Systems Analysis to Increase HIV Testing Delivery and HIV Diagnosis in Primary Care Clinics in South Africa

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Background: Provider-initiated testing and counseling remains highly underused in many South African health facilities. We implemented a systems analysis to investigate whether simple adjustments to HIV testing services (HTS) delivery can increase HTS provision.

Setting: Ten primary care facilities in the Ekurhuleni District in South Africa.

Methods: Following a baseline HTS assessment that showed limited offering of HTS by clinicians, clinic staff had the option to adopt several change approaches to increase HTS delivery using existing human resources. Approaches included adjusting HTS timing, strengthening HTS promotion, counsellor management, and implementing reward systems. Evaluation was conducted identically to the baseline study using patient exit interviews to quantify HTS engagement and value stream mapping to map patient flow through the clinic.

Results: We conducted 2163 exit interviews and followed 352 patients for value stream mapping. After change implementation, a significantly higher proportion of patients reported being offered HTS (742/2163, 34.3% vs. 231/2206, 10.5% during the baseline period; χ^2 $P < 0.001$) and having undertaken testing (527/2163, 24.4% vs. 197/2206, 8.9% during the baseline period; χ^2 $P < 0.001$) with only a 3-percentage point decrease in HIV-positive yield (14.0% vs. 17.1% during the baseline period). The median time to HTS offer decreased from 77 minutes to 3 minutes after clinic arrival during the intervention (χ^2 $P = 0.001$).

Conclusions: A systems approach can be an effective and appropriate implementation strategy to augment HTS delivery and increase HIV diagnoses. This low-cost approach may be extended to optimize other aspects of clinic service delivery.

Key Words: HIV, South Africa, provider-initiated testing and counseling, primary care, testing, implementation science

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INTRODUCTION

South Africa remains significantly affected by the HIV epidemic with an estimated 7.5 million people living with HIV (PLHIV) and 200,000 new infections in 2019.[1] Early detection of undiagnosed HIV and subsequent engagement into HIV treatment is vital to reduce illness, death, and HIV transmission.[2–4] As an entry point into the HIV care continuum, the optimal delivery of HIV testing services (HTS) is particularly relevant for HIV programs in South Africa, which are aiming to initiate close to 900,000 people onto antiretroviral therapy (ART) between 2020 and 2022.[1,5] Of the HTS strategies employed in South Africa, facility-based HTS is a long-standing and essential method for identifying PLHIV and providing periodic repeat testing for those who are negative. Compared with community-based HTS, facility-based testing, because of higher patient volumes and the convenience of a single location, is more likely to reach higher testing numbers and has the ability to provide onsite ART initiation and linkage to follow-up services. Currently, the majority (72.8%) of South Africans who receive HTS report accessing HTS through public-sector primary health clinics.[6] As such, provision of HTS in these clinics plays a crucial role in increasing the proportion of PLHIV who know their status.

More recently, because of facility-based testing's advantages and important role in HTS provision, public health facilities have sought to expand testing through the adoption of provider-initiated testing and counseling (PITC). With PITC, clinic staff offer, encourage, and recommend HTS to all clinic attendees, including those who may not be seeking HIV care services. Several studies have shown high acceptability, high uptake, and a high yield of newly identified HIV-infected individuals through PITC.[7–10] More importantly, PITC reaches individuals already seeking clinical care, and possibly, for this reason, individuals diagnosed through PITC are more likely to promptly initiate HIV care

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compared with those diagnosed through community-based HTS.[11–13] Currently, however, PITC remains highly underused in many South African health facilities despite a national policy mandating its offer as a standard component of medical care.[14] Several studies from Botswana, Malawi, Namibia, Rwanda, and South Africa have all reported low delivery of PITC, with a range of 8%–15% of patients being offered HTS during a clinic visit.[15–20]

We observed several barriers that limit the translation of PITC policies into routine practice within 10 health facilities in the Ekurhuleni District in South Africa.[21] Specifically, a lack of human resources, time constraints for patients and staff, and inadequate infrastructure to ensure privacy and norms among clinic staff contributed to only 10.5% of clinic patients being offered HTS. Moreover, value stream mapping identified that the timing of HTS offering usually occurred late in a patient's already long visit and did not take advantage of considerable queueing time in the clinic. In this study, we sought to overcome these challenges by using a systems approach to identify and apply simple yet tailored implementation strategies to increase HTS delivery within these same health facilities.

