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PART I
Case Studies, Experience Papers and Work in Progress

From Evidence to Practice: The implementation of digital health interventions in Africa for achievement of Universal Health Coverage

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Editorial to the HELINA 2019 proceedings

Nicky Mostert
Nelson Mandela University, Port Elizabeth, South Africa
The HELINA 2019 Conference

The 12th HELINA (HEaLth INformatics in Africa) conference was organized from 20 – 22 November 2019 in Gaborone, Botswana. The conference was hosted by the University of Botswana (UB) e-Health Research Unit under the Department of Computer Science, in collaboration with: Ministry of Health and Wellness (MoHW), Ministry of Transport and Communication (MTC), Botswana Institute for Technology Research and Innovation (BITRI), and the Botswana Health Information Management Association (BoHIMA), with Support from Stop TB Partnership in Geneva and Virtual Business Network (VBN) Services.

The conference focused on evidence to practice of digital health interventions to achieve universal health coverage. Digital health is an enabler for equitable health care access, from clinical care to public health. The conference provided a platform to showcase digital health interventions that have not only shown benefits, but are also sustainable.

The Conference Themes

The call for submissions for HELINA 2019 covered a broad range of themes related to the implementation of digital health interventions in Africa under the title “From Evidence to Practice: The implementation of digital health interventions in Africa for achievement of Universal Health Coverage”. Academic research papers, work in progress papers, and case study/experience papers where solicited within the following themes:

- The maturity model approach to implementation of digital health solutions
- Digital Health Learning Systems
- Quality and use of health data and systems
- Big data analytics in health care
- Health Information Systems Interoperability
- Continuous Quality Improvement of health data and systems
- Development of competent human capacity for digital health
- Sustainable ICT-solutions for health service delivery
- Artificial Intelligence and frontier technologies in digital health

Review process

After a call for papers was sent out a total of 133 submissions were received. A double blind peer review process was used for evaluating each full research and work-in-progress paper. These submissions were anonymized before being submitted to at least 2 reviewers according to their area of expertise. The Scientific Programme Committee based their final decision on the acceptance of each submission on the recommendations and comments from reviewers. Accepted submissions were then sent back to the authors for revision according to the reviewers’ comments. This review process resulted in the following acceptance rates:
Full research papers: 4.5% (n=8)
Work in progress papers: 6% (n=5)
Case studies and experience papers: 8% (n=11)
Rejected or retracted papers: 82% (n=109)
In order to be included in the conference proceedings, an accepted paper had to be presented at the conference.

Nicky Mostert, HELINA 2019 SPC Chair

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12th Health Informatics in Africa Conference (HELINA 2019)

Peer-reviewed and selected under the responsibility of the Scientific Programme Committee

Assessing How Health Data Systems Support Data Use in the Tanzanian Health System

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Abstract. Health data systems are crucial tools for evidence-based policy formulation, planning and decision-making at all levels of health systems. However, in spite of having a large number of projects implementing health related data systems in most developing countries, it is not clear to what extent these systems support data use for evidence-based actions. This study aimed to explore current data systems used in the Tanzanian health system and examine how the systems support data use. The study contributes to the assessment studies conducted within health information system (HIS) literature in the context of the developing countries since there were few studies which mapped existing health data systems and assessed how they support health information exchange and usage. The study employed desk review and key informant interviews (phone calls, physical visits, emails) especially the custodians and users of the various data systems. The review identified 169 health related data systems which are used in the health sector and beyond. Moreover, the review has indicated that not all of the identified systems have capabilities for data analysis, visualization, decision support and data exchange (interoperability). It is recommended that design and development of health data systems should be properly coordinated to make sure they support data use for informed planning and decision making.

Keywords: Health data systems, Data Use, Health Information Systems, Tanzania

1 Background

HMIS is a structured system whereby health data are recorded, stored, processed and used for policy-making, planning, implementation and evaluation of health programs [1], [2]. Health data systems and better data use are key components of a responsive health system which guide evidence-based health actions. Data systems can be defined as sub-components of the Health Information Management Systems (HMIS) that support the practices for data capturing, transmission, processing, storing, retrieving, analysis and dissemination to different stakeholders [3]. studies have defined data use as a continuing process that integrates analysis, synthesis, interpretation and reporting of health data to support decisions on health actions in the health system [4]–[6]. Some examples of decision-making processes where data can (and should) be used are: developing or revising a policy, creating or revising a programme or strategic plan; providing advocacy for a policy or programme, allocating resources, provision of quality healthcare services, monitoring a programme; and planning and budgeting, to mention just a few. Although data use is vital for planning and aiding evidence-based actions, literature shows that, rarely data are used to monitor programs and make decisions beyond individual patient care [7] as a result [3]

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calls upon different interventions to improve data use for improved efficiency and effectiveness in delivering quality health care services.

The adoption and implementation of data systems has been widely touted to improve data use practices around the evidence-based decision making [8]. The Tanzania Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) and its partners recognize the great potential of digital data systems in transforming healthcare delivery by enabling information access and use to support healthcare operations, management, and decision making [6]. The Government of Tanzania developed National eHealth Strategy 2013-2018 currently under review as National Digital Health Strategy 2019 - 2024 in efforts to harness and guide planning, implementation, and coordination of digital health initiatives [9]. Furthermore, National eHealth Steering Committee was established for improving coordination, stakeholders' engagement, resource mobilization, review and approval, monitoring and evaluation of e-health initiatives.

Some of the data systems that were implemented under the eHealth Strategy included scale up of district health information software version 2 (DHIS2) and implementation of Planning and Reporting (PlanRep) system in all councils, facility financial accounting and reporting system (FFARS) at health facilities, an electronic logistics management information system (eLMIS) countrywide and Epicor 9 at Medical Stores Department (MSD). The Government of Tanzania also successfully rolled out of an electronic integrated disease surveillance and response system (eIDSR) countrywide and implemented an electronic health facility registry (HFR) as well as the national sanitation management information system (NSMIS). In spite of having a large number of projects implementing health related data systems but, it is not known how these systems support data use practices [6].

Moreover, studies in developing countries argue that existing health data systems are greatly affected by unavailability of data resulting from inability of data systems to analyse data in required format [7], [10]. Ideally, the overall goal of health data systems is to optimize the performance of the health system at all levels of administration through the timely provision of necessary and sufficient information needed by the health managers to plan, monitor, and evaluate their activities [7]. Also, other studies indicate that information system design and development activities had mainly based on technical approaches with little attention on the needs of local health workers including use of health information systems for problem solving [11], [12]. As consequences of inefficient or poorly performing health data systems, vital health decisions, in this context, are made based on crude estimates of disease and treatment burdens [6].

The data systems are expected to provide reliable information to support decision-making process at each level of the health system. Thus, any data system despite the level of operations should support not only collection and storage but also processing, and retrieval of data for better utilisation [13]. More specifically, design of health data systems should aim at improved access to and delivery of quality health services through better access to quality information required by all users of the systems [14].

Improved access to and better use of data requires a system to be integrated, decentralized, functional and reliable [15]. However, one of the obstacles for achieving utilization of data for evidence based actions from implemented data system is the existence of gaps between information systems design and its reality of use known as 'design reality gaps' manifesting where data system ignore the local context practices and realities [16]. This further emphasised the need to ensure that systems should be designed to meet user requirements and needs as well as local context realities.

In responding to data use challenges, the Tanzanian Government established the Data Use Partnership (DUP) to support the implementation of Tanzania's Digital Health Investment Road Map [3] which builds upon the eHealth Strategy 2013-2018 [6]. The Road Map outlines 17 investment recommendations aiming to build robust health information systems and promote data use for improving health services and outcomes. The planned interventions aim to increase data use to identify and solve problems, measure performance and allocate resources; and for health workers use data to track clients, support clinical decisions and provide services efficiently and build local capacity in technology and governance. In light of the above, the Government of Tanzania and its partners are calling for increased and improved investments in data systems and data use to strengthen their ability to make evidence-based decisions.

The study contributes to the assessment studies conducted within HIS literature in developing countries context. While numerous studies like [4], [5] have addressed health data use topics there are few studies which mapped existing health data systems and assessed how the systems support data use and provided recommendations to improve its design in order to improve health information usage. Thus, the findings from this study calls upon key stakeholders including system developers, owners and users to strengthen their data systems through Principles of Digital Development1 in order to meet the primary role of the data systems on supporting data availability for evidence-based decision making.

2 Methodology

This study employed qualitative research methods. Data collection was mainly based on desk review technique and supported by key informant interviews. Desk review aimed at collecting, organizing and synthesizing available information on existing health related data systems in Tanzania as well as data use capabilities available in the systems. Our desk review included literature scanning and analysis of secondary data. The documents which were scanned included journal articles, thesis/dissertation reports, system reports, relevant websites (ministries, health implementing and development partners), and relevant presentations materials. Existing system inventories and reports were also collected from ministries, departments and agencies, implementing and development partners.

The data collection mapping tool consisted of groups of indicators for the assessment: (1) description of a system and (2) availability of data use functionalities. The following nine (9) indicators were used to describe the identified systems: abbreviation, and name of the system, sector, custodian of the system, financial supporter, developer/technical supporter, geographical coverage, program/section supported and health system building block supported. Also, the following six (6) indicators were used to examine how the data systems support health data usage: application categories, types of data captured, availability of data synthesis and visualization, types of data synthesis and visualization supported, availability of data exchange capabilities, and availability of decision support capability.

The assessment adopted indicators from the existing frameworks such as the WHO classification of digital health interventions [18], WHO building blocks framework of the health system, as well as literature on determinants of data use such as data availability, usability, analysis, visualization, decision support [17]. Furthermore, the assessment employed data system artefacts review technique to gather information on system features. The authors reviewed data systems which they had access by using system review guide. The review of data system artefacts provided richer data which could not be obtained through desk review technique.

The study also conducted several semi-structured interviews (face to face, emails and phone interviews) to in order to supplement data which were not found through desk review when filling in the data system mapping tool.

Data analysis was performed by the authors iteratively during a six-day mini-workshop. The information collected about each system was compiled and entered into the developed mapping tool. The data analysis was guided by aforementioned specific objectives and thus the data was categorized into two broader themes: identified data systems and data usage. The authors also applied the lens of the data use cycle [4] to ensure the full cycle from design of data tools, data capture, converting data into information and use of information to make decisions was considered during the analysis.

Ethical issues were maintained during the study by explaining the purpose of the data system review and its intended use. Participants provided oral consents before interviews. However, Since the study relied much on document review there might have been other data system missed out especially those without clear documentations available online. Also, some data systems and data use initiatives are implemented as projects and phased out, these might not have been covered under our study scope due to unavailable documentations.

3 Results

The study identified 169 health related data systems which were further assessed for their categories and data use capabilities. As summarized in Table 1 below, of the identified health related data systems were further grouped under 21 application categories were identified during the review. The highest number of application categories for identified systems were electronic medical systems 30 (18%), and client communication systems 20 (12%). The lowest number of data systems was client information system

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[1] https://digitalprinciples.org/

(1%), environmental monitoring system (1%), learning and training system (1%), and research information system (1%).

Table 1. Summary of identified data systems by application category

S/	Application Category	Count	Percent
1.	Census, Population information and Data warehouse	7	4
2.	Client Application	4	2
3.	Client Communication	20	12
4.	Client Information System	1	1
5.	Client Monitoring System	2	1
6.	Community -Based Information System	6	4
7.	Electronic Medical Records	30	18
8.	Emergency Response System	4	2
9.	Environmental Monitoring System	1	1
10.	Facility Management Information System	8	5
11.	Health Financing	17	10
12.	Human Resource Information System	13	8
13.	Knowledge Management System	3	2
14.	Laboratory and Diagnostic Information System	14	8
15.	Learning and Training Systems	1	1
16.	Logistics Management Information System	16	9
17.	Pharmacy information System	2	1
18.	Public Health and Disease Surveillance	5	3
19.	Research Information System	1	1
20.	Routine Health Information	12	7
21.	Shared Health Record and Health Information Repositories	2	1
Total		**169**	**100**

Of these 169 identified systems, 82% are specifically for the health sectors. As summarized in Table 2 below, majority of the systems (49%) are related to service delivery block of the health system. The desk review revealed that 66% of the systems capture individual data while 15% for gathering aggregated data as presented in Table 3.

Table 2. Summary of health data system mapped

S/N	Health system block supported	Count	Percent (%)
1.	Access to Essential Medicine	19	11
2.	Financing	19	11
3.	Health Information System	15	9
4.	Health Workforce	13	8
5.	Leadership and Government	21	12
6.	Service Delivery	82	49
Total		**16**	**100**

Table 3. Type of data captured in the identified data systems

S/	Types of Data Captured	Count	Percent
1.	Individual data	111	66
2.	Aggregated data	26	15
3.	Both	11	7
4.	Others (SMS based information and client interaction platforms)	21	12
Total		169	100

However, of the 169 systems, 57(34%) indicated to have various data synthesis and visualization capabilities. Some of the data synthesis and visualization capabilities include dashboard, charts, graphs, charts, pivot tables, scorecard, and trend analysis. Nevertheless, the data analysis capabilities could be limited to support local data usage. For example, out of 49 systems which have data analysis capabilities;

only one (1) identified system had GIS analysis capability, one (1) identified system had client/patient tracking capability, and only five (5) could carry out performance analysis including facility performance report and human resource performance data.

Also, there were fewer systems 57 (34%) and 49 (29%) which have data synthesis and visualization and data exchange capabilities including importing and export data (through excel, CSV, PDF, XML file and JSON data format) respectively. For instance, only eight (6) data systems could exchange data with the DHIS2 were identified as listed in Table 4.

Table 4. Data exchange capabilities among the identified data systems

Data system	System Description	Data exchange capability with other systems
DHIS2	District Health Information System version 2	Supports integration (JSON, Web API, etc), Import and Export (Excel, CSV and pdf)
eIDSR	Electronic Integrated Disease Surveillance and Reporting system	Electronic sharing to DHIS2
GoT-HOMIS	Government of Tanzania Hospital Management Information System	Electronic transfer to DHIS2 also Import and Export (Excel, CSV and pdf) capabilities
DHIS2 Tracker	Family planning decision support for community health workers	Import and Export (Excel, CSV and pdf) capabilities
SIMS	Site Improvement Through Monitoring System	Share data with agent system and DATIM
PRODMIS	Project Data Management Information System	Import and Export in Excel, CSV and PDF format
eLMIS	Electronic Logistic Management Information Systems	Interfaced with DHIS2, also have Import and Export in Excel, CSV and PDF capabilities
DATIM	Data for Accountability Transparency Impact Monitoring	Import and export data
HMIS (DHIS) portal	National Health Management Information System Web Portal	Import and export data from DHIS2
JEEVA	Hospital management system	Import and Export (Excel, CSV and pdf)
eHMIS	Electronic Hospital Management Information System	Electronic transfer to DHIS2 also Import and Export (Excel, CSV and pdf) capabilities

In addition, only 1% of identified systems had decision support capabilities including drug stock monitoring, predict stock level, stock alerts and notifications, notification and reminders SMS to providers, and provide medical recommendation based on the final diagnosis.

S/N	Data use Aspects	Count	%
1.	Availability of Data Synthesis and Visualization	57	34
2.	Availability of Data exchange Capability Supported	49	29
3.	Availability of Decision Support Capability	12	1

4 Discussion

Several studies indicate that data analysis, visualization and data exchange capabilities are important features of health data systems in order to influence data utilization [18], [19]. Contrary, the findings from this review show that most of the data systems were implemented with limited capabilities for using information such as insufficient analysis and visualization capabilities and, lack of decision support systems for tracking clients and supporting clinical decisions. Furthermore, numerous health data systems are lacking data exchange (interoperability) capabilities. Thus, most of the data systems need to be improved to include data analysis, visualization, decision support features, tracking clients and supporting clinical decisions features in order to increase availability and easy interpretation of health information. Moreover, it is critical for the systems need to be interoperable and reliable for effective use of data [15].

There is significant relationship between availability of data systems and data use, as such data systems garner information which is essential for monitoring health, and for evaluating and improving the delivery of health-care services and programs [20]. One of the strategies for improving data systems is to use simple automated analysis tools at facility level to allow local data use likewise DHIS2 to facilitate data collection, analysis, interpretation and use in the health sector [3].

Some of the barriers for translating data into action identified previous studies include poor data quality, poor access to data, lack of capacity of health managers and providers in core competencies for data use, and poor identification of information needs [14], [21]. This study has also indicated that another barrier for making information available to health workers so that they could use to inform their action is poor design of health data system which do not facilitate data analysis, visualization, interpretation and use. For example, there are fewer systems that have patient tracking capability and or decision support to help health workers in taking informed action at the point of care.

