Feasibility, effectiveness, budget impact and surveillance of partner services for HIV in Kenya

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Abstract

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Epidemiology, Global Health, and Allergy and Infectious Disease

Introduction: HIV assisted partner services (aPS), is widely practiced in the United States and Europe but less so in Africa largely due to limited data on their effectiveness and feasibility in routine health care settings. Yet aPS could increase HIV testing rates, reduce STI/HIV exposure, and assure prompt linkage to antiretroviral therapy (ART) initiation. We report the effect of immediate aPS in improving 1) the rate of HIV testing, 2) case-finding of HIV-infected individuals, and 3) linkages to HIV care for their partners. The trial determined the number needed to interview to identify one new case of HIV and explored, geographical differences in case finding rates. Additionally we assess the budget impact of scaling up aPS in Kisumu County, the region with the third highest number of HIV-infected persons in Kenya. We also present results of the pilot of a surveillance system for aPS.

Methods: A cluster-randomized design was used to recruit eligible HIV-infected index cases from 18 clusters allocated to two study arms, immediate and delayed. The intervention was elicitation of sexual history from index cases and enumeration of sexual partners of HIV infected index cases in the preceding three years, notification, testing and referral to care if HIV-infected, of the named sexual partners. Participants in the delayed arm received a similar service only that this was delivered six weeks later. We used generalized estimating equations to evaluate the effect of the intervention on rates of HIV testing, identification of new HIV tests, HIV infections and enrollment to HIV care. The number of index cases needed to interview and the case finding rates were also evaluated using a similar approach. The study was registered in ClinicalTrials.gov as number NCT01616420.

To estimate the budget impact, we constructed an Excel-based costing tool to simulate the budget impact analysis of HIV partner services on an annual basis over a 5 year time horizon. HIV Testing and Counseling (HTC) and aPS unit and total costs were estimated and allocated using ingredient-based approaches. Time motion was used to determine full-time equivalent of tracing sexual partners of index patients. Weighted costs of ART, clinic visits and hospitalizations that accrued due to aPS were generated through decision tree modeling. We estimated a range, where the lower-bound cost assumed that all sexual partners tested were HIV-negative and the upper-bound cost assumed that all sexual partners were HIV-positive. All costs were undiscounted and reported separately for the task-shifting scenarios. Appendix I outlines the assumptions regarding the patient workload and the number of providers available to do aPS in Kisumu County. Appendices II & III are the assumptions for calculating HIV testing costs and budget impact respectively. Appendix IV is the decision trees for determining expected costs for antiretroviral therapy, clinic visits and hospitalization visits.

For the pilot of the surveillance system, we revised the national HTC data collection tool to include specific questions on whether clients testing for HIV were doing so due to an exposure from an HIV-infected partner.

Results: The study enrolled 1119 index cases from 18 different clusters (550 in the intervention arm and 569 in the control arm) who mentioned 1872 sexual partners. Of the sexual partners, 1292 (69%), [620 in the intervention arm and 672 in the control arm] were enrolled. Enrollment and follow-up data were available for 579 (63%) of sexual partners mentioned in the immediate arm and enrollment data available for 672 (70%) in the delayed arm. 388 in the immediate arm during enrolment and within the study after enrollment, and 118 in the delayed arm in the preceding two months before enrollment (Incidence Rate Ratio (IRR) 3.78, 95% CI: 3.08-4.65). The incidence rate ratio comparing rates of new testing for HIV between the immediate and delayed groups was 11.50 (95% CI: 5.56-23.78). Immediate aPS also increased the number testing positive and those enrolled in HIV care, IRR 3.22 (95% CI: 2.26-4.61) and 3.95 (95% CI: 2.48-6.28) respectively. The number of index cases needed to interview (NNTI) to identify an HIV infection in the partners was 4.08, and that to identify a newly testing partner was 3.34. No study-related intimate partner violence was reported.

The average annual aPS costs are US$ 1,092,161 and US$ 753,547 for Kisumu County using nurses and CHWs, respectively. The weighted average cost of scaling up aPS over a five period using nurses was 45% higher compared to CHWs (US$ 5,460,837 and US$ 3,767,738 respectively). Overall, the differences between the upper and lower bound costs were 8.7% for nurse-based aPS and 2.5% for the CHW-based approach. Over the time horizon, the total budget impact of nurse-model was US$ 1,726,832, 69.2% and 29.5% of which were accounted for by aPS costs and ART costs respectively. The CHW model incurred an incremental cost of US$ 1,184,640, 68.6% lower than the nurse-based model. Proportional distribution of impact across budget categories was similar in the two models, although CHWs model had lower aPS related impact

The weighted unit costs of HIV testing across the three levels of facilities for HIV-infected index clients using nurses were US$ 25.36 and US$ 17.86 using CHWs. Costs for testing sexual partners of infected index clients were higher overall, with an HIV test costing US$ 19.18 per person if all tests were negative and US$31.07 per person if all tests were positive for nurses and US$ 11.74 per person and US$ 14.14 per person for CHWS respectively.

Median time for data capture using the HTC form was 4 minutes (IQR: 3-15), with a longer duration for HIV-infected participants, and there was no reported data loss.

Interpretation: aPS is safe, effective and feasible at the population level and should be implemented as part of HIV Testing and Counseling (HTC delivery). In addition to early ART initiation, aPS may have considerable effect on HIV transmission at the population level. Furthermore, aPS is affordable although not cost-saving and routine Health Information Systems (HIS) may be used to monitor aPS outcomes.

Dedication

I dedicate this dissertation to my lovely wife Beatrice Leboo, children Kipchumba, Kipkurui and Jelimo, my parents, Peninah Talai Cherutich and the late Richard Kurui, as well as my father-in-law, Philip Leboo.

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Introduction

HIV Assisted partner services (aPS), the elicitation of contact information, exposure notification, HIV testing and counseling (HTC) and linkage to care for sexual partners of HIV-infected persons is widely accepted as a public health effort.

The three most recognized modes of partner notification are 1) passive referral in which the person diagnosed with the STI (index case) is encouraged to disclose the results to his/her partners without direct involvement of a health care provider; 2) contract referral in which the index case is allowed a short period of time in which to contact and refer his/her sex partners, after which the provider notifies partners; and 3) provider referral in which the provider contacts sex partners directly, without a waiting period. HIV-uninfected partners may also benefit from other HIV prevention interventions such as male circumcision or pre-exposure prophylaxis.

In Malawi, the provision of provider referral was found to be feasible and increased by 2-fold the number of partners of HIV-infected persons who underwent testing compared to simply advising newly diagnosed persons to notify their partners themselves[1]. In Cameroon, an ongoing PS program was found to be highly effective, with 83% of sexual partners successfully notified, necessitating only 3.2 index cases to identify one HIV case[2]. Although aPS has been found to be efficacious and effective, the delivery and determination of effectiveness of aPS at the population level is required. Given the nature of real world implementation PS services should be tailored to the specific needs of the policy makers and communities, therefore programs should be evaluated using pragmatic study designs, such as cluster randomized trials. Additionally, there are residual concerns on the potential social harms of aPS such as intimate partner violence (IPV). A review article of more than 71 articles evaluating the relationship between IPV and HIV confirmed the presence of shared risk factors for IPV and sexually transmitted diseases, including HIV[3], however, studies specifically examining whether couple counseling or partner notification results in an increase in IPV have not shown a causal relationship[4, 5]. Given the high prevalence of lifetime intimate partner violence in East Africa and other regions hard hit by the HIV epidemic[6], introduction of a partner services program warrants close monitoring for IPV, as we are proposing in this study.

Although aPS is feasible and effective in both high and low-income resource settings, further scale up in Africa may depend on its demonstrated affordability[2]. In Malawi, active partner notification services by health providers were cost-effective compared to patient referral alone. However, this study was localized in an urban area, was clinic-based and did not include active community tracing of sexual partners, and did not estimate the cost of scaling up aPS [7]. More costing data is required to enable decision making in countries bearing the highest burden of HIV. Until recently, the methodology of conducting, analyzing and reporting BIA was not available hence limiting its application. However based on seminal work done by the International Society of Pharmacoeconomics and Outcomes Research (ISPOR), BIAs, are now a distinct discipline in economic evaluation[8]. Our study will provide data in an African country on the financial consequences of implementing PS using existing HIV testing platforms.

If aPS is found to be cost-effective, it would have to be implemented and monitored largely though passive surveillance techniques. In order to determine the impact of partner notification, monitoring the uptake and effective coverage is vital. Integration of notification outcomes in health information systems will enable time-series analyses of PS services and potentially enable the determination of the contribution of PS in reducing new HIV infections. Furthermore, the motivations for HIV testing in Africa are poorly understood and the limited data that are available either exclude PS outcomes or are in high income settings[9, 10]. Yet monitoring reasons for seeking HIV testing can be useful for identifying novel methods for increasing testing and for evaluating interventions to promote desired testing behaviors. Our study will therefore inform scale up efforts for PS and will provide preliminary data for future studies.

The Kenyan Ministry of Health has included delivery of PS as one of several strategies to increase uptake of testing. The finding of this study will not only influence partner services in Kenya, but will accelerate the adoption of partner notification services as an added strategy for combination HIV prevention in high burden settings.

The aims of the dissertation research were:

- To evaluate the effectiveness of aPS to increase rates of HIV testing, case finding and enrollment in HIV care of sexual partners of HIV-infected individuals.
- To estimate the cost of HIV testing and counselling, aPS and the budget impact of scaling up aPS in Kisumu County, Kenya.
- To demonstrate the feasibility of integrating aPS surveillance into routine health information systems through utilization of electronic data collection and storage.

Study Population

For Chapter 1, we enrolled 1119 HIV-infected participants (index cases) from 18 study sites in Nairobi, Central and Western Kenya. Index cases had to be willing to participate, newly or recently diagnosed, at least 18 years of age and at low or moderate risk of IPV. Index cases classified at moderate risk were followed up at 10, 20 and 30 days following enrollment. Potential participants deemed at high risk of IPV were excluded from study participation. We also enrolled 1292 of their sexual partners who provided information on their HIV testing behaviors as well as enrollment in HIV care.

In Chapter 2, the study design did not include any study participants as we used publicly available information to estimates costs and budget impact.

For Chapter 3, the study population was a purposive sample of clients seeking HTC services at the 18 study sites. All clients aged 18-64 years and presenting at the above study sites for HIV testing were eligible for inclusion.

Outline of Chapters

Each chapter in this report constitutes a study aim. The first chapter describes the effectiveness of aPS in improving HIV testing, case finding and enrollment in HIV care among sexual partners of HIV-infected index cases. It presents data from a cluster randomized trial comparing immediate versus delayed aPS and enhances the body of evidence for aPS in resource limited settings. The chapter also contextualizes the effectiveness of aPS with the global desire to increase access to antiretroviral therapy, reduce population viremia and halt HIV transmissions.

Chapter 2 details the affordability of aPS if implemented in one of the Kenya counties with a high burden of HIV. In this chapter the unit and total costs for both HIV testing and aPS are presented and incremental costs of scaling up aPS compared to HIV testing alone are presented.

Chapter 3 outlines potential utilization of routine health information systems for aPS surveillance and describes the application of smart-phones to collect reasons for HIV testing, a key metric for measuring scale up of aPS.

Chapter 1: Effectiveness and feasibility of partner services for HIV in Kenya: A parallel cluster randomized trial

Abstract

Introduction: HIV assisted partner services (aPS), is widely practiced in the United States and Europe but less so in Africa largely due to limited data on their effectiveness and feasibility in routine health care settings. Yet aPS could increase HIV testing rates, reduce STI/HIV exposure, and assure prompt linkage to antiretroviral therapy (ART) initiation. We report the effect of immediate aPS in improving 1) the rate of HIV testing, 2) case-finding of HIV-infected individuals, and 3) linkages to HIV care for their partners. The trial determined the number needed to interview to identify one new case of HIV and explored, geographical differences in case finding rates.

Methods: A cluster-randomized design was used to recruit eligible HIV-infected index cases from 18 clusters allocated to two study arms, immediate and delayed. The intervention was elicitation of sexual history from index cases and enumeration of sexual partners of HIV infected index cases in the preceding three years, notification, testing and referral to care if HIV-infected, of the named sexual partners. Participants in the delayed arm received a similar service only that this was delivered six weeks later. We used generalized estimating equations to evaluate the effect of the intervention on rates of HIV testing, identification of new HIV tests, HIV infections and enrollment to HIV care. The number of index cases needed to interview and the case finding rates were also evaluated using a similar approach. The study was registered in ClinicalTrials.gov as number NCT01616420.

Results: The study enrolled 1119 index cases from 18 different clusters (550 in the intervention arm and 569 in the control arm) who mentioned 1872 sexual partners. Of the sexual partners, 1292 (69%), [620 in the intervention arm and 672 in the control arm] were enrolled. Enrollment and follow-up data were available for 579 (63%) of sexual partners mentioned in the immediate arm and enrollment data available for 672 (70%) in the delayed arm. 388 in the immediate arm during enrolment and within the study after enrollment, and 118 in the delayed arm in the preceding two months before enrollment (Incidence Rate

Ratio (IRR) 3.78, 95% CI: 3.08-4.65). The incidence rate ratio comparing rates of new testing for HIV between the immediate and delayed groups was 11.50 (95% CI: 5.56-23.78). Immediate aPS also increased the number testing positive and those enrolled in HIV care, IRR 3.22 (95% CI: 2.26-4.61) and 3.95 (95% CI: 2.48-6.28) respectively. The number of index cases needed to interview (NNTI) to identify an HIV infection in the partners was 4.08, and that to identify a newly testing partner was 3.34. No study-related intimate partner violence was reported.

Interpretation: aPS is safe, effective and feasible at the population level and should be implemented as part of HIV Testing and Counseling (HTC delivery). In addition to early ART initiation, aPS may have considerable effect on HIV transmission at the population level.

Introduction

HIV Assisted partner services (aPS), the elicitation of contact information, exposure notification, HIV testing and counseling (HTC) and linkage to care for sexual partners of HIV-infected persons, is widely accepted as a public health practice in the United States and Europe[11, 12]. HIV partner services have not been scaled up in Africa due to limited data on their effectiveness and feasibility in routine health care settings. Yet in Kenya,, there is a statutory obligation for HIV-infected persons and health providers to inform sexual partners of potential exposure and in 2013, 63 countries globally had legal provisions to penalize HIV non-disclosure, exposure or transmission[13, 14].

Clinical trial data from the United States and Malawi have demonstrated the efficacy of aPS, however, these studies were small, were individually randomized and did not include active community tracing of sexual partners[1, 15]. Program data from Cameroon indicate that aPS can be implemented in limited resource settings[2]. However these data were not comparative, did not assess the acceptability of aPS, and could not fully evaluate the potential for intimate partner violence (IPV). Large-scale, community randomized studies are required to define population-level feasibility and effectiveness of aPS.

aPS could increase HIV testing rates, reduce sexually transmitted infections (STI) and HIV exposure, and assure prompt linkage to antiretroviral therapy (ART) initiation therefore reducing STI/HIV acquisition and transmission[16, 17]. The impact of aPS would be greatest in sub-Saharan Africa where HIV is endemic and HIV testing and ART coverage rates are low[18]. Although significant expansion of HIV testing has been reported in Kenya, recent surveys show that only about 10% of adults in Uganda and Nigeria report testing within the preceding year[19]. Traditional approaches such as Voluntary Counseling and Testing (VCT) are in inaccessible to many and mobile and home-based testing as well as partner services targeting pregnant women tend to be more effective in reaching men in particular[20, 21]. Increasing HTC coverage would facilitate expanded ART uptake and reduction in population-level HIV transmission, a major global health initiative[22].

Using an NIH-funded implementation science study we report the effectiveness of aPS among individuals testing HIV-positive at 18 rural and urban Kenyan HTC sites in improving 1) the rate of HIV testing, 2)

case-finding of HIV-infected individuals, and 3) linkages to HIV care for their partners. The trial also evaluated the number needed to interview to identify one new case of HIV and determined geographical differences in case finding rates.

Methods

The study design and methods have been previously reported[23]. Briefly, 18 HTC sites were allocated into two study arms, immediate and delayed, using restricted randomization.

