Continuous quality improvement (CQI) for HIV testing and counselling services for adolescents (HTC): A cost analysis of implementation

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Abstract:

The number of adolescents living with HIV is increasing globally. AIDS-related deaths among adolescents have increased while among the other age group people it has decreased. Nevertheless, HIV remains under-diagnosed in this population. We need economic assessment of continuous quality improvement for HIV testing and counselling services that provide cost of scalability and adaptability data for CQI interventions and informs policy makers about the impacts of program dollars spent on such impactful strategies. This would help prioritize methods that ensure high quality preventative services for HIV.

University of Washington, Seattle, in collaboration with Kenyatta National Hospital, Nairobi, addressed the competency issues of voluntary counselling and testing services provided to adolescents [14 – 15 years] at KNH by implementing CQI. The CQI implementation proved to be beneficial to improve the knowledge of HIV prevention and transmission amongst adolescents, satisfaction among adolescents, intent to retest and health worker satisfaction. For this study, we did a cost analysis of implementation of CQI implementation. We carried out the cost analysis from a payer's perspective to inform Government of Kenya the costs involved in scaling-up CQI nationally for HTC. We carried out micro-costing analysis utilizing the ingredients approach. We characterized the costs by activities and over time.

The CQI intervention needed the expert team, the management team and intervention team including 32 health care professionals for implementation. With investment of $ 6.7 per adolescent and **$ 42,509** in total over a period of seven months we were able to improve the knowledge of HIV prevention and transmission amongst adolescents, satisfaction among adolescents, intent to retest and health worker satisfaction. Thus, we conclude that investing in the health workforce training has the potential to improve the efficiency of current HTC services being offered in Kenya.

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Abbreviations:

ACASI Audio Computer-Assisted Self-Interview Software

AIDS Acquired Immunodeficiency Syndrome

CQI Continuous Quality Improvement

DALYS Disability-Adjusted Life Years

DASH Developing Adolescent Strategies for HIV testing

HIV Human Immunodeficiency virus

HCW Health Care worker

HTC HIV Testing and Counselling services

KAIS Kenya AIDS Indicator Survey

KNH Kenyatta National Hospital

ODK Open Data Kit

PI Principal Investigator

QALYS Quality-Adjusted Life Years

QI Quality Improvement

RA Research Assistant

SOP Standard Operating Procedure

STI Sexually Transmitted Diseases

UW University of Washington

VCT Voluntary counselling and testing services

WHO World Health Organization

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I am grateful to my husband, UW colleagues in Kenya, friends and family for their enthusiasm and support in all ways.

I. Introduction:

Prevalence of HIV among adolescents in Kenya:

In sub-Saharan Africa, adolescents have a high risk of acquiring HIV infection, and compared to adults have an increased risk of late diagnosis, poor adherence, treatment failure, and early death [1]. According to the Kenya AIDS indicator Survey [KAIS] 2012, the prevalence of HIV is 5.6% in youth aged 15-64 years. HIV incidence is high in adolescents, particularly among women infecting 21% of women in 15 – 24 years of age every year [2]. Nevertheless, HIV remains under-diagnosed in this population [3]. Healthcare providers have cited unique challenges in providing HIV testing, counseling, and treatment services for adolescents [3].

Role of voluntary counseling and testing services [VCT] in reducing HIV transmission, related morbidity and mortality:

Effective counseling of HIV-negative clients reinforces knowledge of HIV transmission/prevention, encourages repeat testing, and increases use of HIV prevention methods amongst them. For HIV positive individuals, effective VCT services promote early detection of HIV, referral for medical treatment and linkage to social support services. In addition to HIV-specific services, VCT may provide general reproductive health counseling and services including partner dynamics, family planning, and sexually-transmitted infections (STI). Consequently, optimal VCT services minimize testing stress and anxiety amongst adolescents, support women to make informed reproductive health decisions, and reinforce knowledge of HIV prevention and transmission. In summary, VCT plays an important role towards achieving broader health outcomes by protecting against new HIV infections, improving the lives of people living with HIV

and decreasing deaths amongst HIV/AIDS patients as it broadens access to family planning, STI services and treatment [3].

Current HIV Testing and Counselling Services [HTC] scenario in Kenya:

According to KAIS, in the year 2007 the annual coverage of HIV testing services [HTC] was 34% in Kenya, which in the year 2012 increased to 57%. There are total 5,980 VCT sites offering HTC in Kenya currently [3]. With high demand for HTC in Kenya and large number of sites offering services, adapting impactful strategies that offer adequate, accurate and highly efficient HTC becomes crucial.

Need to adopt CQI for providing quality HTC services nationally:

According to the World Health Organization (WHO) guidelines, HTC includes the following components: pre-test counseling, HIV test, post-test counseling, referral and linkage to other appropriate health services (including HIV treatment, family planning and STI referrals) and assessment of other health related conditions such as Tuberculosis. It becomes extremely important that the local hospitals and sites offering HTC adhere to recommended WHO standards and high quality services. Low-quality counseling and testing services may deter adolescents from seeking care, resulting in onward HIV acquisition or transmission in their sexual networks [4,5]. Quality improvement (QI) methods for HTC is an approach that can help understand the HTC quality issues, and help address site specific barriers [5]. Thus, adapting QI methods is a significant component for HTC to improve the quality of deliverables when scaling-up HTC and working towards the UNAIDS 90-90-90 target to end AIDS by 2030 [4,5].