METHODS

We conducted an initial systems analysis of HTS delivery across 10 government-run primary care facilities in the Ekurhuleni District of South Africa.[21] HIV testing approaches were based on national policy for low-risk individuals (annual repeat testing) and high-risk individuals (quarterly repeat testing).[14] The study team did not alter these HTS guidelines. The decision to offer HTS was made by clinic staff. The methods used for the initial systems analysis were replicated in the end line assessment.

Following the baseline systems analysis, clinic-level results on HTS were presented to clinic staff and management to illustrate the current state of HTS delivery at each facility. The initial presentation was made to all clinic staff (from physicians to janitors) and was followed by facilitated discussions to generate contextually appropriate change approaches to address findings from the baseline results. After the initial round of presentations at each clinic, study staff returned to each facility to share ideas from other clinics with clinic management and finalize each clinics' change approach. Based on the discussions with clinic staff, simple approaches in 4 domains were identified as strategies to optimize HTS (Table 1). Clinics were encouraged to adopt only those changes they saw as feasible and beneficial among these approaches. Once potential approaches were agreed upon, clinic managers worked with a quality improvement team to implement their selected strategies. Our study team tracked HTS delivery within the clinics over time to evaluate the impact of the implemented strategies. The study team facilitated both the assessments and the presentation of information to clinic staff and returned biweekly for 3 months to assess and support strategy implementation.

Implemented Changes

All 10 facilities implemented HTS review meetings, group promotion of HTS, and increasing available HTS workspace. HTS review meetings were held weekly or biweekly and allowed clinic staff to review HTS data and to identify barriers and potential solutions. Group promotion of HTS involved counselors discussing the availability, benefits, and steps associated with HIV testing and treatment initiation in waiting areas throughout the day, although increasing available HTS workspace involved the setup of outside tents or use of unoccupied clinic space for HTS. Strengthening HTS promotion through health talks and adjusting HTS timing were the next most adopted changes, implemented by 9 of the 10 health facilities. These facilities had lay counselors or other lay health workers provide health talks twice a day in patient waiting areas to promote HTS and offer HTS earlier during the clinic visit.

Counselor management in the form of a counselor team leader was the next most implemented strategy, adopted by 8 facilities. In each facility, the team leader rotated quarterly and, at the end of which, was issued a certificate. Eight facilities also adopted an HTS champion to help promote and support HTS. The least implemented changes were adjusting counselor schedules (4 facilities) and creating a counselor of the month certificate (4 facilities). Adjusting counselor schedules involved staggering counselor shifts to ensure that there was a counselor on duty throughout the day, while a counselor of the month certificate was given to a team member based on his or her achieving or exceeding the existing Department of Health testing targets.

Outcomes

The primary outcome measure was the proportion of clinic patients offered HIV testing. Secondary outcome measures included the proportion of clients who completed HIV testing and the time to offer HIV testing. This overall approach to assessing HTS delivery mirrors that used in the initial systems analysis.[21]

Data Collection

Primary and secondary outcomes were measured during the initial systems analysis (January 2017 to June 2017) and then were repeated for an end line assessment starting 3–6 months after the HTS improvement strategy was implemented and the study team was no longer supporting the clinics (end line data collection was conducted from April 2018 to August 2018). A more detailed methodology on the data collection strategy was previously described.[21] Briefly, we used 3 independent streams of data collection: exit interviews, value stream mapping, and HTS register abstraction. Exit interviews and value stream mapping were conducted in parallel within the same facilities but on different days. HTS register abstraction was conducted at the end of data collection for each clinic and used to capture HIV-positive testing yield.