Study setting and population

Seven clusters were located in Central Kenya (including Nairobi, the capital city) and 11 in Western Kenya. The background HIV prevalence in each of the clusters varied from 4.1% to 14.3% and identified between 3 and 134 HIV cases per month. The clusters were chosen to reflect the geographical diversity in demographics, HIV prevalence and sexual behavior characteristics. Potential participants were deemed eligible if they were willing to provide consent, at least 18 years of age, not pregnant and reported no severe IPV. We also excluded those who lived outside a 50 km radius from the study site.

Randomization and stratification

The details of the randomization, intervention allocation and other methodological aspects have been previously reported[23]. The 18 clinics were randomly assigned in order to achieve a balance between immediate and delayed intervention arms; between urban and rural locations, between regions (Nairobi, Central and Nyanza) and within regions. We used Microsoft Excel™ 2010 spreadsheet (Microsoft, Redmond, WA, USA), to create a dataset with 3360 options and then used a random number generator to select sites. Neither the health advisors who collected the data nor the health workers who referred index cases to the study were blinded to the allocation.

Study procedures

Clinic staff referred HIV infected index cases to health advisors for screening and enrollment. All potential study participants were evaluated for eligibility although women were specifically assessed for risk of IPV. Women who reported a history of IPV within the previous 1 month were excluded from study participation. Women were classified as at moderate risk for IPV if they reported a history of IPV during their lifetime

either from a current or past partner; and/or feared IPV if they participated in the study. These women could be eligible for study participation and if enrolled, received special monitoring.

Persons who declined study participation were counseled during post-test HIV counseling to disclose their HIV status to sexual partners, as per the standard of care in Kenya.

The intervention was elicitation of sexual history and enumeration of sexual partners of HIV infected index cases in the preceding three years, notification, testing and referral to care if HIV-infected of the named sexual partners. Participants in the delayed arm received a similar service only that this was delivered six weeks later. Consenting HIV index cases provided data on demographics, sexual behavior, HIV testing history, and HIV care and treatment status. Specifically we asked for detailed information including number, address, location and relationship for all sex partners they had in the prior three years. Sexual partners were not screened for enrollment into the study and those in the delayed arm were not followed-up. Sexual partner provided data on their prior HIV testing history, and current enrollment in HIV care if already known positive.

Partners of index cases were notified either through phone or home/work visits. Initial partner notification was by phone, but if the health advisor was unsuccessful they made two further attempts to notify the partner. Partners were classified as lost to follow-up after at least 3 unsuccessful attempts at telephone and/or home visits or if partners refused to meet with the health advisor. Locatable partners were then tested for HIV and if positive, referred to care. When partners were located and identified at 6 weeks in the delayed intervention clinics, they were asked whether they had tested for HIV in the preceding two months, and if yes, the test result, and whether they sought care (HIV-positive partners only). The proportion responding positively was considered as the baseline rates used for comparison with data obtained in the immediate arm. In the immediate arm, sexual partners not tested at enrollment reported if they had tested within the study in the preceding 6 weeks and all HIV positive partners including those tested at enrollment provided information on enrolment in HIV care, and initiation of ART. Both index and their sexual partners were evaluated for IPV incidence at their 6-week visit.

Consenting participants were screened for HIV antibody using KHB Colloidal Gold (KHB Shanghai Keshaun Bioengineering Co, Shanghai, China). Non-reactive specimens were reported as HIV-negative. Reactive specimens were confirmed with the First Response™ 1-2.0 (PMC Medical Pty. Ltd, Daman, India) and those that tested reactive on both assays were reported as having final HIV-positive result.

Sample size

We adapted the Hayes and Moulton formula[24] and conservatively estimated that by enrolling 60 participants per cluster we would require 9 clusters per arm to have 80% power at α=.05 (two-tailed) to detect a two-fold difference in the number of sexual partners testing for HIV between the study arms. The number of those testing and those newly diagnosed HIV-positive participants per index was assumed to be Poisson (mean=λ_0) and the coefficient of variation from cluster to clusters was assumed to be k=.25.

Outcomes

The primary outcomes for this trial were the number testing for HIV, number newly testing, number testing positive and the number enrolled in HIV care, at 6 weeks. The number of sexual partners testing for HIV in the immediate arm included all those enrolled and consenting to HIV testing and who reported at follow-up that they tested after enrollment but within the study. In the delayed arm, these constituted those testing outside the study but in the preceding two months before enrollment. The number newly testing in both arms were a subset of those testing, but at the time of testing, had never been tested before. The number testing positive in the immediate arm was the verified HIV positive result as a subset of those tested. In the delayed arm, this number was determined as a self-reported HIV positive result among partners testing 2 months preceding enrolment. Enrollment in HIV care among HIV-infected partners was determined at follow-up in the immediate arm and for those in the delayed arm, it was evaluated at enrollment.

The secondary outcomes were the number of index cases needed to interview (NNTI) to test one sexual partner, identify one HIV case among the partner and to identify one partner who had never tested before. NNTI was calculated by dividing the number of enrolled index cases by the number testing, newly testing, and testing positive in each cluster and region,. Other secondary outcomes were the case finding rate per

region and residence, defined as the proportion of those sexual partners who tested for HIV, who were either newly testing or testing positive.

Data was collected on smart phones using the Open-data kit (ODK) platform, encrypted and submitted daily to servers at the National AIDS/STI Control Program (NASCOP). The University of Washington, Seattle hosted the back-up server.

Data analysis

Incidence rate ratios for primary aims (number testing, testing positive, newly testing and enrolled in HIV care) were estimated using a Poisson link and applying the number of index cases enrolled as the offset for each primary aim. To account for clustering within study sites and nesting within index cases, we used generalized estimating equations (GEE) to model the effect of aPS on the primary aims. The NNTI was modelled as Poisson, offsetting by the number of enrolled index participants to compare NNTI across regions and residences. GEE was used to account for clustering of the index cases within sex partners. Likewise, the case finding rates as assumed to be Poisson, offsetting by number testing for HIV and accounting for clustering by sex partners. All these models applied an independent correlation matrix. All the analyses were performed in the statistical software Stata version 12.1 (StataCorp, College Station, Texas).

The study was approved by the Kenyatta National Hospital Ethics Review Committee and the University of Washington institutional review board. A safety review committee consisting of NIH and study co-investigators and study coordinators was convened every six months to evaluate the incidence of IPV

The study was registered in ClinicalTrials.gov as number NCT01616420.

Results

Figure 1: Study Profile

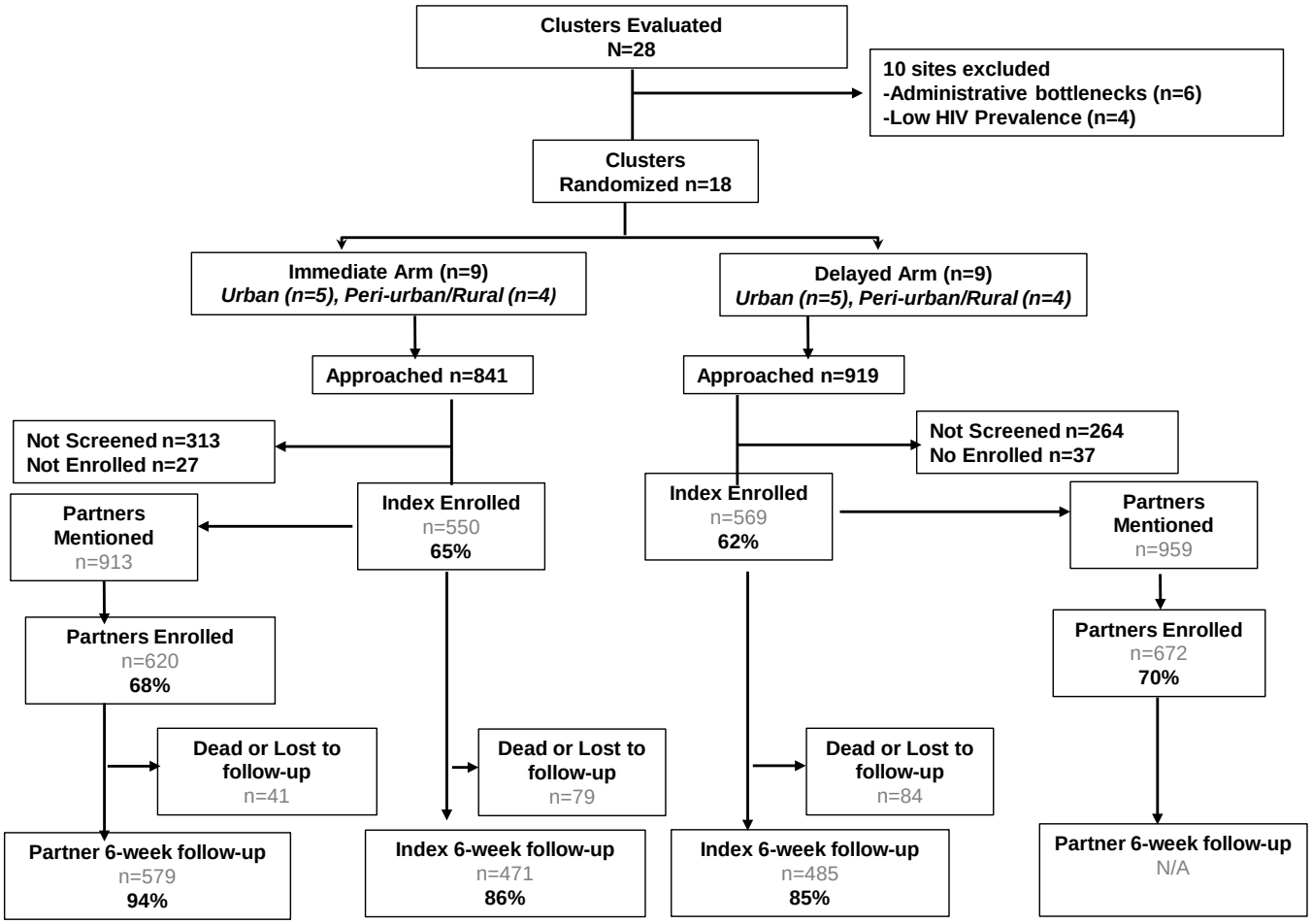


Figure 1 details the study profile. Between August 2013 and June 2015, we evaluated 28 clusters, randomized 18 of them and conducted enrollment and follow-up for 1119 HIV infected index participants and 1872 sexual partners. Ten potential clusters were excluded because of administrative bottlenecks or a low HIV caseload. One thousand seven hundred and sixty (1760) HIV-infected index cases were approached for participation, out of which 1183 (67.2%) were assessed for eligibility. Among the 53 HIV-infected index cases who were ineligible, 0.9% were pregnant, 0.5% were below 18 and 3.1% were considered at high risk of IPV. A further 11 index cases were excluded because they were already enrolled in HIV care for more than 6 weeks. Overall, 1119 (63.6%), an average of 62 per cluster, were enrolled in the study, 550 in the immediate arm and 569 in the delayed arm. Of the 1872 sexual partners mentioned by the enrolled index cases, 1292 consented to enroll in the study. Six-week follow-up data

was available for 471 (86%) of index cases in the immediate arm and 485 (85%) in the delayed arm and for 579 (94%) of enrolled sexual partners in the intervention arm. Study sites differed in the proportion of enrolled index cases and their sexual partners, as well as female-male age differences (Figures 2 & 3). Overall, except for one site, there were more female index cases enrolled across the clusters. In one site median age of male participants was 20 years higher than the females' and in one other site, we enrolled five times more females than males. Sex differences in median age were less discernible among enrolled sexual partners but on average, we recruited more male partners, and who were older than the female participants.

