High HIV Testing Uptake and Linkage to Care in a Novel Program of Home-Based HIV Counseling and Testing With Facilitated Referral in KwaZulu-Natal, South Africa

Heidi van Rooyen, PhD, Ruanne V. Barnabas, MD, DPhil,†‡§ Jared M. Baeten, MD, PhD,†‡‖ Zipho Phakathi,* Philip Joseph,* Meighan Krows,†‡ Ting Hong, MD, PhD,†‡ Pamela M. Murnane, MPH,‖ James Hughes, PhD,§‖ and Connie Celum, MD, MPH †‡‖*

Objective: For antiretroviral therapy (ART) to have a population-level HIV prevention impact, high levels of HIV testing and effective linkages to HIV care among HIV-infected persons are required.

Methods: We piloted home-based counseling and testing (HBCT) with point-of-care CD4 count testing and follow-up visits to facilitate linkage of HIV-infected persons to local HIV clinics and uptake of ART in rural KwaZulu-Natal, South Africa. Lay counselor follow-up visits at months one, three and six evaluated the primary outcome of linkage to care. Plasma viral load was measured at baseline and month six.

Results: 671 adults were tested for HIV (91% coverage) and 201 (30%) were HIV-infected, of which 73 (36%) were new diagnoses. By month three, 90% of HIV-infected persons not on ART at baseline had visited an HIV clinic and 80% of those eligible for ART at baseline by South African guidelines (CD4≤200 cells/μL at the time of the study) had initiated ART. Among HIV-infected participants who were eligible for ART at baseline, mean viral load decreased by 3.23 log10 copies/mL ($p<0.001$) and the proportion with viral load suppression increased from 20% to 80% between baseline and month six.

Conclusions: In this pilot of HBCT and linkages to care in KwaZulu-Natal, 91% of adults were tested for HIV. Linkage to care was ~90% both among newly-identified HIV-infected persons as well as known HIVinfected persons who were not engaged in care. Among those eligible for ART, a high proportion initiated ART and achieved viral suppression, indicating high adherence and reduced infectiousness.

Key Words: home-based counseling and testing, point-of-care CD4, facilitated referral and linkage to care, HIV treatment and adherence, HIV infectiousness

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INTRODUCTION

South Africa has the greatest number of persons living with HIV infection of any nation,[1] yet only approximately 50% of adults in South Africa are aware of their HIV serostatus.[2] Antiretroviral therapy (ART) can significantly reduce HIV transmission and infectiousness.[3,4] However, to achieve a population reduction in HIV incidence with ART, very high levels of HIV testing, linkages to HIV care, uptake of ART, and sustained adherence to ART will be needed to significantly reduce HIV infectiousness.[5]

New HIV testing strategies will be required to approach the target of universal knowledge of HIV status. Home-based counseling and testing (HBCT) involves the delivery of HIV counseling and testing by lay counselors to adults in their homes. HBCT was pioneered in a district-wide program in rural southwestern Uganda from 2004 through 2007, in which 62% of households were tested with 91% HIV testing uptake[6] with a significant increase in reported disclosure of HIV test results and safer sexual behaviors.[7] HBCT has been successfully implemented in several other localities in the region including Botswana,[8] Zambia,[9] Kenya,[10] Malawi,[11,12] and South Africa[13,14] demonstrating high testing uptake in diverse sub-Saharan settings and high acceptability. By bringing HIV testing to peoples' homes in resource-limited settings, HBCT reaches previously untested persons who are unaware of their HIV infection.[6,9,13,15]

Despite the success of HBCT in achieving high testing uptake, the high dropout in sub-Saharan African countries at each step of the engagement-in-care cascade is increasingly recognized, with challenges in achieving high uptake of CD4 testing and linkages to ART, sustained adherence, and viral suppression, particularly for those who are asymptomatic with higher CD4 counts.[16–18] Although HBCT reaches individuals with higher CD4 counts and asymptomatic disease,[19,20]

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From the *Human Sciences Research Council, Sweetwaters, KwaZulu-Natal, South Africa; Departments of †Global Health; and ‡Medicine, University of Washington, Seattle, WA; §Vaccine and Infectious Diseases Division, Fred Hutchinson Cancer Research Center, Seattle, WA; and ‖Department of Epidemiology, University of Washington, Seattle, WA.