In most cases projects have been uncoordinated and fragmented thus leading to data systems silos which significantly hindered effective data use and sharing of information between stakeholders [7]. Furthermore, the uncoordinated nature of implementing digital health interventions leads to duplication of efforts, and the creation of new solutions that cannot be integrated with other systems or scaled across the health system. An assessment conducted by Japan International Cooperation Agency (JICA) in collaboration with MOHCDGEC indicated that out of 28 regional referral hospitals (RRHs) in which HRHIS and HMIS (DHIS2) were implemented; only 16 (57.1%) and 11 (39.3%) hospitals were not updating and using data from the systems respectively. The two systems have data visualization and data sharing capabilities which facilitate data use for informed decision making. Despite availability of hospital management information systems, the report furthered observed that 8 (28.6%) hospitals did not have systems for tracking medical errors.

5 Conclusion and Recommendations

The study has identified 169 health related data system which are used within the health sector and beyond. Further, review has indicated that not all of the identified systems have capabilities for data synthesis and visualization or exchanging data with other data systems which are among important attributes supporting data use. The desired situation is that health data systems would provide specific information to support decision-making processes at each level of the health system. Data analysis capabilities were limited to support data usage since there were fewer systems with capabilities for decision support, trend or GIS analysis, client/patient tracking capabilities and performance analysis. The findings show that health data systems are not designed with a focus of addressing data utilization challenges. This assessment will inform the requirements for any further development of the systems for better data use which will ultimately inform appropriate actions in quality health services delivery.

The study thus recommends the following:

(a) The development and implementation of health data systems should be properly coordinated and regularly reviewed to make sure they are properly implemented and support data use for informed planning and decision making

(b) Standards and guidelines for designing, development and implementation of health data systems should incorporate data use capabilities such as data exchange, data analysis, synthesis and visualization, business intelligence, and data mining

(c) A detailed assessment of each system needs to be conducted regularly in order to provide better understanding of the features of the systems and data elements collected as well as possible duplication of efforts and waste of resources.

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Using Predictive Algorithms to Offer Differentiated Healthcare in Community: A Study in Rural Kenya

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Background and Purpose: Access to primary healthcare in Kenya is still a challenge to many people especially among resource poor communities. This is mainly due to inadequate health coverage, limited health insurance, alongside constraining socio-cultural and institutional factors. Allocative inefficacies in health spending and poor uptake of health information systems has further aggravated the already dire healthcare situation. Leveraging on well supported Community Health Workers and focusing their efforts towards the most at need members of their communities, has proven to be an effective way of providing primary health care. The purpose of this study is to test a predictive algorithm embedded in a community health workflow application that runs on android based smartphones. The algorithm utilizes historic and routine data to identify individuals with elevated risk for future negative health outcomes. By creating data driven risk profiles, the intervention enables CHWs to optimize their time and effort towards serving the most at need members of their communities.

Methods: The study used Naïve Bayes Algorithm that multiplies probabilities while assuming "conditional independence" of the predictors and Cox Proportional Hazards model. A quasi-experimental design involving three study arms, one experimental and two controls, was employed. Historical and routine data was analysed for monitoring and outcome tracking.

Results: Most health workers have seen more task reminders than they did previously. The project has contributed to new thinking around formalizing differentiated care. The CHWs report to giving high risk tasks priority.

Conclusions: Preliminary data shows success in tagging individuals with elevated risk of negative health outcomes.

Keywords: Machine Learning, Predictive Algorithm, Community Health Volunteers, Health Risk

1 Introduction

Access to formal and equitable healthcare in Kenya has continued to be elusive, especially among the burgeoning communities living under the poverty line [1]. Despite Kenya being considered as a frontrunner in healthcare as well as a pivotal business hub in East Africa [2], the poor continue to suffer increased risk of healthcare exclusion especially because health services require proof of insurance coverage [3], in addition to constraining socio-cultural and institutional factors [4] [5], allocative inefficacies in health spending [6] as well as weak utilization of health information system products (data and evidence) that promote Universal Health Coverage (UHC) [5]. Whilst literature exists on possible approaches to achieving UHC [5] including: the adoption of digital innovations [7]; anchoring of UHC-Health Information Systems (HIS) in primary healthcare sector [5]; building community health

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innovation networks [8]; implementing hybrid rather than fully-independent systems [9]; in addition to incorporating Community Health Volunteers as agents of change in health systems [10], have recently been fronted as solutions to challenges of public health. As a strategy to lessen gaps in access to healthcare, CHWs are engaged largely on an unpaid basis to provide the required vital health systems linkages alongside promotion of hygiene practices [10]. However, as a result of numerous constraints including time, finances and other competing interests and demands, that CHWs encounter, a CHW is unable to meet the required metrics of visiting at least 10 households per day, five days per week, two hours a day (Ideally, a CHW should visit every household under their care at least once within a month). This is further confounded by high geographical disparities in healthcare access in Kenya [2].

As a regional healthcare testbed, Kenya has since adopted health innovations [2] to catalyze achievement of Universal Health Coverage (UHC) targets. Predictive Analytics methodologies embedded with community health can be used to utilize healthcare data to create algorithms that will identify households or individuals with elevated risk for future negative outcomes. By creating data driven risk profiles, interventions can be designed to enable CHWs optimize their time by focusing and prioritizing cases that will maximize their impact. The willingness to intervene is the key to harnessing the power of historical and real-time data. Importantly, to best gauge efficacy and value, both the predictor and the intervention must be integrated within the same system and workflow where the trend occurs [11].

Living Goods (LG) is a not for profit community health organization that embraces innovation and entrepreneurship in driving impact at scale through the roll out of community health interventions geared at maternal and child health. LG leverages a powerful combination of catalytic technology, high-impact training, and quality treatments that empower government CHWs to deliver quality care to their neighbors' doorsteps. The CHW workflows are embedded on a mobile application (the SmartHealth App) that provides assessment and decision support for doorstep healthcare workers while giving actionable analytics for managers.

Living Goods together with its technology partner, Medic Mobile, is running a Predictive Algorithm study (October 2018 – November 2019) that aims to increase services provided to families at highest risk of experiencing negative health outcomes. The Predictive Analytics pilot was successfully launched on October 29, 2018. A platform was designed to utilize the huge health data to assist health workers and health systems deliver targeted, equitable, fast, high-quality healthcare for everyone. While many health risks were tested in the development phase of the project, the final implementation targeted three specific risks: (1) The risk that a pregnant woman would not deliver in a health facility; (2) The risk that a newborn would develop danger signs in the first 28 days after birth, and (3) The risk that a child would become ill and would not be diagnosed by a health worker within 72 hours of symptom onset (Integrated Community Case Management – ICCM). For each of these risks, the model predicts which individuals are most likely to experience them, and then generates tasks for health workers to visit these individuals to deliver health education or counselling at set intervals.

2 Materials and methods

Machine learning algorithms or statistical models can be used to measure the likelihood that an event will occur (e.g. a child contracting malaria) by using a broad set of variables you let the trained algorithm decide which ones are important predictors and in addition, which combinations of variables are important. Figure 1 shows how an algorithm can be used to systematically weight risk factors to produce a single risk score.

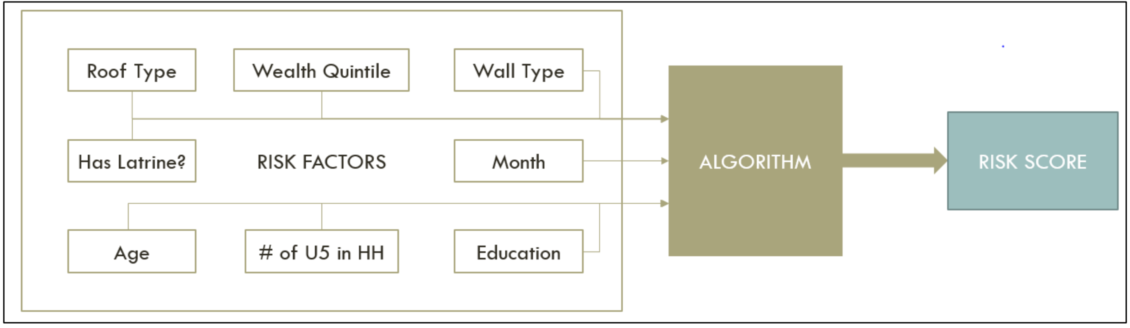


Figure 1. A systematic method of weighting risk factors to produce a single risk score

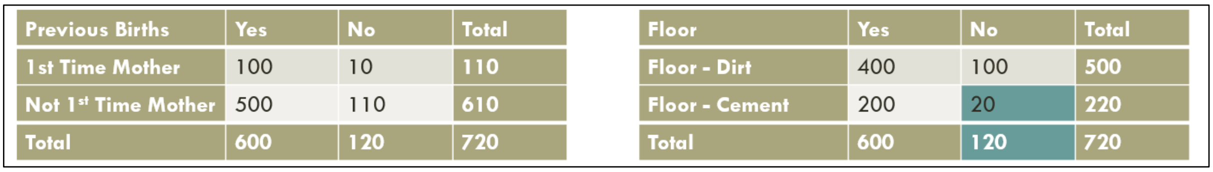
The study employed Naïve Bayes Algorithm by multiplying probabilities together while assuming "conditional independence" of the predictors and Cox Proportional Hazards model. For example, we need six numbers to calculate the probability that a 1st time mother in a household (HH) with a cement floor will deliver in a facility:

1. Probability a woman Delivers in a Facility = 600/720 = 83.3%
2. Probability a woman Delivers Outside a Facility = 120/720 = 17.7%
3. Probability a woman is a 1st time mother if they deliver in a facility = 100/600 = 16.6%
4. Probability a woman is a 1st time mother if they deliver outside a facility = 10/120 = 8.3%
5. Probability a woman has a cement floor if they deliver in a facility = 200/600 = 33.3%
6. Probability a woman has a cement floor if they deliver outside a facility = 20/120 = 16.6%

Probability of Facility Delivery for a 1st Time Mother with A Cement Floor is proportional to:
[1]*[3]*[5] =83.3 *16.6 *33.3 =46,046.57

Probability of Delivery Outside of a Facility a 1st Time Mother with A Cement Floor is proportional to:
[2]*[4]*[6]=17.7 *8.3 *16.6=2,438.71

Combine them together to get the probability: 46,046.57/(46,046.57 + 2,438.71) = 94.97%



Previous Births	Yes	No	Total
1st Time Mother	100	10	110
Not 1st Time Mother	500	110	610
Total	600	120	720

Floor	Yes	No	Total
Floor - Dirt	400	100	500
Floor - Cement	200	20	220
Total	600	120	720

Figure 2. Dummy data for demonstration

To collect the required data, we used a quasi-experimental design involving the following 3 study arms:

a) Experimental Data: Kenya, Kisii County, Bomachoge Chache Sub-County, Ogembo branch data historically collected by 66 CHWs
b) Control Data 1: Kenya, Kisii County, Bomachoge Borabu Sub-County, Kenyenya branch data historically collected by 53 CHWs
c) Control Data 2: Kenya, Kakamega County, Shinyalu Sub-County, Shinyalu branch data historically collected by 102 CHWs

This triangulation was to facilitate validation of data through cross verification from the two control data sets. This quasi-experimental research method involved collecting and analysing our SmartHealth data and other data points in the community using Focused Group Discussions (FGDs), Key Informant Interviews (KII), and Observations among the experimental group. This is documented through a monthly Monitoring, Evaluation and Learning framework that was developed with the direct input of all the stakeholders. A midline and endline evaluation are scheduled to compare the experimental data to the two controls data sets to assess outcomes.

3 Results

3.1 Integrated Community Case Management

The study proposed including the top 10% of risk scores as high risk. In the training data, this meant that any child with a risk score above 0.35 would be classified as high risk, however in our sample to date, the 90th percentile was 0.24, meaning we had fewer high-risk children than we expected in the sample. This change can be observed in the overall distribution of high-risk patients given in the plot below, as we move from the red cut-off to the blue cut-off and include a greater proportion of the population as high risk.

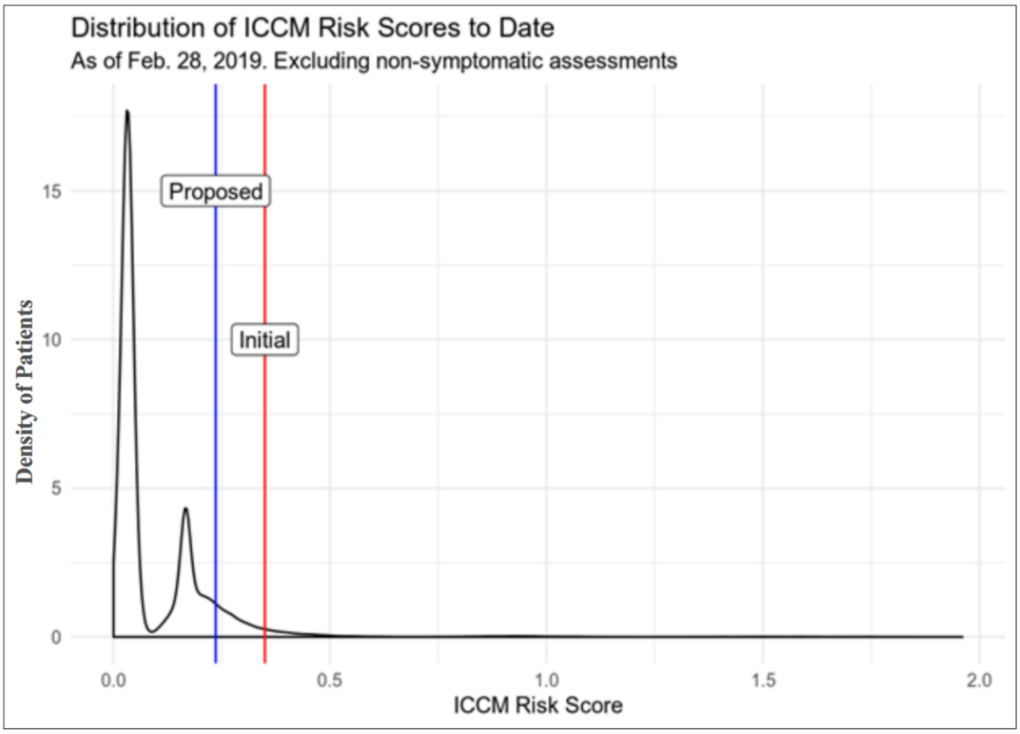


Figure 3. Distribution of ICCM Risk Scores to Date (February 28, 2019). Source: Study data (2019)

The impact of this change on health worker task levels can also be seen in Figure 4. Each row in the plot is the average tasks per period (there are two task periods per month) for one health worker, with the red dot representing the new workload and the teal dot representing the old workload (the old and new workloads are adjusted to exclude non-symptomatic assessments, which were unintentionally included in the risk score calculations at the start of the pilot and result in workloads that were higher than expected). Most health workers will see more tasks than they did previously, though most health workers will still see fewer than 5 tasks being generated in a given period.

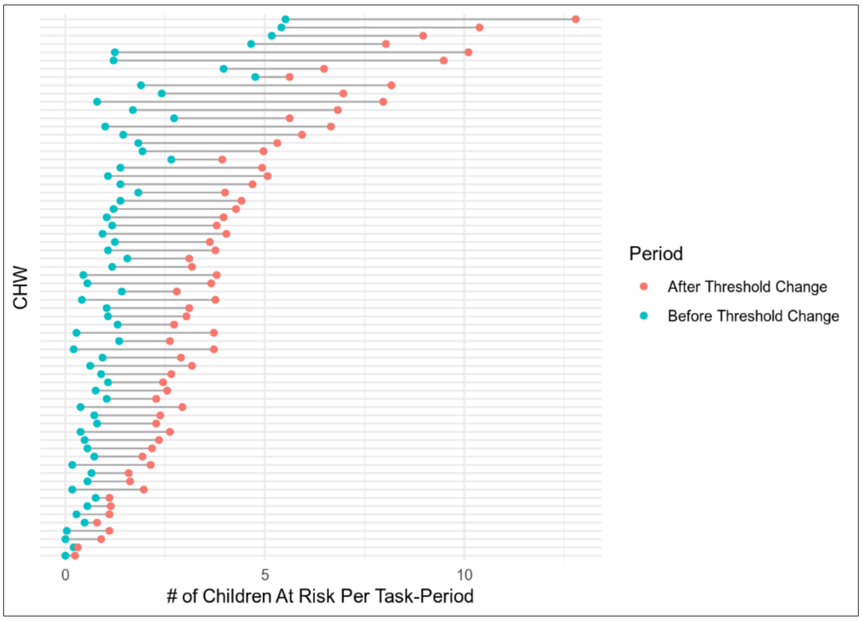


Figure 4. Number of Children at Risk Per Task-Period

In total, we expect the average health worker's workload to increase by approximately 2.6 tasks per period, totalling around 7.3 new tasks per month, which is exactly in line with our pre-pilot expectations.