Figure 2: Basic characteristics index participants in 18 study sites

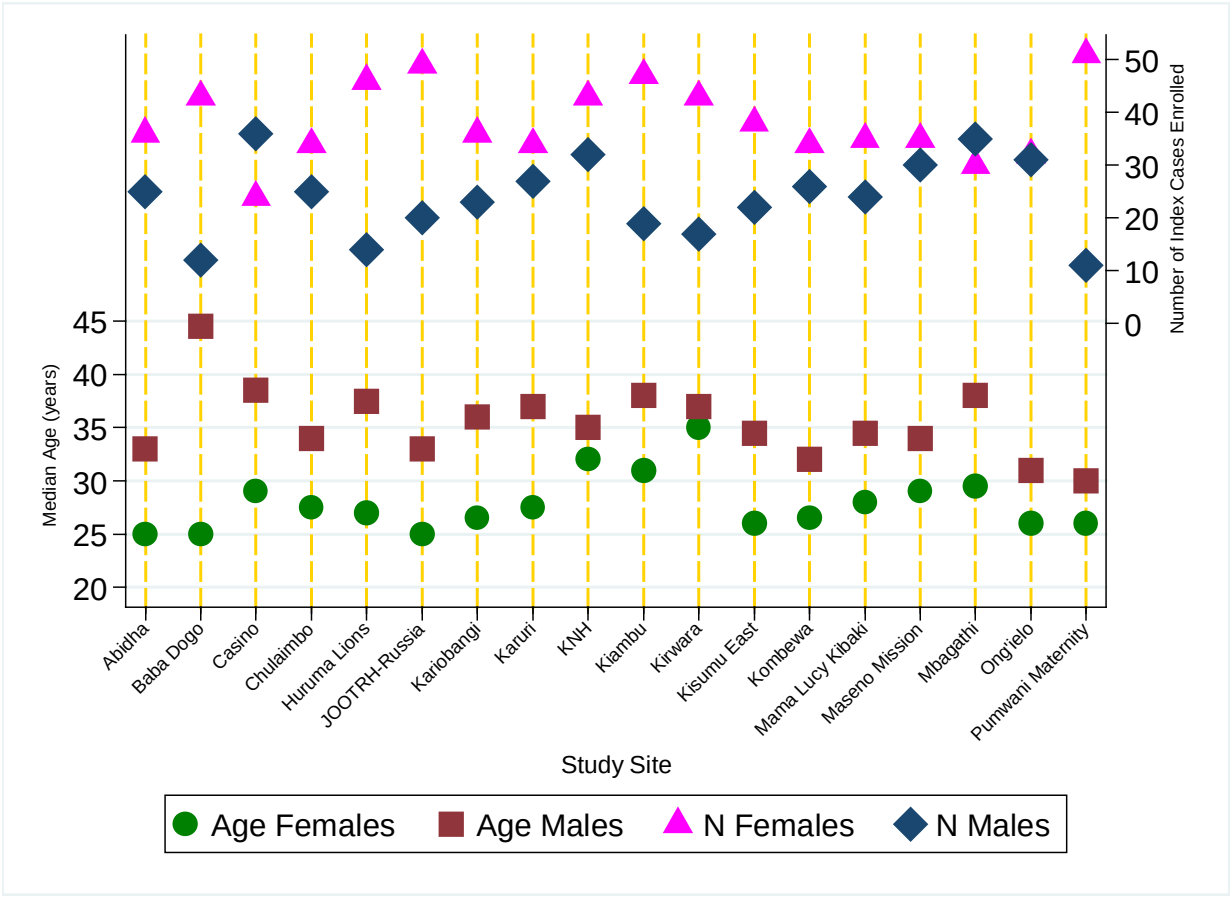
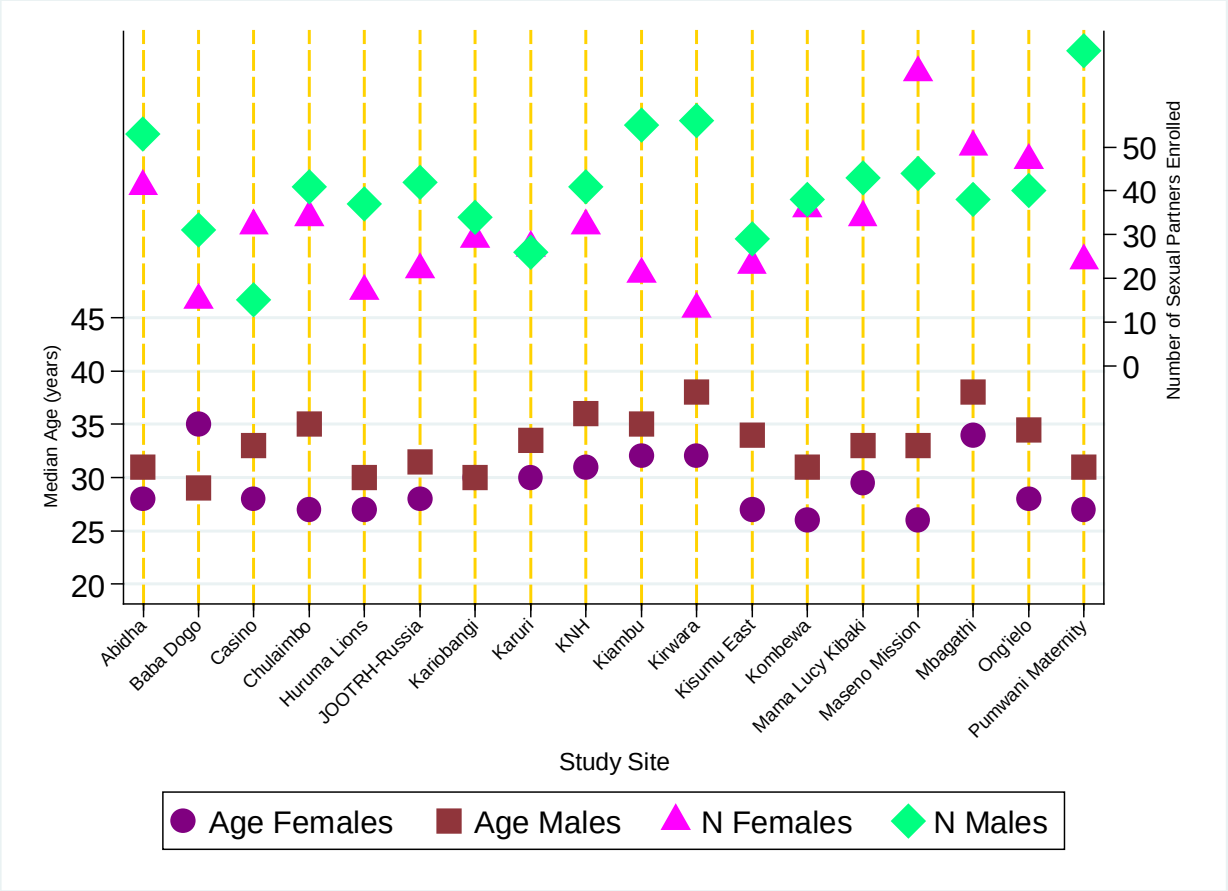
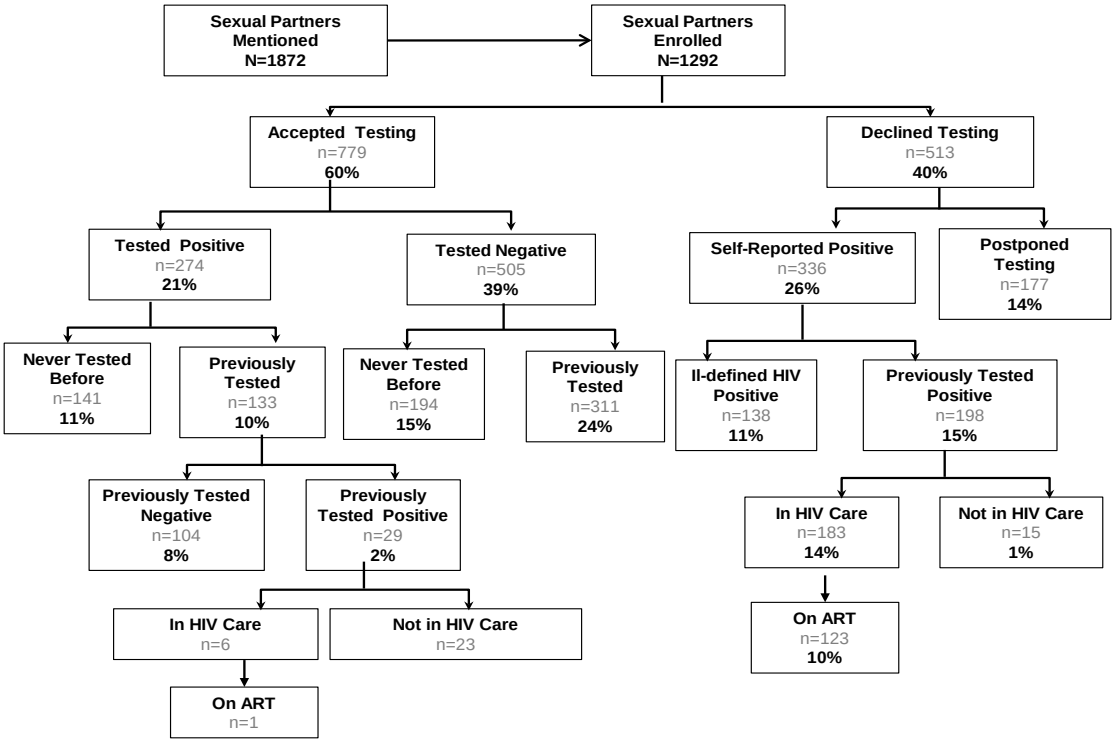


Figure 3: Basic characteristics sexual partner participants in 18 study sites



Five hundred and eighty (31.0%) of 1872 sexual partners who were mentioned could not be traced due to insufficient locator information, unavailability, lack of willingness to enroll, or death. Among enrolled sexual partners, 779 (60%) consented to testing (Figure 4). The refusers cited a previous HIV positive test as the main reason for not consenting to test.

Figure 4: HIV Testing Outcomes of Enrolled Sexual Partners



Baseline characteristics

The characteristics of study participants are described in Tables 1 and 2. The median age (IQR) of 1119 enrolled index cases and their sexual partners was 30 (25-38) and 31 (26-37.5), respectively. Among index cases, the majority was female, in stable relationships and had previously tested for HIV. A higher proportion of index cases were also enrolled in urban and in the Nairobi clusters. Forty percent of index participants mentioned more than one sexual partner, but less than 3% reported >3 sexual partners. Except for a slightly higher proportion of female index cases in the delayed arm, both study arms were similar at baseline in terms of socio-demographic characteristics, HIV-testing behaviors, reported sexual history and their geographical location.

Among sexual partners, several differences in demographic and sexual characteristics emerged. Sexual partners in the immediate arm were younger, more likely to be female and to have tested for HIV before.

Table 1: Baseline characteristics for enrolled index participants (n=1119)

	Immediate Arm(N=550)		Delayed Arm[λ] (N=569)	
	Median (IQR) or N (%)		Median (IQR) or N (%)	
Socio-Demographic characteristics				
Age (years)	30	(25-37)	31	(26-38)
Sex (Female)	322	(58.6)	368	(64.7)
Marital status (Married Monogamous)	305	(55.5)	308	(54.1)
HIV Behavioral characteristics				
Ever Tested for HIV	379	(68.9)	366	(64.3)
Self-reported last HIV test result				
Does not know	10	(1.8)	9	(1.6)
HIV negative	257	(46.7)	264	(46.4)
HIV positive	112	(20.4)	93	(16.3)
Reason for testing for HIV at enrollment				
Sexual Partner is HIV positive	18	(3.3)	16	(2.8)
Notified by partner	11	(2.0)	12	(2.1)
Notified by Health Provider or other	7	(1.3)	4	(0.7)
Pregnant/Partner Pregnant or new sexual relationship	13	(2.4)	12	(2.1)
Own Health or other reason	519	(94.3)	541	(95.1)
Number of lifetime sexual partners(median, IQR)	4	(2-6)	4	(3-8)
Heterosexual	536	(97.5)	561	(98.6)
Partner notification characteristics				
Proportion of naming only one sexual partner[γ]	547	(60.1)	566	(59.9)

Facility-level characteristics				
Region				
Nairobi/Central	294	(53.5)	388	(68.2)
Western(Kisumu, Siaya)	256	(46.5)	181	(31.8)
Location				
Urban	302	(54.9)	322	(56.6)
Peri-Urban	185	(33.6)	186	(32.7)
Rural	63	(11.5)	61	(10.7)

[γ]Among those who provided sexual history

Table 2: Baseline characteristics for enrolled sexual partners of index participants (n=1292)

	Overall (N=1292)		Immediate Arm(N=620)		Delayed Arm[λ] (N=672)	
	Median (IQR) or N (%)		Median (IQR) or N (%)		Median (IQR) or N (%)	
Socio-Demographic						
Age (years)	31	(26-37.5)	30	(26-37)	32	(28-38)
Sex (Female)	562	(43.5)	306	(49.4)	256	(38.1)
Marital status						
Married Monogamous	744	(57.6)	340	(54.8)	404	(60.1)
Married Polygamous	105	(8.1)	60	(9.7)	45	(6.7)
Single	278	(21.5)	135	(21.8)	143	(21.3)
Non-married Cohabiting	44	(3.4)	27	(4.4)	17	(2.5)
Separated/Divorced	121	(9.4)	58	(9.4)	63	(9.4)
Employment status						

Unemployed	212	(16.4)	123	(19.8)	89	(13.2)
Student	12	(5.7)	7	(5.7)	5	(5.6)
Employed(Unskilled)	406	(31.4)	199	(32.1)	207	(30.8)
Employed(Semi-professional)	376	(29.1)	166	(26.8)	210	(31.3)
Employed(Professional)	298	(23.1)	132	(21.3)	166	(24.7)
HIV Behavioral characteristics						
Ever Tested for HIV	751	(58.1)	515	(83.1)	236	(35.1)
Self-reported last HIV test result						
Does not know	12	(0.9)	9	(1.5)	3	(0.4)
HIV negative	511	(39.6)	342	(55.2)	169	(25.2)
HIV positive	228	(17.6)	164	(26.4)	64	(9.5)
In HIV Care	190	(83.3)	141	(86.0)	49	(76.6)
Reason for testing for HIV at enrollment[§]						
Sexual Partner is HIV positive	77	(10.2)	31	(6.0)	46	(19.5)
Notified by partner	69	(9.2)	24	(4.7)	45	(19.1)
Notified by HP	8	(1.0)	7	(1.3)	1	(0.4)
Pregnant/Partner Pregnant or new sexual relationship	120	(16.0)	98	(19.0)	22	(9.3)
Own Health or other reason	554	(73.8)	386	(75.0)	168	(70.2)
Number of lifetime sexual partners(median, IQR)	5	(3-8)	4	(3-7)	5	(3-9)
Number of new sex partners in last 3 months(median, range)	0	(0-50)	0	(0-20)	0	(0-50)
Self-reported Sexual preferences						
Heterosexual	1268	(98.1)	614	(99.0)	654	(97.3)
Bisexual/Homosexual	24	(1.9)	6	(1.0)	18	(2.7)

History of transactional sex	500	(38.7)	240	(38.7)	260	(38.7)
Ever sexual relationship with HIV-infected partner	97	(7.5)	48	(7.7)	49	(7.3)
Condom use at last sex	516	(39.9)	242	(39.0)	274	(40.8)
Facility-level characteristics						
Region						
Nairobi/Central	738	(57.1)	285	(46.0)	453	(67.4)
Western(Kisumu, Siaya)	554	(42.9)	335	(54.0)	219	(32.6)
Location						
Urban	665	(51.5)	298	(48.1)	367	(54.6)
Peri-Urban	452	(35.0)	238	(38.4)	214	(31.9)
Rural	175	(13.5)	84	(13.5)	91	(13.5)

HP: Health Provider

Additionally a lower proportion of sexual partners in the immediate reported testing for HIV due to a notification of an exposure by either a sexual partner or a health provider. All other baseline characteristics of sexual partners were similar across the two study arms.

Effectiveness of partner services

Overall, 506 sexual partners tested for HIV as per the study protocol, 388 in the immediate arm during enrolment and within the study after enrollment, and 118 in the delayed arm in the preceding two months before enrollment(Incidence Rate Ratio (IRR) 3.78, (95%CI:3.08-4.65). The incidence rate ratio comparing rates of new testing for HIV between the immediate and delayed groups was 11.50 (95% CI: 5.56-23.78). Immediate aPS also increased the number testing positive and those enrolled in HIV care, IRR 3.22 (2.26-4.61) and 3.95 (2.48-6.28) respectively (Table 3).

Table 3: Effectiveness of aPS on HIV testing, new HIV testing, new HIV diagnoses and enrollment in HIV care of enrolled sexual partners

Outcome	Immediate Arm±		Delayed Armᵀ		IRR	(95% CI)	ICC	(95% CI)
	Number	(Rate)§	Number	(Rate)§				
Number tested§	388	(0.705)	118	(0.207)	3.78	(3.08-4.65)	0.253	(0.117-0.390)
Number newly tested§	80	(0.145)	8	(0.014)	11.50	(5.56-23.78)	0.051	(0.009-0.094)
Number HIV +§	115	(0.209)	41	(0.072)	3.22	(2.26-4.61)	0.039	(0.004-0.073)
Enrolled in HIV Care	79	(0.144)	23	(0.040)	3.95	(2.48-6.28)	0.034	(0.003-0.066)

IRR=Incidence Rate Ratio. CI=Confidence Interval. ICC= Intracluster correlation coefficient. IRR estimated using generalized estimating equations Poisson regression with independent correlation matrix and index cases as offset variable. ± (N=550 index cases). ᵀ (N=569 index cases). §Rate per index case enrolled

HIV Testing outcomes

Among 1292 enrolled sexual partners, 779 (60.3%) consented to HIV testing, with 336 (26.0%) declining because their perceived themselves to be already infected (Figure 4). The HIV positive status of 138 (11%) of 1292 enrolled participants could not be verified. One hundred and seventy seven (13.7%) of 1292 participants declined testing altogether either because they wanted to test later or elsewhere or they had recently tested for HIV. Overall, 335 (26%) of enrolled study participants had never tested before and 104 (8%), of those testing HIV-positive reported testing negative on a previous test. Among those reporting a previous HIV positive test, the majority were in HIV care and on ART.

Number needed to interview

Among 1119 index cases, 779 sexual partners tested for HIV. The number need to interview (NNTI) to test one sexual partner was 1.44. Three hundred and thirty five were newly tested so the number needed to interview to test someone who had never tested before was 3.34 (NNTI=3.34). Among those tested, 274 were HIV-infected thus 4 index cases needed to be interviewed to identify one new positive individuals (NNTI=4.08). If we include those who declined HIV testing but self-reported being HIV-positive, 463 sexual partners were HIV infected and NNTI to find one HIV-positive person (new or known positive) was determined to be 2.42 (Table 4).

Table 4: Number of index cases needed to interview (NNTI) to test and identify newly testers, and HIV infection among sexual partners across regions and residence

Category	Enrolled Index Cases	Tested	NNTI [§]	p value	Newly Tested	NNTI	p value	Positive	NNTI	p value	Any Positive	NNTI	p value
	Overall(N=1119)	779	1.44	N/A	335	3.34	N/A	274	4.08	N/A	463	2.42	N/A
Region	Western(n=437)	373	1.17	Ref	123	3.55	Ref	131	3.34	Ref	231	1.89	Ref
	Nairobi/Central (n=682)	406	1.68	<0.001	212	3.22	0.325	143	4.77	0.004	232	2.94	<0.001
Residence	Rural (n=124)	111	1.12	Ref	55	2.25	Ref	42	2.95	Ref	76	1.63	Ref
	Peri-Urban (N=371)	279	1.33	0.475	109	3.40	0.055	89	4.17	0.180	178	2.08	0.271
	Urban (N=624)	389	1.60	0.001	171	3.65	0.003	143	4.36	0.033	209	2.99	<0.001

* Number needed to interview (NNTI) = number of index patients needed to enroll to incur a testing outcome. P values are obtained from Poisson regression, offset by the index case using generalized estimating equations. □ Includes those testing for HIV for the first time. [§] Includes those who declined to test for HIV but self-reported HIV positive.