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Correspondence to: Heidi van Rooyen, PhD, HIV/AIDS, Sexually Transmitted Infections and TB (HAST) Program, Human Sciences Research Council, 750 Francois Road, Durban 4001, South Africa (e-mail: hvanrooyen@hsrc.ac.za).

knowledge of HIV serostatus alone is not sufficient to get sustained engagement into care. In a previous district-wide HBCT study in Uganda that tested 264,966 participants and identified 11,359 (4.3%) HIV-positive individuals, only 11% initiated ART.[21] Late presentation results in lower treatment ART response rates, higher mortality, higher treatment costs, and by increasing the duration not on ART also likely contributes to increased HIV transmission rates.[17,20] Strategies to efficiently link newly identified HIV-infected persons into care and assess their eligibility for ART are needed.

We conducted an assessment of a novel adaptation of HBCT that included point-of-care CD4 testing and facilitated referrals to HIV care (HBCT-Plus) in rural KwaZulu-Natal to determine whether this model achieved (1) high HIV testing coverage, (2) identified HIV infected persons who are unaware of their HIV serostatus, (3) reduced potential barriers to engagement in HIV care, and (4) reduced HIV infectiousness through high uptake of and adherence to ART.

METHODS

Research Setting and Procedures

The study was conducted from March 2011 to March 2012 in the Vulindlela subdistrict of the Umgungundlovu District, KwaZulu-Natal, South Africa, which is characterized by high unemployment and low per capita income (below USD $2 per day). HIV prevalence in KwaZulu-Natal was 15.3% among 15-year-old to 24-year-old persons and 23.5% among persons aged 25 years or younger in the 2008 National HIV Prevalence Survey.[2]

The study area was a geographically distinct area of contiguous households within walking distance of a primary health center and an ART care center. After consultation with local leaders, community mobilization activities were conducted to prepare members for the study. Community mobilizers informed households about the study, completed household enumeration, identified eligible resident household members older than 18 years, and assessed optimal delivery times for HBCT. Participants were eligible to participate if they resided in the household, which was defined as spending 2 nights per week in the household. Known HIV-positive participants were considered eligible for the study.

After obtaining individualized written informed consent, participants were administered a standardized questionnaire about demographics, sexual behavior, and history of HIV testing using the mobile phone software Mobenzi Researcher (Durban, South Africa). HBCT was then performed with standardized risk reduction pretest and posttest counseling messages. Counseling and HIV testing were conducted by lay counselors or enrolled nurse assistants in a separate room in the house or privately outside the house. If a couple participated, they were counseled and tested separately with facilitated disclosure provided with their consent.

For persons found to be HIV seropositive, an additional questionnaire was administered about sexual behavior, HIV testing and knowledge, HIV clinic visits, ART initiation, opportunistic infection prophylaxis, and symptoms suggestive of tuberculosis (TB), sexually transmitted infections (STIs), and advanced HIV. Point-of-care CD4 testing was conducted in the home at the same visit when a positive rapid HIV test was obtained, and results were used to determine whether the person was eligible for ART under South African ART initiation guidelines (CD4 $\leq$200 cells and CD4 $\leq$350 cells if pregnant or coinfected with TB). ART initiation guidelines changed to CD4 $\leq$350 cells per microliter in August 2011, and study counseling messages and analysis plans were updated. The importance of accessing treatment was emphasized, and the participant was encouraged to visit their local clinic as soon as possible. HIV-infected persons were counseled on the process of clinic screening, treatment initiation, and adherence so that they were adequately prepared on arrival at the clinic. Participants were compensated with a food parcel for their time but did not receive financial incentives or transport compensation to attend the HIV clinic. The date of the participant's HIV test, point-of-care CD4 test result, STI, TB, and advanced HIV symptoms were provided in a referral letter to HIV clinics to facilitate referral for ART eligibility assessment.

Follow-up visits of HIV-infected persons were conducted at 1, 3, and 6 months to assess uptake of clinic visits and ART initiation and counsel about HIV care and ART adherence. At follow-up visits, study staff completed standardized questionnaires on mobile phones capturing linkage to and retention in HIV care information. Assessment and uptake of HIV care involved a review of HIV care documentation (eg, registration card from HIV care clinic) and recording of medications (eg, HIV care medications and ART). Participants were asked about social harms at every visit. At the baseline and 6-month visit, a plasma sample was obtained for HIV viral load testing.