For exit interviews, data were collected using a brief survey administered by a team seeking to interview a pragmatic convenience sample of at least 50% of the total

TABLE 1. Overview of HTS Improvement Domains and Implementation Strategies Generated Following Meetings With Clinic and District Management and Staff

Improvement Domain	Rationale (Baseline Findings)	Potential Implementation Strategy
Adjust HTS timing by promoting HTS at reception and in the waiting area	Baseline analysis showed that HTS is usually offered during the consultation near the end of the clinic visit when the client has already spent hours at the clinic	Adjust patient flow in the facility in the acute section, eg, Registration > vitals > HTS > consultation
		Adjusting counselor schedules in the facility to ensure that there is a counsellor on duty whenever the clinic is open
		Add additional HTS working space to allow for increased HTS uptake and to better promote privacy and norms among clinic staff
Strengthen HTS promotion through talks given in the waiting area	Despite high acceptance rates once testing is offered, in the baseline findings, only 10% of patients were offered HTS during a clinic visit	Group promotion of HTS at waiting area by counselors discussing benefits and processes of testing and treatment initiation
		Health talk given by clinic staff every 3 hours with a planned topic guide. Ensure to mention availability and benefits of HTS
Counselor management to empower, acknowledge, and motivate counselors on their work	Counselors were not included in facility meetings and therefore many did not feel valued as part of the facility team	HTS review meetings among counselors, staff representatives, and the facility manager to review HTS data, progress, current implementation challenges, and potential solutions
		Appoint a rotating team leader amongst the counselors. Primary responsibilities include creating a duty roster, ensuring complete data capture, and presenting progress toward targets at HTS review meetings
		Appoint an HTS champion who helps promote and support HTS among clinic staff
Reward system for the facility and counselors for meeting targets	Clinic-based rewards for reaching HTS targets will increase awareness of HTS goals and HTS improvement efforts	Bolster counselors' motivation through certificates for being team leaders, completing training, and being counselor of the month

clinic daily head count. In addition to basic demographic data, patients were asked their reason for visit, if they were offered an HIV test, where during the clinic visit the HIV test was conducted, their reasons for declining HIV testing, and if they had received an HIV test in the 12 months before their clinic visit. The value stream mapping data were collected by tracking and manually time-stamping the entire clinic pathway from start to finish for a convenience sample of patients. A time sheet was completed for each participant and included details such as arrival times, wait times, accessed service points, service times, HIV testing service times, and departure times. HTS eligibility is not recorded in clinical documents and was not ascertained in this study. However, a proportion of patients (possibly around 30%) were presenting for HIV care and thus were not eligible for HTS. Participants provided oral consent for both the exit interviews and the value stream mapping.

HIV-positive testing yield (defined as the proportion of patients testing positive out of all patients testing) was assessed through an audit of accessible paper HTS registers for each of the participating clinics over an 8-week period.

Statistical Analysis

End line statistical analysis replicated the baseline analysis approach.[21] In descriptive analyses, categorical variables and measures of HTS coverage and uptake were summarized using frequencies (n) and percentages (%). Continuous variables, including service and wait times, were summarized using median and interquartile ranges. Two-way comparisons for the frequency and distribution of patient engagement in HTS compared with baseline data were conducted using Pearson χ^2 test. Results were provided using summary statistics and χ^2 testing across sex, reason for visit, and facility to assess for any heterogeneous effects. Data were analyzed using Stata v.16 (StataCorp, LLC, College Station, TX).

Ethical Considerations

The study was conducted according to the principles of the Declaration of Helsinki and approved by the University of the Witwatersrand Human Research Ethics Committee, the Johns Hopkins University School of Medicine Institutional Review Board, and the Ekurhuleni District Research Committee.