Funding for HIV prevention in Kenya and further need for economic assessment studies:

According to Kenya national AIDS spending assessment report for the financial years 2009/10-2011/12, HIV/AIDS is a huge burden on the economy and health system of Kenya. The total expenditure on HIV/AIDS from the year 2009 to 2012 is estimated to be US $ 2.4 billion. The government of Kenya has contributed 16% of this total amount while the international donors have contributed 70% and the domestic donors have contributed to 14% of this huge cost. Out of the total budget 20% of funding is spent on prevention of HIV/AIDS [6]. However, to date there are few data on the cost of delivering HIV counseling interventions, and even fewer data on adolescent-focused services [7,8]. In this setting, the economic assessment of HIV prevention strategies becomes imperative as it enables policymakers to align scalable, effective interventions with health and population priorities. Cost analyses focused specifically on adolescent CQI programming can inform not only strategic spending of program dollars, but also may provide projections of larger impacts for the national economy.

From 2015-2016, the UW and collaborators at Kenyatta National Hospital (KNH) HTC evaluated the effectiveness of a Continuous Quality Improvement [CQI] intervention to improve adolescent and youth [14-25 years] HTC. The intervention was found to improve the HIV prevention and transmission knowledge amongst the adolescents, their satisfaction for HIV testing services and their intention for HIV retesting. It also led to increase in referral of adolescents for Family planning and STI services and health worker satisfaction. This thesis project evaluates the cost of CQI to inform the scalability and adaptation of the intervention; it will thus be useful to policymakers and program staff considering CQI as a potential intervention to improve adolescent HTC across Kenya.

Objective: Estimate the cost of implementing continuous quality improvement [CQI] in HIV counseling and testing services delivered to adolescents [14-24 years] at Kenyatta National Hospital [KNH], as a reference model for Ministry of Health to scale-up CQI programming nationally.

Specific Aims:

1. Develop a framework describing the cadre and associated roles of each employee involved in CQI based on those activities.
2. Describe the cost of activities that were implemented under CQI for improving the HIV testing and counseling services provided to adolescents at KNH [15-24 years].
3. Estimate the cost per adolescent of the CQI intervention.
4. Describe challenges and opportunities in estimating these costs.

Table 1: Conceptual Model

Activities	Input	Output	Outcome
Adolescent satisfaction for HIV testing services	-Additional Nurse work hours -Adolescent survey for satisfaction -Support person survey for satisfaction -Tablets -Administration of assessment tool and data analysis time	-Increase in satisfaction of adolescents for HIV testing services -Increase in support person satisfaction	Increase in HIV re-testing among adolescents
Increase in HIV prevention and transmission knowledge	-Counsellor work hours spent in CQI training -Additional counsellor work hours for counselling -Man hours spent for developing the quiz -Administration of assessment tool and data analysis time -Tablets	-Increase in HIV prevention and transmission knowledge among adolescents -Assess adolescent HIV prevention and transmission knowledge	HIV Risk Reduction
Increase in referral for FP and STI	-Additional counsellor work hours	-Increase in number of referrals	Increase in uptake of FP, contraceptives, STI, screening in adolescents
Health worker satisfaction and strengthening health care system	-Work hours for training HCW -Travel cost for CQI trainer	-Increase in HCW satisfaction -Strengthening the registration and reporting system	Strengthening health care system, staff retention, quality improvement of services, program assessment

II. Study Design and Methodology:

Study setting: Formative work and context:

Kenyatta National Hospital (KNH) is a tertiary care facility in Nairobi, Kenya, which has a dedicated service team for HIV counseling and testing. VCT services happen at three sites: the main VCT clinic, the Youth Centre, and the "tents". The Youth Centre provides a wide array of general counseling services for youth in addition to HIV testing. The "tents" are temporary structures established on hospital grounds near a bus depot, which have a very high uptake of passersby seeking a test. Adolescents are seen at all three sites. The main VCT clinics are

integrated with the other KNH HIV care facilities, facilitating linkage of HIV positive individuals to the KNH Comprehensive Care Centre, where they receive HIV care and treatment.

DASH study rationale and intervention description:

In a study focused on increasing pediatric testing uptake in Kenya (CATCH Study), focus group discussions with healthcare workers (HCW) revealed a self-perceived weakness in counseling skills regarding adolescent HIV testing. HCW specifically noted challenges associated with a wide range in adolescent maturity, and conflicting wishes for testing and disclosure when caregivers are present. The DASH Study (Developing Adolescent Strategies for HIV testing) addressed this demand for improved HCW competencies in delivering HTC to adolescents, and evaluated the effectiveness of continuous quality improvement (CQI) to improve adolescent HTC in the following domains: satisfaction with services, accurate knowledge of prevention and transmission, increased intent to retest, and referrals to family planning and STI testing services [9]. The study was divided into three phases:

Baseline (pre-intervention): From 29th October 2015 to 06th December 2015, the study team prepared quality improvement tools: the flow map for HTC at VCT, Youth Centre and tents, following the development of key drivers diagram and baseline data collection for the primary outcomes, and using audio computer assisted self-interview (ACASI) surveys. No CQI changes took place during this period.