HIV testing was conducted using blood obtained by fingerstick tested using rapid serologic tests [SD Bio-Line HIV 1/2 Rapid Test (Standard Diagnostics Inc., Kyonggi-do, South Korea)] and HIV 1/2 Gold Screening Test (G-Ocean, according to South African guidelines). All rapid HIV test results were confirmed by collecting a dry blood sample for enzyme-linked immunosorbent assay (ELISA) testing using the Vironostika Uniform II Plus O (bioMerieux, Marcy l'Etoile, France) to provide quality control for the field-based HIV rapid testing. Point-of-care CD4 testing (Alere, PIMA, Jena, Germany) was done using a fingerstick specimen. To validate the performance of the point-of-care CD4 testing, a paired venous sample was obtained for flow cytometry (Facs Calibur, BD biosciences, San Jose, CA) and for viral load testing. Plasma HIV viral load testing was done using a bDNA assay (Nuclisens, bioMerieux, Marcy l'Etoile, France).

Ethical approval was obtained from the University of Washington Human Subjects Division and the Human Sciences Research Council Research Ethics Committee.

Data Analysis

Completed surveys were encrypted on the mobile phone and stored in a nonhuman readable format. The mobile device securely stored and backed up data daily. Data entry was validated by weekly checks on all the data. In addition, the mobile phone software tracked completed surveys and

provided a follow-up visit schedule for study staff. Laboratory data, CD4 count, and viral load results were provided by the laboratory electronically and merged with the questionnaire data.

Summary statistics were used to describe uptake of testing and linkage to care among eligible participants in the enrollment, baseline characteristics, and follow-up tables. Medians and interquartile ranges (IQRs) were also calculated for continuous variables (ie, age and CD4 cell count). CD4 counts measured by flow cytometry (gold standard test) and point-of-care test were compared by Bland–Altman analysis.[22] The cumulative probability and time to clinic visits and ART initiation was analyzed by Kaplan–Meier methods. Linear regression analysis was used to identify predictors of visiting an HIV clinic and ART initiation. The potential predictors considered included sociodemographic variables, CD4 counts, partner characteristics, and reported symptoms. Mean viral load at baseline and 6 months were compared with a paired *t* test. Proportion with viral load <1000 copies per milliliter, condom use, and ART use at baseline and 6 months were compared using the McNemar test.[23] The data were analyzed using Stata/SE software version 10 (StataCorp LP, College Station, TX) and SAS version 9.2.

RESULTS

Enrollment Characteristics

Between March 2011 and March 2012, 282 households were enumerated, in which 739 adults resided in the households. Of the 282 households, 76 household heads were ineligible for the study primarily because they did not sleep in the household at least 2 nights per week, in part due to migratory labor practices. Of the remaining 205 households, 18 households reported more than 1 household head, 111 (59%) and 76 (41%) households reported a female and male head of the household, respectively. Of the resident adults, 671 (91%) provided informed consent and were tested for HIV, with 51 adults (7%) declining participation, 13 (2%) not present during HBCT visits, and 4 (1%) not being able to provide consent (Table 1). The most common reported reason for declining participation was not ready for HIV testing (28%). Overall, 222 (33%) participants tested were male and 214 (32%) were tested for the first time. Two hundred and one (30%) HIV-infected participants were identified through HBCT, of whom 73 (36%) were newly identified as HIV infected.

Within these households, 71 couples were enumerated, 58 of which both partners were tested for HIV; 48 couples had

TABLE 1. Enrollment Characteristics of Adults Approached Through HBCT in KwaZulu-Natal, South Africa

Enrollment Characteristics of All Subjects Approached	n	Percentage (%)
Households enrolled	281	
Households reporting 1 head of household	187	66
Female headed household	111	59
Households with children under 18 years	89	32
Adults living in households	739	
Adults not present at HBCT visit	13	2
Adults who refused HIV testing	51	7
Adults not able to consent	4	1
Adults consented and tested	671	91
Adults tested* (% of consented)	671	100
Adults who received HIV test results (% of tested)	671	100
Male	222	33
Female	449	67
First time tested	214	32
HIV-infected adults	201	30
Male (% of tested males)	37	17
Female (% of tested females)	164	37
HIV-infected pregnant females (% of HIV$^+$ females)	2	1
Newly identified HIV infection (% of positives)	73	36

*Two participants had no HIV test result due to test indeterminate results (both were known HIV$^+$ on ART).

