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Assisted partner notification services are cost-effective for decreasing HIV burden in western Kenya

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Abstract

Background—Assisted partner services (aPS) or provider notification for sexual partners of persons diagnosed HIV-positive can increase HIV testing and linkage in sub-Saharan Africa (SSA) and is a high yield strategy to identify HIV-positive persons. However, its cost-effectiveness is not well-evaluated.

Methods—Using effectiveness and cost data from an aPS trial in Kenya, we parameterized an individual-based, dynamic HIV transmission model. We estimated costs for both a program scenario and a task-shifting scenario using community health workers to conduct the intervention. We simulated 200 cohorts of 500,000 individuals and projected the health and economic effects of scaling up aPS in a region of western Kenya (formerly Nyanza Province).

Findings—Over a 10-year time horizon with universal ART initiation, implementing aPS in western Kenya was projected to reach 12.5% of the population and reduce incident HIV infections by 3.7%. In sexual partners receiving aPS, HIV-related deaths were reduced by 13.7%. The incremental cost-effectiveness ratio (ICER) of aPS was $1,094 USD (90% model variability $823–1,619) and $833 (90% model variability $628–1,224) per disability-adjusted life year (DALY) averted under the program and task-shifting scenario, respectively. The ICERs for both scenarios fall below Kenya's gross domestic product (GDP) per capita ($1,358) and are therefore considered very cost-effective. Results were robust to varying healthcare costs, linkage to care rates, partner concurrency rates, and ART eligibility thresholds (≤350 cells/uL, ≤500 cells/uL, and universal ART).

Interpretation—APS is cost-effective for reducing HIV-related morbidity and mortality in western Kenya and similar settings. Task-shifting can increase program affordability.

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Keywords

HIV counseling and testing; sub-Saharan Africa; partner notification; mathematical modeling; cost-effectiveness

INTRODUCTION

Despite high HIV burden in sub-Saharan Africa (SSA), only 50% of HIV-positive individuals are aware of their status.[1] A substantial proportion of HIV transmission is estimated to occur from individuals unaware of their infection.[2] HIV-positive individuals in SSA are generally identified through facility-based HIV testing, however coverage is low and insufficient to curb the epidemic.[3] Barriers to facility testing include distance, costs, and confidentiality concerns.[4] HIV-positive individuals often present for care when they are symptomatic, late in their illness.[5]

To combat the epidemic, UNAIDS created ambitious 90-90-90 targets—90% of HIV-positive persons knowing their status, 90% of those tested HIV-positive receiving ART, and 90% of persons on ART virally suppressed.[6] Innovative HIV testing interventions are vital for reaching these targets. The WHO recent guidelines recommending scale-up of partner notification services in SSA to close the testing gap in individuals at high-risk for HIV and unaware of their status.[7] The guidelines emphasize strategic approaches to HIV testing and highlight high yield of HIV-positive individuals identified through partner notification services. The goal of partner services (PS) is to identify sex partners of persons diagnosed with a sexually transmitted disease, notify them of their potential exposure, and provide counseling, testing, and referral to treatment or prevention. Types of PS include: 1) passive referral—newly diagnosed individuals (index cases) are asked to notify their partners of exposure and encourage HIV testing, 2) provider notification or assisted partner services (aPS)—providers contact partners and offer testing, and 3) contract referral—index cases are given a set amount of time to notify partners, after which providers conduct notification.[8] In practice, PS is often implemented as a mix of these options.

PS are widely used in many high-income countries and growing evidence from SSA demonstrates effectiveness.[9] An aPS trial in Kenya, whose results are used for the present analysis, reached 69% of reported sexual partners.[10] APS was scaled up by a non-governmental organization in Cameroon and tested 66% of reported partners, of which 50% were HIV-positive.[9] Similarly, a PS trial in Malawi tested >50% of reported partners using provider and contract referral; 64% of partners tested HIV-positive with high median CD4 count (344 cells/uL).[11] The HIV positivity is similar to published estimates of 45–50% in cohabitating partners of HIV-positive adults, the majority of whom are unaware of their status.[12] High CD4 counts reflect the ability of aPS to reach individuals early in their infection, which can support earlier linkage to care, improving survival and reducing transmission.[11, 13, 14]Implementing aPS requires significant economic investment so determining cost-effectiveness prior to implementation is important. We modeled the impact of implementing aPS in former Nyanza province, a region of western Kenya with high HIV prevalence (15.1%).[15]