RESULTS

Sample Population Overview

During the end line data collection, a total of 5543 patients attended the health care facilities; of which, 2759 patients (49.8%) completed exit interviews. Of those with end line interviews, 596 were dropped from analysis because they did not interact with a clinic provider (eg, fast-lane

medication collection), leaving a final sample of 2163 patients. We conducted value stream mapping among 357 patients (5 observations were excluded from analysis because participants did not engage in any clinical services, leaving a final sample of 352). This compares with 2206 patients with exit interviews and 532 patients followed for value stream mapping in the baseline assessment.

Of patients with exit interviews, 70.2% were women (1514 of 2156). The median age of women was 34 years, whereas the median age of men was 41 years. These demographic data are similar to the baseline data where 69.6% of interviewed patients were women (χ^2 $P = 0.7$), the median age of women was 33 years, and the median age of men was 41 years (Table 2).

In the end line analysis, the plurality of patients who completed exit interviews presented for chronic health services, including hypertension, diabetes, and HIV care (962, 44.5%), whereas other common services included child health (327, 15.1%), acute care for an injury or illness (281, 13.0%), and family planning (279, 12.9%). In the case of child health visits, only the guardian was interviewed. These data are consistent with baseline data where 44.1% of patients presented for chronic health services, 19.3% for acute care, 18.5% for child health, and 7.0% for family planning (Table 2). Compared with the baseline sample, there was a higher proportion of patients who reported being at the facility for the first time, who had an appointment, and who reported testing for HIV in the past 12 months (Table 2).

HTS Offer and Uptake

After the change implementation, a significantly higher proportion of patients reported hearing about HIV testing during the clinic visit, being offered testing, and having undertaken testing during the clinic visit compared with the baseline assessment (Table 3). In the baseline period, 17.8% of patients reported hearing about or discussing HIV testing. This rose to 40.3% of patients in the end line analysis ($P < 0.001$). The percentage being offered testing rose from 10.5% to 34.3% ($P < 0.001$), a 3.3-fold increase, whereas the total percentage of patients tested increased from 8.9% to 24.4% ($P < 0.001$), a 2.7-fold increase. As shown in Table 3, the increase in HTS offer and uptake was seen in both patients who had been and had not been tested in the past 12 months.

End line analysis also showed a reduction in the gender disparity for being offered and undergoing testing compared with the baseline findings. In the baseline sample, women were significantly more likely to be offered testing than men (12.2% of women compared with 6.6% of men; $P < 0.001$). However, in the end line sample, this disparity was diminished with 35.5% of women compared with 31.9% of men being offered testing ($P = 0.1$). For those who declined testing, reasons for declining remained relatively similar across baseline and end line patients with time constraints (79.6% of end line patients) and already knowing their status (14.6% of end line patients) being the 2 most cited responses.

As depicted in Table 4, increases in the proportion of patients offered and undergoing testing were seen in all care categories. Specifically, in terms of offered testing, the largest increases from the baseline sample were in family planning (55.0% compared with 10.4%; $P < 0.001$), acute care (55.4% compared with 13.9%; $P < 0.001$), and antenatal care (85.9% compared with 60.4%; $P < 0.001$). These same categories also observed the largest increases in testing with family planning increasing from 7.8% to 46.2% ($P < 0.001$), acute care from 8.2% to 36.3% ($P < 0.001$), and antenatal care from 59.9% to 79.3% ($P < 0.001$).

Although all clinics showed an increase in offering and completing testing from baseline to end line, the magnitude of the increase varied. Changes in HTS completion ranged from a 4.9-percentage point increase ($P < 0.001$) to a 32.9-

TABLE 2. Baseline and End line Patient Demographic Characteristics From Exit Interviews

	Baseline, n (%) (n = 2206)	End line, n (%) (n = 2163)	*P*
Women	1536 (69.6)	1514 (70.2*)	0.669
Median age of women	33	34	
Median age of men	41	41	
First time at facility	113 (5.1)	231 (10.7)	<0.001
Had appointment	1667 (75.6)	1748 (80.8)	<0.001
Tested in past 12 mo	1167 (52.9)	1468 (68.0)	<0.001
Chronic care	973 (44.1)	962 (44.5)	
Acute care	426 (19.3)	281 (13.0)	
STD	3 (0.1)	37 (1.7)	
Family planning	154 (7.0)	279 (12.9)	
Antenatal care	207 (9.4)	256 (11.8)	
Child health	409 (18.5)	327 (15.1)	
Other	34 (1.5)	20 (0.9)	

*Seven patients were missing gender categorization in the final end line data set, making the denominator for this percentage 2156.
STD, sexually transmitted disease.