TABLE 2. Baseline Characteristics of HIV-Infected Participants Identified Through HBCT

	n (%)	Percentage (%) or Median (IQR)
Age (yrs)	201	34 (27–43)
Age group (yrs)		
≤30	72	36
>30	129	64
Gender		
Male	37	18
Female	164	82
Education		
Primary or less	58	29
Secondary or more	143	71
Employed	60	30
Cohabiting	35	17
Sexually active	146	73
Number of current sex partners	146	1 (1–1)
Condom use with last sex act	82	41
Number of children		
1–3	93	46
>3	13	7
CD4 count (cells/μL)	201	435 (301–591)
CD4 groups (cells/μL)		
≤200	18	9
201–350	48	24
351–500	58	29
>500	77	38
HIV$^+$ adults on ART at baseline HBCT visit (% of positives)	64	32
Partner HIV infected		
Yes*	45	22
No†	46	23
Do not know	106	52
Refused	6	3

*The answer "yes" includes 1 participant who responded "I think so".
†The answer "no" includes 10 participants who answered "I don't think so".

concordant HIV status (43 concordant negative and 5 concordant positive), and 10 couples tested serodiscordant for HIV.

Two participants had indeterminate rapid HIV test results; both were known HIV-infected individuals on ART and were confirmed HIV positive by ELISA on phlebotomy specimens. The remaining rapid HIV test results were confirmed by ELISA on dried blood spots with 100% agreement.

Baseline Characteristics of HIV-Infected Participants

The demographic characteristics of the HIV-infected participants are shown in Table 2. The median age of participants was 34 (IQR: 27–43) years, of whom 36% were older than 30 years of age and 82% were female. Sixty (30%) reported being employed, and 35 (17%) reported cohabiting with their partner. Of the 164 HIV-infected females, the majority (52%) did not know their HIV partner's status, and 22% reported having an HIV infected or probably HIV-infected partner. Of the 128 participants who reported knowing their HIV-infected status when tested through HBCT, the median time since HIV diagnosis was 33 (IQR: 7–60) months. One hundred and eighteen individuals (92% of those who knew they were HIV positive) reported that a CD4 count blood specimen had been previously drawn, of which only 61 (52%) had received their result. We did not obtain self-reported nadir CD4 counts for participants reporting previous CD4 count testing. Sixty-four (32%) HIV-infected participants were on ART at baseline, and 4 reported concurrent treatment for TB coinfection. Fifteen (83%) of the 18 HIV-infected persons with CD4 ≤200 cells per microliter who were eligible for ART by the former South African guidelines were not on ART at the HBCT visit.

Among the 201 HIV-infected participants, the most common reported symptoms were substantial weight loss (n = 67; 33%), poor appetite (n = 60; 30%), and fever (n = 48; 24%). In screening for TB symptoms, 36 (18%) participants reported having ≥3 symptoms of cough, fever, night sweats, and loss of appetite.[24] Fifty-eight (29%) participants reported having STI symptoms (ie, penile or vaginal discharge, genital sores, and/or dysuria).

Agreement Between Point-of-Care and Laboratory-Based CD4 Testing

Of the 201 HIV-infected participants, 193 (96%) had a point-of-care CD4 test in addition to confirmatory CD4 testing by flow cytometry (the gold standard test). The median CD4 count at baseline by point-of-care CD4 testing was 435 (IQR: 297–591) cells per microliter and by flow cytometry was 423 (IQR: 282–591) cells per microliter. Among ART-naive participants, 66 (33%) had a CD4 count ≤350 cells per microliter. There was high agreement between the point-of-care and flow cytometry CD4 test results; the mean difference between point-of-care and flow cytometry CD4 testing was 16 (confidence interval: −1 to 32) cells per microliter by Bland–Altman analysis (Fig. 1).

Linkage to HIV Care and Uptake of ART

Of the HIV-infected participants, 197 (99%), 199 (100%), and 196 (100%) completed their months 1, 3, and 6 follow-up visits, respectively. Three participants died during the study and 2 withdrew. Participants who reported ever visiting an HIV clinic increased from 116 (57%) at baseline to 196 (96%) at 6 months (Fig. 2A; $P < 0.0001$). The cumulative probability of ART initiation by 3 months among those meeting South African guidelines was 86% (Fig. 2B).