3.2 Facility Delivery

The study had proposed including the top 25% of risk scores as high risk by setting the high-risk threshold to be all women with a probability of delivering outside a health facility over 50%. In our sample to date, however, we saw significantly fewer women above that threshold, with the 75th percentile being around a risk score of 0.21. Changing the risk threshold to account for this difference means we will go from the red threshold below to the blue threshold, very clearly increasing the number of high-risk women we expect to see.

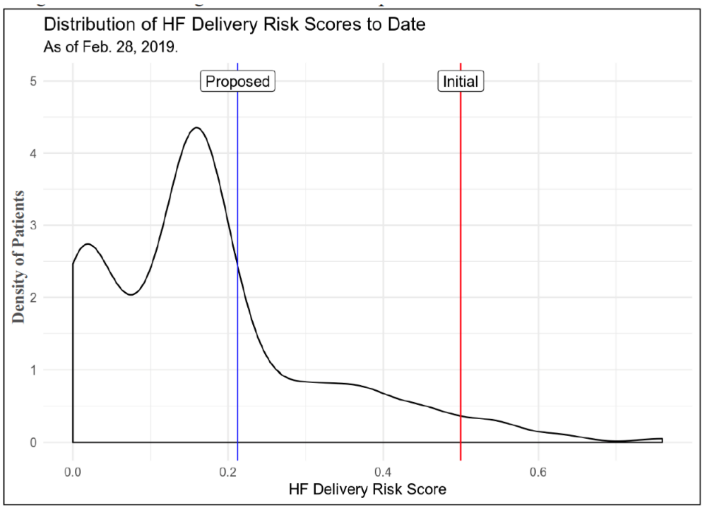


Figure 5. Distribution of HF Delivery Risk Score to Date (Feb 28, 2019)

This change can be looked at on a per-health worker basis, where on average most health workers will see more tasks per month, though the highest risk rate per month will still be one on average.

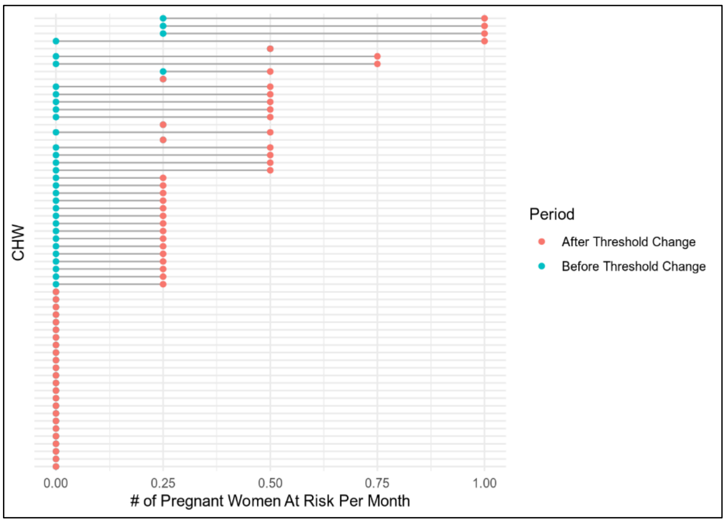


Figure 6. Number of Pregnant Women at Risk Per Month

The impact of this change is seen in the average number of high risk women per health worker - given that each high risk women will generate up to 4 tasks per month, this new mean of 0.27 new high risk women per health worker will produce an increase in tasks of ~1.08 per month, nearly exactly in line with our pre-pilot expectation of 1.2.

3.3 Newborn Danger Signs

Finally, for the newborn danger signs risk, we had proposed classifying the top 20% of risk scores as high risk, requiring a high-risk threshold of 0.025. Given the low overall incidence rates of danger signs in our training dataset, this was always the risk most likely to be out of line with the training data within the intervention area, and indeed we saw this with the 80th percentile of risk scores in our observed data falling at 0.13 (meaning we had more children classified as high risk than we expected in the sample). By changing the cutoff to the observed 80th percentile, we're moving the high-risk threshold from the red line to the blue line in the plot below.

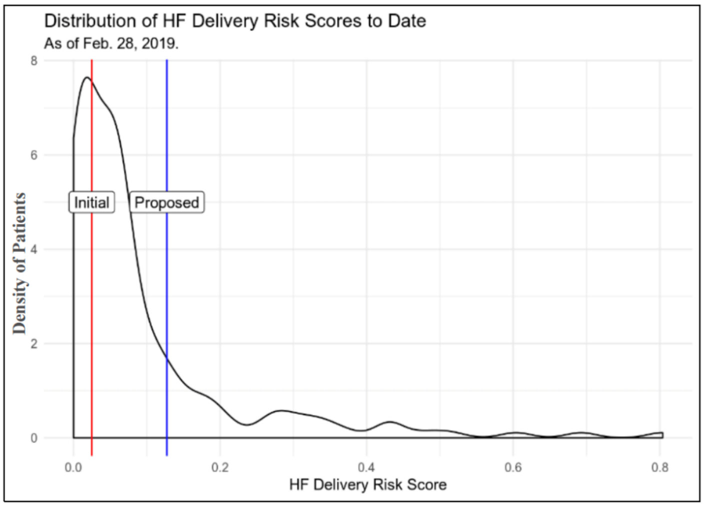


Figure 7. Distribution of HF Delivery Scores to date

The impact of these changes on individual health worker workloads can also be seen in the plot below - most health workers will see their workloads drop by a fair amount as significantly fewer children will be classified as high risk.

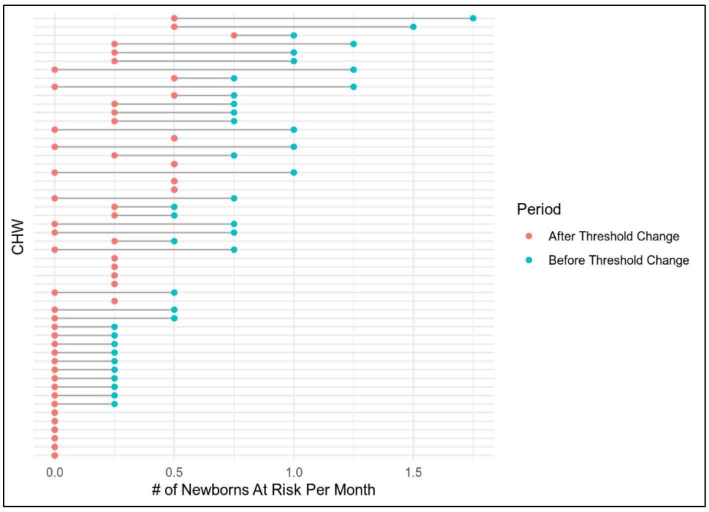


Figure 8. Number of Newborn at Risk Per Month

This impacts the overall expected task rates as well, as on average just 0.16 newborns per health worker will be noted as high risk each month, generating an extra 0.32 tasks (versus our pre-pilot expectation of 0.26).

4 Discussion

The Predictive Analytics pilot was successfully launched on October 29, 2018. Given the emergent need to tweak the pilot risk thresholds to ensure that health worker activity rates were in line with expectations, and the relative rarity of the outcomes that we are seeking to measure, we applied for and were granted a six-month extension by our funders.

Data analysis shows that individuals flagged as high risk have one or more of the following characteristics: 1) They lived far away from health facilities or the CHW; 2) They are in the lowest wealth quintile; 3) They have household dynamics that make them less approachable; 4) They have low trust and poor relationships with health workers. Designing this intervention ensures that there is more focus on such individuals leading to more CHWs and possibly health facility visits. The outcome being a reduction on their health risks.

The study made the following assumptions: That the algorithm will be successfully deployed within the SmartHealth app; The Community Health Workers will correctly use the updated workflow; The algorithm will be accurate in differentiating high risk cases from the general population of cases; Completion of differentiated care tasks will result in improvements in proxy indicators among high risks cases; and that the uptake of the intervention will improve care. The study accommodated the limitation that Naive Bayes classifier makes a very strong assumption on the shape of data set distribution that any two features are independent given the output class.

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Towards development of Heuristic Evaluation Guidelines for a Geriatric Interface on mobile interactive devices in Kenya

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Background and Purpose: The geriatric domain is increasingly growing. It's become an important consumer in acquiring technology that caters for their physical and psychological health. There are challenges though in usage of these technologies in terms of limited infrastructure, dynamics of self-efficacy and cultural differences in developing and developed countries. The current heuristics guidelines for elderly people have developed on the physical (visual) design while little done in the psychological design. The objective of this paper is to identify the key attributes the geriatric persons in developing country need to be incorporated in an interface to support them psychologically.

Methods: An exploratory qualitative study was performed by evaluating the existing heuristics, identifying factors in technology acceptance models and conducting a prestudy. A multi-method qualitative research approach (in-depth interviews and observations) was used.

Results: This study proposes factors identified from existing heuristics, technology adoption models and the prestudy, that will be used in a continuing study to develop heuristics guidelines for an interactive geriatric interface.

Conclusions: Contextualizing the needs of the elderly people in developing countries will enable development of technology that will tackle the decline in physical and psychological health leading to a lonely sedentary lifestyle. This research has been able to establish the psychological factor that needs to be blended with physical factors to ensure that the future design of mobile geriatric interactive interface will be accepted and adopted as it addresses the underlying needs of geriatric persons through heuristic guidelines.

Keywords: Heuristic guidelines, Geriatric Person, Technology adoption models

1 Introduction

The geriatric domain has over the past years emerged as an important consumer in acquiring technology in relation to their physical and psychological health. This has made the higher years of the geriatric persons more autonomous and socially engaging despite their socio-economic standards. The setting of the graying population in developed and developing countries is different when one compares the infrastructure in place, the dynamics of self-efficacy and cultural differences. For the developed countries, the expansive infrastructure has enabled them to improve geriatric care by having smart homes[1]–[3] and use of robotics[4]–[6], therefore investing heavily in such interventions that help the elderly people live autonomously.

The investment in such technology is expensive for many elderly persons living in the rural settings of Kenya (and other African countries) as it is not a priority compared to their pressing needs such as their health and taking care of their grandchildren. The elderly people in rural Kenya, and so in developing countries, have a basic mobile infrastructure that can be utilized as a start point to engage them physically and psychologically. These infrastructural and cultural variances give the idea of development of

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heuristics guidelines, contextualizing a developing country's needs. Innovation in advanced technology care for the aging population has revolutionized the gerontology domain[7]. There are challenges though, especially with the designs and complexities of the technology [8] which limits the confidence and level of engagement for the interested elderly people.

The innovative technology has shown an incremental growth is Ambient Assisted Living (AAL) which unfortunately has been built for the realities of the developed countries and little considerations of the realities in the developing countries like Kenya. This has been so because AAL has successfully achieved autonomy in cases where infrastructure is in place [2] [9]–[13] and where developers are seriously thinking of applications that are interesting and accessible by the elderly users [14] following the heuristic guidelines that fit the users' needs.

Designing an artefact requires a designer to follow specific standards and also guidelines that will enable the adoption and acceptance of the intervention for the users in mind. To establish the acceptance and adoption of an intervention, usability and user experience (UX) speaks volumes hence influencing the study on guidelines to user interface (geriatric interactive interface) for the elderly people. The user interface expresses the user experience as it's the 'face' of interaction between the technology intervention and the user. Good user experience will make people like the tool while inadequate user experience can make people dislike and abandon the tool despite its other benefits [15] [16]

Therefore, as Rodrigues et al.,[17] puts it, by captivating the interest of elder users in technology, we can fight isolation and exclusion and allow the elderly to be more productive, independent and have a more social and fulfilling life. The current heuristics guidelines for the elderly people such as [18] have developed for the physical (visual) design, that is; look and feel, interaction, and functionality. The psychological design has not been looked into where the elderly can give (for example; advice, motivate and share stories especially of historical events) and cognitively engage through technology.

This research combines existing heuristics, technology adoption model factors and findings of a prestudy in proposing factors (physical and psychological designs) that will be measured and validated in as a continuing study that is developing a heuristic evaluation tool.

1.1 Objectives

There are several existing heuristic guidelines that have a cutting edge in assessing the impact of technologies to a geriatric interface. The objective of this paper is to identify the key attributes that the geriatric persons in developing country will need to be incorporated in an interface to support them psychologically. This will be achieved through demonstrating that the heuristics guidelines that are used in developed countries cannot be satisfactory mapped to a geriatric interface in developing countries especially in Kenya.

2 Materials and methods

In this paper, we performed an exploratory qualitative study by evaluating the existing heuristics, identifying factors in three technology acceptance models and carried out a prestudy with the aim of contextualizing and proposing design principles and individual factors that can be used for development of a geriatric interface in developing countries.

For the secondary information, conference papers and journal papers from google scholar, Journal for aging studies and gerontology were analysed as literature. A prestudy was carried out to understand the needs of the elderly when using technology. This prestudy was carried out in two philanthropic social homes. The pre-study involved 10 elderly men and women who are above 65 years and are able to use a mobile phone.

A multi-method qualitative research approach, using in-depth interviews and observations was chosen where each participant would take an average time of 45 minutes in discussing mobile phones features and how they would like the technology to evolve to accommodate their needs.

This is an ongoing research work that envision to develop a heuristic evaluation tool for geriatric interface for mobile devices that satisfy the needs of the elderly people in developing countries.

3 Towards heuristics guidelines for geriatric interface

3.1 User Interface with a touch of grey

Growing old has a degenerative effect on physical and cognitive capabilities (i.e. diminished vision, varying degrees of hearing loss, psychomotor impairments as well as reduced attention, memory and learning abilities) therefore being a great hindrance in usage of technology that has a user interface that is not well suited for the elderly users.

Generally, universal design also known as 'Design for All' is largely adopted to design for diversity, that is, elderly people, people with disability, different age groups and the cultural differences [19]. It has been described as the philosophy in design that recognizes values and accommodates the broadest possible range of human abilities, skills, requirements and preferences in the product and supporting environments to suit the broadest possible end user population [20]. A number of academic papers [14], [20]–[26] have developed guidelines that have been used by developers when designing for the elderly and the physically challenged population yet this cannot be mapped to the needs of the elderly in developing countries due to variations in factors around infrastructure, the broadband and knowledge of technology of the elderly and cultural tenets in these different worlds.

In designing of any user interface, usability and user experience are well known as significant contributing factors to quality of any technological product therefore becoming increasingly important in the mobile development [27] and by extension to mobile applications.

3.2 Developing the Usability heuristics

Though there is no agreement yet about the most effective process of developing heuristics, as [28] shows that most existing heuristics have been developed on the basis of the researcher's extensive experience or by adopting methods usually employed for other purposes. Various authors [28]–[33] have argued though on how heuristics are established.

A researcher cannot be blind to existing heuristics such as the 10 Usability heuristics checklist by Jakob Nielsen [34], Schneiderman's eight golden rules and Norman's seven principles [35]. These principles and heuristics all revolve on the physical look of the geriatric interface where sight and touch are well captured (Table 1). These guidelines have been appreciated and used in different domains successfully but need to adopt the needs of a geriatric person in developing country.

Table 1. Principles from the Universal design principles; Source: Literature

Design Principles	Shneirdermann's	Nielsen's	Norman's	Relevance to geriatric interface
Consistency	√	√		
Feedback	√			√
Use of shortcuts	√	√		
Simple error handling	√	√		
Easy reversal of action	√	√	√	√
Recognition	√	√		√
Internal locus of control	√		√	
Power of constraints			√	
Localization		√		√
Complexity			√	√
Visibility		√		√

From Literature review, the researchers identified two scholarly papers that addressed the heuristic needs of a developing country. Deveza et al., [36] and Van Biljon & Renaud, [37] have developed a generic Human Computer Interaction (HCI) guidelines for developing countries and an extended senior mobile phone adoption checklist (ESMAC) respectively (Table 2).