METHODS

Assisted Partner Services (aPS) intervention

Details of the aPS intervention has been previously published.[10, 16] Briefly, a large cluster-randomized clinical trial was conducted in 18 communities across Kenya (5/2013–5/2015).[10, 16] Study staff based in healthcare facilities tested individuals presenting at the facility through voluntary counseling and testing (client-initiated) and provider-initiated testing. The study approached 1,776 index cases, and 1,119 enrolled (63% acceptance) and reported 1,872 partners in the past 3 years. Overall, 69% of partners were enrolled; enrollment was slightly higher in Nyanza, (72% immediate arm). At intervention sites, study staff immediately contacted partners to conduct aPS. At control sites, staff conducted passive notification according to national guidelines and performed aPS after a 6-week delay. The intervention was effective; partner HIV testing within 6 weeks following index diagnosis was higher in intervention than delayed arm (41% vs. 9%), with similar linkage within 6 weeks after a positive test (60% in aPS and 67% in delayed arm).[10]

Mathematical model

We adapted a previously published dynamic heterosexual HIV transmission model with epidemiologic data from western Kenya (Figure 1).[17] Briefly, the individual-based model simulates HIV/AIDS natural history using stochastic monthly transitions between states. Men and women are characterized by age (≥18 years), sexual activity, circumcision status, condom use, herpes simplex virus (HSV) infection status, CD4 count, ART use, and migration. Individuals form long-term or short-term partnerships, and can have ≤2 concurrent partnerships, including partners outside the community. Nyanza-specific demographics, household structure, migration patterns, HIV prevalence, sexual behavior, and condom use were obtained through the UNAIDS Kenya AIDS Indicator Survey (KAIS) dataset.[15] The model was calibrated to HIV prevalence from Nyanza. See Appendix for details on inputs, and calibration.

The rate of HIV transmission is estimated as a function of an individual's sex, coital frequency, condom use, HSV infection, CD4 count and ART status of partner, and male circumcision. The model simulates HIV testing, ART initiation and dropout in a 231,850 household community(~500,000 adults). We ran the model 200 times and summarized results over 10 years using the 5^{th} and 95^{th} percentile outcomes to represent 90% stochastic model variability (range).

Status quo and intervention scenarios

For the status quo (no intervention) scenario, we modeled current HIV testing and ART initiation rates using KAIS data.[15] Individuals have a monthly probability of undergoing HIV testing depending on their sex, age, HIV status, and CD4 count. Individuals testing HIV-positive have a CD4-dependent monthly probability of linking to ART (Appendix). We assumed implementation of Kenya's current ART initiation guidelines (universal ART).

In intervention scenarios, newly diagnosed HIV-positive index cases have a 71% probability of consenting to aPS and their sexual partners have a sex-dependent probability of being

located and consenting (68% and 57% for women and men respectively not aware of their HIV-status and 6% for persons aware of their HIV-positive status). Acceptance rates are based on Nyanza-specific data from the aPS trial. We assume only partners not currently migrating and not on ART can consent to aPS. Individuals testing HIV-positive through aPS are assumed to link to ART at the same CD4-dependent background rates as those testing at facilities as found in the aPS trial.

Costs

We conducted a micro-costing study in three aPS clinics in Nyanza from a payer perspective.[18] Costs (2014 USD) were collected from expense reports, staff and expert interviews, and divided into: personnel, transportation, equipment, supplies, buildings and overhead, start-up, and phones/data monitoring. Time and motion observations were conducted over three weeks (June 10–30th 2014). Research time (e.g. administering informed consent) and other research costs were removed from programmatic costs. Time and motion and staff interviews were used to inform productivity assumptions (average number of partners tested per day). Capital costs (e.g. motorcycles, furniture), and start-up costs (e.g. staff hiring/training) were annualized assuming 5-year useful life and discounted annually at 3%. We assumed 5% supply wastage and estimated economic costs for donated goods (Appendix).

Costs were estimated for two scenarios: 1) higher cost program scenario, using similar staff structure as the aPS trial—highly-trained health advisors conducting aPS, and 2) lower cost task-shifting scenario in which health advisors are replaced with community health workers (CHWs) and project supervisor are replaced with CHW managers. We assumed that CHWs tested 25% fewer partners per day compared to health advisors. Costs were estimated separately for HIV-positive and negative partners as the former required additional counseling and supplies. Intervention costs were divided by number of partners tested to determine cost/person tested. Other costs (facility HIV testing, ART, and HIV/AIDS related hospitalizations) were estimated from the literature[19–22] (Table 1 and Appendix). We assumed the health system incurred pre-ART costs in analyses with ART eligibility thresholds of ≤350 cells/uL and ≤500 cells/uL; no pre-ART costs were incurred under universal ART initiation.