Overall, 64 (32%) participants reported ART use at baseline, and 36 participants initiated ART during the study. Of the 36 who initiated ART, 12 had a baseline CD4 count ≤200 and 10, 10, and 4 patients had a CD4 count 201–350, 351–500, and >500 cells per microliter, respectively. Clinical reasons for initiation ART at higher CD4 counts included

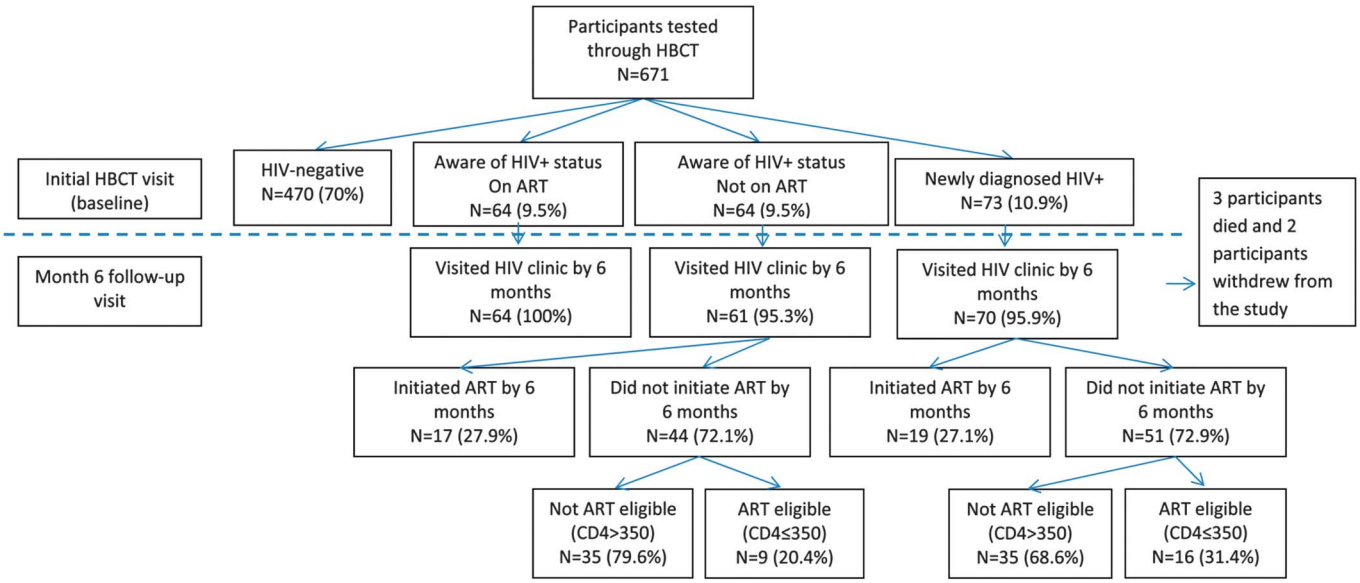

FIGURE 1. Study flowchart.