Technology adoption models were also analysed to describe the factors that affect the user's intentions on usage of technology, that is a mobile device. STAM by[38], STAM by [39] and Almere model by[40] were analysed and different factors adopted for our research(Table 3)

Table 2. Existing generic guidelines of mobile development and guidelines from a developing country context

Factor	Principle	Detailed guideline	Definition
Physical	*Feedback* [37]	1. Key Buttons should provide for clear tactile when pressed i.e. Tactile design for mobile apps (*haptic feedback*). 2. Application Sounds 3. Speech output	To alert an elderly person that there is an action selected on the mobile device
	Visibility [36]	1. Minimize reliance on text 2. Use clear fonts, simple and clear 3. Use clear and larger buttons with both icons and text 4. Use simple graphics 5. Reduce number of features available at any given time	Ability of an elderly person to be able to view the mobile device screen comfortably so as to undertake an action
	Complexity [36], [37]	1. Simplified menu structures to avoid nesting 2. Avoid scrolling bar 3. Keep screen simple and limit number of tasks 4. Avoid complex interaction styles 5. Linear navigation better than branched, hierarchical structures.	Ability of the elderly to successfully carry out a task using the mobile device
	Cultural [36]	1. Use real life metaphors to explain foreign concepts 2. Use familiar language 3. Use culturally relevant icons 4. Prefer realistic cartoons for representing pictorial content	Ability of the elderly to relate with the features displayed by the mobile device as its their everyday custom
	Recognition [37]	1. Design for simplicity and few elements on the mobile device 2. For memory use recognize option other than recall 3. Shorter output messages 4. Establish appropriate level of challenge	Ability of the elderly person to cognitively engage with the mobile device to accomplish a task.
	Safety [37]	1. Large emergency button in a prominent place (programmable function) 2. Alarm and reminder functions (such as wake-up and medication)	Ability of an elderly person to easily seek assistance to do a particular task. The degree to which an elderly person can use technology to interact more efficiently and safely (ergonomics)

Table 3. Factors adopted for heuristic development

Model	Construct (s)	Definition
STAM [38]	Social Influence	The ability of an elderly person to engage (connect) with family, peers and friends through technology. The degree to which the elderly person is satisfied with personal relationships and support from friends and family
The Almere Model [40]	Perceived enjoyment	The ability of an elderly person to enjoy the interaction with the technology
STAM [39]	Perceived Usefulness	The degree to which an elderly person believes that using the particular technology will improve his/her quality of life
	Perceived Ease of Use	The extent to which an elderly person believes that using a technology is free of effort
	Attitude	The individual positive or negative feelings or appraisal about using technology,
	Cognitive abilities	The degree to which the elderly person engages their memory in thinking, learning and concentration

3.3 Pre-research

Scholars [36] [37] [41] guidelines are successful factors to be considered in creating technology for the elderly in Kenya as it considers both the physical and psychological factors.

These guidelines though have not modelled the main factor that brings a sense of belonging/self-worth to the elderly person. The self-worth factor for an elderly person is when they can feel their worth to the society they live in, rather than being viewed as a burden. The elderly people were a source of wisdom, dealt with community/family feuds and gave historical stories which were keenly listened to and followed by the younger generations. The grey hair earned them respect and also their importance to the society was felt.

Thematic analysis was performed on the qualitative data so as to identify the key issues under the physical and psychological factors that were affecting the elderly people in using a technology. The identified issues were grouped in themes as presented herein; The physical factors were obtained through interviews and observation of usage of mobile phone. The psychological factors were obtained through interviews and observation.

- Visibility: Respondents who were using their phones (majority are using feature phones) complained of the device being too small therefore the font and the icons not visible because of their eye problems.
- Complexity: The respondents complained of the nested layering of the mobile services. For example, (i) to make a phone call, scrolling down to phone book to select a name and make a phone call was an uneasy task for them. (ii) Difficulties in engaging with social sites such as WhatsApp for communication purposes yet they enjoyed the connectivity especially video chatting. (iii) The games available were fast paced and timed therefore they did not feel it’s worth their time. One of the elderly men preferred a physical boardgame than a computer boardgame because of the timing aspect and not being a multi-player game (displeased playing against the computer as there is no human emotions evoked)
- Self-worth (Actualization): The self-worth is when the elderly person can share and he/she is able to be intellectually engaged. This way he/she feels that he can give either a historical account or even sound advice especially on morality in ways to associate with everyone in the society who are in their different stages of life. They expressed their concern on how the younger generation is not upholding culture that used to view them as honourable men and women in the society. They also stated that they did not feel the sense of belonging in the today society as they are not involved in matters arising to give their wise inputs as they might have experienced it before.

Towards developing new heuristic guidelines, this research proposes to blend the psychological needs to technology where the geriatric persons can use the technology through a retro perspective to engage socially and cognitively with the society around them. The existing heuristics, the factors from technology adoption models and the prestudy findings are blended in proposing factors to consider when developing heuristics guidelines for an interactive geriatric interface that includes the physical and psychological factors (Table 4).

Table 4. Proposed guidelines for the new heuristic guidelines for a mobile geriatric interactive interface

Category	Guidance and Factor	Derived from
Geriatric Interface Factors (Physical)	Exploration (Easy Reversal of Action)	Schneiderman's golden rules; Nielsen's heuristics; Norman's principles
	Feedback	ESMAC; Schneiderman's golden rules
	Visibility	HCI guidelines for developing countries; Nielsen's heuristics; ESMAC
	Complexity	HCI guidelines for developing countries; Norman's principles; ESMAC
	Recognition	Schneiderman's golden rules; Nielsen's heuristics
	Localization	HCI guidelines for developing countries; Nielsen's heuristics; ESMAC
	Safety	ESMAC and Touch-Based mobile heuristics for elderly people
Individual factors (Psychological)		
	Social Influence	STAM by Renaud & Biljon; Almere Model; STAM by Chen & Chan
	Perceived Enjoyment	Almere Model
	PU (Need of usage)	STAM by Renaud & Biljon; STAM by Chen & Chan
	PEOU	Almere Model; STAM by Chen & Chan
	Attitude	Almere Model; STAM by Chen & Chan,
	Cognitive capabilities	STAM by Chen & Chan
	Self-Worth (Actualization)	Pre-research

4 Conclusions

Heuristics evaluation of technology usage for special groups such as the disabled and the elderly people has enabled them to appreciate technology in their daily living by engaging them socially and intellectually (cognitive growth). The acceptance and adoption of technology has seen these special groups enjoy their life even in their sedentary stage. Unfortunately, developing countries like Kenya adopt a design for all which is not catering for the needs of these special groups. Therefore, this paper bringing forth the significance of this research in two folds (1) *To show the need of heuristic guidelines that are contextualizing the needs of the elderly people in a developing country setup* (2) *To propose the design guidelines that will later on in a different study be measured and validated by geriatric persons in developing countries in developing a heuristic evaluation tool.*

From the study, the geriatric persons that participated showed great need of technology that will not only look at how they can use technology but also how they can share and feel the sense of belonging and self-worth through technology (psychological design). The geriatric people have a wealth of knowledge through experience that will benefit a younger generation. This sharing through technology will give them the poise/respect that they once had but unfortunately took a nosedive because of the widening gap between the young generation and the graying population.

Contextualizing the needs of the elderly people in developing countries, especially in Kenya, will enable tackling the quick decline in physical and psychological health that leads to a lonely sedentary lifestyle. This research has been able to establish the psychological factor that needs to be blended with other physical factors to ensure that the future design of mobile geriatric interactive designs will be accepted and adopted as it addresses the underlying needs of the graying population in a developing country, more so in Kenya.

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Fortitudo Telemedicine - A Tool to Mitigate the Healthcare Deficits in a Developing Country? A Work in Progress

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Background and purpose: A critical decrease in the number of healthcare providers in developing countries is one of the major impediments to healthcare access. Factors contributing to the lack of healthcare providers include low doctor-to-population ratio, emigration of doctors, long travel distances to hospitals, an increasing cost of healthcare, and a concentration of doctors in urban cities. The objective of this pilot study is to share our experience and outcomes of the role of telemedicine in a developing country as a possible adjunct to traditional care.
Methods: We set up an electronic medical record system, OpenMRS, with added telemedicine modules. We recruited and vetted doctors. Patient-initiated consult requests received via website and SMS were then entered into OpenMRS. Doctors contacted patients for diagnosing, requesting further diagnostics, requesting specialist consults and/or sending prescriptions to patients via SMS.
Results: In the first year, there were 510 new patient registrations and 572 total consultations. Patient age ranged from less than one year to 77 years, with a median of 29 years. Among the users of the service, 51.8% (264) were female. 52.2% of patient requests were web requests, the remaining were via SMS. We received over 50 reviews via our web/social media sites – all were positive.
Conclusions: Telemedicine is a good adjunct that helps doctors reach their patients, especially in rural areas where there is a shortage of healthcare professionals. Furthermore, we believe our experiences provide an excellent model for replication in other locations. All of our software is publicly available as open source.

Keywords: Telemedicine; Africa; Healthcare; OpenMRS; Fortitudo

5 Introduction

A critical decrease in the number of healthcare providers in developing countries is one of the major burdens to healthcare access in those countries. This deficit is most severe in Africa which holds 11% of the world's population [1]. Many factors contribute to the lack of healthcare providers, including low doctor-to-population ratio [2], emigration of doctors to other countries [2], long travel distances to hospitals [3], increasing cost of healthcare, and concentration of doctors in more urban cities [1]. Africa has only 2.3 healthcare workers per 1000 population, in contrast to most developed countries, e.g., the United States which has 24.8 healthcare workers per 1000 population [2]. The shortage of healthcare workers in developing countries undoubtedly contributes to poor healthcare outcomes and widespread disease burden, ultimately resulting in decreased life expectancy and quality of life [4]. There have been several measures taken by both governmental and non-governmental organizations in those countries to mitigate this crisis with varying outcomes. Like the problem itself, the solution is multifaceted and will involve both political and economic commitment to healthcare in those countries. In settings where the

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distance between healthcare providers and patients impede quality or access to care, it has been suggested that telemedicine can potentially be a useful tool in bridging that gap [5].

There are several challenges involved in the setup and operation of the telemedicine service in developing countries. Some of these challenges include the lack and cost of infrastructure, the lack of collaboration between physicians and information technology personnel, as well as legal and policy barriers [6]. In this study, our objective is to share our experience and outcomes for this pilot project with the role of telemedicine in a developing country as a possible adjunct to traditional care. We evaluated patient predisposition to the use of telemedicine, patient experience, and some challenges involved in the use of telemedicine in this setting. Beyond this study, we will continue to collect and analyze more data on patient experience to further validate our results over a longer period.

6 Materials and methods

We set up an electronic medical record system, OpenMRS, on a secure and encrypted cloud server and added telemedicine modules to the system, mainly consisting of a consult list where patients awaiting consultations are posted. Then, we recruited doctors and gave them privileges on OpenMRS after careful vetting of credentials. Doctors and ancillary staff were then trained via video demonstrations on how to use the system. They were trained on how to write consult notes, send electronic diagnostic requests, e.g., labs, X-ray, etc. to patients, and how to send electronic prescriptions to patients directly from OpenMRS. Finally, we set up a website, www.fortitudotelemed.com, through which patients were able to request telemedicine consultations. In addition, patients who may not have been tech-savvy or who may have preferred to request a consult through other means, we registered a telephone number in Nigeria; these patients were able to request consultations via SMS using this registered number. After requests were received, we entered patient information on a consult list on OpenMRS. Finally, if necessary, patients were able to submit pictures (e.g. dermatologic concerns) or other documents including laboratory and radiologic results. This extra information was then uploaded to the patients' record where doctors viewed it.

Doctors logged in periodically or received notification on a secure group chat where they checked for patients awaiting consults. They called patients (on a first-come-first-served basis[1]), diagnosed, requested further diagnostics, and/or sent prescriptions to patients via secure SMS from OpenMRS. When treating doctors needed a specialist perspective on a patient, doctors also requested a physician-to-physician consult with a specialist associated with the project Connecting Kids with Care (CKC) [7]. Our OpenMRS system interoperates with CKC to facilitate prompt physician-to-physician consultations for patients who need a specialist – these volunteer specialists are based in the U.S. Figure 1 provides an overall viewpoint of the aforementioned flow.

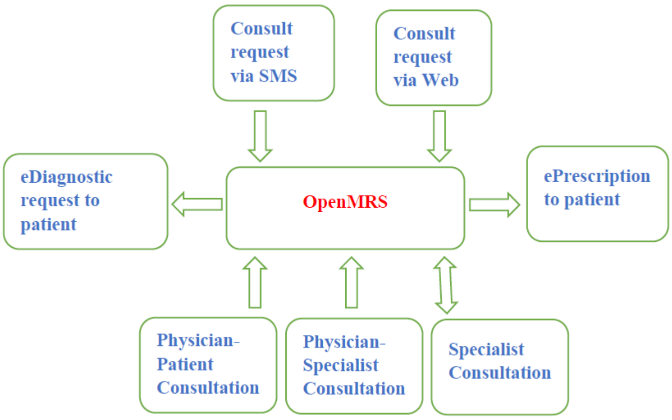

Figure 1. Schematic of operational flow of Fortitudo Telemedicine

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[1] Patients can select specific doctors, as well as selected health specialties.

After a consultation was complete and the patient received ePrescription and/or diagnostic requests, patients then took the SMS requests/prescriptions to their pharmacy, or laboratory/diagnostic center to obtain medications or further testing respectively.

7 Results

We collected data on the utilization of the telemedicine service in the first year from May 2018 to May 2019. A consolidated breakdown of our data is presented in Table 1. Over this time period, there were 510 new patient registrations and 572 telemedicine consultations. Patients' age ranged from less than 1 year to 77 years, with a median age of 29 years (mean age 30.8 years). The gender data of the 510 newly registered patients included 51.8% (264) female and 48.2% (246) male. The rate of repeat consultations was 10.8% [(572-510)/572 * 100%] and did not appear to differ much between male versus female patients (30 vs 32). The peak age group of users was 21-30 years, which constituted 46.5% (237) of all users. Among users, 52.2% (266) requested a consult via our website while 47.8% (244) requested a consult via mobile SMS. There is a slight difference in gender among patients who used the website to request a consult with 52.3% (139) male and 47.7% (127) female. Most website users (72.8%) preferred to get service from any available doctor, as opposed to 27.2% who indicated they preferred a specific doctor. To get an indication of physician responsiveness, we measured time-to-complete charting. The median time to chart for all patients was 102 minutes. Among all registered patients, only 1.1% (6) were unreachable by telephone.

Table 1. Demographics and utilization of telemedicine service (weighted sample), N = 510

Variable (N = 510)	Number (%)
Ages (<1 to 77yrs; Median 29yrs; Mean 30.8yrs)	
Age: 0-10	20 (3.9%)
Age: 11-20	35 (6.7%)
Age: 21-30	237 (46.5%)
Age: 31-40	142 (27.8%)
Age: 41-50	45 (8.8%)
Age: 51-60	17 (3.3%)
Age: 61-70	11 (2.2%)
Age: 71-80	3 (0.59%)
Sex	
Female	264 (51.8%)
Male	246 (48.2%)
Medium of consult request (N = 572)	
Via Website	298 (52.2%)
Via SMS	274 (47.8%)
Prescription and Diagnostic requests (N = 572)	
Electronic prescriptions sent	464 (81.2%)
Request for further diagnostics sent	312 (54.7%)

We also analyzed the cost involved in running our telemedicine service. In the first year of service, the total cost of providing 572 consultations was \$3,537.09, bringing the overall cost per consult to \$6.18. This overall cost included the cost of initial infrastructure setup, company registration, and other miscellaneous costs. The month-to-month "running cost" (excluding initial setup costs and after expenditure stabilization) averaged $3.31 per consult. Figure 2 provides the trend of overall consults, expenses and cost per consult since the start of service.

Table 2 provides the overall expenditure broken down by type, which includes the physician/clerk cost (amount paid to doctors and the clerk for providing consultations). The advertisement cost includes the cost of advertisement for the service on social media, SMS campaigns, and printing and distribution of flyers. Finally, the technology cost includes the cost of the OpenMRS host server, along with the website and domain purchase/maintenance.