TABLE 3. Baseline to End line Comparison for Offered HTS, Received HTS, and HIV-Positive Yield Rates

	Baseline, n (%) (n = 2206)	End line, n (%) (n = 2163)	*P*	Relative Factor Change
Asked about HIV testing	392 (17.8)	871 (40.3)	<0.001	2.27
Offered testing	231 (10.5)	742 (34.3)	<0.001	3.27
Not tested in past 12 mo*	47 (4.5)	127 (18.4)	<0.001	4.08
Tested in past 12 mo*	184 (15.8)	614 (41.8)	<0.001	2.65
Received HTS	197 (8.9)	527 (24.4)	<0.001	2.74
Not tested in past 12 mo*	37 (3.6)	76 (11.0)	<0.001	3.05
Tested in past 12 mo*	160 (13.7)	450 (30.7)	<0.001	2.24
HIV-positive test yield†	1399 (17.1%)	2776 (14.0%)		0.82

*Percentage for these data are of those in the category, not the overall sample (ie, the denominator is the number of individuals tested or not tested in the past 12 months).
†Calculated from an audit of clinic HTS registers over 8 weeks.

TABLE 4. Baseline to End line Comparison of HTS Offer and Testing Completion by Reason for Visit From Exit Interviews

	Baseline		End line		
	Offered, n (%)	Received HTS, n (%)	Offered, n (%)	Received HTS, n (%)	χ^2 *P*, Received HTS, Baseline vs. End line
Chronic care	17 (1.8)	16 (1.6)	145 (15.2)	43 (4.5)	<0.001
Acute care	59 (13.9)	35 (8.2)	155 (55.4)	102 (36.3)	<0.001
STD	2 (66.7)	2 (66.7)	30 (81.1)	26 (70.3)	0.734
Family planning	16 (10.4)	12 (7.8)	153 (55.0)	129 (46.2)	<0.001
Antenatal care	125 (60.4)	124 (59.9)	220 (85.9)	203 (79.3)	<0.001
Child health	7 (1.7)	4 (1.0)	34 (10.5)	20 (6.1)	<0.001
Other	5 (14.7)	4 (11.8)	5 (25.0)	4 (20.0)	0.547
Total, n (%)	231 (10.5)	197 (8.9)	742 (34.5)	527 (24.4)	<0.001

Percentage for these data are of those in the category, not the overall sample (ie, the denominator is the number of individuals who reported seeking chronic care, acute care, etc.).
STD, sexually transmitted disease.

percentage point increase ($P < 0.001$), with a median increase of 16.4 percentage points (interquartile ranges, 8.3 percentage points and 17.5 percentage points).

HIV-Positive Yield

Based on an audit of the paper HTS registers, the yield of positive test results was 14.0% during the end line period compared with 17.1% during the baseline period (Table 3).

Value Stream Mapping

During the end line phase, a total of 352 value stream mappings were completed with a median of 39 per clinic. Overall, the median total time at the clinic was 126 minutes, with a median of 23 minutes of service time and 98 minutes of wait time. Among participants who did not have HIV testing, the median service time was 23 minutes and the median wait time was 97 minutes, whereas those who did undergo HTS had a median service time of 59 minutes and a median wait time of 119 minutes (Fig. 1). The median time to being offered HTS decreased from 77 minutes after clinic arrival at baseline to 3 minutes after clinic arrival during the end line assessment ($P = 0.001$). This was primarily a result of HTS being initially offered at the beginning of the visit by counselors and registration clerks rather than exclusively by clinicians during the consultation toward the end of the visit. Consequently, the overall median time in the clinic among patients receiving HTS decreased from 201 minutes at baseline to 186 minutes during the end line assessment.