Training: From 07th to 10th December 2015, a CQI consultant from the University of Washington traveled to Kenya to train the staff in CQI methodology. The training period included a large informational meeting at which VCT, youth center, tent administration and the overall staff

were provided with an overview of the process. A dedicated CQI team received training and led CQI activities over seven months.

CQI Intervention: From 11th December 2015 to 31st May 2016, the team conducted sequential Plan, Do, Study and act (PDSA) cycles to monitor the benefit/futility of changes enacted. The planned changes were implemented by the health care workers and hospital management. Weekly data was collected for the implemented modification followed by the process assessment to study the outcome and process variables. The areas for process improvement were identified followed by changes that were deemed to be beneficial toward target outcomes and were retained while those which were not found to be effective were discarded as mentioned in the Table 2.

To ensure sustained implementation of beneficial changes, the CQI team trained all non-CQI staff members in the procedural changes. Changes were additionally "hardwired" into standard operating procedures (SOP) documents and training materials.

Data Collection and Analysis:

We performed a cost analysis of the CQI intervention and included CQI startup and training costs, but excluded research costs. The analysis was carried out from a payer perspective, in order to inform potential Government of Kenya investment in CQI programming. As our study is not from a societal perspective we did not include the indirect costs or adolescent opportunity costs, these are discussed in a separate analysis presented elsewhere. We identified and categorized the direct non-medical costs for this project. In this case, the direct non-medical costs included the costs associated with the training and capacity building of health workers, evaluation of service access, development of data collection tools, weekly presentation of the run charts, training for

Table 2: HTC activities before and after CQI

Objective	Activities	BEFORE CQI	AFTER CQI	Changes Implemented /abandoned	Cost Incurred
Health worker satisfaction	Flow map	No	Yes	Implemented	Yes
	Training on PDSA	No	Yes	Implemented	Yes
	Leadership learning session for interpretation of chart and how to give feedback	No	Yes	Implemented	Yes
	Weekly meetings for discussing survey results and changes	No	Yes	Implemented	Yes
	Changes incorporated in SOP			Implemented	Yes
Adolescent Satisfaction	Music	No	Yes	Implemented	No
	Smiley stickers	No	Yes	Implemented	Yes
	Attention to wait time	No	Yes	Implemented	No
Intent to retest	Accurate Testing	Yes	Yes	NA	No
Increase HIV prevention and transmission knowledge	**Pre-test counselling**	Yes	Yes	NA	No
	Testing knowledge around methods of prevention	No	Yes	Implemented	
	Use of cue cards	No	Yes	Implemented	
	Test information on prevention during posttest session	No	Yes	Implemented	
	Pre-counselling questionnaire by counselor [CQI tracking sheet] process/outcome indicator	No	Yes	Implemented for a while / abandoned	
	Post-test Counselling	Yes	Yes	NA	No
	Open ended question during the counselling session	Low level	Yes	Implemented	
	Correcting in correct knowledge during session	No	Yes	Implemented	
	Assessing transmission and prevention knowledge qualitatively after the session	Low level	Yes	Implemented	
	Post counselling questionnaire by counselor	No	Yes	Implemented	
	Extensive STI Screening and FP[separate].	No	Yes	Implemented	No
	Checklist for counsellors	No	No	Implemented	No
	Others				
	Training of HCW 'deep kissing' not route of transmission	No	Yes	NA	Yes
	Test poster on wall with prevention and transmission routes [youth center]	No	Yes	Implemented	Yes
Early treatment Initiation	Linkage to care	No	Yes	Implemented but was not as Standardized/ abandoned	No
Survey Data Collection and Analysis	Developing Survey	No	Yes	NA	Yes
	Collecting data of survey	No	Yes	NA	Yes
	Analyzing data	No	Yes	NA	Yes

tech support, supplies and travel. Additionally, we classified the costs as 'variable costs' and 'fixed costs' depending on the variability feature of the cost. We included only the program costs for our analysis. To be precise, the study did not incur any patient costs, primarily the cost incurred was the program cost, cost associated with health system strengthening. Overall, we categorized data based on the phase of implementation of services and type of cost.

Cost for CQI implemented at VCT, YC and tents were captured and characterized by activities and over time [10,11]. Data was collected through interviews with the management team, intervention team and expert team in Nairobi and Seattle. A costing framework was prepared that listed phase-wise activities for reference of the health care workers being interviewed. The time assessment questionnaire is attached in the Appendix section for reference.

Email surveys were sent to the team members based in Seattle to collect the information about the time they contributed to CQI activities. Further, online meetings were organized to discuss the time use of the Seattle team and the information was validated with the team lead. The team in Nairobi was interviewed one on one for collecting information about the activities they were involved in and their time-utility. This information was cross-validated with other members. We could not contact three counselors who were on leave and their time contribution was estimated on the basis of data collected from 10 counselors. Also, the head of unit was not available and the time contribution was collected from the CQI lead and confirmed with head of VCT unit. Table 3 mentions the cadre of the people who were a part of CQI, their respective responsibilities and the time they contributed to CQI activities.