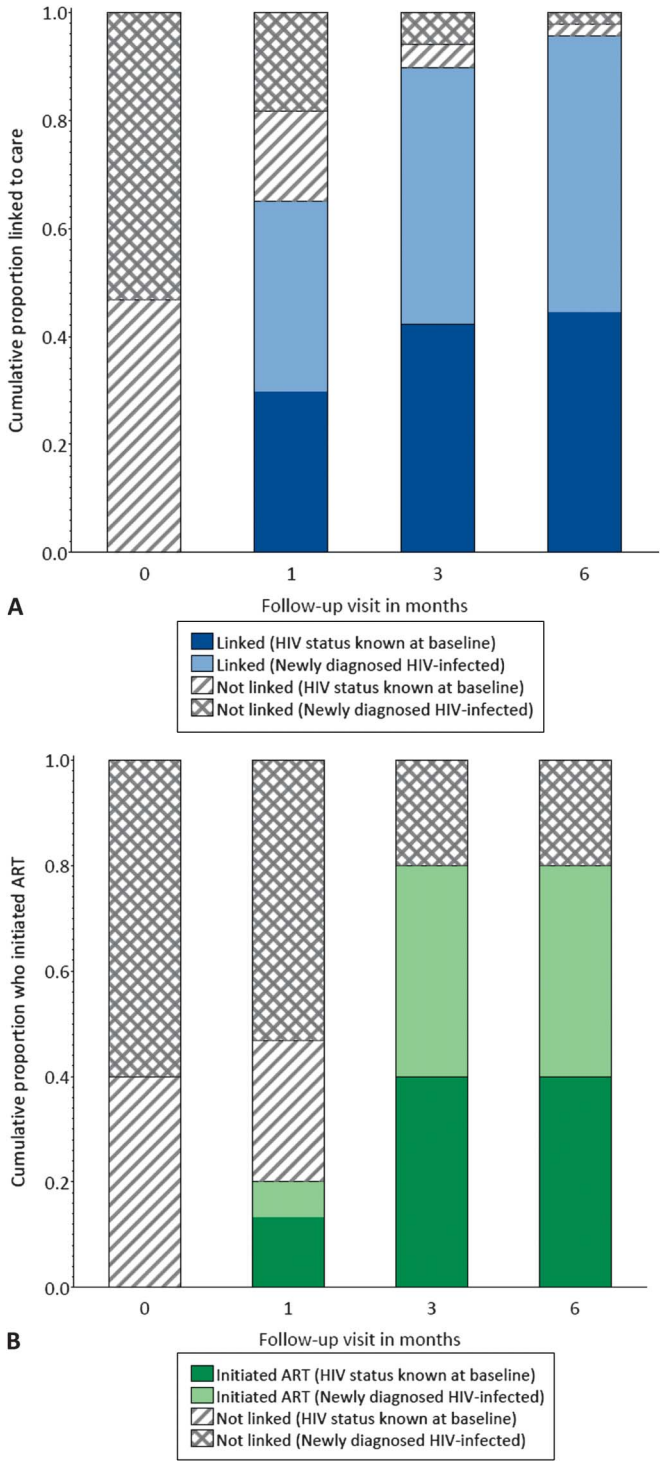

FIGURE 2. Cumulative probability of A, visiting an HIV clinic (linked) among HIV-infected participants not on ART (96% at 6 months*); and B, initiating ART among HIV-positive participants with CD4 ≤200 at enrollment (80% at 6 months). *Six of the 201 HIV-infected participants identified at initial HBCT visit (baseline) did not visit an HIV clinic by 6 months. Of the 6 participants, 3 died, 2 withdrew from the study, and 1 remained in follow-up but did not visit a clinic.

pregnancy and TB coinfection. Due to the time to complete clinic staging for ART initiation, 60% of individuals were on ART for less than 3 months when the exit viral load was measured.

Among the 196 participants for whom viral load measures were available at baseline and 6 months, mean HIV viral load decreased by 0.31 $\log_{10}$ copies per milliliter ($P = 0.009$). Among the participants with CD4 ≤200 cells per microliter (n = 15) and CD4 ≤350 cells per microliter (n = 62), mean HIV viral load decreased by 2.46 $\log_{10}$ copies per milliliter ($P = <0.001$) and 0.79 $\log_{10}$ copies per milliliter ($P = 0.003$), respectively (Table 3). Among the 132 participants not on ART at baseline, of whom 36 initiated ART during the study, HIV viral load decreased by 0.49 $\log_{10}$ copies per milliliter ($P = 0.009$). For the 12 participants eligible for ART (CD4 ≤200 cells/μL) at baseline who were not on ART, 11 initiated ART and mean HIV viral load decreased by 3.23 $\log_{10}$ copies per milliliter ($P = 0.009$). The percentage of all HIV-positive participants with HIV viral load <1000 copies per milliliter increased from 50% at baseline to 55% at month 6 ($P = 0.21$). For participants with a CD4 count ≤200 cells per microliter, the percentage with viral load <1000 copies per milliliter increased from 20% to 80% ($P = 0.01$) and for those with ≤350 cells per microliter, it increased from 44% to 63% ($P = 0.02$). Of the 137 participants not on ART at enrollment, 37 (27%) had baseline viral load <1000 copies per milliliter despite reporting that they were not currently on ART.

Because rates of clinic visits and ART initiation among those eligible were very high, regression analysis did not identify predictors for clinic visit (data not shown). In univariate analysis, CD4 count, age, and reporting any HIV-related symptom were significantly correlated to ART initiation. However, in the final multivariate model, only baseline CD4 count predicted ART initiation.

The mean number of sex partners reported by HIV-infected partners at baseline and 6 months did not change (mean = 1.1, SD = 0.40) but reported condom use at last sex increased significantly from 44% at baseline to 68% at the 6-month visit ($P < 0.0001$) (Table 3). There was no statistically significant difference in condom use by ART initiation during the study. Of the 58 couples who were both partners and were tested for HIV, 95% mutually disclosed their status.