Budget impact analysis

We calculated the undiscounted incremental cost of implementing aPS over 5 years by subtracting total costs of the status quo from the intervention scenario. We included intervention and HIV/AIDS healthcare-related costs (incurred and averted).

Cost-effectiveness analysis

We calculated the incremental cost-effectiveness ratio (ICER) of adding aPS to standard of care per disability adjusted life year (DALY) averted over a 10-year time horizon. Consistent with health economic conventions, we considered an intervention to be very cost-effective if the ICER was less than Kenya's 2014 GDP per capita ($1,358 USD)[24] and cost-effective if the ICER is less than 3-times Kenya's GDP per capita.[25] Costs and benefits were discounted annually at 3%.[26]

Sensitivity analyses

We assessed the impact of aPS under three ART initiation thresholds (≤350 cells/uL, ≤500 cells/uL, and universal ART). We varied costs of ART initiation, health care use for HIV-positive persons not in care, and ART provision (from 50% lower to two times higher). We evaluated a conservative scenario in which ART initiation costs and ART provision costs were doubled while costs of health care use (HIV+ not in care) were halved. Further, we explored a scenario in which ART costs were reduced to $80/person-year in response to a recent Clinton Health Access Initiative (CHAI) ART market report projecting lower ART drug costs in the next few years due to the adoption of new drugs. Specifically, generic dolutegravir has been approved by the FDA and low dose efavirenz and tenofovir alafenamide fumarate are projected to disrupt the ART market in the next 2–3 years.[27] We also explored the effect of increasing sexual partnerships (doubling partner concurrency rates), lowering HIV testing rates by 25%, and lowering linkage to care after HIV testing by 50%. Finally, we lowered aPS acceptance rates by 25%.

RESULTS

Costing

Time and motion observations showed the aPS intervention takes approximately 40–60 minutes once a partner is successfully traced (after removal of time for research-related activities). After accounting for time for index case screening, partner tracing, paperwork, and other responsibilities, we estimated health advisors could test 2 partners per day and assumed community health workers tested 25% fewer partners than health advisors (1.75 partners tested/day). Costs per partner tested ranged from $48–55 for the program scenario and $27–32 for the task-shifting scenario. Staff salaries represented the majority of costs (60–80%) (Table 2).

Health and economic impact of aPS

Figure 2A–C displays model-estimated health benefits and costs of aPS under universal ART initiation. Health benefits varied by model run due to stochastic variability, but all runs projected positive health gains. APS was projected to avert 492 HIV infections, 759 HIV-related deaths, and 6,198 DALYs per 500,000 adults over 10 years.

Under universal ART, aPS achieved 12.5% coverage of the modeled population over 10 years; HIV positivity was 25.3% in partners tested. APS was projected to avert 3.7% of HIV infections, 2.6% of HIV-related deaths, and 1.4% of DALYs in the community compared to standard of care (Table 3). Among partners receiving aPS, 13.7% of HIV-related deaths and 8.9% of DALYs were averted. The 5-year undiscounted incremental costs of implementing aPS was $3.5 million (3.2–3.8 million) per 500,000 adults under the program scenario; costs decreased to $2.5 million (2.2–2.8 million) under task shifting. Corresponding aPS ICERs were $1,094 (range $823–1,619) and $833 per DALY averted (range $628–1,224) under the program and task-shifting scenario, respectively. ICERs of both scenarios fell below Kenya's per capita GDP ($1,358) and were considered very cost-effective. Under task-shifting, 93% of model simulations fell below Kenya's per capita GDP, while 80% of program scenario ICERs were below the threshold.

Sensitivity analyses

Table S21 shows the impact of aPS under three ART initiation thresholds (≤350 cells/uL, ≤500 cells/uL, and universal ART). As ART initiation thresholds expands from ≤350 cells/uL to universal ART, HIV-related deaths and DALYs averted in aPS partners increase while incremental costs of aPS decrease (resulting in more cost-effective ICERs). Across all ART initiation criteria, ICERs for aPS under both scenarios fell below Kenya's per capita GDP.