We enumerated the total costs of the DASH project by performing micro-costing analysis using the ingredients approach [11]. Since the facilities providing HTC services also provide other services related to the intervention we were careful to calculate the costs for DASH intervention singly. The amount of time dedicated by the KNH management, the facilities utilized and other technical resources used were estimated by calculating the proportion of time consumed by the health care professionals exclusively for this particular project. This information was collected through questionnaires using the direct measurement approach. Henceforth, we evaluated the final cost by multiplying the salaries of individual health care worker with the proportion of the time they spent on the project using Microsoft Excel. We collected cost data in local currency and converted into US dollars.

III. Results:

The cadre and associated roles of each employee involved in CQI:

A total of 32 health care professionals contributed their time to implement CQI at KNH over a time period of seven months from 29 Oct 2015 to 31 May 2016 to improve HTC services. It primarily included three teams: (1) **the expert team** that was responsible for leadership and engagement with senior leaders when needed to assure successful operation of CQI, (2) **the management team** that was responsible for training the KNH staff, understanding and preparing the quality improvement tools [the flow map, key-drivers diagram, process indicators], review of the CQI progress and provision of feedback during weekly meetings, and (3) **the intervention team** that was responsible for recruitment of adolescents, implementing the changes in counseling adolescents, developing Open data kit (ODK)for CQI, analysis of the collected data, sharing the results weekly with the team and over all administrative support. The expert team was made up

of 4 members from KNH including the head of unit, site director and head of VCT and youth center. The management team consisted of 1 CQI trainer from University of Washington, 2 study Co-Investigators from Global WACh, 1 post-doc research fellow and 1 implementation science fellow from University of Washington and 2 CQI lead from KNH. The intervention team constituted of 13 counsellors, 3 analysts,1 research fellow from UW, 2 support staff for recruitment and a receptionist. Table 3 has the detailed characteristics of the people involved in CQI, their responsibilities and respective time contribution.

Time use and cost estimates for CQI:

Overview of cost estimates for implementing CQI:

The total time contributed by 32 health care professionals for CQI activity from 29 October 2015 to 31 May 2016 was **3,860 hours** and the total cost estimate of the salaries was **$ 39,649**. Total project cost including the salaries and additional program costs was **$ 42,509.** For this project, we did not add additional resources to the existing staff structure at KNH, did not increase the working hours of the staff and thus, did not pay extra salaries for CQI to the implementation staff. The CQI activities were integrated into their activities as a part of a daily practice over a period of seven months. We projected the opportunity cost in this study by estimating the salary of each employee at KNH based on their time use in CQI activities. It may not incur financial costs associated with employees already on staff. However, the cost of management team or consultants from affiliated organization will incur financial costs.

All the team members who executed the CQI were on the same site and none of them was travelling during the CQI implementation thus it was easy and very inexpensive to conduct learning sessions, webinars and weekly meetings with them all together. In addition, we had 3 trained data analysts

and systems available at KNH for the data analysis of CQI so no additional support was needed around data collection, data entry and use. Lastly, University of Washington and KNH has shared a strong professional relationship for more than two decades so it was easy for the KNH team and UW research team to work in liaison.

Time use by staff for implementing CQI based on the phase of the program:

The **pre-intervention phase** included the following activities: development of flow map for VCT, youth center and tents at KNH, development of key driver diagram and baseline data collection. It required 328 health worker hours in total. The **training period** included the four-days training at KNH and 3 webinars. It required 929 hours in total. The **intervention phase** required 2603 hours in total. The majority of time under the intervention activity was spent developing the data tools, collecting data and analyzing data cumulatively consuming 915 hours. The meeting time including implementation team and management team meeting consumed 653 hours. Team at VCT spent 10 minutes every day discussing the changes to be implemented while youth center team spent 30 minutes in a week. 750 hours were spent on administrative activities, managing logistics and leading the project.

Health care professionals' time-use and cost estimates based on the expertise of the team:

The expert team contributed 264 hours of their time for implementing CQI successfully at KNH. The time spent by site director was the least, 12 hours, mostly in the meeting for the updates of the project and reviewing the study progress. The time spent by head of department was 59 hours, the time spent by nurse officer at youth center was 82 hours and maximum time was spent by head of VCT unit, 111 hours. Each of them spent time in CQI training. The head of department and VCT spent additional time participating in weekly management meetings. The head of VCT unit and

youth center had to spend extra time in communication and administrative activities. The head of youth center spent additional time in change evaluation activities and VCT head spent additional time in leading activities and logistic support. The total estimated cost of recruiting the expert team in CQI process was **$ 1,361.**

The management team contributed 1187 hours of their time for overall activities and the cost was estimated to be **$20,025.** for employing the management team. The highest cost component was the trainer's cost. The cost of hiring a CQI trainer for 4-day training, regular leadership webinars and overall guidance for conducting CQI would be $ 5,285. Entire team spent time preparing the QI tools. The co-PI spent additional time developing ODK and participating in weekly management meetings. The highest time was spent by the two CQI leads, 178 hours and 584 hours respectively, primarily supervising the daily activities, ensuring operational support, communicating with all the team members in implementation team, management team and the expert team and carrying out the administrative activities.