There was 1 reported case of social harm; a participant temporarily lost his income and residence but returned to live at home with support within 3 months.

DISCUSSION

This pilot of HBCT integrated with same day point-of-care CD4 testing and follow-up (HBCT-Plus) in KwaZulu-Natal, South Africa, demonstrates very high uptake of HIV testing in a setting with HIV prevalence of 30%. The field performance of the point-of-care CD4 test was excellent in comparison with CD4 testing through flow cytometry on a venous sample. Point-of-care CD4 testing and lay counselor follow-up achieved almost universal linkage to HIV care and ART initiation following South African guidelines. Our findings demonstrate that HBCT can achieve very high levels of knowledge of HIV serostatus, HIV care linkage, and uptake of ART, all of which will be necessary to achieve a population impact of ART as prevention. Notably, 6 months

TABLE 3. Change in Behavior and Viral Load From Study Enrollment to 6-Month Follow-up Visit Among HIV-Infected Persons Identified Through HBCT

	n	Baseline*, Median (IQR)	Month 6‡, Median (IQR)	Change Over 6 Months	P†
Behavior and uptake of care					
Number of sex partners (#2)	196	1.0 (0.0–1.0)	0.0 (1.0–1.0)	−0.08	0.03
		n (%)	n (%)		
Condom use during last sexual intercourse	186	81 (44)	127 (68)	25	<0.001
Clinic visit among HIV+					
All	201	115 (57)	195 (97)	40	<0.001
Aware of HIV+ status	128	108 (84)	125 (98)	13	<0.001
Newly identified HIV+	73	7 (10)	70 (96)	86	<0.001
ART use					
All participants	201	64 (32)	99 (49)	17	<0.001
Aware of HIV+ status	128	64 (50)	80 (63)	13	<0.001
ART eligible (CD4 ≤200)	9	3 (33)	9 (100)	67	§
Newly identified HIV+	73	0 (0)	19 (26)	26	§
ART eligible (CD4 ≤200)	9	0 (0)	6 (67)	67	§
HIV viral load		Mean HIV viral load (log_{10} copies/mL)			
All HIV+	196	2.92	2.64	−0.28	0.02
HIV+ not on ART at baseline	132	3.74	3.30	−0.44	0.007
HIV+ on ART at baseline	64	1.24	1.30	0.06	0.624
CD4 ≤200 (excluding HIV+ on ART at baseline)	12	4.93	1.70	−3.23	<0.001
CD4 201 to ≤350 (excluding HIV+ on ART at baseline)	31	3.77	3.40	−0.36	0.29
Change in percent with viral suppression (<1000 copies/mL) from baseline to 6 months (%)					
All HIV+	196	50%	55%	5%	0.21
HIV+ with CD4 ≤200	15	20%	80%	60%	0.01
HIV+ with CD4 201 to ≤350	47	51%	57%	6%	0.55

*Baseline visit is the first HBCT visit at study enrollment.
†McNemar test was used to calculate *P* value for binary outcome and paired *t* test was used to calculate *P* value for continuous outcome.
‡Three participants died and 2 withdrew from the study and were excluded from the follow-up analysis.
§Cannot compute McNemar *P* value due to 0 cell counts (either none on ART at enrollment or none who had not initiated by 6 months).

after HBCT implementation, we observed a significant decrease in mean HIV viral load among the HIV-positive persons identified through HBCT-Plus and an increase in the proportion with viral load <1000 copies per milliliter among those participants eligible for ART. South African guidelines for ART changed during the 6-month follow-up period, with 46.8% (22 of 47 participants with CD4 ≤350 cells/μL at baseline) of HIV-infected persons with CD4 ≤350 initiating ART during the follow-up. Thus, the reduction in viral load and infectiousness we observed is a conservative measure of the program's impact, given the expanding ART guidelines in South Africa and relatively short (6 months) follow-up interval.