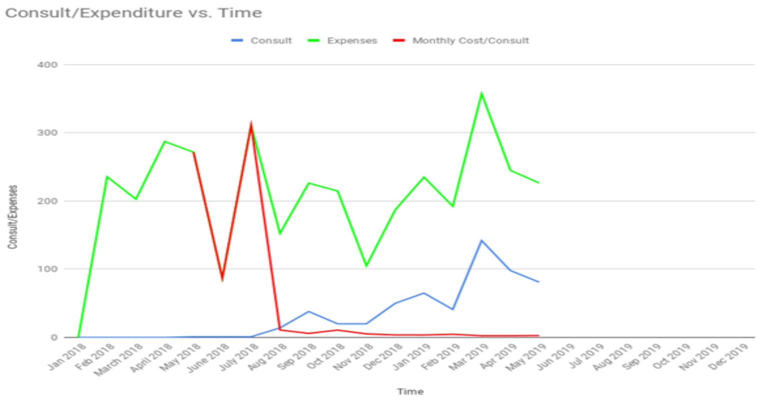

Figure 2. Trend of cost, expenses and cost/consult

The majority of the cost was used for advertisement (41.5%), followed by Technology (36%) and Physician/Clerk (22.5%). Most of the consults (85.1%) were done by paid physicians while non-paid, volunteer physicians, completed the rest of the consults (14.9%).

Table 2. Breakdown of expenditure by type and doctors who completed consults by type

Expenditure and Doctors	Cost (% of total cost)
Expenses	**$3,537.09**
Physician/Clerk cost Advertisement cost Technology	$ 795.3 (22.5%) $1468.01 (41.5%) $1273.7 (36%)
Consult by Doctor Types (N = 572)	
Paid doctors in Nigeria: Non-paid Volunteer doctors Abroad	482 (85.1%) 84 (14.9%)

8 Discussion

Telemedicine service is a relatively new concept in most developing countries and could potentially be a great adjunctive tool to bridge the gap in healthcare access in developing countries. From our experience, it seems patients are open to receiving care via telemedicine. Though we are yet to compare the efficacy of telemedicine to traditional service, we suspect telemedicine may provide more access due to the relatively fast service and the associated convenience to patients. In the first year of service, Fortitudo telemedicine provided 572 consults to 510 newly registered patients. Most users were in the 21-40 age group and there was no gender predilection among users. Patients requested consults via our website, www.fortitudotelemed.com, or via SMS text messages to a local phone number. There was not much distinguishing preference among users for web request versus SMS request. Among patients who provided feedback, 100% reported having a positive experience with the service.

There were several challenges involved in the setup and operation of the service. The telemedicine service has been provided at no cost to the patients resulting in a significant skepticism among patients pertaining to the authenticity of the service. This skepticism initially discouraged patients from use of the service, but later improved as patients started receiving service and were reassured of the service's authenticity. Other challenges included the cost of setting up this service. A significant portion of the cost involved technology expenses, including setting up and maintaining a secure server for OpenMRS, the cost involved in social media advertisement for the service, and the cost of website and domain management. There was also an immense amount of time and skill required to program the telemedicine modules in OpenMRS2.

From a physician's perspective, there was a great deal of positive feedback, as involvement of physicians in the service is flexible and compatible with their work schedule. They were also able to follow up with their clinic patients via telemedicine, especially patients who would have had difficulty attending a follow-up visit in clinic due to distance or other extraneous factors. Another challenge involved clinical presentations which could not be adequately served through telemedicine, as is the case for most medical emergencies. Those patients were referred to the nearest hospital. We maintain a list of local hospitals on our website to help patients locate the nearest hospital in cases of emergencies. Finally, among doctors who provided service, paid doctors provided most of the consultations as compared to unpaid volunteer diaspora doctors. This raised concerns for long term financial sustainability of the project as patients currently receive service free-of-charge.

9 Conclusion

In summary, telemedicine could be a helpful tool to improve healthcare in developing countries as it has the potential to improve healthcare access, provide more rapid service, decrease cost and travel compared to traditional service. Preliminary data suggest that patients are open to this model but further data will be needed to validate our experience. We believe our experiences provide an excellent model for replication in other locations. We are providing all of our software as freely available open source.

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[2] The ongoing time requirement, spread out over several months for technological commitment, was about 4 hours per month.

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The effect of knowledge sharing on team effectiveness within neonatal intensive care units through the lens of clinical leadership

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Background and Purpose: This is a research in progress which falls within a larger project aimed at implementation of neurodevelopmental supportive care in the neonatal intensive care units. The study seeks to extend the frontier of knowledge management by addressing the paucity of literature on leadership and knowledge sharing on the effectiveness of team-based care among clinicians in the neonatal intensive care units in private and public hospitals in South Africa. The organization and exchange of knowledge resources by healthcare leaders is critical for the provision of safe and high-quality care for pre-term babies. Therefore, it is necessary to study the impact of leadership practices on knowledge sharing in the neonatal intensive care units. This study seeks to investigate the influence of clinical leadership practices on knowledge sharing among clinicians in the neonatal intensive care units and how it simultaneously improves effectiveness of team-based care.
Methods: Underpinned by knowledge-based theory and Kouzes and Posner leadership practices model, this study employs a pre-test/post-test research design with mixed method approach. Data will be collected from participating hospitals in South Africa. Statistical package for social science software (SPSS) will be used to analyse quantitative data while content analysis will be used to analyse qualitative data.
Conclusions: The output from the research is expected to provide a useful contribution to the domain of literature in knowledge management and clinical leadership in healthcare from the context of South Africa. Moreover, this study will also provide awareness to healthcare institutions by exploring the dynamics of knowledge sharing and clinical leadership in an integrated framework to capture impact of interactions of the nature of knowledge on neonatal care; assist administrators, health policy makers and hospital management to exploit and make effective use of knowledge-based resources to enhance patient care which can improve the productivity of health care organizations.

Keywords: Clinical leadership, Knowledge, Neonatal care, South Africa

1 Introduction

The emergence of the knowledge-based economy has placed an emphasis on knowledge as a tool for performance in organizations [1]. Thus, it is imperative for knowledge to be harnessed, managed, and maximised for improved productivity [2]. In the context of healthcare sector, healthcare institutions such as hospitals are considered as knowledge-based organization due to the high production of knowledge. It is therefore crucial to maximise the exploitation of knowledge capital effectively given the responsibility of patient care improvement and patient safety. Healthcare organisations are gradually utilising knowledge management strategies to achieve organisational goals [3]. Despite the increasing importance of knowledge management capabilities, knowledge sharing is considered the most crucial and valuable strategic asset for influencing organizational actions [4]. Recently, knowledge sharing has generated considerable interest in healthcare due to its capability to deliver strategic results relating to effectiveness,

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efficiency and capacity enhancement [5]. Existing literature has acknowledged numerous factors of knowledge sharing in organizations. Among these factors, the influence of various leadership practices on the knowledge sharing behaviour of followers has frequently been examined [6]. Applying the concept of leadership in healthcare may provide insight into the ways in which leadership can influence patient outcomes. Research has shown that the poor clinical leadership and under-utilization of knowledge resources results in poor quality of care and dissatisfied patients. Interventions for exploiting knowledge sharing in clinical settings have received substantial interest in existing literature. In healthcare delivery, clinical decision making is still problematic and continues to be perceived as a top-down and authoritative process despite a move towards interdisciplinary team working [7].

The neonatal intensive care unit (NICU) is a complex adaptive healthcare system with a fast-paced care environment that provides long-term care for infants who are born of low birth weight and are particularly vulnerable to medical errors and high-risk situations. The need for improvement in the provision of neonatal care services is a concern in South Africa and challenges to implement good practice in the NICU are immense with the development of new interventions that can improve outcomes for the babies [8]. From the view point of existing literature, this necessitates among many other factors, efficient leadership [9], the efficient utilization of knowledge resources [10] and active knowledge sharing [11]. Extant literature highlighted that effective leadership is linked to patient outcomes through indirect impact on reduction of mortality rates [12] and knowledge exchange is among the important elements of effective and successful health care outcomes. Thus, knowledge sharing within an interdisciplinary team in the NICU is crucial for achieving shared goals of patient outcomes. In this scenario, the healthcare professionals in the NICU must have abilities that guarantee technical and evidence-based practice in the care given to the neonates. Lubber and Kenner [13] revealed that preterm infants are reliant on public and private health care for a long period of time due the risks associated with immaturity. Thus, renewed and consistent efforts are required for cohesive team dynamics among the medical teams are required to provide quality care for the preterm babies in the NICU [14] and maximally utilizing knowledge resources for improved health outcomes in the NICU.

Extant literature revealed that no comprehensive study has been carried out in the South African context that integrates the aspect clinical leadership practices and knowledge sharing capabilities of the medical team in the NICU and how it affects team effectiveness in the provision of quality of care of preterm babies. It is against this background that this study was conceived. Therefore, this study attempts to broaden the frontier of knowledge, by addressing the dearth of literature on clinical leadership practices on knowledge sharing in the NICU and how it simultaneously improves effectiveness of medical teams in neonatal care in public and private hospitals in South Africa.

2 Theoretical framework and Hypotheses

The theoretical foundation of this study is underpinned by the concepts from knowledge-based theory and Kouzes and Posner's leadership model. The proposed research model depicts the relationships between the variables of study and are discussed in the subsequent paragraphs.

2.1 Kouzes and Posner's leadership model

Kouzes and Posner developed a model of leadership called leadership challenge model that consists five practices of exemplary leadership. These practices are modelling the way; inspiring a shared vision, challenging the process, enabling others to act and encouraging the heart [15]. The first practice, modeling the way reflects how exemplary leaders model the way in their organizations by clarifying their values and setting the example through daily actions that demonstrate that they are deeply committed to their beliefs. The second practice, inspiring a shared vision combines leadership values and visions with the followers' visions and dreams. According to [16], in order to inspire a shared vision, leaders must first envision exciting and enabling possibilities and enlist followers in a common vision. A shared vision that serves the interests of followers and leaders, as well as the organizations 'interests, will increase and sustain the commitment of followers over time [16]. The third practice, challenging the process reflects how leaders search for opportunities and look for innovative ways to improve the organizations by experimenting and taking risks. And because leaders know that risk taking involves mistakes and failures they accept the inevitable disappointments as learning opportunities. Enabling others to act which is the fourth dimension reflects how leaders foster collaboration, build spirited teams by actively involving others and strive to create an atmosphere of trust and human dignity. Finally encouraging the heart, the first practice of exemplary leaders reflects how leaders celebrate accomplishments and recognizes contribution that each individual makes. Leaders also knows that in every winning team, the members need to share in the rewards of their efforts [16].

2.2 Knowledge-based view theory

The knowledge-based view of the firm which is an extension of resource-based view of the firm (RBV) considers knowledge as the most strategically significant resource of the firm [17]. Knowledge is considered the most important strategic resource since superior knowledge owned by organisations can be used to create innovative ideas and new ways of providing superior value of goods and services to customers ([18]; [19]). Knowledge is embedded and carried through multiple entities including organisational culture and identity, policies, routines, documents, systems, and employees. As a result, the capacity to create, convert, apply and share knowledge can lead to the creation of sustained superior performance [17], because it has value, is a unique creation, and therefore is difficult to imitate [20]. Grant [17] noted that "the success of the KBV can be attributed to the fact that it extends beyond the traditional concerns of strategic management to address other fundamental concerns of the theory of the firm, notably the nature of coordination, organisational structure, the role of management and the allocation of decision-making rights, determinants of firm boundaries, and the theory of innovation".

2.3 Leadership, knowledge sharing and team effectiveness

As noted by [16], exemplary leaders are a salient source for emulation and observation because of the virtue of their status and their attractive personal traits. Thus, followers are expected to have a greater tendency to engage in knowledge sharing behaviour under a right supervision and knowledge must be accurately communicated [21]. Knowledge sharing among team members results in improved team performance such as improved decision making, better problem solving and enhanced creativity ([22]; [23]). According to [24], the coaching behaviour of an empowering leader includes encouraging team members to solve problems together, thereby providing them with opportunities to share their knowledge. Knowledge sharing has long been viewed as one of the most important components of knowledge management. Therefore, maximizing the value of knowledge is important for leaders for improved healthcare performance [25].

The effectiveness of team members is impacted by varying exchange of knowledge, ideas, views and expertise in teams and depends on the quality of communications among team members ([26]; [27]). Therefore, the factor of knowledge sharing is considered crucial to team performance [28] and has become an important area of research [29]. Knowledge sharing is one of the precarious team processes which is the fundamental component of knowledge management [30]. The viability and effectiveness of knowledge sharing is exceptionally reliant on the behaviour of the members of the team, for example, members' passionate insight, their way of interaction within team mechanisms, collaboration, and their insight application to the ultimate mission of the organization [31]. Exchange of knowledge between health care professionals' increases team members' awareness of each other's' skills and expertise, leading to continued improvement in decision-making and efficient patient care [21]. Complex and time-critical tasks in the ICU require interdisciplinary teams to integrate and combine different areas of expertise in a complementary, rapid and sequential manner during task execution. It is well documented that effective decision making in ICU teams impacts patient outcomes [32].

The specialization and the fragmentation of individual operations requires more team work among different specialists in the NICU. Coordinating these processes, demands for leaders who know themselves and their teams, who know how to prioritize and work with people and also timely resolution and intervention of conflicts in the unit [33]. In the NICU, decision-making skills, an integral characteristic of clinical leadership is crucial for the coordination and management of care. Moreover, effective clinical leadership has been linked to a wide range of functions: it is a requirement of hospital care, including system performance, achievement of health reform objectives, timely care delivery, system integrity and efficiency, and is an integral component of the health care system ([34]; [35]).

Therefore, healthcare organizations must continue to develop and support effective leadership strategies while also seeking ways of maintaining and promoting leadership development in practice [36]. Team leadership is crucial for team effectiveness and facilitate the development of shared objectives, oversee decision making processes and guide the team to reach their synergistic potential, whereby the collective effort surpasses the sum of individual contributions. Previous evidence has highlighted the importance of effective team leadership on patient outcomes in the ICU [32]. Thus, the study sought to test the following hypotheses:

H_1: Clinical leadership practices positively influence knowledge sharing capability

H_2: Knowledge sharing capability has a significant positive influence on team effectiveness

H_3: Clinical leadership practices positively influence team effectiveness

H_4: The relationship between leadership practices and knowledge sharing positively influences team effectiveness.

Figure 1 displays the proposed research model.

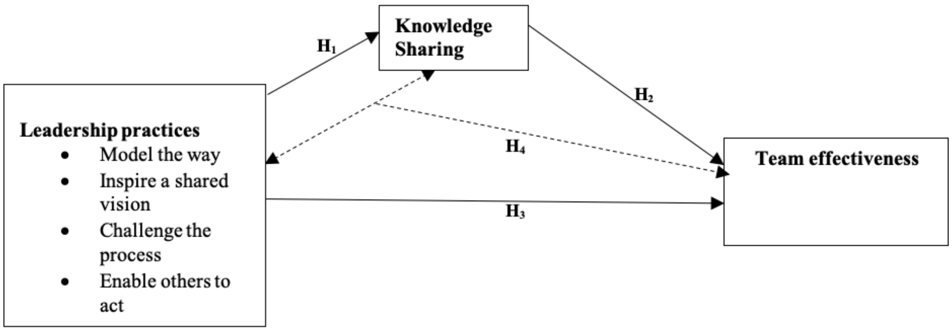

Figure 1. Research model

3 Methods

Creswell [38] underlined that research methodology provides a generic framework to describe the philosophical positions and rational that underpinned the inquiry.

3.1 Research paradigm

The pragmatic research paradigm is the philosophical underpinning for this study. Pragmatism applies a practical approach, integrating different perspectives to help collect and interpret data. The pragmatic approach allows the use of both qualitative and quantitative research methodologies to collect information and make inquiry into complex phenomenon of social and natural contexts [38]. The pragmatic paradigm will be utilized as the philosophical orientation of this study to address the research objectives which require the collection of quantitative and qualitative data.

3.2 Research design and approach

The study will utilize pre-test/post-test design with mixed methods approach to explore the relationships of clinical leadership, knowledge sharing and team effectiveness in the NICU.

3.3 Population and Sampling

The population of this study consist of clinicians in the neonatal care units in both private and public hospitals in South Africa. Purposive sampling will be applied in the selection of respondents from the participating neonatal intensive care units.

3.4 Data collection procedure

The research instruments which will be used for the collection of data in the study are; (i) the Leadership Practices Inventory (LPI) questionnaire (II) the knowledge sharing questionnaire; (III) team effectiveness questionnaire and (IV) focus group interview schedule. Validation studies of the tools has been conducted to confirm their reliability and validity. The reliabilities for the LPI, team effectiveness and knowledge sharing questionnaires as measured by Cronbach alpha coefficients, are consistently strong, and above this criterion, 0.80. Internal reliability for these tools has also been found to be quite robust across a very wide range of sample populations. A pilot study will be carried out in this research to test, validate and refine the focus group interview schedule in order to identify any problems that the respondents might face in understanding the questions and to reduce inaccuracies and inconsistencies in the interview schedules.