The NNTI to test one sexual partner, identify one case of HIV or any case of HIV was higher in Nairobi/Central region compared to the Western Region (p values <0.001, 0.004 and <0.001 respectively). Rural-urban differences in NNTI were noted with higher NNTI in urban areas compared to rural areas. Specifically in rural areas, 1.12, 2.25 and 2.95 index cases needed to be interviewed to test one sex partner, to identify new testers and to find an HIV infected partner. More than half (52.2%) of partners in Nairobi/Central were testing for the first time, a significant difference from the Western Region (p value <0.001) (Table 5). Overall, 35.2% of those tested were HIV-infected and this did not differ across geographical regions or between urban and rural areas.

Table 5: New HIV testing and Case Finding Rates across regions and residence

Category	Number Tested	Number Newly Tested	Proportion newly testing	P value	Number HIV Positive[§]	Case Finding Rate[§]	P value
	Overall (N=779)	335	0.430	N/A	274	0.352	N/A
Region	Western (N=373)	123	0.330	Ref	131	0.351	Ref
	Nairobi/Central(N=406)	212	0.522	<0.001	143	0.352	0.981
Residence	Rural (N=111)	55	0.495	Ref	42	0.378	Ref
	Peri-urban (N=279)	109	0.391	0.151	89	0.319	0.362
	Urban (N=389)	171	0.440	0.440	143	0.368	0.869

* Case Finding Rate= number of index patients needed to enroll to incur a testing outcome. P values are obtained from Poisson regression, offset by the number tested using generalized estimating equations. [§] Only includes those who consented to test for HIV

Intimate partner violence

At 6 week follow-up, 90 (8%) IPV events were reported, 2 (0.2%) were possibly related to the study, one in each study arm. However, none of the sexual partners of the two were notified by a health advisor because one was in the delayed arm and the other opted to notify on their own.

Discussion

This is the first large-scale community trial to evaluate effectiveness of partner services and it confirms the effectiveness of partner services in increasing HIV testing and HIV case-detection. We demonstrated a substantial effect of aPS in identifying undiagnosed infection. Compared with the delayed intervention group, sexual partners receiving immediate aPS were 12-fold more likely to be newly testing. Previous studies have demonstrated doubling of rates of HIV testing and new diagnoses following partner notification[1, 15]. These studies elicited sexual partners in the preceding three months to one year and also did not involve community tracing of partners. In our trial we obtained more detailed locator information for partners up to 3 years ago, and were able to enroll two-thirds of our participants. Other studies confirmed successful notification and testing of less than half of mentioned sexual partners[1, 15]. This may partially explain the larger effect in our study.

Among all partners, the NNTI to identify one HIV infected case was 4.08. This compares well with other African studies but is lower than in the United States[25]. Substantial heterogeneity in NNTI potential reflects the HIV prevalence and the rate of HIV testing across the study sites. That we did not detect any regional or locational differences in case finding rates in not surprising. HIV prevalence among sexual partners was 35.2 %(ranging from 26% to 47.5%) across clusters. These are four to eight times the Kenya national prevalence and denote that sexual partners of HIV-infected persons are at particularly high risk regardless of the background HIV prevalence in the community. Still, there could be regions with larger proportions of undiagnosed infection in which aPS would be very effective in tandem with the call for continued HIV surveillance and application of geospatial approach to HIV interventions[26].

A significant proportion of partners could not be located because they were not at home. Strategies to increase enumeration and locatability of sexual partners may increase overall effectiveness of aPS. However, national programs should explore different strategies for enhancing locatability. Text messaging and internet-based programs may overcome these challenges[27, 28]. Despite the one-way aspect of these approaches, it could be improved further by interactive text messaging and internet communication as this may, in addition to phone contact, appear higher preferable by health providers[29].

Among enrolled partners, HIV testing acceptance was high (60%). PS studies in Cameroon showed a similar rate of testing (66.8%)[2]. Although approximately 40% did not consent to test in our study, this was due to a previously known HIV positive result, and the majority was already enrolled in HIV care. Only 14% declined HIV testing altogether. This is consistent with many opt-out approaches for HIV testing in which testing uptake is relatively high[30-32]. Based on these results, we conclude that HIV testing is unlikely to be a major barrier in the scale up and implementation of aPS and Opt-out HIV testing should remain as the pivotal mechanism for testing in aPS. A quarter of sexual partners had never tested for HIV before, of whom half were HIV-infected and could be substantial reservoir of HIV infection.

Of note however that is among those who declined HIV testing due to self-reported knowledge of their HIV positive status, enrollment to HIV care and initiation of ART was high. However, this could not be independently verified. Overall effectiveness of aPS would be therefore be limited if HIV infected persons are not linked to care, initiated on ART promptly and followed up for optimal retention in care[33]. It would be appropriate to ensure follow-up of those declining testing to ensure linkage to care and initiation of ART.

Our results are generalizable to global settings for several reasons. The pragmatic design of the trial, the expanded eligibility criteria of index cases, and the lack of screening of sexual partners reflected aPS implementation in the public-sector settings. Although we engaged highly-trained nurses to offer aPS in the study, task shifting to lower cadre providers is possible as has been done with more complex interventions such as male circumcision and delivery of ART[34-36]. Data collection using the ODK platform is feasible and could be expanded as technology and internet connectivity is increasingly pervasive in

most parts of the world. Still, cost-effectiveness studies are required to compare traditional data collection systems and ODK-platforms.

In conclusion, this cluster RCT found aPS to be effective at the population level. aPS could be implemented as part of HTC delivery with a focus on populations and regions with highest risk of acquisition and lowest uptake of HTC. Immediate aPS is not any more harmful than delayed aPS. However this question requires further evaluation and screening and monitoring of IPV to identify highest risk persons should be considered as aPS is scaled up.

Coupled with efficient linkage to care and immediate initiation of ART as recently demonstrated in the Strategic Timing of Antiretroviral Therapy (START) trial, aPS could potentially increase ART access and lead to population level reductions in HIV incidence[37].

Chapter 2: Estimated costs and budget impact of assisted partner services In Kenya

Abstract

Introduction: Assisted partner services for HIV (aPS), the elicitation of sexual history, and tracing and testing of sexual partners of HIV-infected index cases, are effective and feasible in both high and low-income settings. However, aPS may not necessarily be affordable in limited- resource settings due to the high burden of HIV infection. We applied the ISPOR guidelines to estimate the budget impact of aPS compared to current practice of HIV testing and counselling (HTC) in Kisumu County, Kenya. Additionally, task-shifting to community health workers (CHWs) was compared to utilizing nurses to scale up aPS.

Methods: We constructed an Excel-based costing tool to simulate the budget impact analysis of HIV partner services on an annual basis over a 5 year time horizon. HTC and aPS unit and total costs were estimated and allocated using ingredient-based approaches. Time motion was used to determine full-time equivalent of tracing sexual partners of index patients. Weighted costs of ART, clinic visits and hospitalizations that accrued due to aPS were generated through decision tree modeling. We estimated a range, where the lower-bound cost assumed that all sexual partners tested were HIV-negative and the upper-bound cost assumed that all sexual partners were HIV-positive. All costs were undiscounted and reported separately for the task-shifting scenarios.

Results: The average annual aPS costs are US$ 1,092,161 and US$ 753,547 for Kisumu County using nurses and CHWs, respectively. The weighted average cost of scaling up aPS over a five period using nurses was 45% higher compared to CHWs (US$ 5,460,837 and US$ 3,767,738 respectively). Overall, the differences between the upper and lower bound costs were 8.7% for nurse-based aPS and 2.5% for the CHW-based approach. Over the time horizon, the total budget impact of nurse-model was US$ 1,726,832, 69.2% and 29.5% of which were accounted for by aPS costs and ART costs respectively. The CHW model incurred an incremental cost of US$ 1,184,640, 68.6% lower than the nurse-based model. Proportional distribution of impact across budget categories was similar in the two models, although CHWs model had lower aPS related impact.

The weighted unit costs of HIV testing across the three levels of facilities for HIV-infected index clients using nurses were US$ 25.36 and US$ 17.86 using CHWs. Costs for testing sexual partners of infected index clients were higher overall, with an HIV test costing US$ 19.18 per person if all tests were negative and US$31.07 per person if all tests were positive for nurses and US$ 11.74 per person and US$ 14.14 per person for CHWS respectively.

Conclusion: aPS is affordable but not cost-saving within the five-year time frame. There is scope for increasing cost-efficiency of aPS by reduction of aPS and ART related costs and by task-shifting aPS to community health workers.

Introduction

Assisted partner services (aPS), the systematic elicitation of contact information, exposure notification and active tracing of sexual partners of HIV infected patients, is essential for HIV prevention. Compared to HIV testing and counseling (HTC) alone, aPS increases HIV testing rates, reduces STI/HIV exposure. Coupled with immediate initiation of ART, aPS may lead to reduction in population-level HIV transmission, a major global health initiative[22, 38]. The impact of aPS could be substantial in Kenya where HIV is endemic and HIV testing and ART coverage rates are low[18].

Although aPS is feasible and effective in both high and low-income resource settings, further scale up in Africa may depend on its demonstrated affordability[2]. In Malawi, active partner notification services by health providers were cost-effective compared to patient referral alone. However, this study was located in an urban area, was clinic-based, did not include active community tracing of sexual partners, and did not estimate the cost of scaling up aPS [7]. More costing data is required to enable decision making in countries bearing the highest burden of HIV.

The Kenya Ministry of Health(MoH) is currently considering aPS as a priority intervention[38]. However, recently decentralized administrative units, the counties, require data to enable appropriate budgeting for existing and new HIV services. Kisumu County, the area with the second highest prevalence of HIV in Kenya is among the five counties contributing 51% of new HIV infections in Kenya[39]. The county has a well-established HIV testing and counseling (HTC) public health program supported by the President's Emergency Fund on AIDS Relief (PEPFAR). The HTC package, also referred to as Voluntary Counseling and Testing (VCT), includes HIV testing of patients and minimal counselling support to enable HIV infected clients to disclose their HIV status to their sexual partners. Adding aPS to HTC programs would require that health workers actively engage HIV-infected patients and trace their sexual partners. Including aPS to current HTC programs could elevate total HIV program costs in the county, but may be cost-saving depending on their relative reduction of hospitalizations and HIV incidence resulting from increased uptake of ART over time. Furthermore, the implementation of aPS could include task shifting, a strategy of shifting activities to lower level health workers endorsed by WHO, UNAIDS and PEPFAR[40].

Task-shifting is a widely accepted strategy for increasing population level coverage of interventions including HIV testing and initiation of ART and recent reviews on its effectiveness are favourable [41].

Using an NIH-funded implementation science study we conducted a cost and budget impact analysis of aPS in Kisumu County, Kenya. The overall aim of the study was to evaluate the affordability of aPS in the county. Specifically we estimated the total and units costs of HTC and aPS. Additionally we calculated the incremental costs and budget impact of scaling aPS compared to HTC alone over a five year horizon.

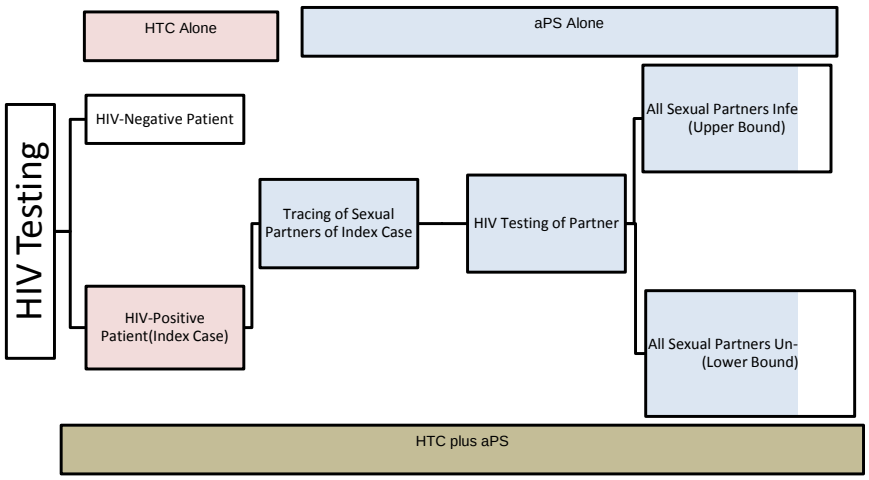
Methods

Study design

A Microsoft Excel™ 2010 spreadsheet costing tool (Microsoft, Redmond, WA, USA), was used to generate total and unit costs of HTC and aPS and simulate the budget impact of HIV partner services on an annual basis over a 5-year time horizon. We applied the International Society for Pharmaeconomics and Outcomes Research (ISPOR) guidelines to conduct a budget impact analysis[8]. Using a payer's perspective, we compared two scenarios; one, the current practice (HTC alone) and second, adding aPS to HTC (Figure 1). For aPS, in addition to basic HIV testing of index cases, health workers traced the sexual partner of the index case and tested the identified partner. In addition to comparing aPS with current practice, we explored an additional scenario for task-shifting from nurses to lay workers –CHWs for aPS.

Study setting

Figure 1: Conceptual Model HTC and aPS[1]



[1]*HTC Alone includes testing of an HIV infected index. aPS includes HTC of HIV infected index and tracing and testing of sexual partners The red box denotes HTC alone and the Blue boxes denotes the additional interventions*

We anticipated that partner notification would be provided in addition to the existing Kenya MoH HTC services in Kisumu County mainly at three levels of the health systems (hospital, health centre, and dispensary). Briefly, the health system in Kisumu County includes 9 hospitals, 20 health centres and 80 dispensaries that offer HTC. The staffing patterns and HTC client loads were determined using MOH program records (Appendix I). Study-related costs for supplies, equipment, transport and personnel were retrieved from an NIH-implementation science study [23]. We conducted a time-motion in two of the actively recruiting aPS study sites which were purposively selected to examine partner tracing times, to validate HTC client workload and estimate building space allocation for HTC. These sites were a peri-urban, tested approximately 100 and 500 persons per month respectively and reported a HIV positivity rate of 5-8%. One facility was a MoH health centre and the other a faith-based hospital.

Costing procedures

Information on resource use and costs were collected for mutually exclusive categories for start-up and recurrent costs and to capture all inputs, including, personnel, transportation, equipment, supplies, buildings and overhead and data capture and use as per WHO recommendations[42].

Fixed costs included start-up, program management (planning, and supervision), staff training, transportation, facility space, and equipment. We used the aPS study expense reports to estimate the program start-up and staff training costs as well as costs of vehicles and equipment. However we made adjustments for initial program supervision using local per diem rates, rather than investigator personnel costs. The start-up costs included planning, training and supervision costs of HTC providers in Kisumu County. We assumed that a ten-day training would suffice as per standard practice for HIV trainings in Kenya. A provision for one refresher training during the course of the time horizon was made and was considered part of the start-up costs. Transportation costs included purchase of trucks and motorcycles. Dispensaries were not allocated any vehicles and we assumed that staff in these facilities would use public transport for aPS. HTC space allocation was estimated at 100 square feet and we applied local rental rates to generate costs for building and overheads. Other equipment costs included furnishings, furniture and other office fittings.

Recurrent costs included personnel, HIV testing kits and consumables, stationery, utilities, airtime as well as data collection tools. We used aPS study salaries to derive personnel costs for nurses and CHW costs were estimated using expert opinion. All these personnel costs aligned well with salary scales from the Kenya Salaries and Remunerations Commission. The costs for HIV testing and treatment included HIV test kits, consumable supplies, and were obtained from PEPFAR, and the Global Fund indicative prices. All other recurrent costs were obtained from the aPS study records.

Personnel full time equivalent (FTE) for HIV testing of index case and the sexual partners was calculated based on staffing norms and the possible number of HIV tests per staff per day (Appendix I). We assumed that there would be sub-optimal FTE as has been observed in sub-Saharan African before[43]. Personnel costs for on-going planning, management and leadership were deemed to be negligible and

were not included in the cost analysis. However, staff time for partner tracing and other provider related costs were collected using time and motion studies and was validated using expert opinion.

All costs were undiscounted but annuitized over the useful life of their respective useful lives.