Figure 3 and Table S20 show the impact of varying healthcare costs on ICERs in the base-case scenario. Halving ART initiation costs made ICERs more attractive while doubling costs increased ICERs. Conversely, halving healthcare costs for HIV-positive persons not in care increased ICERs amd doubling costs lowered ICERs. Both costs had little impact on the ICERs; both program and task-shifting scenarios remained very cost-effective. However, varying ART provision costs did have a large impact on ICERs; halving ART costs yielded ICERs of $1,209 and $791 per DALY averted with program and task-shifting, respectively: both were below Kenya's GDP per capita. Doubling ART provision costs resulted in ICERS that exceeded Kenya's per capita GDP; the ICER for the task shifting scenario was $1,413 per DALY averted, slightly higher than Kenya's GDP per capita ($1,358). However, both scenarios were cost-effective at the higher threshold of 3-times Kenya's per capita GDP. Similarly, the conservative scenario, in which ART initiation costs and ART provision costs were doubled while costs of health care use (HIV+ not in care) were halved resulted in ICERs that were cost-effective only when using the higher threshold of 3-times Kenya's GDP. Reducing ART costs to $80, as is projected by CHAI, resulted in the most attractive ICERs $729 and $468 per DALY averted in the program and task-shifting scenario, respectively.

Table S22 shows the effect of doubling partner concurrency rates. Both program and task-shifting scenarios remain very cost-effective. Lowering linkage to care by 50% after a positive HIV test resulted in slightly lower aPS health benefits but ICERs were similar to the base case (Table S23). Assuming 25% lower background linkage to care resulted in more cost-effective ICERs and a higher proportion of HIV-related deaths averted in aPS partners (Table S24). Reducing aPS uptake in sexual partners by 25% resulted in lower health benefits but ICERs remained cost-effective (Table S25).

DISCUSSION

APS can cost-effectively reduce HIV-related morbidity and mortality in western Kenya. The high HIV positivity demonstrates that aPS is an efficient and high yield method to target resources towards those at highest risk of HIV. Although aPS is projected to achieve only 12.5% population coverage over 10 years, it has a measurable impact on HIV burden (reducing incident infections by 3.7%). In contrast, passive notification has had little success in SSA.[11] The model-projected 14% deaths averted in aPS partners over 10 years suggest that the intervention may reach persons who may otherwise have not accessed care. Intervention impact is projected to increase with expanding ART eligibility thresholds, which may be in part attributable to high CD4 counts in partners who would not be eligible for ART at lower thresholds.

Our conclusions were robust to ART eligibility thresholds, ART initiation and healthcare costs, lowering baseline ART linkage rates, and increasing the proportion of the population with more than one partner (concurrency). However, consistent with previous analyses, ICERs were sensitive to ART costs, highlighting the importance of access to reasonably priced drugs, particularly with expanding ART eligibility.[17] Recent market reports projecting lower ART costs within the next 2–3 years are promising for increasing the cost-effectiveness of HIV interventions.[27] Our finding are similar to a prior analysis which found aPS cost-effective in Malawi.[8]

We conservatively assumed that aPS would only provide benefits to newly diagnosed HIV-positive sexual partners and would not impact HIV-negative or unlinked HIV-positive partners. Therefore, the largest projected intervention impact was on HIV-related deaths in aPS partners. However, aPS may also reduce transmission by notifying HIV-negative persons that they are at high-risk of HIV acquisition and facilitating couples HIV-testing, disclosure, and referral to prevention. Indeed, the aPS clinical trial conducted couples testing of the index case with their sexual partner when appropriate. Couples testing can increase ART initiation and adherence in while decreasing high risk sexual behavior.[28] In HIV-positive pregnant women, couples testing has been found to increase adherence to both ART and prevention of mother-to-child transmission (PMTCT) regimens.[29–32] Additionally, aPS can be used as an entry point to provide Pre-Exposure Prophylaxis (PrEP) for serodiscordant partnerships. PrEP demonstration projects in Kenya and Uganda found high adherence in HIV-negative partners given short-term PrEP (for use before their partner initiated ART and 6 months afterwards until viral suppression).[33] In light of recent WHO guidelines recommending PrEP for those at high risk of infection, HIV testing interventions that identify persons for both treatment and prevention are needed. Finally, unlinked HIV-positive person may be motivated to link to care after aPS. Thus our cost-effectiveness findings are conservative. As more data become available on additional benefits from aPS, this analysis should be revisited.