3.5 Operationalization of Measures

Leadership practices. Leadership practices will be assessed using the Kouzes and Posner leadership practice inventory (LPI) tool by [39]. Participants data will be used to analyse the leadership practices of their supervisors. Each statement is evaluated on a ten-point Likert-scale. A higher value represents more frequent use of a leadership behavior. The anchors for the scale include: (1) Almost never do what is described in the statement; (2) Rarely; (3) Seldom; (4) Once in a while: (5) Occasionally; (6) Sometimes; (7) Fairly Often; (8) Usually; (9) Very Frequently; and (10) Almost always do what is described in the statement. Sample items are "I challenge people to try out new and innovative ways to do their work "and "I build consensus around a common set of values for running our organization ".

Knowledge-sharing. The four-item scale proposed by [40] will be used to measure individual perceptions of the extent of knowledge sharing by team members**,** Statements were made on a 5-point Likert-type scale (1 = *strongly disagree* to 5 = *strongly agree*). Sample items are "People in our team share their special knowledge and expertise with one another," and "More knowledgeable team members freely provide other members with hard-to-find knowledge or specialized skills."

Team effectiveness. Team effectiveness will be assessed by using the team effectiveness diagnostic tool developed [41]. Statements were made on a 5-point Likert-type scale (1 = *strongly disagree* to 5 = *strongly agree*). Sample items are "Team problem solving results in effective solutions" and "Our team has mechanisms in place to monitor its result".

3.6 Data analysis

Analysis of Moment Structures (AMOS) version 22 using statistical package for social sciences (SPSS) will be employed for the analysis of the quantitative data using descriptive statistics such as percentages and frequency for the demographic data and statistical techniques such as structural equation modelling (SEM) to answer the research questions and hypotheses. Qualitative data will be subjected to content analysis.

4 Conclusions

The framework of this study is developed based on extant literature. This study is expected to contribute to the body of literature on leadership and knowledge management in neonatal care by addressing the paucity of research by investigating the relationship of leadership practices and knowledge sharing among healthcare professionals in the neonatal intensive care units and the impact of team effectiveness in South African hospitals. Moreover, this study will also provide practical inputs to healthcare organizations by exploring the dynamics of knowledge sharing and clinical leadership practices in an integrated framework to capture the impact of interactions of the nature of knowledge on neonatal care. Consequently, the expected findings could provide useful and practical guidelines for healthcare professionals in the NICU to realize the potential values of knowledge resources in improving healthcare delivery. The results from this study may serve as a baseline for future research and contribute to the existing body of literature in neonatal care in the South African environment.

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Utility of an Electronic Adverse Drug Reaction Reporting System in Uganda: Design and Validation

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Background and Purpose: Adverse drug reactions (ADRs) are a major health problem, which impose profound morbidity, mortality and financial burden on patients and health systems. Uganda`s ADR monitoring is paper-based, and faces challenges including delayed report delivery, and errors in transcription. Although electronic reporting systems are associated with timely report delivery and good report completeness, their implementation is still limited in the East African Region. Using the user requirements including capturing data in the respective fields of the national ADR form, capacity to acknowledge receipt of submitted ADRs, ensuring privacy and data confidentiality, and capacity to generate summary trend reports, this study aimed to develop and validate an electronic ADR reporting system for Uganda.

Methods: We followed the design science methodology to develop and validate the electronic ADR system that was used to develop and validate the system.

Results: The electronic ADR reporting system met all its functional requirements and users found it useful for ADR in Uganda. Particularly the system was capable of capturing all minimum events data, reporter feedback, analysis, and trending of reported data to guide decisions on drug safety.

Conclusions: Electronic ADR reporting systems are a viable means of addressing the challenges of convectional drug safety monitoring systems. From our study, it is evident that such systems have utility to enhance timely reporting in Uganda and other similar resources limited settings; as well as potentially support analysis of reported data to support decision-making about the safety of medicines.

Keywords: Adverse Drug Reaction (ADR); Pharmacovigilance; Electronic ADR reporting system

1 Introduction

Adverse drug reactions (ADRs) are a major health problem estimated to be the fourth leading cause of death in the USA, and accounting for an average of 10% of hospital admissions globally [1]. Their financial burden on hospital budgets is estimated at 15% [2]. In Uganda, almost half (49.5%) of all hospitalised patients are prone to experiencing an ADR [3]. Healthcare systems rely on reporting of suspected adverse drug reactions (ADRs) by health workers, to detect and avert drug related adverse reactions [4], [5]. The effectiveness of surveillance systems for early detection of drug-mediated harm relies greatly on the timeliness of the reported case information [6], [7].

According to the National Drug Authority Annual Pharmacovigilance Report for July 2015 – June 2016, Uganda`s paper based voluntary surveillance system is afflicted by delayed reporting. This delayed report delivery curtails efforts for early detection or detection at all, and identification drug adverse effects [8]. Legal interventions mandating health workers to report ADRs within given timelines have not had a positive impact on timely reporting, not only in Uganda but also in other countries where they have been passed [9]. Alternative methods of data collection including longitudinal observational studies and surveys have been adopted to generate complete and timely drug safety information. However, the

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increasing resources and expertise they require have limited their influence [10]. The positive impact precedence of IT solutions in other sectors of health has several countries exploring electronic solutions [11], [12]. Data mining from linked drug or disease registries, logic algorithms that detect and flag potential associations between drug and patient clinical events are growing in use in the developed world [13], [14]. The lack of such databases in Africa and data standards for interoperability and linkage between them continues to limit adoption of these useful methods of drug safety surveillance [15].

In trying to address the challenge of delayed reporting in resource limited settings, its vital at this time to explore ways of leveraging on the existing systems and infrastructure of drug surveillance that exert least financial, and technical burden. Accordingly, this study proposed and explored the utility and acceptability of an electronic ADR reporting system that allows reporters to submit ADR reports directly to the NPC as a solution to the challenge of delayed report transmission in Uganda`s pharmacovigilance reporting system.

2 Materials and methods

We used design science methodology, which is an approach to research in information systems that aim to design and evaluate artifacts to solve an identified problem [17]. This methodology follows a set of six iterative activities of i) problem identification; ii) definition of objectives for a solution; iii) design and development; iv) demonstration; v) evaluation; and vi) communication [18]. The scope of this study was limited to the definition of objectives for a solution, through documentation of functional requirements, and the development and validation of the electronic ADR reporting system. To develop the electronic ADR reporting system, an instance of the open source application DHIS2 was developed to incorporate the system user requirements. This application is based on a java scripting language for its logic and SQL for its databases. The Medra terminology was procured and incorporated into the system. This was to allow uniform and unambiguous coding of reported adverse drug reactions. We acquired an Internet domain and hosted the system online. The electronic ADR reporting system was validated on its usefulness and acceptability in selected health facilities in Uganda.

Rationale for using DHIS2: The DHIS2 system is open source with flexibility to allow users to define their content, and add new modules based on need without the need for programing. This flexibility combined with pre-existing implementation in Uganda in tracking other health data would make incorporation into the existing national reporting framework easy and less resource intensive. According to its official site, DHIS2 is built to facilitate easy interoperability based on universal standards like HL7. the would make any efforts of system linkage easier.

Approach to system validation: Routinely, system validation encompasses assessment of usefulness (in line with identified functionalities), usability, and usage over time. To achieve the study objectives, our validation approach encompassed the first two attributes, but since the system was used for a limited time, the third attribute was not assessed. Usefulness was assessed to determine the extent to which the system met the identified system functional requirements, whilst usability on the extent of user satisfaction with ease of use, error recovery, responsiveness, and similar usability parameters.

3 Functional requirements and design models for the electronic reporting system

From the responses, during requirements gathering, we deduce that it was imperative to capture ADR reports based on data elements in the national reporting form. National forms contain all data elements that are necessary to enable the causality assessment of a reported case using clinical evidence [6]. According to the European Medicines Agency (EMA), the minimum criteria for a valid report should include; at least one identifiable reporter, one single identifiable patient, at least one suspect adverse reaction and at least one suspect medicinal product.

Submitted ADR reports were noted to contain patient medical histories and information, which mandated measures to assure confidentiality. According to the “Uganda National guidelines on detection and reporting of ADRs”, the transmission of the paper forms from reporter to the NPC may go through several hands from the regional focal persons to district assistant drug inspectors, NDA regional officers, then to the NPC. This does not adequately assure confidentiality. Electronic transfer of the forms presents a viable solution to this challenge.

It was essential for health facilities to perform aggregate data analysis of the reports submitted for purposes of assessing the ADR-drug relationship. This causality assessment can be carried out by a number of stakeholders including clinicians, academia, regulators and industry. At the clinician level its relevant to make decisions about patient therapy [16]. The availability of the proposed system was also identified as a key necessary capability. Although reporters indicated that they retain carbon copies of all reports submitted, there is no clear provision for aggregate report analysis at the facility level.

As described by the respondents, reporting during actual patient care was difficult and the possibility to report even outside on-going care would be useful. Adverse drug event documentation depends on the availability of the paper form. The electronic system would allow health workers to report at any point from anywhere.

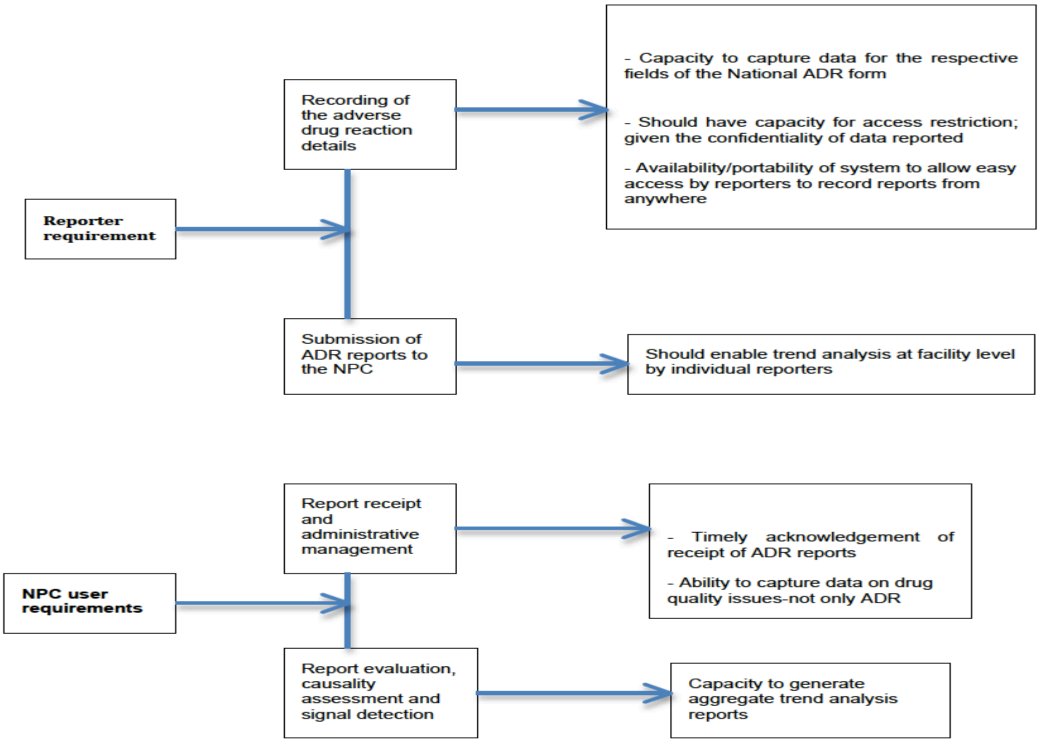


Figure 1. Summary of functional requirements

Acknowledgment of receipt of ADR reports to the reporter was identified as an important functionality for the proposed system. Pharmacovigilance centers are expected to give informed acknowledgement of receipt to the submitting health care worker [6]. It is also a measure of the center`s responsiveness, and low feedback rates dampen health worker reporting morale [6]. The "Uganda National annual pharmacovigilance report-2017" cited low levels of reporting among healthcare providers. This electronic ADR reporting system functionality would improve reporter morale and reporting levels.

Capacity for data analysis and trending at the NPC (regulator) was identified as key system functionality. Regulatory agencies perform this function to identify risk signals and facilitate decisions on the risk-benefit balance of the drugs [16]. Ability to detect risk signals underscores the relevance of the pharmacovigilance system to ensure medicine safety [6]. There was a system and form for reporting product quality concerns; and the capacity of the proposed system to capture these reports was identified to be vital. In line with these observations, a summary of the identified electronic ADR reporting system functional requirements is presented above.

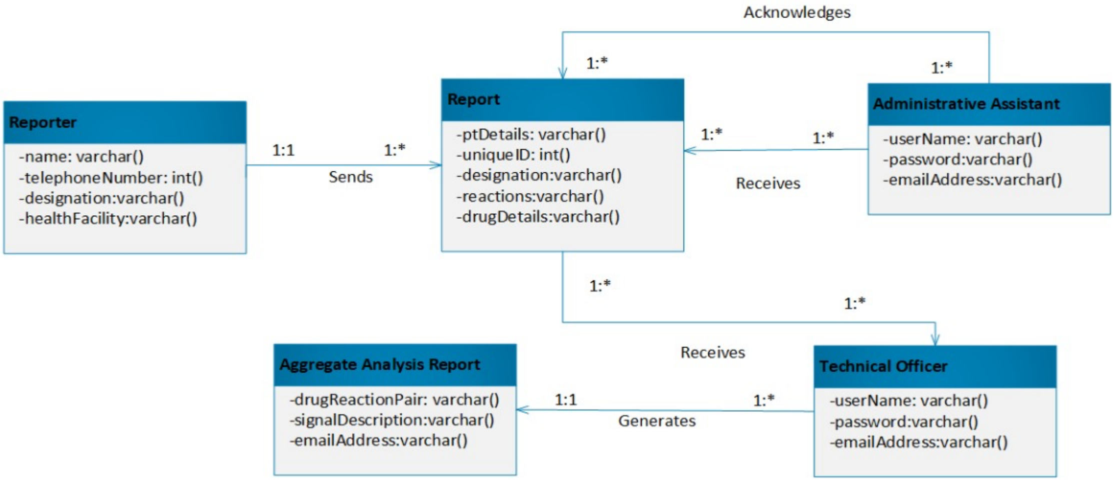
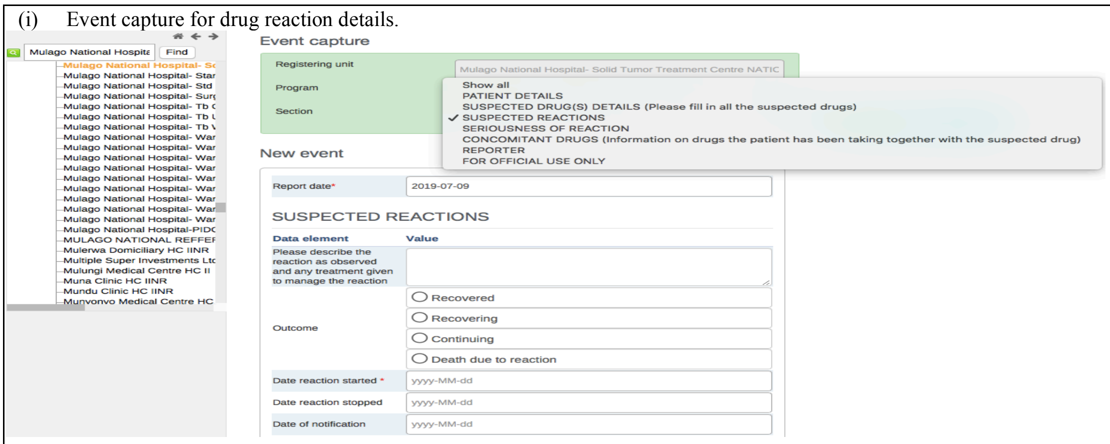


Figure 2. Illustration of the class diagrams that guided the system design

4 Results

(i) Event capture for drug reaction details.