Within each budget category, we estimated the total costs for HTC for both index and sexual partners by factoring in the quantities of resources used and summing up across these categories. Specifically for personnel, we estimated the total number of personnel and their FTE for providing HTC. The number of HIV tests conducted was based on patient workload and FTE for personnel. These costs were calculated separately for each of the three types of health facilities and each of the two task-shifting approaches. We also estimated different costs depending on the HIV test results, with the upper bound total costs assuming all persons tested are HIV-infected and lower-bound costs, otherwise.

To determine the HTC cost per person, we identified the total program costs for Kisumu County and divided these by the patient workload using the approach by Metlzer[44]. We assumed that a dispensary, health centre, and a hospital would have 2.5, 10 and 15 HIV positives per five-day week respectively and this constituted the upper bound for HIV testing costs. Conversely, we assumed at a dispensary, health centre and a hospital would have, 15, 25 and 40 HIV negatives per five-day week respectively and this would constitute the lower bound for HTC costs. For community testing of sexual partners we estimated that across the three levels of health facilities, HTC providers would test an average of 10 HIV positive partners and 15 HTC negative clients per week. These numbers reflect realistic volume load and existing national HTC guidelines[45, 46]. The unit cost for each HTC strategy was weighted by the annual HTC client load at each of the three types of health facilities.

The unit cost of aPS was estimated for testing the index case, tracing their sexual partner and testing the partner (Figure 1). The upper bound costs assumed that all index were HIV-positive and all sexual partners were HIV-positive. The lower bound assumed on the other hand had similar assumptions only that the sexual partner would be negative. We estimated that an HIV-infected index case would name an average of 1.67 sexual partners all of whom accrue tracing costs and that 0.96 sexual partners would be tested for HIV per index case. Lower and upper bound aPS unit costs were calculated thus:

Lower bound= [Cost of HIV positive index case] + [1.67*Cost of Tracing] + [0.96*Cost of HIV negative sexual partner]

Upper bound= [Cost of HIV positive index case] + [1.67*Cost of Tracing] + [0.96*Cost of HIV positive sexual partner]

To reflect program-level costs, and to capture the heterogeneity of facility-specific expenditures and patient load, we calculated weighted costs of HTC alone and HTC plus aPS using the estimated distribution of HIV infected patients and outpatient visits at each level of health care (Appendix I). Inputs for the HTC costs were obtained from the aPS study and published literature (Appendix II).

Table 3 outlines the calculation of total aPS costs. Over the time horizon, total PS costs would rise as a function of scale and annual coverage mix of eligible populations between HTC alone and aPS. Total costs were determined for each type of health providers and categorized as lower or upper bound depending on the HIV status of the sexual partners of the HIV-infected index. We weighted these lower and upper bound aPS costs by the HIV prevalence (35%) of sexual partners in the aPS study.

Demographic and epidemiological data from Kisumu County were combined to estimate the eligible population. The eligible population for this intervention was prevalent and incident HIV cases in Kisumu County. Prevalent cases were derived from the Kenya AIDS Indicator Survey 2012 and from UNAIDS Reference Group Estimates Spectrum model[47]. All those enrolled in HIV care were however excluded from the analysis. Incident cases were estimated using the Kenya national age-and sex-specific incidence estimates from the Spectrum model. We anticipated that 50% of this population would be identified based on current rates of HIV testing[18]. Furthermore, the size of this eligible population would rise marginally at a rate of 3% over the five-year time horizon as a function of increased population growth rate, increased rate of HIV testing and increased survival.

Budget impact model

Cost data, the size of the eligible population and the scale rates were combined to estimate BIA for scaling up over 5 years. Using a Microsoft Excel™ 2010 spreadsheet (Microsoft, Redmond, WA, USA), we simulated increasing coverage of aPS from 5%, 10%, 20%, 30% and 50% from year 1 to 5

respectively. The HIV-infected sexual partners of index cases were assumed to incur costs of antiretroviral therapy (ART), HIV clinics visits and hospitalization. However, primarily due to viral suppression, we assumed that these would avert HIV treatment costs. We estimated that all these costs would accrue immediately. ART, clinic visit and hospitalization costs were calculated using TreeAge Pro 2015 decision tree modelling software (TreeAge Software Inc., MA, USA)(Appendix III). Populations receiving aPS would have a 12% higher probability of receiving ART, a higher probability of hospitalization and a similar probability of clinic visits conditional on ART initiation. However hospitalization costs would be lower for the aPS group (Appendix III).

The costs of clinic visits were considered independent of the severity of HIV infection and the scale up strategy and assumed only to be associated with the coverage of aPS over the 5 year period. Costs related to hospitalization and averted HIV infections were assumed to accrue immediately. HIV-negative sexual partners were deemed not to accrue HIV-related costs except for aPS. In summary, we made the following assumptions.

- HTC and aPS costs were weighted based on the HIV infected and total outpatient workload of each of the three levels of health facilities.
- Costs of all inputs would not change over the time horizon, but the eligible population would rise due to population growth, increased rates of testing and survival.
- Fifty percent of the eligible HIV-infected population would have access to HIV testing and that over five years, aPS would be scaled up to achieve a population coverage of 50%
- HIV-infected sexual partners would accrue ART, clinic visit and hospitalization costs as well as averted infections immediately

Cost metrics and budget impact outcomes

We report unit of both HTC and aPS, and the lower and upper bound undiscounted total HTC and weighted aPS program costs. These costs are reported separately for each task-shifting strategy. We also report the total budget impact of aPS, and per HIV-infected index case, for each year of scale up within a five year budget cycle. These outcomes are separately reported for a nurse-based provider model and a task shift model using CHWs.

Sensitivity analyses

We varied the lower and upper bound aPS costs for the two task-shifting scenarios by -50 to +150% to determine their relative contribution to overall aPS costs. A one-way sensitivity analysis was performed and presented using tornado plots.

Results

The unit cost of HTC alone for HIV testing of index cases varied across the three levels of health facilities (data not shown). In the nurse-based model, HTC ranged from US$ 8.8 per person assuming all HIV tests in a hospital are negative to US$ 100.8 per person if all HIV tests conducted in the lowest level clinic are positive. Using CHWs to provide HTC, the cost was US$ 5.6 per person in a hospital for HIV-negative patients and US$ 62.8 per person for an HIV-infected case in the lowest level clinic. Table 1 presents weighted unit costs for HTC by HIV status of index cases and type of health provider. Overall, the lower-bound costs for HIV testing were US$ 10.03 per person if all tests at a given time were negative and the upper bound was US$ 25.36 person if otherwise. The weighted unit costs of HIV testing across the three levels of facilities for HIV-infected index clients using nurses were US$ 25.36 and US$ 17.86 using CHWs.

Table 1: Total and unit HTC costs for index case, per type of health provider and HIV-infection status, US$ 2014[§]

	HTC by Nurses				HTC by CHWs			
	HIV-positive		HIV-negative		HIV-positive		HIV-negative	
	Total cost	Unit Cost	Total cost	Unit Cost	Total cost	Unit Cost	Total cost	Unit Cost
Startup costs	5,116	0.15	5,310	0.06	3,460	0.12	3,460	0.04
Scale up costs								
Personnel	591,126	18.04	605,544	7.02	282,238	9.76	282,238	3.41
Transportation	21,057	0.57	19,936	0.20	32,249	0.82	32,249	0.31

	Equipment	2,748	0.08	2,824	0.03	386	0.01	386.35	0.00
	Supplies	142,372	4.22	155,258	1.76	142,372	4.23	156,278	1.76
	Buildings and overheads	42,307	1.44	50,079	0.62	42,307	2.05	42,307	0.62
	Data capture	28,306	0.87	28,475	0.33	27,386	0.88	27,386	0.32
Total Cost		**833,035**	**25.36**	**867,430**	**10.03**	**530,403**	**17.86**	**544,309**	**6.47**

[§]Weighted estimates of costs across three levels of health care (dispensary, health centre and hospital). HTC: HIV Testing and Counselling. CHW: Community Health Worker

The total costs of testing HIV-infected index cases in Kisumu County were US$ 830,035 and US$ 530,404 with nurses and CHWs respectively. The largest proportion of costs was personnel related, 71% with nurses and 53% with CHWs.

The unit costs for aPS to test sexual partners of index cases followed a similar pattern (Table 2).

Table 2: Total and unit HTC costs for sexual partners of HIV-infected index case, per type of health provider, US$ 2014[§]

Budget Category	HTC by nurses				HTC by CHWs			
	Lower Bound		Upper Bound		Lower Bound		Upper Bound	
	Total cost	Unit Cost	Total cost	Unit Cost	Total cost	Unit Cost	Total cost	Unit Cost
Startup costs	5,310	0.13	5,116	0.20	3,544	0.09	3,460	0.09
Scale up costs								
Personnel	605,544	14.84	591,126	22.95	290,615	7.19	282,238	7.23
Transportation	19,936	0.53	21,057	0.84	30,543	0.81	32,249	0.86

Equipment	2,824	0.07	2,748	0.11	372	0.01	386	0.01
Supplies	78,302	1.82	110,163	4.26	74,221	1.83	164,313	4.20
Buildings and overheads	50,079	1.07	42,307	1.61	50,079	1.12	42,307	1.04
Data capture	28,475	0.71	28,306	1.10	27,386	0.69	27,386	0.70
Total Cost	**790,473**	**19.18**	**800,825**	**31.07**	**476,763**	**11.74**	**552,343**	**14.14**

§ §Weighted estimates of costs across three levels of health care (dispensary, health centre and hospital). HTC: HIV Testing and Counselling. CHW: Community Health Worker. Lower bound assumes all tests at any given time are HIV-negative and upper bound assumes all tests at any given time are HIV-positive. Includes costs for community tracing of sexual partners.

As expected, these costs were higher overall, with an HIV test costing US$ 19.18 per person if all tests were negative and US$31.07 per person if all tests were positive for nurses and US$ 11.74 per person and US$ 14.14 per person for CHWS respectively. Upper-bound costs were 62.0% higher when providing services using nurses and 20.4% higher if using CHWs. The cost of tracing a sexual partner through aPS was US$3.57 per person and did not differ by the HIV status of the sexual partners. The higher bound cost of assisted partner services was calculated to be US$ 61.15 while the lower bound was US$49.73 per person for nurse-based testing and US$ 37.40 per person and US$ 35.09 per person for CHW-based approach, respectively (Table 3).

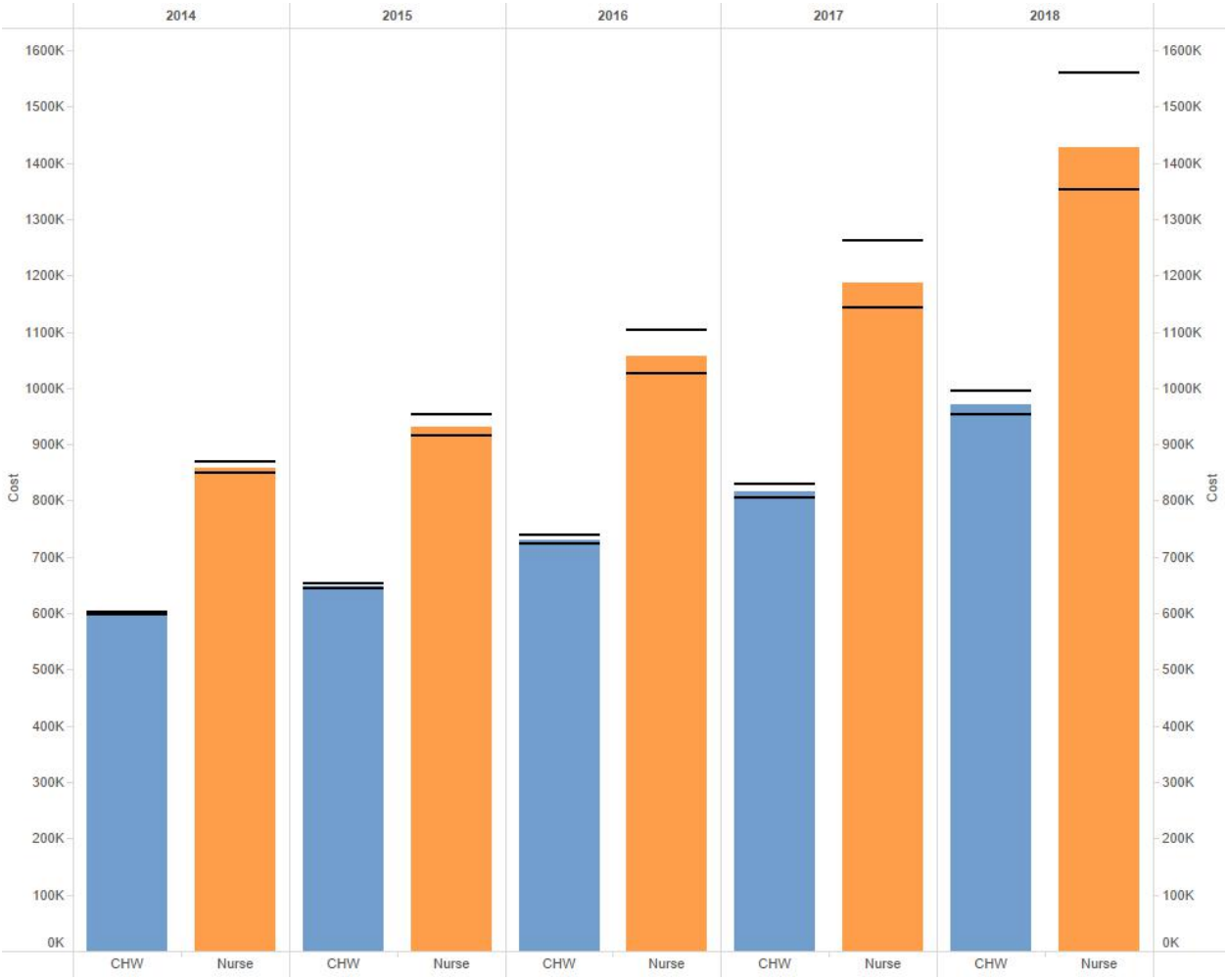
Table 3: Eligible population, unit cost of aPS and 5-year coverage mix of aPS and standard of care[§]

Total Eligible Population: 64,146						
Coverage Mix	aPS				HTC Alone	Total
Year 1(5% aPS)	1,604				30,469	32,073
Year 2(10% aPS)	3,303				29,732	33,035
Year 3(20% aPS)	6,805				27,221	34,026
Year 4(30% aPS)	10,514				24,533	35,047
Year 5(50% aPS)	18,049				18,049	36,098
Unit Costs	Nurse				Nurse	
	CHWs				CHWs	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound		
	49.73	61.15	35.09	37.40	25.36	17.86

[§] HIV testing costs for an HIV infected index. aPS costs include HTC for a positive index case and HTC and tracing of sexual partner. Lower abound assumes sexual partner in HIV-negative and upper bound assumes sexual partner is HIV-positive. Coverage mix (Number of persons) assuming 50% uptake of HTC and aPS and a modest scale up rate to reach 50% population coverage in 5 years. aPS: assisted Partner Services for HIV. CHW: Community Health Worker. Eligible population excludes those already enrolled in HIV care, and increases a function of population growth

The total costs of scaling up aPS over a five-year period were US$5.5 million when using nurses and $3.8 million when using CHWs (Figure 2). Annual aPS costs varied from US$600K among CHW in 2014 to US$1.4 million among nurses at the end of time horizon. Personnel related costs represented between 54- 70% of all HTC costs depending on the task-shifting approach , with supplies (including HIV test kits and office stationery), taking up close to a fifth of all costs (17%). Other costs were minimal. The weighted costs of scaling up aPS over a five period using nurses were 45% higher compared to CHWs (US$ 5,460,837 and US$ 3,767,738 respectively). Overall, the differences between the upper and lower bound costs were 8.7% for nurse-based aPS and 2.5% for the CHW-based approach.