Scaling up aPS is likely more affordable with task-shifting to community health workers, a more realistic scenario in SSA given shortage of healthcare professionals.[34] A pilot study in Mozambique found aPS conducted by community health workers was safe, acceptable, and resulted in a doubling of partners tested compared to passive referral.[14] Further, conducting aPS within antenatal care and community-based strategies (e.g. home, campaign, and mobile testing), can increase coverage and facilitate couples testing. Implementing a tiered approach in which HIV-positive index cases are first encouraged to bring their partners for testing (contract referral) with staff actively tracing only those partners who have not been located, can increase efficiency. Prior aPS studies have found that contract referral is as effective as active notification.[9, 11] Linkage to care is another important concern for aPS scale-up. Studies have found that community-based HIV testing may result in lower linkage to care since it is conducted outside of the healthcare system.[3] If implemented, aPS should monitor linkage and staff may need to conduct follow up visits to encourage partners to access care. Encouragingly, aPS in Cameroon reported high linkage (86% of HIV-positive partners), with most partners preferring to test outside facilities, highlighting the importance of community-based options.[9] Additionally, linkage rates in the current trial were similar in partners testing positive through the intervention compared

to those visiting a facility through passive referral. Finally, although aPS is effective, its population impact is not sufficient to curb the HIV epidemic. Therefore, aPS should be scaled up alongside a combination of community-based prevention strategies including home and mobile HIV testing.

The strength of this analysis includes the use of a complex model parameterized with sexual and health seeking behavior from a representative survey in western Kenya and aPS costs and effectiveness from a trial conducted in the same region. Additionally, we conducted sensitivity analysis, incorporated stochastic variability and reported the results with 90% ranges of model outputs. However, our results are subject to limitations. Although we account for stochastic variability, our model does not account for parameter uncertainty. Intervention effectiveness was obtained from a randomized clinical trial that utilized well-trained health advisors and which may not fully translate to real world scale-up. To account for this, we utilized time and motion studies to estimate realistic testing volume and reduced efficiency under the task-shifting scenario. The model was parameterized with sexual and health seeking behavior from KAIS, which relies on self-report and is subject to non-response and social desirability biases. Model estimated aPS partner HIV positivity in the model was lower than that observed in the trial (25.3% vs. 34%); this would lead to a conservative estimate of intervention impact. Further, although we use the commonly cited threshold of Kenya's GDP per capita as a benchmark for cost-effectiveness, there is no consensus on a threshold below which interventions should be considered cost-effective. If we utilized a more conservative threshold of 0.5 times Kenya's GDP per capita, aPS would no longer be considered very cost-effective except in the case of task-shifting with ART costs reduced to $80 per person-year. Although CEAs provide information about the value of investing in a health intervention, they do not provide information on affordability, political will, and health distributional equity, which are important considerations factoring into HIV policy development.