The intervention team spent 2,409 hours in total and the cost estimated for this team was **$18,262**. The technical support team spent 1188 hours developing ACASI tools, managing the data and analyzing the data. This data comprised the baseline data as well as the intervention data for four outcome indicators: satisfaction amongst adolescents for testing and counseling services, improvement in HIV prevention and transmission knowledge among adolescents, intent to retest among adolescents and satisfaction among health care workers. The time for counselors included their training time, meeting time and discussion time but not the counseling time as it was a part of activity before CQI. On cross checking the data from VCT data base the time spent by counselors before and after CQI were the same however the content, emphasis and method of counseling changed resulting into improved outcomes. Time spent by each counselor was 71 hours

on an average including their time for CQI training, meetings with implementation team and evaluating ongoing changes. There were total 13 counselors who supported HTC at VCT, youth center and tents. The recruitment of adolescents and survey assistance consumed 112 hours. Two health care workers along with receptionist were appointed to assist the survey administration and make the adolescents feel comfortable at HTC.

On the whole, the major expense for our project was the salary of Research Assistance, $11,307, from University of Washington who developed ODK and developed weekly run charts spending 538 hours in total followed by $5,286 attributable to the salary of the CQI trainer who spent 122 hours in total for developing the material for the training and implementing it.

The management team was based in U.S. and their salaries were at par with the American standard salaries except the two CQI lead who were KNH staff. These two CQI lead, the expert team and implementation team constituted the local staff and their salaries were estimated at par with the local Kenyan salaries. The salaries for the two CQI leads totaled to $ 4172, the salaries for the 4 expert team associates totaled to $ 1,361 and the salaries for 20 implementation staff members totaled to $ 6,955.

Figure 1: Proportion of time used based on the role the employee in implementing CQI