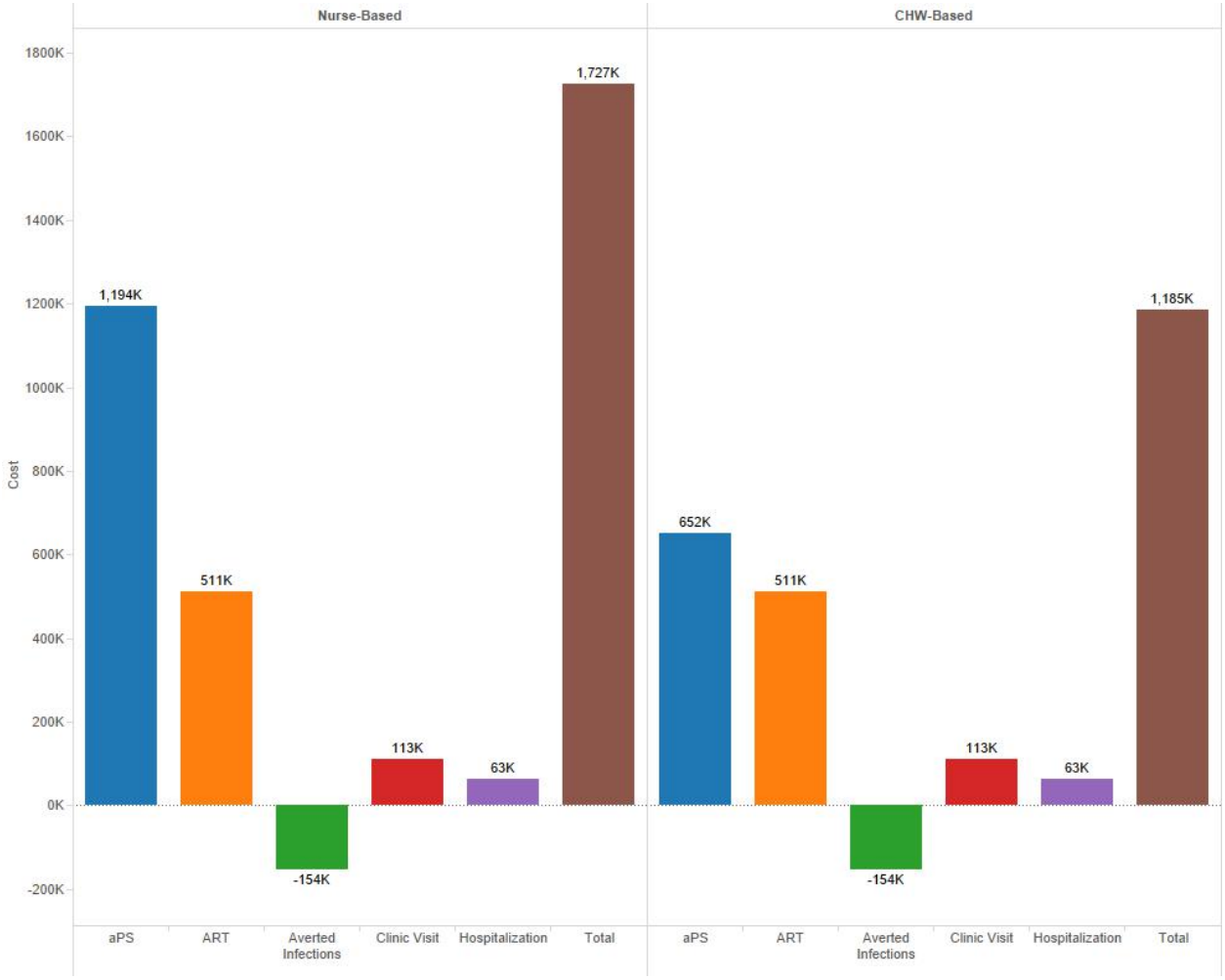
Figure 2: 5 year aPS undiscounted costs in Kisumu County, per type of health provider, US$ 2014



CHW: Community Health Worker. Horizontal black markings on the bar chart are lower and upper bound costs for each category

Over the time horizon, the total incremental cost of the nurse-model was US$ 1,726,832. The CHW model incurred an incremental cost of US$ 1,184,640, 68.6% lower than the nurse-based model. The incremental costs of averted HIV infections were US$ 154K and the largest share of budget impact was contributed by aPS and ART (Figure 3).

Figure 3: Estimated 5-year budget impact of aPS, Kisumu County, US$ 2014



Proportional distribution of impact across budget categories was similar in the two models, although CHWs model had lower aPS related impact. The overall incremental cost per HIV-infected index was US$ 0.19 and US$0.13 for each of the task-shifting options (Table 3& 4).

Table 3: Estimated budget impact 2014-2018, Kisumu County, US$ 2014

		2014	2015	2016	2017	2018
aPS costs[±]	Nurse (LB)	39,081	40,254	124,384	213,525	395,876
	CHW (LB)	27,631	28,460	87,941	150,966	279,891
	Nurse (UB)	57,395	59,117	182,671	313,585	581,387
	CHW (UB)	31,336	32,276	99,732	171,2016	317,416
ART Cost	Nurse	24,551	25,288	78,140	134,140	248,696
	CHW	24,551	25,288	78,140	134,140	248,696
Clinic Visit Costs	Nurse	56,579	2,914	9,004	15,456	28,656
	CHW	56,579	2,914	9,004	15,456	28,656
Hospitalization	Nurse	31,752	1,635	5,053	8,674	16,082
	CHW	31,752	1,635	5,053	8,674	16,082
Averted Infections	Nurse	(60,299)	(3,105)	(9,596)	(16,474)	(64,743)
	CHW	(60,299)	(3,105)	(9,596)	(16,474)	(64,743)

[±] LB: Lower Bound· UB: Upper Bound

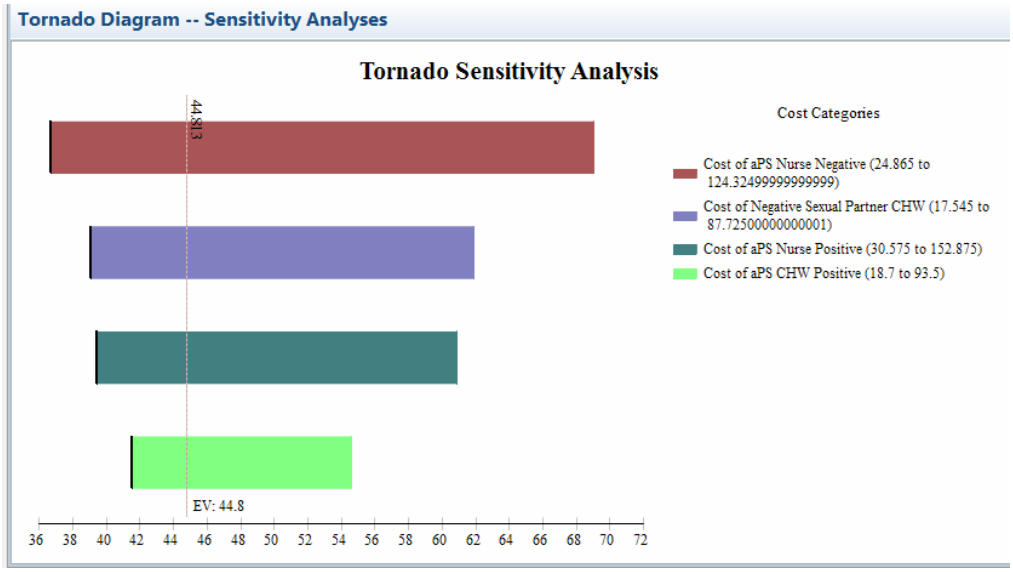
Table 4: Proportional Distribution of Budget Impact on Budget Categories

Cost Category	Nurse-Based Scale Up			CHW-Based Scale Up		
	Total	Per Index[±]	% of BI[□]	Total	Per Index[±]	% of BI
aPS	1,194,156	0.13	69.2	651,964	0.07	55.0
ART	510,816	0.05	29.5	510,816	0.05	43.2
Clinic Visit	112,610	0.04	6.5	112,610	0.04	9.5
Hospitalization	63,197	0.02	3.7	63,197	0.02	5.3
AI[§]	(153,947)	(0.05)	(8.9)	(153,947)	(0.05)	(13.0)
Total	**1,726,832**	**0.19**		**1,184,640**	**0.13**	

[±] Per HIV-infected index case. [□]BI: Budget Impact. [§] AI: Averted Infections

In sensitivity analyses, the lower-bound aPS costs for both staffing scenarios were sensitive to variations in cost (Figure 4)

Figure 4: Tornado chart showing sensitivity analyses of lower and upper bound costs



Discussion

These are the first data in Africa of the financial consequences of scaling up aPS using the HTC delivery settings. In Kisumu County, aPS would cost US$ 5.76M and US$ 3.83M over 5 years using nurses and CHWs respectively assuming all sexual partners tested are HIV-infected. If Government of Kenya were to add aPS services to existing HCT services, the costs would be within budgetary limits of the Government of Kenya and PEPFAR. In 2015 alone, PEPFAR plans to spend US $ 1.5M for HTC in Kisumu County which compares well with our findings of approximately US$ 1.09M annually[48]. Additionally, the Kenya HIV prevention strategy and the PEPFAR country operations plan suggest geographic prioritization of HIV prevention services in regions of highest HIV burden and resources to increase identification of HIV-infected cases would be a key policy initiative of both Kenya MoH and PEPFAR[38, 49].

As anticipated, major drivers of the aPS unit costs regardless of HIV status were staff costs. These costs would include hiring, training and retraining. These finding support continued task-shifting as a potential strategy for reducing costs for HIV testing and aPS in Africa. Community health workers reduce HIV testing costs by between 30-55% and overall aPS costs by an average of 30%. Additionally lower cadre workers improve health systems by reducing waiting times, reducing workload and enhancing quality of care[50]. Utilization of CHWs for aPS could therefore be a realistic goal for national programs in Africa.

Overall, more than ninety percent of budget impact is attributed to adding aPS to HTC services and the resulting increase in ART treatment costs. The sensitivity analysis implies that using nurses to provide aPS in settings where there is a higher likelihood of identifying HIV-negative sexual partners is not cost-efficient. In order to contain costs, aPS scale up should consider task-shifting from nurses to using CHWs and target the areas with high HIV prevalence and low rates of HIV testing. Sustained efforts to reduce delivery costs of ART should be encouraged to include task-shifting of ART initiation and monitoring, point of care viral load measurements and lower drug prices. This would have significant impact on the scale up of aPS.

Our results validate previous estimates of HIV testing. We determined the range of an HIV test cost from US$ 10.03, if all persons tested in a given year are HIV negative to US$ 25.36, if all are HIV-positive. In

limited resource countries, an HIV test in the health facility ranges from US$ 10-30, and community HIV testing costs US$ 2-126 depending on the setting[30, 51-53].

The unit cost of aPS ranged from US$ 35.09 per person to US$ 61.15 per person depending on the task-shifting approach and the burden of HIV among sexual partners. These findings differ substantially from those from other aPS costing studies. In Malawi, the cost per person tested was US$19 which was lower than in our study[7]. However, the study was located in an urban area, and the estimated costs did not include partner tracing. Furthermore, their costing did not take into account the variation in testing costs due to prevailing rates of HIV prevalence. Our estimation of lower and upper bound values closely reflects the dynamics of HIV testing within a program because it is based on empirical estimates of the number of partners reached and tested. True testing costs are stochastic values that depend on the background rates of HIV prevalence, intensity of case finding and staffing norms. The aPS costs presented in this study appear robust to background HIV prevalence with the higher bound-lower bound cost spread approximately 9%with nurses and as low as 0.6% with CHWs. This implies that using CHWs in particular is efficient even in low HIV prevalence settings where most sexual partners would be HIV-negative. Additionally, our estimates provide planners and program managers with the flexibility to weight HIV testing costs based on the local HIV prevalence and therefore budget more accurately.

The findings of our study are potentially generalizable to other HIV-endemic settings and could be used alongside CEAs to generate league tables for decision making. Even if an intervention has a favorable incremental cost-effectiveness ratio, it may not be feasible to implement given the size of the population in need of the intervention. BIA takes into account the size of the eligible population, and models the current intervention mix and the expected mix after the introduction of the new strategy[54]. With a fixed budget, similar interventions may be ranked based on their lowest ICER and budget impact and interventions allocated funding until the budget in exhausted.

Our study had several limitations. Our time in motion studies were based in two facilities and may not have been asymptotically valid. The costing tool used in this study did not fully account for the number and cost of infections that aPS would avert and this limited our ability to explore the potential for aPS to be cost-saving. However, our estimates provide policy makers with the appropriate framework to estimate

resources required for aPS. Our approach is appropriate and is consistent with the ISPOR guidelines which prefer static models for shorter time horizons[8].

This study has demonstrated that aPS is affordable but not cost-saving within the five-year time frame. There is scope for increasing cost-efficiency of aPS by reduction costs through task-shifting aPS from nurses to community health workers.

Chapter 3: Surveillance of assisted partner services using routine health information systems in Kenya

Abstract

Introduction: The utilization of routine health information systems (HIS) for surveillance of assisted partners services (aPS) for HIV in sub-Saharan is sub-optimal, in part due to poor data quality and limited use of information technology. Consequently, little is known about coverage, scope and quality of HIV aPS. Furthermore, we have limited understanding of characteristics of HIV-infected cases or reasons for HIV testing. Yet, affordable electronic data tools, software and data transmission infrastructure are now widely accessible in sub-Saharan Africa.

Methods: We designed and implemented a cased-based surveillance system using the HIV testing platform in 18 health facilities located in five administrative units (counties). The components of this system included an electronic HTC) intake form, data transmission on the Global Systems for Mobile Communication (GSM), and data collection using the Open Data Kit (ODK) platform. We defined rates of new HIV diagnoses, and characterized HIV-infected cases. We also determined the proportion of clients who reported testing for HIV because a) they were notified by a sexual partner b) they were notified by a health provider, or c) they were informed of exposure by another other source. Data transmission times were evaluated.

Results: Median time for data capture was 4 minutes (IQR: 3-15), with a longer duration for HIV-infected participants, and there was no reported data loss. Among 4,351 clients, HIV prevalence was 14.2%, ranging from 4.4- 25.4% across facilities. Regardless of other reasons for testing, only 107 (2.5%) of all participants reported testing after being notified by a health provider of sexual partner. A similar proportion, 1.8% (79 of 4351), reported partner notification as the only reason for seeking an HIV test. Among 79 clients who reported HIV partner services (PS) as the reason for testing the majority (78.5%), was notified by their sexual partners. The majority (47.2%) of HIV-infected patients initiated their HIV testing, and 57.2% tested in a VCT co-located in a health facility.

Conclusion: aPS surveillance using new technologies is feasible, and could be readily expanded into HIV registries in Kenya and other sub-Saharan countries. Partner services are under-utilized in Kenya but further documentation of coverage and implementation gaps for HIV and aPS services is required.

Introduction

Assisted Partner Services (aPS) for HIV, the elicitation of sexual history of HIV-infected persons and testing of their sexual partners is widely accepted as routine public health practice in the United States and Europe[11, 12]. In Africa, aPS has been demonstrated to be feasible, effective and cost-effective, and more studies are ongoing in Kenya to corroborate this evidence[1, 2, 7, 23]. aPS could potentially increase HIV testing rates and enhance HIV case finding. However, in Kenya, there are no surveillance systems for case-reporting of HIV-infected index cases and for monitoring the scale up of aPS. Specifically, there is no data on whether HIV Testing and Counseling (HTC) clients are testing due to an exposure from an HIV-infected sexual partner.

Although demographic surveillance systems and nationally representative household surveys are in place, these are expensive, are not timely, and household surveys in particular are not designed to track individuals over time[55]. Furthermore, these surveys are often statistically powered at the national or regional level and advanced analytical techniques are required to generate small area estimates[56, 57]. Routine health information systems (HIS) may be more appropriate for tracking dynamic aPS outcomes including reasons for HIV testing and rates of new diagnoses.

The utility of routine HIS for aPS surveillance, however, is limited by poor data quality, lack of representativeness and the cost involved in collecting and analyzing the data. Also, HIS systems are paper-based, with sub-optimal completeness and delays in reporting. Furthermore, information systems in sub-Saharan Africa do not routinely track patients across the HIV care continuum. Even when client-based data is available, the system for transmission, storage and retrieval is virtually non-existent. Yet, for tracking aPS implementation, real time information systems that leverage on digital platforms, versatile databases and unique personal identifiers are required.