Our results are likely generalizable to other settings in SSA. Although we focused on a high HIV prevalence region of Kenya (15.1%), aPS studies have found consistently high HIV positivity (30–60%) in partners regardless of background HIV prevalence,[9, 11] likely because sexual partners of HIV-positive persons have high exposure or may have been the source of infection. Additionally, since aPS is event-driven, cost-effectiveness should remain fairly stable, as areas with low HIV prevalence will have fewer index cases requiring tracing. APS may be even more efficient in settings where general population testing is not implemented due to low HIV prevalence. Indeed, aPS is commonly used in developed countries with low HIV prevalence. Acceptability of aPS among sexual partners is high across African settings, with interventions in Malawi, Cameroon, and Kenya (current study) reporting uptake of 51–63%.[9–11, 16] Further, we evaluated aPS under three different ART initiation criteria so results can likely generalize to countries with different or changing ART guidelines. Additionally, background HIV testing coverage in Kenya is higher than other countries in SSA. If aPS were implemented in countries with lower testing rates, it would provide greater health benefits as partners are less likely to undergo facility HIV testing. In SSA, where heterosexual transmission is the primary driver of the HIV epidemic and half of HIV-positive persons do not know their status, aPS is a promising strategy to fill testing gaps.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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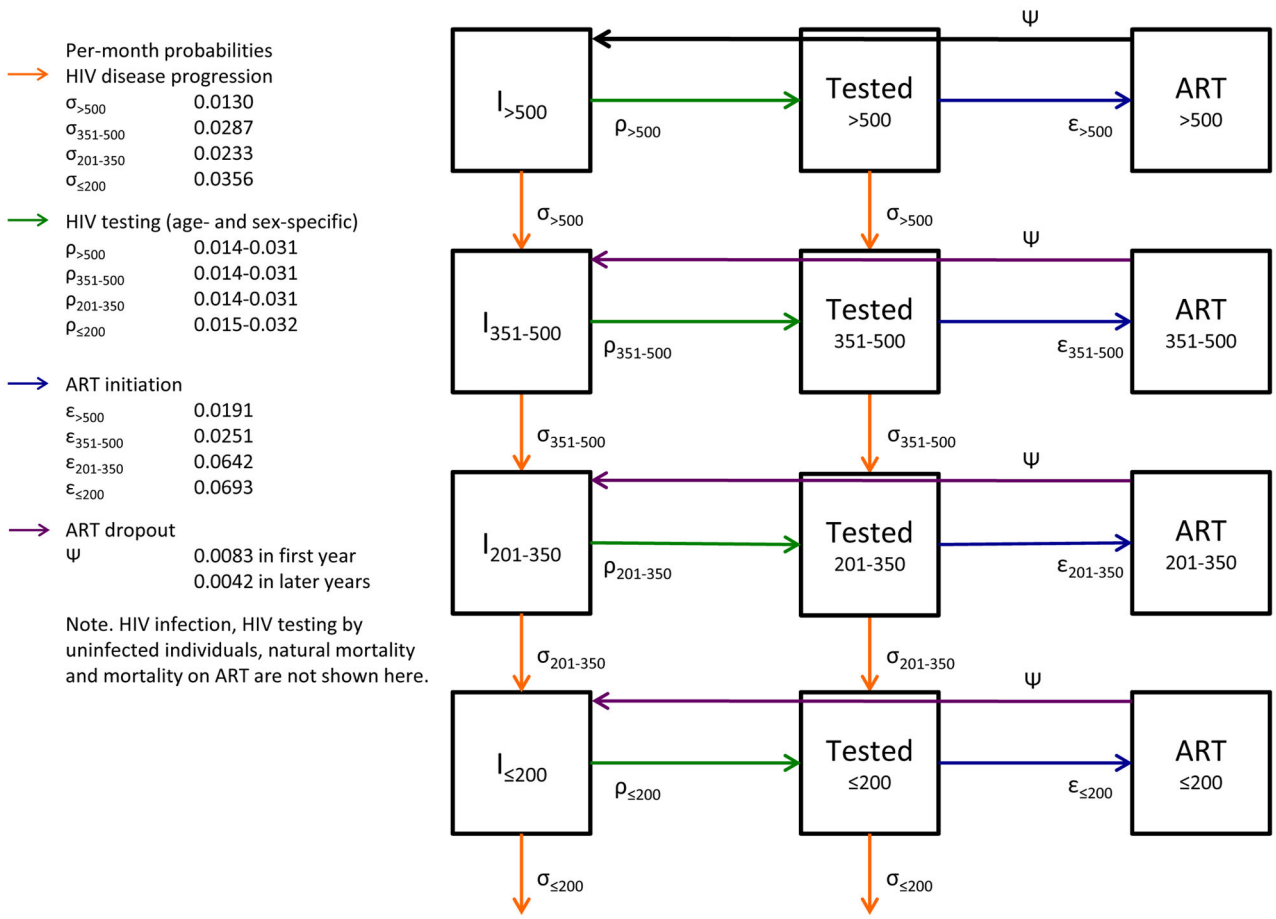

Figure 1.

Simplified model schematic of HIV disease progression and the HIV care cascade among HIV-positive individuals. HIV-positive individuals progress through HIV disease stages and on to HIV-related death at rates σ (top to bottom); subscripts indicate the CD4 cell count category to which the rate applies. Infected individuals (and uninfected, not shown here) are tested at rate ρ, attend clinics for CD4 staging and other clinical tests at and initiate antiretroviral therapy at rate ε. Antiretroviral therapy dropout occurs at rate ψ irrespective of CD4 category at antiretroviral therapy initiation and individuals return to their previous CD4 count unlinked to care.