Event capture

Registering unit: Mulago National Hospital- Solid Tumor Treatment Centre NATIC
Program
Section

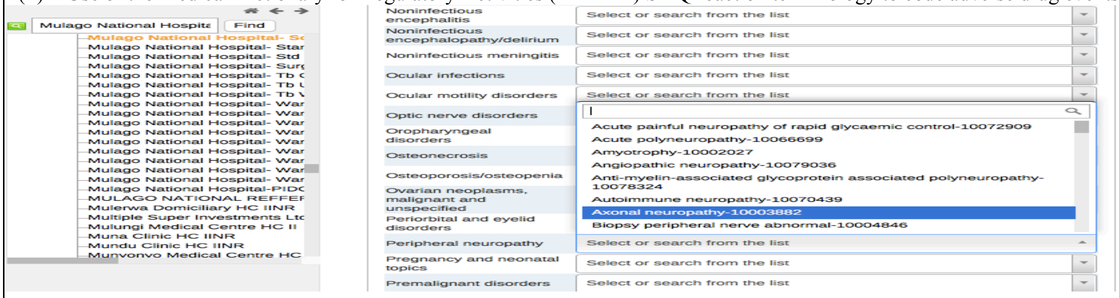
New event

Report date*: 2019-07-09

SUSPECTED REACTIONS

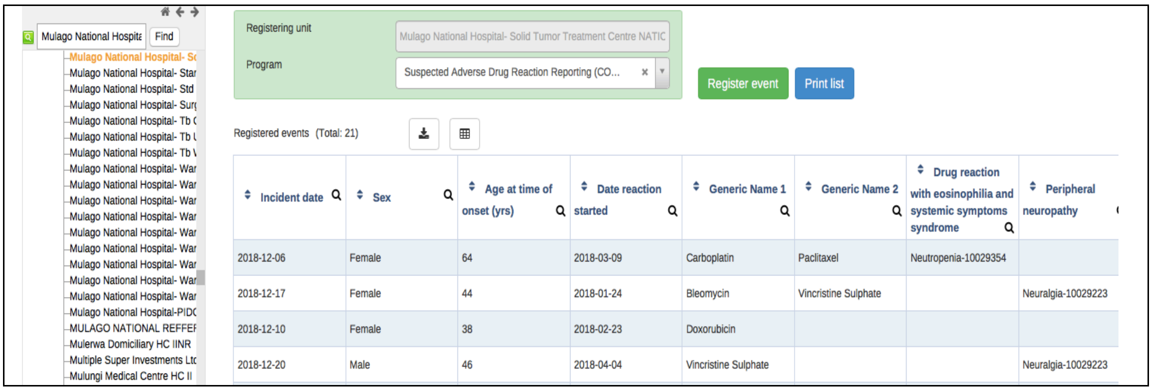
Data element	Value
Please describe the reaction as observed and any treatment given to manage the reaction	
Outcome	○ Recovered ○ Recovering ○ Continuing ○ Death due to reaction
Date reaction started *	yyyy-MM-dd
Date reaction stopped	yyyy-MM-dd
Date of notification	yyyy-MM-dd

(ii) Use of the Medical Dictionary for Regulatory Activities (MEDRA) SMQ reaction terminology to code adverse drug events



Noninfectious encephalitis	Select or search from the list
Noninfectious encephalopathy/delirium	Select or search from the list
Noninfectious meningitis	Select or search from the list
Ocular infections	Select or search from the list
Ocular motility disorders	Select or search from the list
Optic nerve disorders	
Oropharyngeal disorders	
Osteonecrosis	
Osteoporosis/osteopenia	
Ovarian neoplasms, malignant and unspecified	
Periorbital and eyelid disorders	
Peripheral neuropathy	Select or search from the list
Pregnancy and neonatal topics	Select or search from the list
Premalignant disorders	Select or search from the list

(iii) Line listing of adverse drug events reported in the database



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Mulago National Hospital- War
Mulago National Hospital-PIDC
MULAGO NATIONAL REFFEF
Mulerwa Domiciliary HC IINR
Multiple Super Investments Ltc
Mulungi Medical Centre HC II

Registering unit: Mulago National Hospital- Solid Tumor Treatment Centre NATIC

Program: Suspected Adverse Drug Reaction Reporting (CO...

Registered events (Total: 21)

Incident date	Sex	Age at time of onset (yrs)	Date reaction started	Generic Name 1	Generic Name 2	Drug reaction with eosinophilia and systemic symptoms syndrome	Peripheral neuropathy
2018-12-06	Female	64	2018-03-09	Carboplatin	Paclitaxel	Neutropenia-10029354	
2018-12-17	Female	44	2018-01-24	Bleomycin	Vincristine Sulphate		Neuralgia-10029223
2018-12-10	Female	38	2018-02-23	Doxorubicin			
2018-12-20	Male	46	2018-04-04	Vincristine Sulphate			Neuralgia-10029223

Figure 3. Screen shots for the electronic ADR reporting system

1.1 Electronic ADR reporting system verification

Verification of the electronic reporting system was done in order to check if the developed system prototype adequately met the design specifications as documented in the design models (i.e. "if the system was built right"). We exposed the system to dry run simulations using six dummy reports to verify performance at: "report filling and submission", "report receipt and acknowledgement", "report assessment and MeDRA coding", and "generation of summary trend reports. Results of the system verification process indicated that the system prototype adequately met the design specifications as documented in the design models. All the verification steps showed positive results according to the model specifications. Observations of each verification procedure are shown in table 1 below.

Table 1. Steps carried out and results of the system verification process

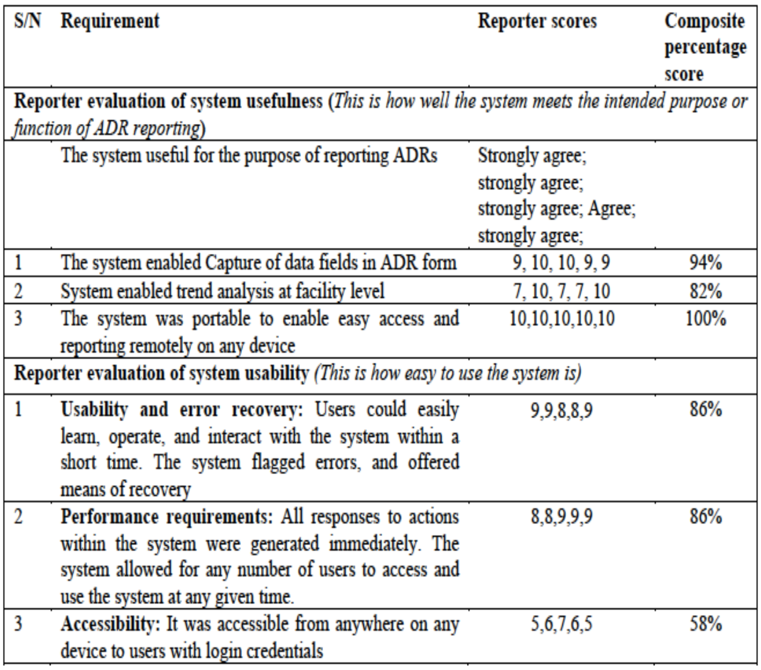
Design process	Verification Assessment Procedures	Result
Report filling and submission	**Security login:** – Attempted login with wrong and correct credentials **Data capture form verification:** – Opened and completed the form with dummy ADR report details **Report saving and submission verification:** – Half of entered reports were submitted directly and others saved for completion later. Saved reports re-accessed and submitted **Log out:** – Logged out of the system by selecting the log out option	**Security login:** – Access only granted with correct login credentials **Data capture form verification:** – Data capture form had all required fields, in the right data format for respective fields **Report saving and submission verification:** – All submitted reports appeared on the submitted list, had all entered details on reopening – Saved reports were accessible on reopening; allowed further completion and submission **Log out:** – Exited the system upon selecting the log out option
Report receipt and acknowledgement	**Security login:** – Attempted login with wrong and correct credentials **Opening and acknowledging reports:** – Accessed list of submitted reports; open each report individually and sent an acknowledgement message to respective reporter. – Opened report account to verify messages **Log out** – Logged out of the system by selecting the log out option	**Security login:** – Access only granted with correct login credentials **Opening and acknowledging reports:** – All acknowledgement messages sent against each report were available in the reporter account **Log out:** – Exited the system upon selecting the log out option
Report assessment and MeDRA coding	– A MeDRA term was selected from the list of terms for each report – Presence of Coded Medra terms were verified on the list of reports	– All coded terms were displayed with the respective reports
Generation of summary trend reports.	– The trend analysis option was selected – Tabular and graphical summary reports, were generated by selecting different report parameters; E.g. suspected generic name, reaction, etc.	– Trend summary reports were generated including the selected attributes on each instance.

1.2 Electronic ADR reporting system validation

The electronic ADR reporting system was validated on its usefulness and acceptability in selected health facilities in Uganda. In this research context, we defined usefulness as the "ability of the system to meet functional requirements by at least 50%", while acceptability is defined as the "ability of the system to be scored as useful for ADR reporting and at least 50% in the usability evaluation by more than half of the respondents". A total of five health workers at Uganda cancer institute (chosen due to the higher risk of ADRs among patients on cancer chemotherapy [19] and availability of IT infrastructure) and three technical staff of Uganda National Authority-NDA (the national ADR coordinating center) were pre-trained on the system before using it for a period of two months from December 2018 to January 2019. At the end of this period, users evaluated the system using a questionnaire, with provision for comments and narrative. The system users evaluated the system based on the predefined functional and non-functional requirements, and usefulness. There was a maximum satisfaction score of 10 (ten) for each system attribute evaluated. From the total participants in each category; health worker (5), and, NDA (3), each attribute had a maximum possible score of 50 or 30 points respectively. To derive the actual percentage satisfaction score, the actual points score was divided by 50 or 30 points for each attribute as the denominator and multiplied by 100%.

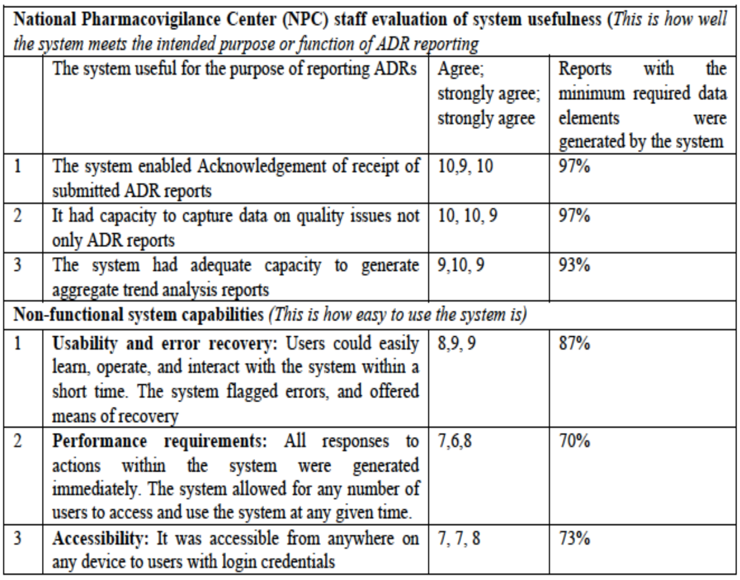
Validating results in Table 2 and Table 3 respectively showed that overall there was a 100% response from all reporter participants (two doctors and three nurses) and NDA staff (all pharmacists) . All respondents found the system to be useful for the purpose of ADR reporting. On the functional requirements, reporters remarked that the system adequately captured the relevant reporting information, enabled trend analysis of facility level data, and offered adequate user restriction through password login requirement. Health workers remarked that the system`s capacity for report trend analysis at the facility level was useful for drug safety decisions at the hospital level, and made the reporting efforts more relevant to them. Respondents from NDA noted that the arrangement of reaction terms made it difficult to find the required terms corresponding to the reported reactions.

Table 2. Results of system evaluation by reporters



S/N	Requirement	Reporter scores	Composite percentage score
Reporter evaluation of system usefulness (*This is how well the system meets the intended purpose or function of ADR reporting*)			
	The system useful for the purpose of reporting ADRs	Strongly agree; strongly agree; strongly agree; Agree; strongly agree;	
1	The system enabled Capture of data fields in ADR form	9, 10, 10, 9, 9	94%
2	System enabled trend analysis at facility level	7, 10, 7, 7, 10	82%
3	The system was portable to enable easy access and reporting remotely on any device	10,10,10,10,10	100%
Reporter evaluation of system usability (*This is how easy to use the system is)*			
1	**Usability and error recovery:** Users could easily learn, operate, and interact with the system within a short time. The system flagged errors, and offered means of recovery	9,9,8,8,9	86%
2	**Performance requirements:** All responses to actions within the system were generated immediately. The system allowed for any number of users to access and use the system at any given time.	8,8,9,9,9	86%
3	**Accessibility:** It was accessible from anywhere on any device to users with login credentials	5,6,7,6,5	58%

Table 3. Results of the system evaluation by National Pharmacovigilance staff



National Pharmacovigilance Center (NPC) staff evaluation of system usefulness (*This is how well the system meets the intended purpose or function of ADR reporting*			
	The system useful for the purpose of reporting ADRs	Agree; strongly agree; strongly agree	Reports with the minimum required data elements were generated by the system
1	The system enabled Acknowledgement of receipt of submitted ADR reports	10,9, 10	97%
2	It had capacity to capture data on quality issues not only ADR reports	10, 10, 9	97%
3	The system had adequate capacity to generate aggregate trend analysis reports	9,10, 9	93%
Non-functional system capabilities (*This is how easy to use the system is)*			
1	**Usability and error recovery:** Users could easily learn, operate, and interact with the system within a short time. The system flagged errors, and offered means of recovery	8,9, 9	87%
2	**Performance requirements:** All responses to actions within the system were generated immediately. The system allowed for any number of users to access and use the system at any given time.	7,6,8	70%
3	**Accessibility:** It was accessible from anywhere on any device to users with login credentials	7, 7, 8	73%

On the non-functional requirements, reporters and NDA staff indicated that the system was easy to learn with few attempts and to use with a few user steps. There were prompts for errors that helped with error recovery and more accurate report completion. System accessibility didn't satisfy reporters and NDA staff due to Internet disruptions on some days. This also affected system response times.

Overall, 21 reports were submitted to the database. Neutropenia and anaemia were the most reported events with doxorubicin, and cisplatin, followed by oral sores with bleomycin. Vincristine and paclitaxel mediated neuralgia was also reported. A review of the Ugandan ADR reports in the global database showed that no report had ever been submitted regarding these known toxic products.

5 Discussion

The electronic ADR reporting system validation aimed to establish the assessment of user satisfaction, that is, if the pro-type performed what it was designed to do in respect to the identified functional and non-functional requirements. We deduced from the responses that the electronic system was useful in reporting ADR incidents. Similar systems have demonstrated the capacity to increase the number of ADRs reported to the national drug surveillance system, with automatic form filling and easier ADR report analysis [20].

Results showed that users were strongly satisfied with the system with regards to its functional requirements across reporter and NDA respondents, albeit with limitations in the performance attributes. User satisfaction is recognized as a key factor that contributes to the success and adoption of information systems [21], [22]. Factors known to influence user satisfaction include user involvement, perceived usefulness and perceived ease of use [23]. Respondents positively appraised the usefulness of the system to report ADRs and requirements gathering with extensive user involvement during system verification boosted user satisfaction. It's therefore reasonable to expect positive user acceptance and adoption of such a reporting system in Uganda. Limitations observed in system performance attributes due to Internet interruptions have to be addressed by any efforts to scale up such a system in Uganda.

Last but not least, it's reasonable to explore the benefits that open source software-based systems like our prototype would present in resource-limited settings like Uganda. Such systems have registered good user acceptance in some African countries already and are a potential approach for developing systems that are easily adaptable, and with minimal resources [24].

Electronic ADR reporting systems are a viable means of addressing the challenges of convectional drug safety monitoring systems. From our study, it is evident that electronic ADR reporting systems be useful tools to enhance timeliness reporting in Uganda and other similar resource limited settings. Additionally, such systems can potentially support the analysis of reported data to support decision-making about the safety of medicines. With the adoption of the openMRS in the Uganda health system, it is reasonable to explore the possibility to incorporate an ADR reporting module in this national system.

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Strengthening Government capacity for routine immunization data management using the GEEKS Approach in Nigeria

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1 Background

A centralized health management information system is the bedrock of a country's health service delivery [1-2]. In Nigeria, the routine immunization (RI) modular dashboard was introduced on the District Health Information System, version 2 (DHIS2) platform in 2017. Its goal was to report indicators of RI performance from all 37 states. Staff from the National Stop Transmission of Polio (NSTOP) managed most of the day-to-day operations related to DHIS2 implementation. As more states report their data through the RI Module, the Government became concerned over its excessive reliance on partners to provide effective data management and analysis services. Government professionals need to be equipped with relevant skills to manage and use robust health information systems, data systems, and Information Communication Technology (ICT) infrastructures in a sustainable manner to promote health and well-being of people in countries, including Nigeria [2]. The new strategic plan of Government of Nigeria requires that all public health informatics and data management capacities around DHIS2 be moved to the Department of Planning, Research and Statistics of Nigeria's National Primary Health Care Development Agency (PRS-NPHCDA), and that reliance on partner organization be reduced to a minimum [3].