There exists a broad range of robust and flexible devices to manage data, including personal digital assistants (PDAs) and smartphones. These have been applied in public health settings to deliver interventions and measure their impact[58]. Overall, electronic collection of data is cost-effective, is less prone to data loss and is of higher quality than paper-based systems[59-61]. However their use for surveillance is limited, and not adequately described yet, high quality HIS data should be the norm in sub-

Saharan Africa[62-64]. More data are needed on the applicability of electronic collection and transmission of routine HIS data.

In an NIH/PEFAR-funded implementation science study, we piloted an electronic smart-phone based data collection system using the HIV testing and counselling (HTC) intake form to demonstrate its feasibility and generate baseline data for aPS surveillance. The Kenyan Ministry of Health's National AIDs and STI Control Programme (NASCOP), Kenyatta National Hospital (KNH), and the University of Washington (UW) partnered to conduct a cluster-randomized trial at HIV testing sites in Kenya to evaluate the effectiveness, cost-effectiveness, and feasibility of HIV assisted partner services across 18 HTC clinics in Central and Western Kenya[65]. To establish the timeliness, and data quality of electronic collection and transmission of data from the HTC intake form, we explored reasons for HIV testing, characterized HIV-infected patients, and determined the proportion of clients with new HIV diagnoses.

Methods

Stakeholder buy-in

At the time of the study, the HIV intake form (MoH 362), a paper based HTC and laboratory register was the MoH approved tool for collecting and summarizing HIV testing data from health clinics. We engaged the national HTC technical working group (TWG) for approval to insert additional questions on the HIV testing intake form. The additional questions were: Why did you test for HIV today? Client would respond either because they knew that a sexual partner was HIV positive and if this option was chosen, clients would further indicate if it's the positive partner that had informed them, a health provider on any other methods of notification. We then sought and obtained approval from the Health Information Systems (HIS) Department of the Ministry of Health Kenya to utilize the revised form for study purposes. Further to this, we received consent from HIS to convert the intake form electronically and to use smart phones for data collection.

At the health facility level, we discussed the roll-out of the revised tool and health providers and facility managers advised the study team to implement the electronic form alongside the paper based system so as not to disrupt the existing reporting requirements to the regional and national levels.

Digitization and data entry

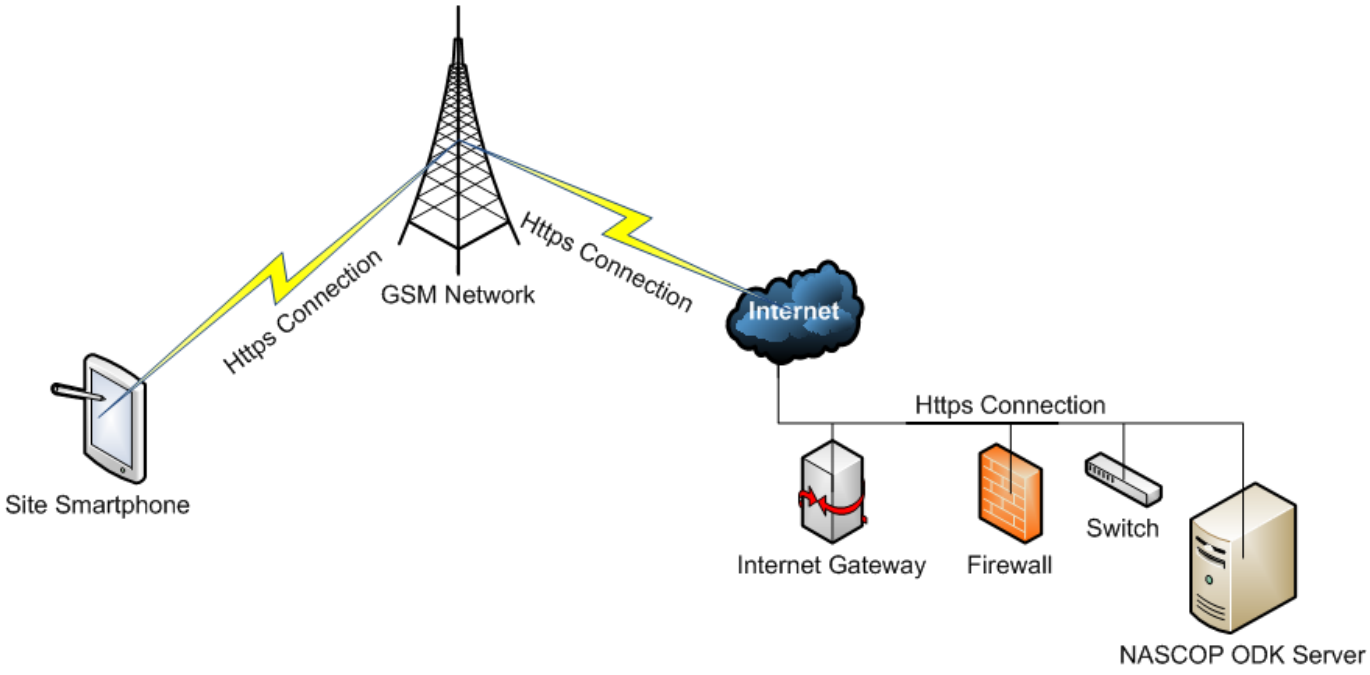
The paper form of the HTC intake form was converted to an electronic format using the ODK platform. ODK Aggregate is an open source application providing a ready-to-deploy server and data repository to provide blank forms to ODK Collect and accept finalized forms from ODK Collect. This software can visualize the collected data using maps and simple graphs, export data, and publish data to external systems. We enhanced the form by developing elaborate skip patterns to the questions and also re-arranged the responses to be more sensitive to the client. Data entry was made using smartphones, with protections against accidental deletion. Once the data was submitted, no record was maintained on the phone.

We set up the ODK Aggregate server at NASCOP with appropriate firewalls. The web connection was a 256-bit Secure Socket Layer Encryption providing an extra layer of protection for system users. This protection defended against login and password theft and also protected against Internet Service Providers throttling and bottlenecks. System users were restricted and all users had passwords that met minimum standards of security.

The NASCOP ODK Aggregate servers were built around a virtualized CentOS Linux environment. The CentOS Linux distribution is a stable, predictable, manageable and reproducible platform derived from the sources of Red Hat Enterprise Linux (RHEL). The CentOS Project is a community-driven free software effort focused around the goal of providing a rich base platform for open source communities to build upon. We implemented a web-based user interface for the server. This interface ran on Apache Tomcat, an open source software implementation of the Java Servlet and Java Server Pages technologies.

Network setup for the NASCOP ODK Server was configured on a Gigabit Fiber-optic connection to allow transmission over longer distances with minimal loss and electromagnetic interference. Research assistants uploaded the data at the end of each working day using GSM/GPRS network connection [Figure 1].

Figure 1: Schematic for electronic data collection, transmission and storage



ODK: Open data kit. GSM: Global System for Mobile Communication. NASCOP: National AIDS/STD Control Program, Kenya

Study settings

The HTC intake form was implemented in all 18 study sites and in tandem with the feasibility and effectiveness aim of the main study[23]. Briefly, the main study was a cluster-randomized trial in which 18 HTC sites were allocated to two groups to evaluate the effectiveness of immediate aPS compared to delayed aPS for HIV. HTC was available either as client-initiated (VCT) or provider-initiated (PITC). VCT services were defined as integrated if they were co-located in a health facility. PITC services include testing of pregnant women, patients undergoing medical evaluation and those admitted to inpatient wards. In this study, we enrolled only ambulatory clients who came in to test at the designated clinic in each study site. For practical reasons health advisors were free to choose the days and times to collect this data electronically in a way that enabled them to perform other tasks of enrolling and following up for main study. Data was collected in five counties at 18 health facilities as follows: Kiambu (2 facilities), Kisumu (5 facilities), Muranga (1 facility), Nairobi (8 facilities) and Siaya (2 facilities).

Study population

The study population was a purposive sample of clients seeking HTC services at the 18 study sites. All clients aged 18-64 years and presenting at the above study sites for HIV testing were eligible for inclusion.

Study procedures

After HIV testing, these clients were informed that as standard procedure, their information would be entered into the electronic register in a confidential manner and that they had the right to decline participation. Those who declined participation were not denied any additional service at the VCT clinic. Because this was a public health necessity, we did not make efforts to screen participants for eligibility and neither did we consent them for participation. Upon completion of data entry, the health advisors submitted the data for each client to the Kenya National AIDS/STI Control Program (NASCOP) server.

Statistical Analysis

Our analysis was based on a convenient sample and consisted of all data collected from the 11th November 2013 and 2nd April 2015. The main outcomes of this study was the completion times of the data capture and the proportion of HIV testing clients who report testing for HIV either because a) there were notified by a sexual partner b) they were notified by a health provider or c) they were informed of exposure by any other source. Because of potential overlapping reasons for HIV testing, the numerator was any positive response to one of the above questions regardless of other reasons for testing. We calculated the proportion of HIV-uninfected participants who self-reported to belong to pre-defined high-risk categories (uncircumcised, ever received money in exchange for sex, engaged in fishing trade, truck driving, with history of having sex with an HIV-infected partner, divorced or separate, in a HIV sero-discordant relationship). We also report the proportion of participants reporting testing for the first time, by HIV status and those with a prior knowledge of HIV status who retest for HIV. We present frequencies, tabulations based on 4,351 observations in five counties.

We obtained a research exempt status from the UW and KNH Institutional Review Boards as this was considered a public health initiative.

Results

Out of the 4351 participants, majority, 2516 (63.3%) were tested in the integrated VCT clinic. In particular, only 7.1% tested at the outpatient clinic in the two Kiambu health facilities. The mean age (standard deviation) was 30.1(9.7), 56.2% were women and about half were married. The HIV prevalence was 14.2 %, and ranged from 4.4% to 25.4% across facilities, and among those infected, 17.5% were not screened for tuberculosis (Table 1). Health facilities in Kiambu and Muranga counties reported a lower prevalence of male circumcision and more than twenty percent of women participants in the Muranga health facility self-reported to be pregnant. Of 720 (16.6%) who tested as couples, 88 (12.2%) were sero-discordant. Additionally, 583 (81.0%) were concordant sero-negative and 45 (6.3%) were concordant sero-positive. 82(1.8%) self-identified as sex workers.

Table 1: Socio-demographic, behavioural and biological characteristics of clients, by county, in 18 HTC clinics in Kenya (N=4351 unless otherwise specified)[γ]

	Total (N=4351)	Kiambu (n=824)	Kisumu (n=1036)	Muranga (n=113)	Nairobi (n=1964)	Siaya (n=414)
Age(mean,sd)	30.1(9.7)	30.1(9.5)	30.1(11.0)	30.6(10.7)	30.2(8.9)	29.0(10.0)
Sex (Female)	2447(56.2)	494(60.0)	551(53.2)	73(64.6)	1091(55.6)	238(57.5)
Testing Model						
CITC	2567(59.0)	442(53.6)	470(45.4)	62(54.9)	1363(69.4)	230(55.6)
PITC	1784(41.0)	382(46.4)	566(54.6)	51(45.1)	601(30.6)	184(44.4)
Testing Venue	3978(91.4)	809(98.2)	806(97.8)	109(96.5)	1899(96.7)	355(85.8)
Integrated VCT	2516(63.3)	733(90.6)	379(47.0)	62(56.9)	1157(60.9)	185(52.1)
GOPC	1246(31.3)	57(7.1)	375(46.5)	38(34.9)	630(33.2)	146(41.1)
Others	216(5.4)	19(2.3)	52(6.5)	9(8.2)	112(5.9)	24(6.8)
Pregnant [±]	159(6.5)	17(3.4)	22(4.0)	17(23.3)	83(7.6)	20(8.4)
Uncircumcised [□]	375(19.7)	10(3.0)	158(32.6)	1(2.5)	127(14.6)	79(44.9)
Married	1994(45.8)	380(46.2)	525(50.7)	49(43.4)	814(41.5)	226(54.6)
HIV-infected	616(14.2)	55(6.7)	171(16.6)	5(4.4)	306(15.7)	79(19.1)
Couples[§]	720(16.6)	98(11.9)	192(18.6)	28(24.8)	345(17.7)	57(13.8)

[γ] N(%) unless otherwise specified. [±]N=2447, only women. [□]N=1904, only men. [§]N= 4332, only couples. CITC: Client-Initiated HIV Testing and Counseling. PITC: Provider-Initiated HIV Testing and Counseling. GOP: General Outpatient Clinic

Reasons for testing

All 4,351 participants gave at least one reason for seeking an HIV test (Figure 2). A significant proportion reported testing for screening purposes or due to routine offer by health provider (40.6% and 44.4%, respectively). Only 107 (2.5%) of persons reported testing as a result of aPS by a health provider or by an HIV-infected sexual partner, in addition to other reasons. This ranged from 0% to 12.5% across facilities. Only 79 (1.8%) respondents reported aPS as the only reasons for testing.

Among the 79 clients who reported aPS as the only reason for seeking an HIV test, the majority (78.5%), learnt of their potential exposure through their sexual partners. Only 8.8% of all PS were reportedly done by the health provider, although with a wide variation across counties (Data not shown). In Muranga and Kiambu, none of the participants tested because a health provider had disclosed to them their potential exposure. However this was approximately 18% in Kisumu. Other reasons for testing (1.1% of total) included re-testing by known HIV-positives (n=36), and testing as a requirement for jobs, medical certificates and travel (n=14)

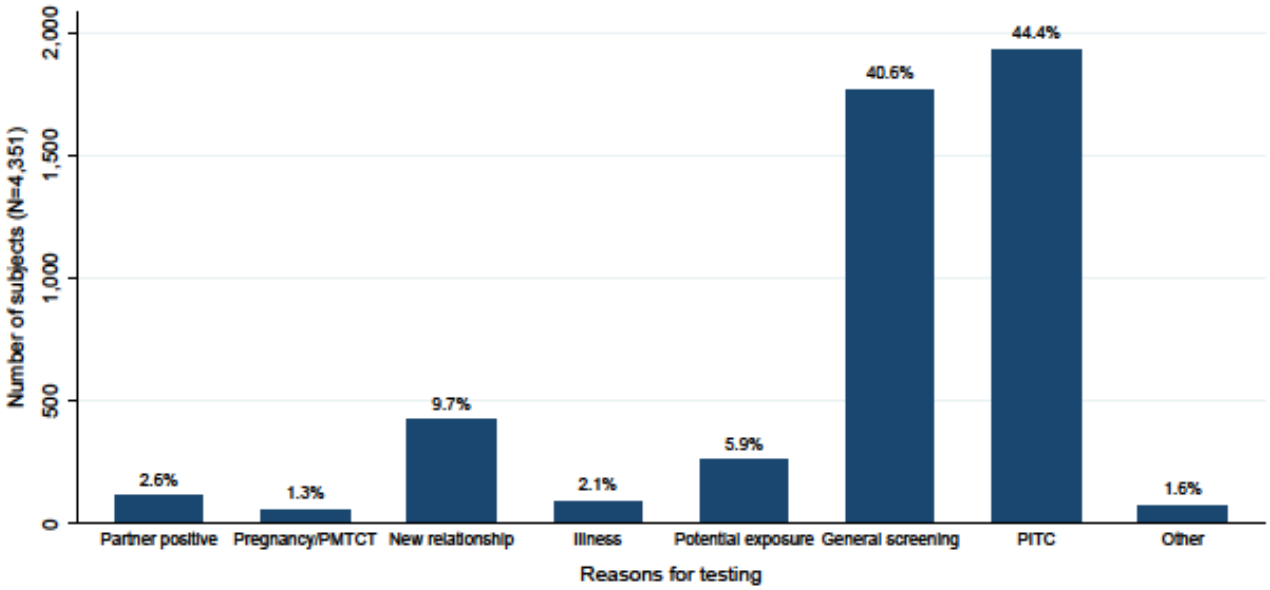


Figure 2: Reasons for HIV Testing for HIV (N=4351) [a]

[a] Other category includes re- testing by HIV-infected persons (N=36), testing as requirement for marriage, travel or insurance (N=14) and testing for marriage or separation (N=21). These are in addition to other reasons for testing

HIV case detection

616(14.2%) of HTC clients were HIV-infected, the majority, 370(60.1%), were women, and tested for HIV at a VCT co-located in the health facility (Table 2). Approximately half (47.2%) of these HIV-infected

patients tested on their own initiative, just over one tenth (15.3%) tested with their sexual partners. Of the 88 who tested with their partners, 47.9% reported an HIV-negative. Of the 616 HIV-infected patients, 33(5.4%) were fisher folk, 25(4.1%) reported engaging in transactional sex, six were truck drivers and one was injecting drugs. Among HIV-infected persons, a third was learning their status for the first time either because they were testing for the first time, or their previous test result was negative. Overall, 720 (16.6%) tested as couples, with twice the proportion reporting in Muranga testing as such compared to Kiambu.