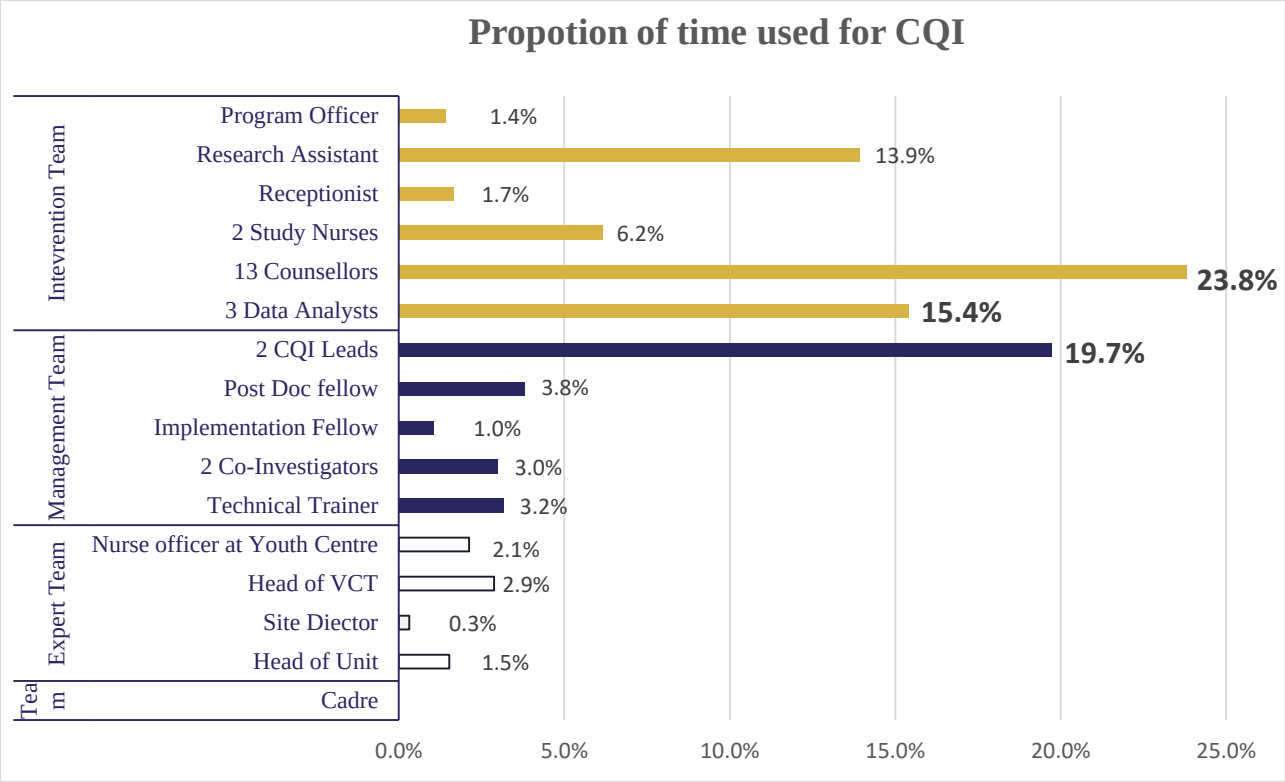


Figure 2: Proportion of time used based on expertise of the team

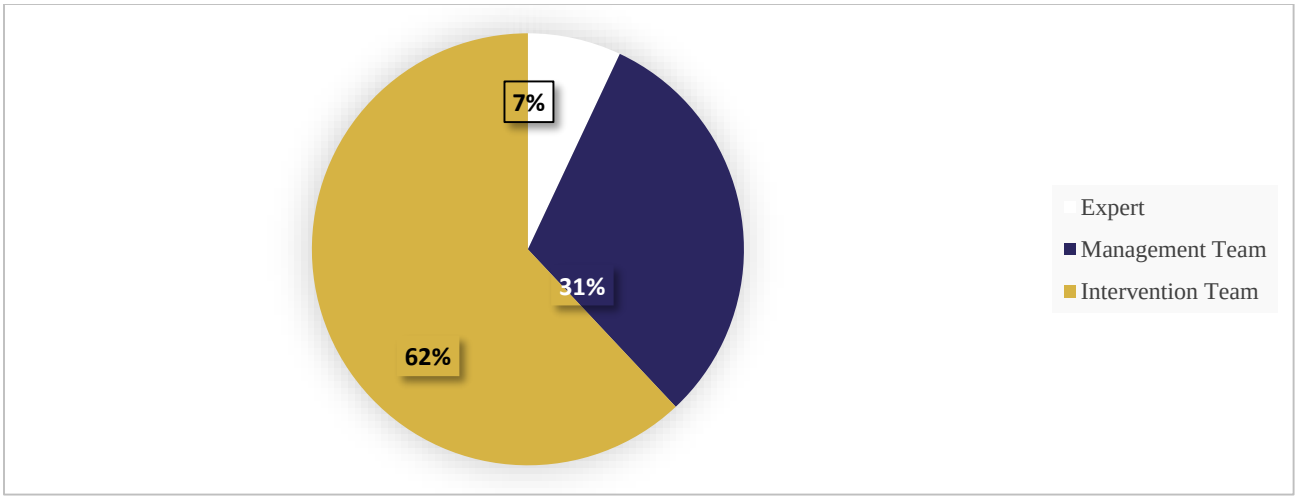


Table 3: CQI team: Cadre, associated responsibilities, time contribution and estimated cost

	Cadre	Role	# staff in DASH study	# staff needed for replication	Time Contributed	Cost Estimate in $
Expert Team	Site director	-Leadership and supervision -Review team data/ reports and plan relevant content for QI teams -Management calls if available	1		12	$ 82
	Head of Unit		1		59	$ 402
	Head of VCT	-weekly implementation/ management calls -Engage regularly in discussion regarding changes to be implemented -Administrative activities -Logistic/ communication	1		111	$ 505
	Head of youth center		1		82	$ 373
Management Team	Technical advisor	Conduct CQI Training	1	1	122	$ 5,286
	PI/ Co-I	-Flow mapping -Baseline Data -Key Drivers Diagram -Weekly management meetings -Review and feedback for overall process	2	1	56 60	$ 2,868 $ 2,955
	UW fellow		1		40	$ 1,183
	Post-doc fellow		1	1	147	$ 3,561
	Co-I/ CQI lead	-Supervising the daily activities -Ensuring operational support -Communication with all the team members -Administrative activities -Participating in implementation/management meetings	2	1	178 584	$ 1,517 $ 2,655
Implementation Team	Counsellor	-Participating in implementation meetings -Review data and plan changes to be tested -Implement changes -Engage regularly in discussion regarding changes to be implemented. -Regularly share results, successes, and challenges with team members of other unit and senior leadership in their organization	13		Approximate 71	Average $ 262 Total $ 3,412
	Program Officer	Supervision	1		55	$ 250
	Research Assistant	-Developing QI tools -Data management and preparing run Charts	1		538	$ 11,307
	Data analyst	Data Analysis	3		260 261 74	$ 1,038 $ 1,182 $210
	Study nurse	-Client Recruitment -Data Collection -Operational Support	2	Not required	119 119	$ 379 $ 338
	Receptionist	Administration	1		64	$ 146
	Total					$ 39,649

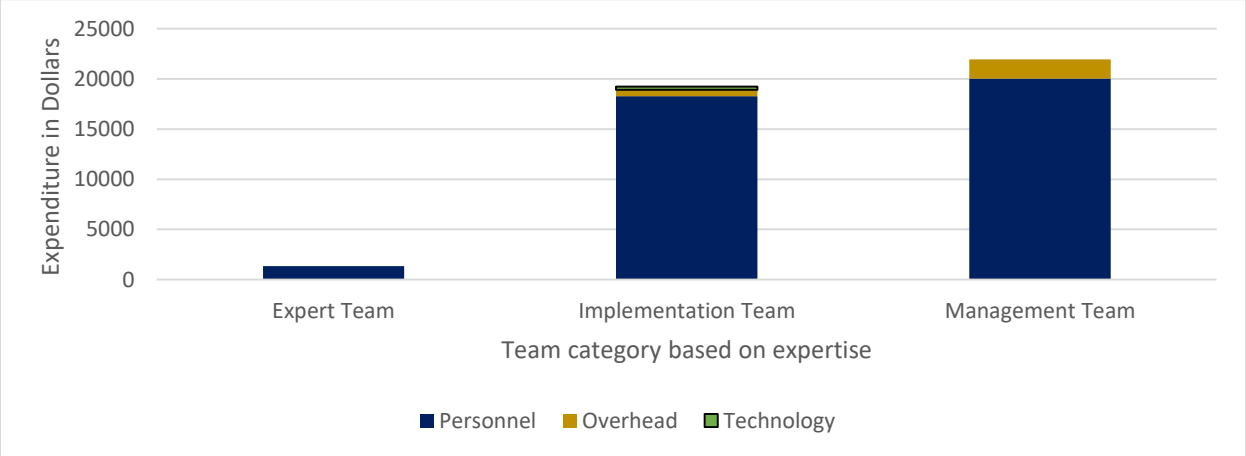
Additional program Costs:

The additional program cost included the cost of two tablets, $320, travel cost for the CQI trainer, $1900, the cost of lunch during the 4-day training for all the participants, $ 638 and cost of printing SOP and smiley stickers, $3. Thus, total additional cost for this program was **$ 2,861.**

Table 4: Costs of implementing CQI for HTC in Kenya:

Category	**Source of data**	**Amount**	**Percentage**
Personnel cost based on time utility	Primary data collection through interviews	$ 39,649	**93.28%**
Tablets	Purchase Receipts	$ 320	0.75%
Travel	Itineraries	$ 1900	4.47%
Miscellaneous	Purchase Receipts	$ 640	1.5%
Total		**$ 42,509**	**100%**

Figure 3: Expenditure categorized based on team expertise



Start-up cost and recurrent cost:

The start-up costs included the costs attributed to the development of the data evaluation tool that totaled to $ 4,232. The recurrent cost comprised of the cost attributed to activities performed to train the employees, collecting data, analyzing data team meeting discussions, evaluating run charts, and overhead cost. The total recurrent cost estimate was $ 38,276.

The cost estimate of the CQI intervention per adolescent utilizing the HTC:

We estimated the cost of implementing CQI per patient by dividing the total cost of the project with the number of adolescents that accessed HTC services during CQI intervention. The number of adolescents who utilized HTC over a period of seven months during which the CQI intervention was implemented [November 2015 – May 2016] was 6356. Thus, on average, 46 adolescents accessed HTC per day. The total cost estimate of conducting CQI is $ 42,509. Thus, the cost per adolescent for implementing CQI in such a busy government facility with 46 adolescent accessing HTC facility per day is $ 6.7.

Opportunities and challenges in estimating costs of CQI:

We applied the best practices for performing cost analysis for this study and the results demonstrate that with investment in CQI methods for HTC focusing on adolescent-centered services we can efficiently improve the quality of HTC increasing HIV prevention and transmission knowledge among adolescents, improving HTC service satisfaction and intent to retest We carried out opportunity cost by estimating the cost for time spent by employees already on KNH staff, which might not incur financial costs, to provide a better understanding of investment in hiring staff when needed.

Data regarding time contribution of employees for CQI was collected retrospectively since there was no documentation of such data during the study and this might have affected the accuracy of the data. However, we validated the data with different team members during one-on-one time assessment meetings. We also confirmed the data again with CQI lead. Secondly, the CQI intervention was carried out during a time when NASCOP was also running several national campaigns to increase child and adolescent HIV testing rates, which could affect the number of clients presenting for services during our study period, and would affect our estimate of cost/adolescent. Finally, in the DASH study, the CQI was implemented a part of a research study, and in some cases it was difficult to discriminate CQI from costs that were purely research-focused. To minimize the error, we had in-depth discussions with the management team to understand and reasonably segregate the activities under CQI and resources utilized.

IV. Discussion:

Major cost involved in CQI:

The focus of our study was to estimate the costs involved in implementing CQI at KNH, to improve HIV counseling and testing services delivered to adolescents [14-24 years]. The **total cost for executing CQI to improve HTC in a facility** with an average adolescent client rate of 46 adolescents /day was **$ 42,509.** and **cost of implementing CQI per adolescent was $ 6.7.** As mentioned in Table 4, 93.28% of total investment for CQI programming goes towards the staff salaries. Thus, major portion of the expense in CQI is associated with training of health workers and thus strengthening the health care system to improve the HIV prevention and transmission knowledge amongst adolescent, increase the proportion of adolescents who intend to retest and increase the work satisfaction of healthcare workers.

Investing in human resources promises increased efficiency and quality performance:

VCT services being labor intensive, investing in labor ensures superior care delivery with improved health outcomes [13]. Unlike investment in equipment, space and system, investment in labor does not depreciate over time. On the contrary, financing enhanced and rigorous quality improvement trainings **reinforce the potential of health care workers to perform better** as it improves the provider skills and their confidence in applying CQI in their daily work [13,14]. Moreover, people tend to **engage more** as they adapt their training knowledge in daily work, share their learnings and process new ideas working with groups. As they apply new ideas to their regular activities consistently and test the changes over subsequent iterations they **become aware of the shortcomings of the current conducts as well as efficient approaches** for carrying out daily activities. Effecting the changes that were beneficial while abandoning the ones that were inefficient further helps them to **maximize the efficiency of the existing resources** without adding new resources. We observed in our study like other studies, the process of testing the changes in a team and achieving results by implementing small changes **motivated the team and made the workforce more efficient [**14,15**]**. For this project, we did not add additional resources to the existing staff structure or increase the working hours of the staff at KNH. Yet, 3860 hours in total were adjusted by 32 health care workers in their regular working hours along with routine activities. This might be a result of adjustment in their leisure time, improvement in efficiency, intrinsic motivation or loss of entertainment time during work hours. In each scenario, the intervention proves to be **valuable**. With investment of $ 6.7 per adolescent and **$ 42,509** in total over a period of seven months we were able to improve the HIV prevention knowledge in VCT by 25% increase ($p=0.057$), transmission knowledge among adolescents in youth center and tents by 58% ($p<0.001$) and 33% in VCT ($p=0.008$) [9]. We also observed increase in proportion of