DISCUSSION

Through a combination of implementation strategies geared toward the needs of each clinic, we were able to create substantial improvements in a number of key HTS parameters: awareness of HIV testing, proportion of patients offered HTS, proportion of patients receiving HTS, and time from clinic arrival to being offered HTS. Specifically, the proportion of patients who underwent HTS increased from 9% to 24% ($P < 0.001$), and the time to initially being offered HTS decreased from 77 minutes to 3 minutes ($P < 0.001$). Despite a substantial increase in HIV testing, the HIV-positive yield decreased only 3.1 percentage points from the baseline assessment. As a result, the total number of HIV diagnoses increased following the changes to improve HTS implementation. These results demonstrate success with increasing HTS provision using a systems analysis–based approach to identify contextually appropriate implementation strategies.

Our baseline analysis confirmed a significant health system weakness to HTS delivery—offering of facility-based testing was low, but acceptance when offered was high (85% accepted testing). Through the use of system assessments, we were able to describe the current state to clinic management and staff and work with them to identify contextually appropriate opportunities for system improvements. Through this process, a variety of simple and adaptable approaches were implemented to optimize HTS delivery. These approaches required minimal financial outlay and no additional human resources and are likely sustainable as long as policies and priorities regarding HTS remain in place. Costs were primarily in printed health communication materials for posting in the clinic, numbered cards for a queuing system (for some clinics), time for staff meetings to discuss changes, and foldable gazebo style tents to add private outdoor space for HTS.

These are the only results we are aware of in which a systems analysis approach has substantially increased the delivery of HTS. Other efforts to improve HTS delivery have generally been more resource intensive. For example, a study in Zimbabwe observed more than a 20% increase in the number of tests undertaken after deploying additional providers to clinic sites to perform HTS.[22] A study in Kenya was able to identify a number of HIV-positive individuals by expanding HTS eligibility to include those who had received an HIV test less than 12 months ago and nonpatients at clinic sites, although the HIV-positive yield was only 1%.[23] Several other studies in clinics have reported on the use of novel technologies coupled with additional personnel such as facilitated HIV self-testing. In a study from Malawi, 13% and 14% of patients received HIV testing in standard and optimized facility-based HTS, respectively, whereas 51% received HIV testing when HIV self-testing was included in the testing algorithm—although this added considerable test