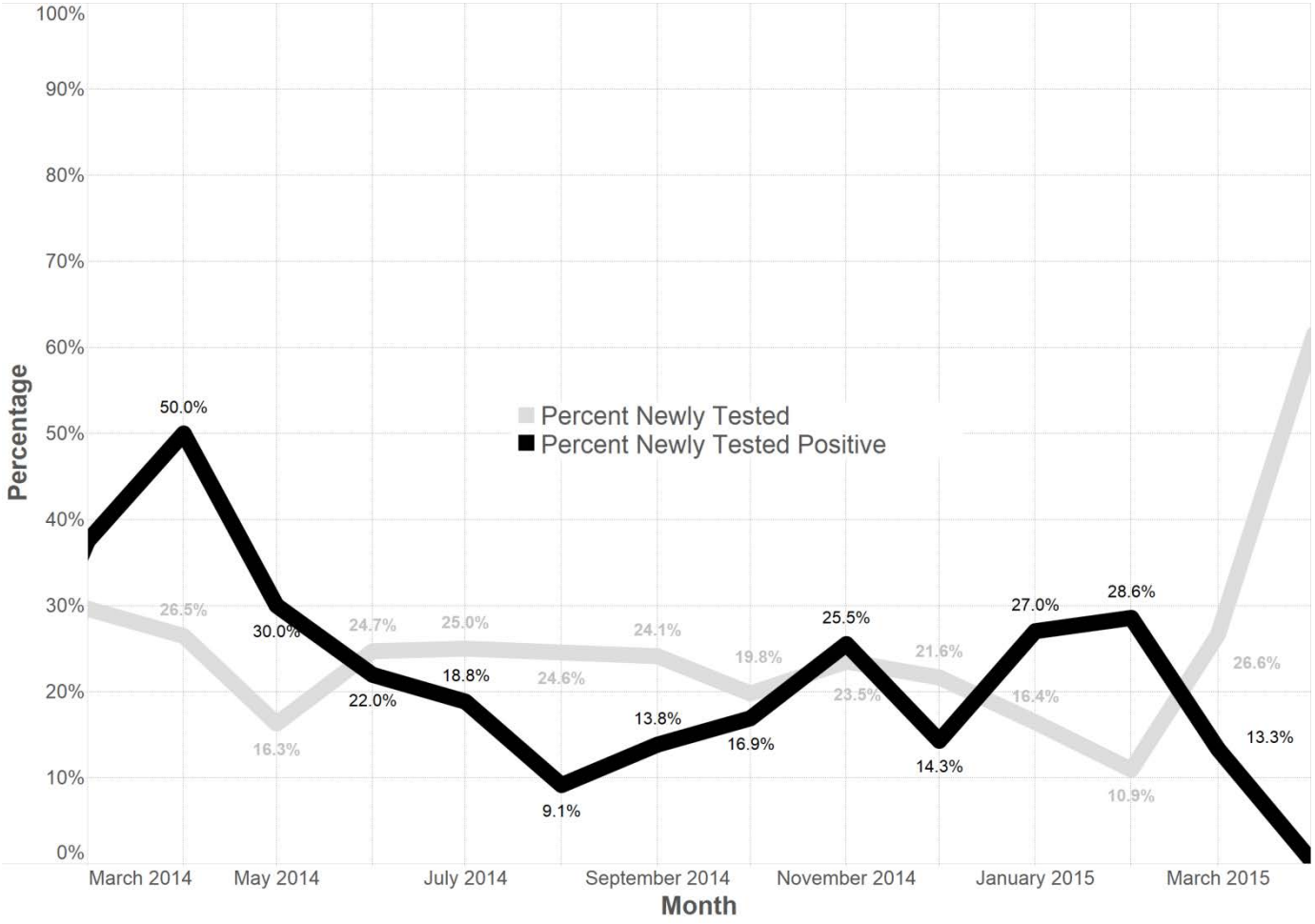
Table 2: Socio-demographic characteristics, and HIV testing behaviors of HIV-infected clients, by county, in 18 HTC clinics in Kenya (N=616 unless otherwise specified)

	Total (N=616)	Kiambu (n=55)	Kisumu (n=171)	Muranga (n=5)	Nairobi (n=306)	Siaya (n=79)
Age(mean,sd)	32.5(9.1)	32.3(6.9)	32.0(9.5)	38.2(4.8)	33.0(9.2)	31.7(8.9)
Sex (Female (N (%))	370(60.1)	37(67.3)	98(57.3)	5(100.0)	1891(61.8)	41(51.9)
Testing Model (N (%))						
Client-Initiated	291(47.2)	23(41.8)	60(35.1)	1(20.0)	165(53.9)	42(53.2)
Provider Initiated	325(52.8)	32(58.2)	111(64.9)	4(80.0)	141(46.1)	37(46.8)
Testing Venue[±] (N (%))						
Integrated VCT	291(57.2)	36(70.6)	44(38.3)	3(60.0)	175(61.2)	33(63.5)
GOPC	185(36.4)	11(21.6)	57(49.6)	2(40.0)	98(34.3)	17(32.7)
Others	33(6.4)	4(7.8)	14(12.1)	0(0.0)	13(4.5)	2(3.8)
Testing as Couple	94(15.3)	9(16.4)	22(12.9)	0(0.0)	50(16.3)	13(16.5)
Has HIV-negative partner (N (%))[±]	45(47.9)	7(77.8)	10(45.5)	0(0.0)	25(50.0)	3(23.1)

[±] Among those testing at health facility (n=509). [±] Among those testing as couples (n=88). GOPC: General Outpatient Clinic

Over the course of 17 months, the proportion of those newly diagnosed with HIV remained relatively stable although the proportion newly testing appeared to reduce over time [Figure 3]. Across all the sites, the proportion new HTC clients declined from a high of 41.3% in November 2013 to a low of 10.9% in February 2015. Although 79.2% had tested for HIV before, only 16% of participants were tested as couples.

Figure 3: Plot indicating proportion newly tested for HIV and newly diagnosed over 12 months

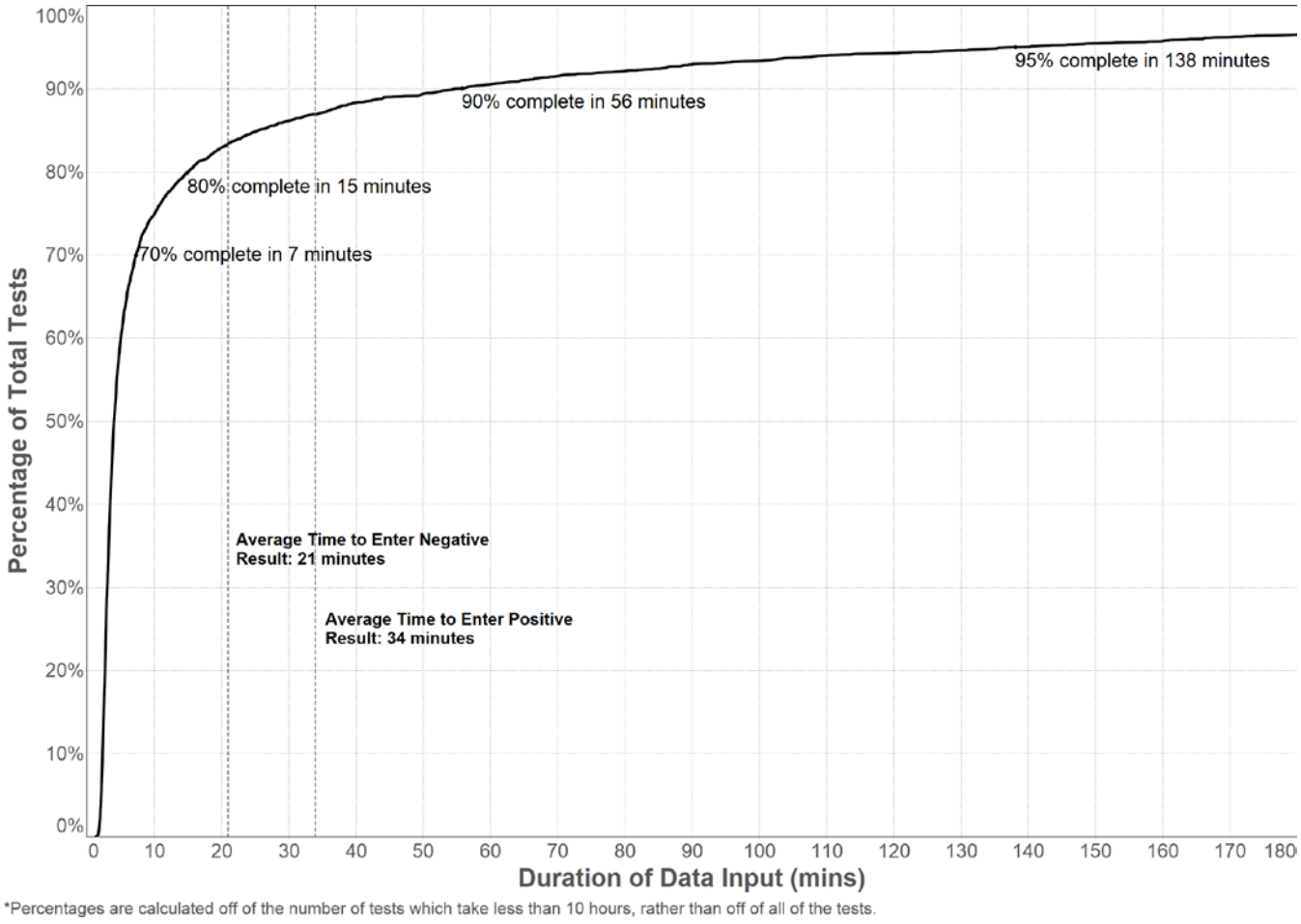


Completion times

Completion times for the HTC intake form are shown in Figure 4. The median completion time was 4 minutes (IQR: 3-15). The median times in minutes (IQR) was 4 (3-11) and 10 (5-42.5) for HIV negative

and HIV positive persons respectively. The mean time to enter an HIV negative and an HIV positive result was 21 and 34 minutes respectively. Approximately 5% of all test HTC intake forms were not completed even after 2 hours. There were no reported data losses during transmission and archiving.

Figure 4: Electronic data capture times, in minutes



*Percentages are calculated off of the number of tests which take less than 10 hours, rather than off of all of the tests.

Missing data

There were no data on sexual history of HIV-infected index cases including locator information for their sexual partners. Additionally, data on men who have sex with other men (MSM) was not captured in the HTC intake form.

Discussion

This study demonstrates that the collection, transmission and analysis of routine health information data using mobile smart phones is feasible, with the majority of health advisors collecting the information within

ten minutes. This compares well with other studies that have applied smart phones or PDAs to enter routine data[58]. Paper-based forms, may take as much time to fill but it would require daily summaries to be physically transported to district or county health offices where they are manually entered into the web-based national health registry, a process that often takes days[66]. Despite this, a significant time effort is required to establish the infrastructure, enhance network security, develop and pilot the electronic data intake forms. We suggest that an economic evaluation of smart-phone based data collection and transmission should be considered and compared alongside paper-based information systems.

These are the first data from a national surveillance program in Kenya to determine if HTC clients are testing as a result of exposure notification. This will serve as preliminary data for future studies and as baseline for aPS coverage. Although we report a low rate of testing due to notification, it would be due to low knowledge of HIV status among those infected with HIV. It would be desirable to model what this proportion would have been had a higher proportion of HIV infected persons known their positive status.

The low proportion of high risk population in this study is not surprising. Key populations are often hidden, do not attend health facilities and maybe less likely to report their high-risk behaviors to health providers due to stigma[67]. In this report, 31% of clients tested at the outpatient clinic compared with 44% in national surveys[18]. This may have limited our ability to detect higher numbers of key populations. Surveillance using health facility HIS therefore may not be suitable for populations at high risk of HIV acquisition. Current surveillance efforts for sex workers, MSMs and PWIDS that include respondent driven sampling, poll booth surveys and venue-based and internet-based sampling techniques should continue[68].

Our findings suggest a high rate of new HIV diagnoses especially in Western Kenya. Whereas this could indicate background incidence of HIV, intensified HIV testing and case finding may have contributed to this phenomenon. The rate of new diagnoses appears to decrease especially in regions with a high HIV testing coverage. This could be an effective way of measuring the success of targeted HIV testing strategies that aim to increase the yield for case detection. It would be desirable to enhance the surveillance tools to further characterize these new HIV diagnoses in terms of their sexual behaviors, partnerships, geospatial location and access to HIV care, and viral suppression. In San Francisco and British Columbia, HIV-cased based systems have been used to estimate HIV outcomes through

meticulous documentation of new cases[69, 70]. With sufficient time-series, cased-based HIS provides high-time resolution data and could also be used for measuring impact of interventions[71]. The application of unique personal identifiers and biometrics combined with an expanded cased-based HIV registry would be useful in this regard. The support by the HTC TWG for the revised electronic HTC intake form was crucial, but much needs to be done to allay perceptions that this would be parallel system to the HIS that was potentially costly. Beyond demonstrating its cost-effectiveness, smart-phone based systems should demonstrate flexibility and ability to integrate with current HIS platforms.

Future HTC intake forms should include detailed information on sexual partners of HIV-infected cases, including appropriate locator information. Additionally, they should be linked to HIV treatment registries to monitor long term treatment and prevention outcomes of HIV-infected cases and their sexual partners.

Strengths and limitations

Routine facility-based HIS surveillance, may lack representativeness, although this could be improved through increased coverage and weighted estimators to reduce bias[72]. Our study was not nationally-representative and only reflected characteristics of select patients who sought HTC. Estimates for some outcomes in our pilot have been imprecise due to low sample size. A larger sample size and longer time-series would have enabled more robust estimation of new HIV diagnoses.

This work helps to establish that electronic aPS surveillance is possible, outlined key implementation gaps for the HIV testing and partner services programs and laid the foundation for an HIV registry in Kenya.

Summary & Next Steps

We have demonstrated that aPS is effective in increasing rates of HIV testing, in identifying HIV infections and in enhancing enrollment in HIV care. Furthermore, aPS is affordable and information systems to evaluate its scale up are feasible. As the first cluster-randomized trial for aPS, these findings have global health significance. With these findings, there is now ample evidence to make global recommendations

on aPS and to expand access to aPS as a routine public health practice in low-income countries with the highest burden of HIV.

There are four key next steps. First, the cost-effectiveness of aPS needs to be evaluated. Although affordable from a payer's perspective, CEA data is required to provide policy makers of the relative value of aPS compared to standard of care alone. The findings from the CEA, together with the budget impact would be useful for guiding policy makers and normative agencies in moving aPS to scale.

Second, we shall disseminate these results widely to the World Health Organization, the Ministry of Health in Kenya, HIV implementing partners and donors. The goal will be to consider the development of guidance to countries on the scale up of aPS. This would include training needs, service delivery models and impact evaluation.

Third, we shall work with budget holders in the Ministry of Health and counties that are considering implementing aPS to improve their capacity to determine the financial consequences in their relevant counties. Training materials on budget impact analysis will be developed and made widely available.

Fourth, the HIV registry needs to be expanded beyond the study sites. We shall work together with the Ministry of Health in Kenya, to enhance the HIV registry to include more aPS outcomes. Specifically we shall establish mechanisms to track patients identified through aPS over time to document linkage to HIV care.

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