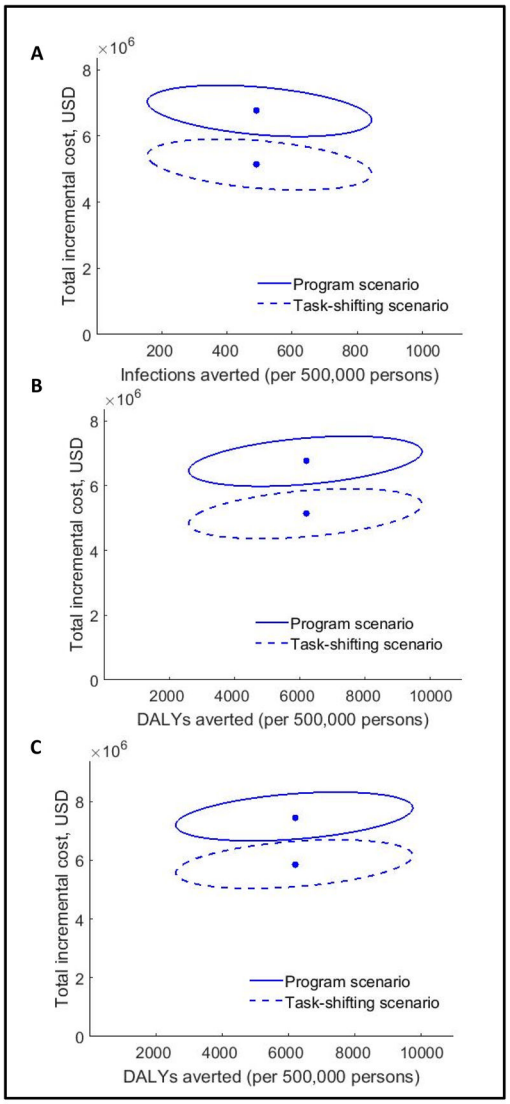

Figure 2.

Health benefits and discounted costs associated with the aPS intervention under the base-case scenario (ART initiation for all HIV-positive persons). Ellipses encompass 90% model variability across 200 simulations. Health benefits shown are infections (A), HIV-related deaths (B), and disability adjusted life-years (DALYs) averted (C) for a population of 500, 000 persons at start of model projection.

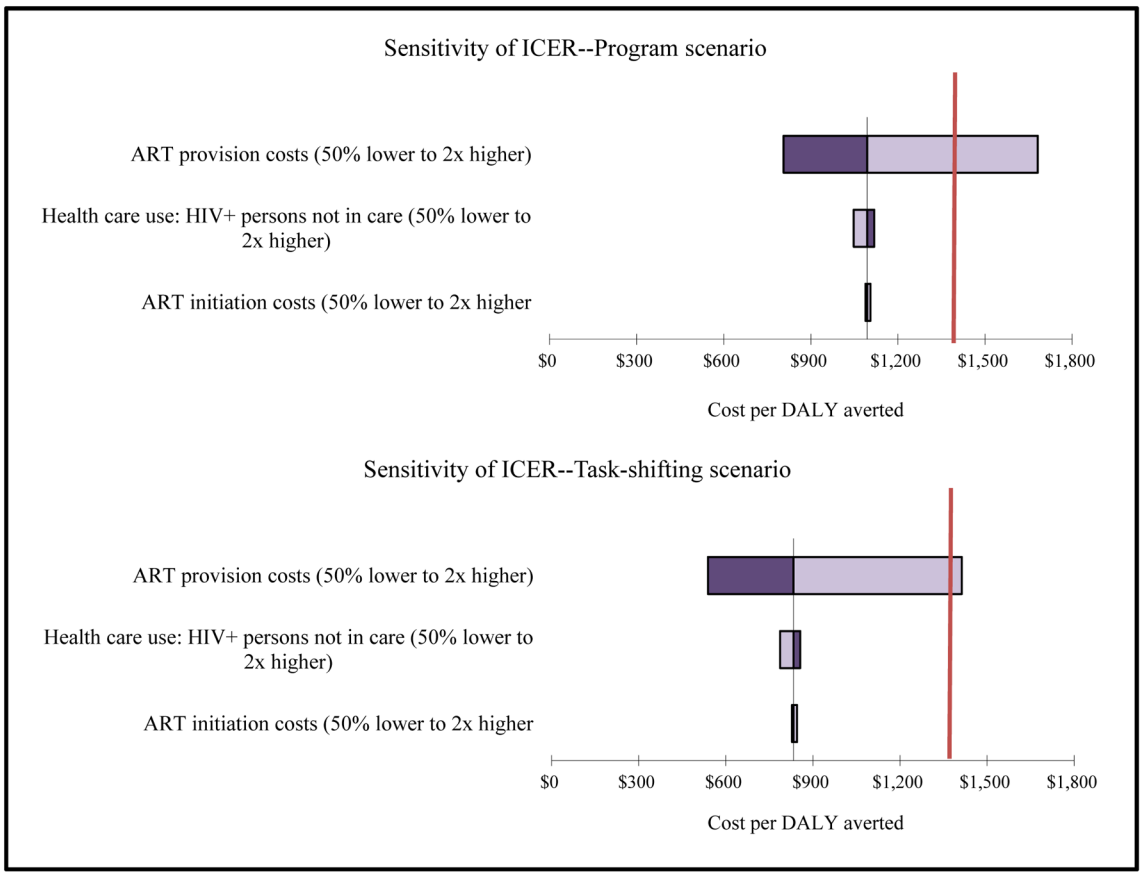

Figure 3.