adolescents that intended to re-test for HIV by 44% (p=0.067) at youth center. On the whole, **investment in CQI trainings ensures improvement in quality of service delivery** to meet the WHO recommended requirements of HTC and thus is an important competent for working towards the 90-90-90 goal by 2020 [14,15,16].

The need to empower local health force to reduce overall program costs:

The overall program cost can be reduced by about 45%, if the local health workforce were empowered and employed for scaling-up HTC across Kenya. As we see in our study, 29% of project costs are utilized for the Research Assistant [RA] salary, 13% of program cost is consumed for the remuneration for the trainer and 4.45% cost is used in the travel cost of the trainer. As both these team members were a part of University of Washington and were based in Seattle the remuneration for them was at par with American standard salaries. CQI training by an expert was viewed to be essential for the success of the project; but this cost could be decreased by employing a local Kenyan CQI consultant. Additionally, replication or scale-up of CQI for HTC can be made less costly if CQI activities were led completely by the local healthcare work force, in which case the UW RA salary would be translated to a local clinical lead. Empowering Kenyan health work force to provide CQI trainings in health care settings, to develop assessment tools and perform data analysis would bring down the cost tremendously and make the project more sustainable [17].

Implications of findings:

Comparison with other studies:

There are very few studies with data on cost and cost-effectiveness analysis for QI methods practiced in health care settings [18]. All the studies have proved that investment in QI methods

improves the health outcomes and reduces the overall program cost [19, 20, 21]. Like other studies, the DASH study demonstrates that implementing CQI results in improvement in quality of HTC services and has the potential to improve health outcomes. Unlike other studies this study only performed cost analysis since the data on Quality-adjusted life years QALYS and Disability-adjusted life years DALYS was not available to calculate the reduction in the program costs.

For health care practitioners:

The study results may have significant implications for the health care system and national health budget of Kenya. National implementation of CQI has the potential to improve the efficiency of current HTC services being offered in Kenya. Cost data presented in this study provide information to health care professionals for replicating or scaling-up CQI method for HTC focusing on adolescent-centered services nationally. Hence, such evidence-based data will instigate the uptake of impactful CQI methods for HTC.

For future research: For future cost-effectiveness studies, a longer study period and follow up for endpoints will be needed. In future, with QALYS and DALYS data available this data can be used for a cost-effectiveness study.

V. Appendix:

Name	
Cadre	
Total time spent	

A	B. Type of Activity	C. Activity	D. Tick if you were involved in the activity	E. Activity time	F. Mention No. of days/weeks spent in the activity	G. No. of hours spent per week
Pre-intervention	CQI Preparatory Activities	CQI training Nairobi		4 Days [7 Dec-10 Dec 2015]		
		CQI training Seattle		-		
		Flow mapping		1 week		
		Key drivers Diagram Development		1 week		
		Baseline Data		29 Oct 2015 – 11 Dec 2015		
		In Column D mention if you were involved in other activities apart from the ones mentioned in the column				
	CQI trainings and meetings	Weekly management team meetings [For the meetings mention the number of meetings you missed]		Dec 2015– May 2016 every week		
		Weekly implementation team meetings [For the meetings mention the number of meetings you missed]		Dec 2015 – Feb 2016 weekly, Mar 2016 –May 2016 biweekly		
		Leadership Webinar		09 march		
		Implementation Webinar		11th March		
		Final Training Session		12th April		
		Evaluate changes		10 min everyday		
Intervention	CQI survey recruitment, enrollment	Developing Survey		Last week of Oct 2015		
		Recruitment		Dec 11 2015 - May 31 2016		
		Survey administration		Dec 11 2015 - May 31 2016		
	CQI Data System Development, Collection and Analysis	Collecting data		Dec 11 2015 - May 31 2016		
		Analyzing data		Dec 11 2015- May 31 30 2016		
		In Column D mention if you were involved in other activities apart from the ones mentioned in the column				

	CQI Coordination, communications and study logistics	Lead		Oct 2015 – May 2016		
		Operational support		Oct 2015 – May 2016		
		Mentorship and Technical support		Oct 2015 – May 2016		
		Mention if involved in other activities apart from the ones mentioned in the column				
Implementation	Implemented Changes	Changes incorporated in SOP/Questionnaires before and after counselling				
		For counsellors only: Amount of time spent before and after CQI in full counselling session	Before: ___mins After: ____mins			
		Mention if involved in other activities apart from the ones mentioned in the column				

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