possible that there are differences in patient characteristics for individuals testing at different programs, such as motivation to seek care, acceptance of HIV diagnosis, or fears of stigma, that may explain differences in retention in care later on. For example, the role of tester in seeking out testing itself varies by testing programs, with HBCT offering testing to those least actively seeking care or testing compared to other testing included in this analysis. Readiness for diagnosis may differ from those testing via VCT since VCT testers have availed themselves of testing for reasons possibly related to risk behaviors or illness. Alternatively, a patient diagnosed through PITC is accessing healthcare at the time of the test, although they may not have sought care with the intention of testing for HIV. Their HIV diagnosis most likely arose from diagnostic tests ordered by a clinician and therefore patients diagnosed via PITC may be less motivated to remain in care compared to those who actively sought out testing via VCT. Further research, particularly qualitative research, may provide additional insight into how testing programs impact later retention in HIV care.

Our analysis demonstrated that patients who entered care following PITC were more likely to disengage and transfer out of care, and they had higher mortality rates, compared with patients who enrolled in HIV care following VCT. A recent study from Zambia similarly found decreased retention in care at 6-months among those diagnosed via PITC compared with patients diagnosed via VCT.²¹ Because patients who enroll in care from PITC are more likely to have advanced disease compared with those diagnosed via other testing programs, some of the increased attrition from care following PITC in this study and previous research may be related to underreported mortality. Our models attempted to account for differences in disease stage by adjusting for CD4 count and ART status; however, there may be incomplete ascertainment of death among this sample of patients, given that a substantial amount of the LTFU within eastern African treatment programs is likely due to underreporting of migration and death.^{22,23}

There are several limitations to consider with the findings presented here. It is possible that those who link to care following testing from either HBCT or VCT may be different in important ways from those who do not link to care from either testing program, with potential for selection bias among those included in this analysis. Individuals who accessed VCT actively sought out testing, compared to those testing via HBCT, where decisions to test were more passive. While linkage to care following HBCT varies widely across settings in SSA²⁴ and has been shown to be low in one catchment of our program,³ it is unknown whether there are more generalized differences in characteristics of patients entering care that would induce selection bias between testing programs, potentially impacting the results shown here in unknown ways. Future research is needed to examine the entire cascade, from testing through long-term retention, using novel statistical approaches to fully capture and examine the impacts of testing modality on health seeking behaviors, accounting for all losses occurring in the care cascade, including attrition between diagnosis and enrollment in care. Other limitations of this analysis include the potential for under-ascertainment of outcomes related to migration or death, particularly among patients disengaged from care. It is possible that the differences in the probability of death among patients enrolling from the TB clinic reflect differing resources of follow-up for this particular patient population. There may be some error associated with the measurement of point of entry as it is mainly self-reported by patients. Finally, we could not compare patient outcomes from regions with and without availability of HBCT because it was implemented program-wide.

This paper presents results from a statistical approach that attempts to capture transitions in and out of care, transfers, and death within one modeling framework.¹² The results may therefore provide a more comprehensive picture of retention compared to previous studies. Our results demonstrate that this statistical approach may be a feasible and practical way to examine the impact of covariates on transitions between states in the HIV care cascade.

While prior research has demonstrated the feasibility and acceptability of HBCT on uptake of testing, the cost effectiveness of HBCT, and the increased identification of individuals with higher CD4 counts^{5,17,18} there has been limited research to compare the transitions through the care cascade among patients diagnosed from HBCT. Patients diagnosed with HIV via HBCT in this study were more likely to be retained in care and less likely to die when compared with patients diagnosed via VCT. Most patients were diagnosed via PITC and the probability of transitioning out of engaged to other less optimal states was more likely among these patients, compared with other testing programs.

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Figure 1.

Graphical representation of retention aspects of care in the spanning of the HIV care continuum. Circles represent operational states that define the care retention. **Engaged** represents engaged in care state. **Disengaged 1, 2 and 3+** represents disengaged for 1 interval (200 days; missed 1 expected clinical visit), 2 consecutive intervals (missed two visits), and 3 or more intervals (missed 3 or more visits), respectively. Arrows represent all possible one-step transitions within and between states and their practical meanings.

Baseline socio-demographic and clinical characteristics of 77,358 patients enrolled in care between 2008 and 2016, overall (total) and by point of entry into care (VCT, HBCT, PITC, TB/inpatient, Other^{*}).

Table 1

Baseline patient characteristics	Total N=77,358	VCTn=21,536	HBCTn=5,321	PITCn=39,538	TB/inpatientn=2,211	Othern=8,752
Female, n (%)	51,445 (67)	13,770 (64)	3,648 (69)	26,988 (68)	1,248 (56)	5,791 (66)
Median age, in years (IQR)	35 (28, 43)	36 (29, 44)	36 (28, 45)	34 (27, 41)	37 (31, 45)	35 (29, 43)
Married or living with partner, n (%)	20,987 (27)	5,477 (25)	992 (19)	11,849 (30)	440 (20)	2,229 (25)
Median CD4 cell count, in cells/mm ³ (IQR) [*]	248 (102, 437)	225 (94, 414)	323 (188, 511)	247 (100, 438)	131 (44, 287)	310 (145, 479)
Year of enrollment, n (%)						
2008	4,264 (6)	1,944 (9)	126 (2)	1,186 (3)	377 (17)	631 (7)
2009	14,320 (19)	6,160 (29)	518 (10)	5,207 (13)	455 (21)	1,980 (23)
2010	13,670 (18)	4,325 (20)	855 (16)	6,402 (16)	447 (20)	1,641 (19)
2011	12,527 (16)	3,145 (15)	1,281 (24)	6,469 (16)	316 (14)	1,316 (15)
2012	9,997 (13)	2,137 (10)	674 (13)	5,958 (15)	213 (10)	1,015 (12)
2013	7,632 (10)	1,550 (7)	525 (10)	4,652 (12)	137 (6)	768 (9)
2014	7,810 (10)	1,249 (6)	779 (15)	4,936 (12)	126 (6)	720 (8)
2015	6,564 (8)	931 (4)	546 (10)	4,332 (11)	134 (6)	621 (7)
2016	574 (1)	95 (4)	17 (3)	396 (1)	6 (3)	60 (7)