Previous HBCT projects have shown that HBCT is acceptable, can achieve high coverage and almost universal knowledge of HIV status, and identifies HIV-infected persons previously unaware of their serostatus and at higher CD4 cell counts.[6,8–13,20,25–27] To foster linkages to HIV care, our HBCT-Plus program used the same HBCT strategy coupled with point-of-care CD4 testing to facilitate the initial step in determination of ART eligibility, a critical step in the HIV testing and treatment "cascade".[18,28] Study staff conducted a point-of-care CD4 test for HIV-infected persons when they were identified in HBCT and provided same day counseling about their CD4 result and the importance of HIV care, information about HIV care options, and a referral card. Point-of-care CD4 testing avoided the HIV-infected person having to make 2 clinic visits for phlebotomy followed by another visit in 1 to 2 week's time for CD4 test results and ART eligibility assessment. We demonstrated that the point-of-care CD4 testing was highly acceptable at the time of learning when one was HIV infected, feasible to be conducted in homes in a rural South African setting, facilitated specific counseling on HIV care and faster determination of ART eligibility, and had excellent agreement with a paired venous sample tested by flow cytometry. This builds on a prior observational study of point-of-care CD4 testing in Mozambique, which demonstrated a reduction in loss to pretreatment follow-up but did not change loss to follow-up between CD4 staging and ART initiation.[29]

The high linkages to HIV care observed within 6 months of HBCT was in the context of point-of-care CD4 testing combined with follow-up visits by lay counselors at 1 and 3 months, who provided counseling and assessed HIV clinic attendance and ART initiation. As an objective measure of the prevention impact of HBCT and HIV care linkages with ART initiation based on South African ART guidelines, we compared HIV plasma viral load before and 6 months after HIV testing through the HBCT program. Our finding of

decreased mean viral load among the HIV-infected persons identified through HBCT is encouraging because it was achieved in the context of the previous South African ART initiation guideline of CD4 ≤200 cells per microliter. Given that implementation of South Africa's new guideline of ART initiation at CD4 ≤350 cells per microliter began half way through the study, it was encouraging to observe a high proportion with viral load suppression among participants with CD4 ≤350 cells per microliter. Thus, with potential incomplete viral suppression due to 40% of participants initiating ART between the 3-month visit and the 6-month follow-up visit, when viral load was measured, and with incomplete coverage of ART among those with CD4 ≤350 cells per microliter due to changing ART initiation guidelines in South Africa, our findings are likely an underestimate of the potential of HBCT to increase the proportion of persons with viral load <1000 copies per milliliter.

Limitations of our study include the modest sample size and short follow-up interval of 6 months. The linkages to HIV care were facilitated by the clinic location within walking distance of study participants, and it will be important to evaluate this model in more remote areas with greater distances to clinics. A factor that may have influenced the high uptake of linkages to care was that most participants were seen by the same staff member at follow-up visits, which may have increased engagement in care. Last, clinic visits and ART initiation were confirmed by examination of the clinic card and ART medication bottles as clinic electronic health records were not available. We did not measure ART in plasma of participants who reported not being on ART but had low viral load.

Cost-effectiveness analysis will be conducted of the program component costs for HBCT, point-of-care CD4 testing,[30] and lay counselor follow-up relative to HIV care linkage, ART initiation, viral suppression as an objective measure of the public health benefit, and the projected clinical benefits of averted disability and mortality. A recent modeling article estimated that with 90% annual HIV testing of adults and treatment by South African guidelines (CD4 ≤350 cells/μL) costs of the program would break even within 2 years due to the savings of HIV cases averted.[31] Further, HBCT could be combined with other mobile testing strategies with demonstrated success at increasing testing uptake among youth and men who are not as readily reached through HBCT[32] and community mobilization and HIV testing campaigns.[33] Mathematical models of HIV in KwaZulu-Natal suggest that HBCT every 4 years with associated behavior change, uptake of ART uptake, and medical male circumcision could have a sustained impact on the epidemic.[5] HBCT could utilize an existing cadre of community health workers in South Africa and many other African countries to deliver integrated health care to communities, which would facilitate implementation of the HBCT strategy.[34] Combining this decentralized model of health care delivery, using point-of-care tests, and more fully utilizing the capacity of electronic systems for health system monitoring and communication has the potential to be a powerful approach to increase ART uptake for HIV treatment and prevention.

In summary, HBCT-Plus in rural KwaZulu-Natal, South Africa, achieved almost universal knowledge of HIV status, linkage to HIV care, and ART uptake following South African guidelines, which was achieved through point-of-care CD4 testing and lay counselor follow-up of HIV-infected persons. A significant reduction in plasma HIV levels was observed, which indicates potential public health benefit and clinical benefit of this strategy. Further evaluation of this model in diverse African settings should be undertaken to evaluate the impact and cost-effectiveness of HBCT and to inform national HIV treatment and prevention programs.

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