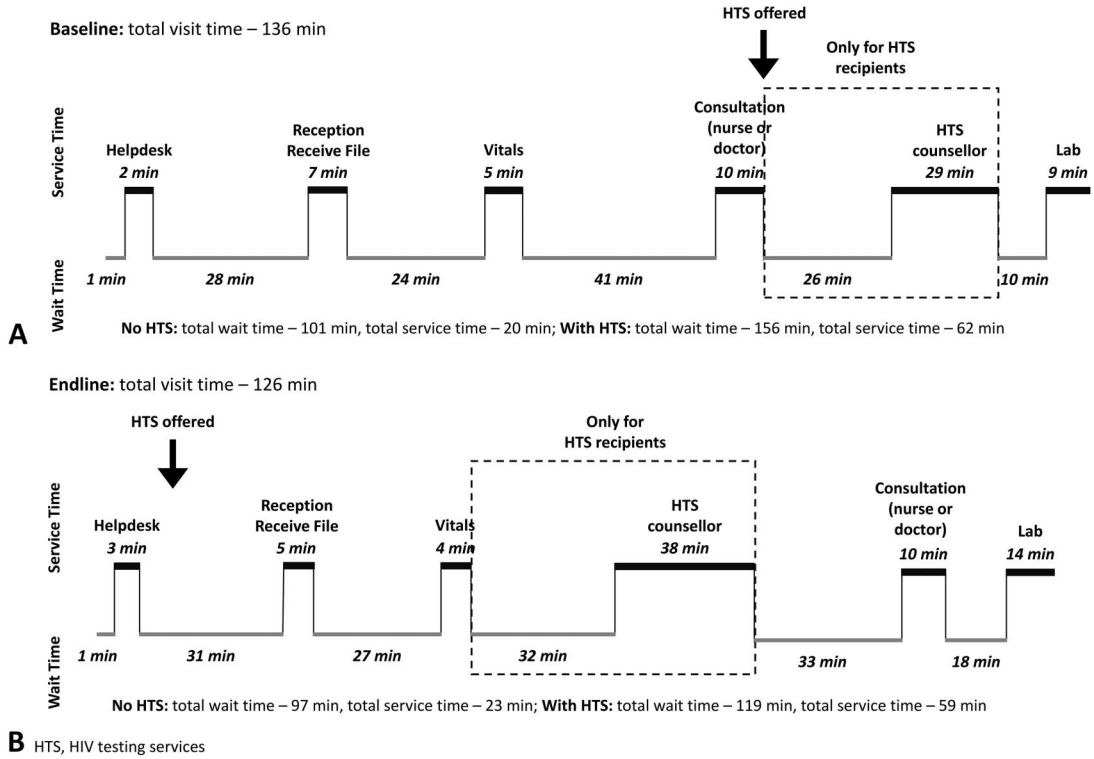

FIGURE 1. Baseline and endline value stream map of median total visit time and median wait and service times with and without HTS.

kit cost, human resources, and space requirements.[20] The 3.6-fold increase in HTS in the study from Malawi is similar to the 3.3-fold increase in HTS we observed with a much less resource-intensive approach. The reengineering we implemented required only a discrete number of data collection and staff meetings for systems analysis, clinic engagement, and implementation planning. Notably, we found that staff were excited by the baseline systems analysis and how these data pointed to specific opportunities for change. Routine systems-level data generation and facilitated discussion with clinic staff and management may facilitate organic continuous quality improvement. However, despite improvements, the fact that many clients still did not undergo HTS points to the need for additional strategies, possibly targeting specific populations.

This study has strengths of a "real-world" setting of public clinics with implementation strategies selected and implemented by routine clinic staff. In addition, including 10 clinics and assessing a reasonable proportion of patients for exit interviews and value stream mapping add to the study strengths. There are also important limitations. First, assessment of change was based on a before and after comparison. This approach is susceptible to secular trends and variations in service delivery. We believe that the short time between baseline and end line data collection limited secular changes but cannot exclude them. Additionally, although staff were aware of the study during the baseline and end line assessments, we do not believe clinic staff significantly altered behavior because of being aware of the assessments. Staff were clearly informed before both data collection periods that the study was a test of quality improvement implementation and not a performance evaluation. A further limitation is that we depended on patient self-report to determine the change in offering and undergoing HTS. We used this approach because the offer of HTS is not documented on any clinic stationary or registers, making asking patients the only viable approach to ascertaining this information. Another limitation of the exit interview method is that we only interviewed 50% of patients per clinic in the assessments. This could have introduced bias if some patients avoided interviews and were also more or less likely to have undergone HTS. However, we do not anticipate that this bias would have shifted over time and believe that any bias should not affect the validity of the baseline and end line comparisons. We were also unable to determine HTS eligibility and thus were unable to quantify the number of eligible patients who did not undergo HTS. Finally, as we avoided discussing HIV status during exit interviews, the estimated proportion offered testing does not account for the fact that a proportion of people accessing clinic services were already known HIV positive and receiving HIV care and thus would not have received HTS (removing known HIV-positive individuals from the denominator would increase the overall proportion of clients receiving HTS).

We have shown that a systems approach can be an effective implementation strategy to increase provision and delivery of HTS, reaching HTS levels similar to more resource-intensive interventions. In resource constrained

settings, understanding and assessing the delivery system and developing appropriate and locally tailored implementation strategies may be the most effective and practical approach. This low-cost approach may be extended to optimize other aspects of clinic service delivery, including ART initiation, routine viral load monitoring, and differentiated care delivery.

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