^{*} VCT: voluntary counseling and testing; HBCT: home-based counseling and testing; PITC: provider-initiated counseling and testing; TB: tuberculosis clinic or inpatient testing; IQR: interquartile range

Table 2

Adjusted relative risk ratios (and 95% confidence intervals) of testing program (compared to VCT) and transitions from engaged in care to disengaged, transfer and death, relative to remaining engaged at time t.

State at t-1		Engaged in care		
State at t		Disengaged	Transfer	Death
Diagnosis	VCT	Reference		
	HBCT	0.87 (0.83-0.91)	0.67 (0.52-0.82)	0.65 (0.55-0.75)
	PITC	1.09 (1.07-1.12)	1.02 (0.91-1.13)	1.13 (1.06-1.20)
	TB/inpatient	1.15 (1.08-1.23)	0.96 (0.68-1.26)	1.50 (1.30-1.70)
	Other	1.14 (1.10-1.19)	1.75 (1.54-2.00)	1.01 (0.91-1.11)
Age, in years	<35	Reference		
	35	0.64 (0.63-0.66)	0.55 (0.50-0.61)	1.15 (1.08-1.22)
Sex	Female	Reference		
	Male	1.09 (1.06-1.11)	0.88 (0.80-0.97)	1.76 (1.66-1.86)
	CD4<350, no ART	Reference		
	CD4<350, on ART	0.15 (0.15-0.16)	0.28 (0.23-0.34)	0.47 (0.43-0.51)
	CD4 350, no ART	0.31 (0.29-0.32)	0.24 (0.19-0.31)	0.11 (0.09-0.12)
	CD4 350, on ART	0.11 (0.11-0.12)	0.18 (0.15-0.22)	0.13 (0.12-0.15)
	No CD4, no ART	1.60 (1.54-1.67)	1.18 (0.87-1.64)	1.00 (0.89-1.11)
	No CD4, on ART	0.38 (0.36-0.39)	0.53 (0.41-0.68)	0.56 (0.51-0.63)

* VCT: voluntary counseling and testing; HBCT: home-based counseling and testing; PITC: provider-initiated counseling and testing; TB: tuberculosis clinic or inpatient testing; VCT was the reference category in this model.

Adjusted relative risk ratios (and 95% confidence intervals) of testing program (compared to VCT) on transitions from disengaged in care to continued disengagement and death, relative to becoming reengaged at time t.

State at t-1		Disengaged 1		Disengaged 2		Disengaged 3 or more	
State at t	Disengaged 2	Death	Disengaged 3	Death	Disengaged 3	Death	
Diagnosis	VCT	Reference					
	HBCT	0.82 (0.71-0.92)	0.69 (0.28-1.19)	0.74 (0.62-0.90)	1.30 (0.38-2.89)	1.28 (0.64-2.30)	
	PITC	1.14 (1.06-1.23)	0.98 (0.72-1.39)	1.24 (1.10-1.40)	1.77 (1.07-2.97)	1.03 (0.69-1.52)	
	TB/np	1.40 (1.14-1.74)	1.82 (0.84-3.10)	1.17 (0.89-1.59)	2.17 (0.64-4.70)	0.99 (0.26-2.03)	
	Other	0.90 (0.82-0.99)	0.98 (0.61-1.48)	0.79 (0.69-0.91)	1.21 (0.60-2.25)	0.41 (0.18-0.75)	
Age, in yrs	<35	Reference					
	35	0.90 (0.85-0.96)	1.31 (0.98-1.72)	1.00 (0.90-1.10)	1.57 (1.03-2.56)	1.01 (0.72-1.52)	
Sex	Female	Reference					
	Male	0.90 (0.84-0.96)	1.27 (0.97-1.68)	0.89 (0.79-0.99)	0.90 (0.58-1.39)	1.48 (1.03-2.09)	
CD4<350, no ART		Reference					
CD4<350, on ART		0.27 (0.24-0.31)	0.63 (0.42-0.94)	0.32 (0.26-0.38)	0.81 (0.44-1.57)	0.54 (0.37-0.86)	
CD4 350, no ART		0.55 (0.47-0.62)	0.28 (0.16-0.50)	0.81 (0.67-0.98)	0.22 (0.04-0.59)	0.32 (0.16-0.57)	
CD4 350, on ART		0.26 (0.22-0.29)	0.26 (0.14-0.44)	0.31 (0.25-0.38)	0.14 (0.03-0.35)	0.12 (0.05-0.24)	
No CD4, no ART		2.77 (2.25-3.45)	2.40 (1.35-4.45)	2.95 (2.16-4.23)	2.20 (0.57-5.77)	1.14 (0.47-2.38)	
No CD4, on ART		0.39 (0.34-0.45)	0.46 (0.23-0.79)	0.33 (0.27-0.39)	0.52 (0.19-1.29)	0.20 (0.08-0.38)	

* VCT= voluntary counseling and testing; HBCT = home-based counseling and testing; PITC = provider-initiated counseling and testing; TB = tuberculosis clinic or inpatient testing; VCT was the reference category in this model.