Influence of varying healthcare costs on ICERs*

*Base case scenario (universal ART initiation). Red lines represents Kenya's GDP per capita, the threshold utilized for cost-effectiveness.

Table 1

HIV-related healthcare costs[§]

Health care provision	Unit cost (2014 USD)
HIV testing (cost per diagnostic test)	15[19]
Pre-antiretroviral therapy care (per-person-year)	
CD4 count >350 cells per μL	97[22]
CD4 count >200–350 cells per μL	106[22]
CD4 count ≤200 cells per μL	141[22]
Initiation of antiretroviral therapy (cost per initiation)	
Patients in pre-antiretroviral therapy care	37[22]
Patients not in pre-antiretroviral therapy care	50[22]
ART costs	
Cost of ART drug provision (per person-year)	214[23]
Health-care use for HIV-positive people not linked to care (per person-year)	
CD4 count >350 cells per μL, not in HIV care	4[22]
CD4 count >200–350 cells per μL, not in HIV care	13[22]
CD4 count ≤200 cells per μL, not in HIV care	48[22]
End-of-life care (per death)	38[22]
Supply-chain management and programmatic support	
Supply-chain management	20% mark-up on all ART costs[22]
Programmatic support[†]	50% mark-up on all non-ART costs[22]

[§]Costs from Zambia (Eaton et. al) were adapted to Kenya using the ratio of two country's gross domestic product per capita. ART costs were obtained from a national costing analysis from Kenya. HIV testing costs were obtained from a facility-based costing study in Kenya. All costs were inflated to 2014 Kenyan shillings and converted to 2014 US dollars. Health-care use for HIV-positive persons not linked to care includes both outpatient and inpatient costs.

[†]The mark-up for programmatic support applies to non-intervention costs only.

Table 2

Unit costs for the APS intervention per couple tested (2014 USD)

	Program scenario (Unit costs)		Task shifting scenario (unit costs)*	
	HIV-negative	**HIV-positive**	**HIV-negative**	**HIV-positive**
Personnel	38.54	42.83	17.01	19.14
Transportation	3.43	3.81	3.81	4.28
Equipment	0.31	0.35	0.35	0.39
Supplies	2.13	4.55	2.18	4.61
Buildings & overhead	2.02	2.24	2.24	2.52
Startup	1.04	1.16	0.67	0.76
Phones and data monitoring	0.78	0.86	0.73	0.82
TOTAL (per partner tested)	48.24	55.78	26.99	32.52

* The task shifting scenario replaces health advisors with community health workers (CHWs), and has lower cost mobile phones. We assumed CHWs tested 25% fewer partners per day compared to health advisors.

Table 3

Health and economic impact of the aPS intervention (universal ART initiation)[§]

Percent of population receiving APS	12.5%
Health impacts (total population)	
HIV infections averted	3.7% (1.9–5.6)
HIV-related deaths averted	2.6% (1.6–3.6%)
DALYs averted	1.4% (0.1–2.0)
Health impacts (among aPS partners only)	
HIV infections averted	2.6% (−1.3–6.0%)
HIV-related deaths averted	13.7% (10.5–16.3%)
DALYs averted	8.9% (6.7–10.9%)
5-year incremental aPS intervention costs (per 500,000 adults)	
Program scenario (millions)	3.5 (3.2–3.8)
Task-shifting scenario (millions)	2.5 (2.2–2.8)
Cost-effectiveness	
ICER program scenario ($/DALY averted)	$1,094 ($823–1,619)
Percent of program ICERs under Kenya's per capita GDP out of 200 simulations	80%
ICER task shifting scenario ($/DALY averted)	$833 ($628–1,224)
Percent of task-shifting ICERs under Kenya's per capita GDP out of 200 simulations	93%

[§]Values in parentheses represent 90% model variability across 200 simulations (range). Strategies under the threshold of Kenya's GDP per capita ($1,368) are considered very cost-effective.

[¥]Costs and DALYs are discounted at 3% annually. Costs are in 2014 USD.