To achieve this, NSTOP staff proposed to transfer key DHIS2 capacity elements to PRS-NPHCDA data managers assigned to the DHIS2 unit. The framework for this capacity building project was the Growing Expertise in E-health Knowledge and Skills (GEEKS) fellowship, which was developed by the US Centers for Disease Control and Prevention (CDC) [4]. The project for this fellowship aimed at creating a one-on-one close collaboration between a PRS-NPHCDA staffer and one NSTOP staffer. The purpose was to develop the technical capacity of PRS-NPHCDA staff around the operations of the DHIS2 RI Module. A secondary objective was to support the subnational levels, using feedback mechanisms and mentorship to improve the performance of the RI program at the state and local levels. The end goal is for PRS-NPHCDA staff to conduct 80% of DHIS2 daily operations by April 2020, with only limited technical support from NSTOP or other partners. A joint NPHCDA-NSTOP team was admitted to this one-year GEEKS fellowship in April 2019. This presentation describes the activities put in place to achieve the stated objectives, and presents the preliminary results obtained in the first six months of implementation.

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2 Methods

2.1 Staff selection for the fellowship

Participants include six officers from PRS-NPHCDA, and seven staffers from NSTOP. The staff from NPHCDA were selected based on skillsets and position within the agency. NSTOP data mangers were selected based on their expertise around the operations of the DHIS2 Module and their participation in the implementation of the RI module in all states. The pairs were formed based on the responsibilities of the PRS-NPHCDA staffer within DHIS2 operations, and the corresponding expertise of the NSTOP staffer. In addition, the project included a supervisory team formed by one staffer from Nigeria Centre of Disease Control (NCDC, the sponsoring agency for GEEKS in Nigeria), one team lead from PRS-NPHCDA, one team lead from NSTOP, and one GEEKS supervisor responsible for the day-to-day implementation of the fellowship's activities. One CDC Epidemiologist provides strategic and operational guidance remotely. This team provides leadership and coordination to the project.

2.2 Project definition

Capacity transfer on such a large project as the DHIS2 RI Module requires additional sub-division in order to address the individual components of the RI Module. The PRS-NPHCDA and NSTOP team was divided into four groups, each with a specific area of capacity transfer and individual specific objectives, timeline, action tracker and indicators. These areas are:

1. Strengthen RI data analysis and use for decision-making and action at all levels of the NPHCDA system
2. Monitor the implementation of the DHIS2 RI module in the post-transition states
3. Enhance RI data accuracy and completeness at all levels
4. Manage and routinely update all back-end programming for DHIS2

2.3 Training

CDC conducted a 5-day on-boarding training in Lagos, Nigeria to introduce the informatics and educational concepts upon which the GEEKS fellowship is based. The first three days were dedicated to in-class training and team-building activities to learn public health informatics problem solving skills. During the last two days, each group developed a master work plan for its sub-project, in order to design its activities, milestones and objectives for the one-year fellowship.

2.4 Operations

Operations divided themselves in two categories. First, to strengthen the technical capacity of PRS-NPHCDA officers, the NSTOP staffers offered periodic one-on-one mentorship sessions on the most frequent tasks for RI data analysis and interpretation, as well as for DHIS2 back-end programming. Second, to strengthen the feedback loop to subnational officers, the PRS-NPHCDA and NSTOP staffers provided comments and technical support to state-level officers on their RI monthly analyses and reports. Also, they supported the state officers to identify gaps in RI service performance and data quality, and helped address these issues. The strategies used included on-the-job training sessions, in-person or remote mentorship, webinars, and periodic communications to provide updates.

2.5 Monitoring and supervision

The GEEKS supervisor ensures that the work plans of each group are implemented systematically. He provides on-the-job training and mentorship to all groups, fosters coordination, and ensures a single, integrated communication channel between the national-level staffers and the state-level officers. The supervisor also provides one-on-one mentorship to the team lead of the DHIS2 unit within PRS-NPHCDA, so that supervisory skills can be integrated in the larger project. Each group submits a bi-monthly activity reports to ensure consistent progress and adherence to the work plan. The supervisor provides feedback, and verifies the implementation of all recommendations. He also organizes monthly and quarterly review meetings, where each group describes the progress accomplished to date as well as the challenges encountered.

3 Results

3.1 Capacity building at the national level

The main focus of the first three groups is to improve capacity in the areas of RI data management, analysis and interpretation. The NSTOP staffers offer one-on-one support multiple times per week to the PRS-NPHCDA on how to conduct these operations, and the GEEKS supervisor provides daily monitoring and mentorship on specific topics. Using Microsoft Excel, QGIS, DHIS2 pivot tables and SPSS, the groups analyse the variables specific to their sub-project and produce reports to identify gaps and errors. They conduct routine and ad hoc analyses, and interpret RI data results to provide concrete recommendations to state-level officers. In addition, they develop monthly reports to describe the performance of key indicators on reporting rates, vaccination coverage, RI sessions implemented, data quality, vaccine accountability, and supportive supervision. These reports are presented during national-level technical meetings, and are used to discuss possible interventions to strengthen RI performance at the subnational level. No preliminary results are available at this time, but the introduction of formal analyses plans and data-driven discussions at PRS-NPHCDA in already a considerable achievement.

The main focus of the fourth group was to provide hands-on server administration and configurations training, as well as DHIS2 back-end programing skills, to NPHCDA officers. Before this project, the agency had no expertise on DHIS2 programmatic management. Training sessions occur once per week, and focus on the most urgent requests as well as on routine maintenance activities. The development of in-house capacity in this area is an important milestone.

3.2 Feedback to the subnational level

The groups download RI data from the DHIS2 platform to conduct monthly deep-dive analyses on data completeness and accuracy. These results help identify performance issues in both vaccination coverage and data quality, and to summarize them in monthly feedback reports to states. Also, the groups monitor the implementation of these recommendations through tailored monitoring tools, tracking tools and the incoming RI data. Where an issue persists, the groups organize one-on-one phone calls to address the challenge. Measurable improvements are visible on the DHIS2 RI dashboard after six months of targeted support, especially in states that reported the most data quality issues at the start of the project. For example, the entry of data related to the antigens HBV1 and HBV2 (not included in the Nigeria immunization schedule) has steadily declined by 20% since April 2019 [5].

4 Conclusion

The GEEKS fellowship is an excellent framework to foster capacity transfer. Preliminary results suggest that PRS-NPHCDA officers are benefitting from the additional, targeted technical support, and that subnational officers are improving the performance of RI servies in their states thanks to the robust feedback loops. These reports show that the fellowship is on track to achieve its stated goals by April 2020.

Keywords: Capacity building (D057191), Information systems (D007256), Government (D006076), Fellowship (D005257)

Statement on conflicts of interest

There are no conflict of interest.

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Improving the quality of MNCH services through digital learning in Samburu County, Kenya

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1 Background:

Kenya has made significant strides in reduction of child mortality and improvement of maternal health under the Millennium Development Goals (MDGs) though failed to reach the MDG targets for maternal, new-born and child health (WHO, 2015). With the onset of the Sustainable Development Goals (SDGs) and the updated Global Strategy for Women's, Children's and Adolescent's Health (2016-2030) that aims to achieve the highest attainable standard of health for all new-borns, women, children and adolescents, more needs to be done to ensure the targets are met through well targeted investments tailored to the populations being reached.

Compared to the national average, the MNCH indicators in Samburu County are low; For example, 24.5% deliveries at the health facilities compared to 61% national average, 443/100,000 maternal death rates compared to 362/100,000 live births, 64% children fully immunized compared to nationals 75%. This has been greatly attributed to shortage of staff, skills gap, and low access to MNCH services among others.

2 Purpose

Samburu County, is characterized by shortage of staff with only 306 clinicians, serving a population 303,420 people (AWP 2019/2020) and distributed among 93 facilities posing a challenge in capacity building as the facilities have to be closed for a staff to participate in training.

This paper highlights best practice solutions aimed at:

- Ensuring clients receive continuous services and staff are empowered with right skills for quality management of MNCH cases
- Improving the quality of obstetric neonatal and child care
- Increasing access to vital knowledge and information for continuous learning and a reference point for emergencies
- Overcoming network and internet coverage barriers

3 Method

- Develop software for various digital learning platforms that contain various modules on maternal, new born and child health.
- Provide an accessible reference point during CME's and routine operations at the health facility

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4 Results

4.1 Immunization activities

https://play.google.com/store/apps/details?id=io.buildup.immunization
The application targets clinicians and health care managers and is a classical presentation of simple and clear information on immunization activities. This has been largely accessed and utilized throughout the county and the country especially due to the inclusion of updated immunization schedule, vaccine management and performance monitoring (immunization monitoring chart). In 2018, Samburu County emerged as the most improved county in Kenya on immunization services and this app has contributed to that achievement. Since development in September 2017, 1076 people have accessed and used this app.

4.2 Emonc Offline

https://play.google.com/store/apps/details?id=io.buildup.bemoncofflinerev
In Samburu, hemorrhage and birth asphyxia are the leading maternal and newborn complications respectively. The EmONC app has assisted HCWs in managements of maternal and newborn complications for example, in Muruangai Dispensary, a remote facility with no network coverage, a successful management of severe post-partum hemorrhage was done through a uterine balloon tamponade using this app. It was developed in August 2017and has reached 204 HCWs while BeMONC self-training online has been accessed by 190 HCWs.

4.3 Maternal and Perinatal Death Surveillance and Response

https://play.google.com/store/apps/details?id=io.buildup.mpdsrv1
MPDSRV1 is a reference tool for maternal and perinatal deaths with a step by step approach on issues related to maternal and perinatal death review and response. It gives a clear insight on how to handle maternal or perinatal death notification and identification, death reviews and audits at different levels of health care. The information has been adopted in Kenya following WHO recommendation. The app has been used in various occasions for example during a community maternal death review in Ltungai village in Samburu Central where a mother had died due to first delay. This app was launched on June 2018 and has been accessed by 132 HCWs.

4.4 Universal Health Coverage (UHC)

https://play.google.com/store/apps/details?id=appinventor.ai_jimshiz06.UHC
This app was designed to disseminate critical information about Universal health coverage powerful descriptions from various sources much of it from the World Health Organization. In Samburu, it has recently been adopted as a tool for continuous medical education to assist HCWs understand UHC and in turn sensitize communities on the same. It was launched in April 2019 and has been accessed by 132 people and used in 4 CMEs reaching 76 HCWs.

5 Conclusions

These applications have proved to be an effective and efficient as well as accessible and equitable way of reaching HCWs working in hard to reach areas with updated and relevant materials to improve their skills and quality of MNCH service provision. Through digital learning platforms, training costs have been reduced and clients are assured of receiving services. Cumulatively, 1468 HCW have been reached in a span of two years and there's a higher chance of increased number of users. To ensure this happens, there's need for intensive marketing and sharing.

Keywords
Digital learning, Universal Health Coverage, Maternal and child health, Capacity building.

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Evaluation of REDCap as an alternative data management and quality improvement tool for cutaneous lymphoma care in Botswana

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Background and Purpose: Cutaneous lymphomas (CLs) are a rare subtype of non-Hodgkins lymphoma, and patient information on this disease in Botswana is collected with paper forms, subject to inefficiencies.

Methods: In Botswana, we adapted, piloted and evaluated the mobile version of an online database (REDCap) at two main public dermatology services for one year. Pre and post evaluation approaches were used to determine themes on the perceived ideal data management tool and effectiveness of the new innovation. The Computer System Usability Questionnaire (CSUQ) was administered to healthcare workers using REDCap Mobile to measure satisfaction rates on system usefulness, as well as information and interface quality.

Results: 83% of participants used paper-based forms as the clinic data collection tool and of those, 80% expressed dissatisfaction with the paper-based approach. Emerging themes about an ideal clinic data management tool were security (100%) and ease of use (83%). After the evaluation period, the REDCap approach was the preferred tool with favourable overall rating (1.3/7.0), system usefulness (1.0/7.0), information quality (1.3/7.0), and interface quality scores (1.7/7.0) on the CSUQ, compared to the previous data management tools.

Conclusions: Complexities around the diagnosis and management of CLs necessitate an efficient patient data management system. Overall, the REDCap Mobile approach improved on the current data management approach used in Botswana. This new approach could enhance the quality of care and reduce healthcare costs by improving efficiency. The REDCap approach may similarly benefit patient care efforts for other complex medical diseases in other resource-limited settings.

Keywords: Cutaneous Lymphoma, REDCap Mobile, CSUQ, Botswana

1 Introduction

Cutaneous Lymphoma (CL) is a rare subtype of non-Hodgkins lymphoma that comprises a group of neoplastic lymphoproliferative disorders localized to the skin. CLs are classified by the type of abnormal immune cells present within the lesions, which are most commonly T lymphocytes or B lymphocytes [1]. Clinical course is variable, encompassing an array of malignant behaviour from life-long and indolent to metastatic and life-threatening. Data on the prevalence and management of CLs in sub-Saharan Africa is limited with only a few case reports and case series documented [2]. CL is difficult to diagnose and typically requires a number of diagnostic tests over time. Care is often co-managed between dermatology and oncology which can involve a number of different providers who need access to accurate and complete patient data. In addition, in Botswana, a significant amount of dermatology care is provided by rotating dermatology residents from the US and Canada, and this rapid turnover of providers creates an even greater need for unified and reliable data storage for these complex patients. Currently,

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documentation for the management of CLs patients in Botswana is conducted by the very limited dermatology and/or oncology healthcare workers available, and involves the use of paper-based forms, which are prone to inefficiencies [3], including non-uniform data structures, repetitive data capturing and security risks.

CLs management at dermatology clinics in Botswana involves the use of approximately 10 clinical forms recording repetitive patient data over time through clinical visits, thus resulting in longer duration spent doing clinical documentation. Moreover, there are limited effective tools for clinical data management. Both paper based and excel spreadsheet patient records exist at the Dermatology clinics in Botswana and due to visual inspection required in this specialty, clinical images are stored in a shared Google Drive folder on a cloud-based infrastructure. Current tools for CLs data management in Botswana offer non-unified clinical data capture workflows, with no de-identification options and lack of support for common data export formats. Clinical data analysis and reporting is a tedious process as it requires traversing numerous hard copy forms and pulling data from multiple sources for patient care and follow up.

Advancements in information and communications technologies (ICTs), offer alternative platforms for clinical data management [4]. One widely adopted Open Source platform is the Research Electronic Data Capture (REDCap) [5], offering a secure web-based platform for both online and offline data capture towards research studies and operational projects [5]. Having matured and tested over time across various settings, REDCap platform offers the user authentication mechanisms, in-built data quality checks, data logging and advanced encryption algorithms well suited for clinical data management and research [5]. REDCap Mobile application allows for data capture and storage even when there is no internet connectivity, and can later sync when connectivity becomes available [5]. REDCap Mobile approach to CLs data management and reporting has not been developed and evaluated in Botswana.

In view of the perceived benefits of REDCap online database and the need for improved approaches to CL data management, this study aims to evaluate REDCap Mobile approach to address many of the limitations of the mixed paper, excel and non-secure cloud based approach for CL data management in Botswana.

2 Materials and methods

2.1 Ethical Approval

This study received ethical approval from the Institutional Review Boards (IRB) at the University of Pennsylvania, the Health Research and Development Committee of the Republic of Botswana Ministry of Health and Wellness, the University of Botswana (UB), Princess Marina Hospital (PMH) Ethics Committee, and Nyangabwe Referral Hospital (NRH) Ethics Committee. Study participants received written informed consent for participation in the study.

2.2 Perceived Features of a Data Management Tool

In an effort to solicit participants view on an ideal tool for CL data management, we conducted a survey in which 12 local healthcare workers were purposively selected from dermatology clinics at PMH (10) and NRH (2). Selection of the 2 sites was informed by high volumes of Dermatology referral cases during the period of the study. Survey participants were comprised of a nurse (1), medical officers (3), physicians (2), medical residents (4) and research assistants (2). Participants were sent a link to the electronic survey created using REDCap. Following survey responses on a perceived ideal data management tool, analysis of themes emerging from the participants' responses was undertaken.

2.3 REDCap Approach

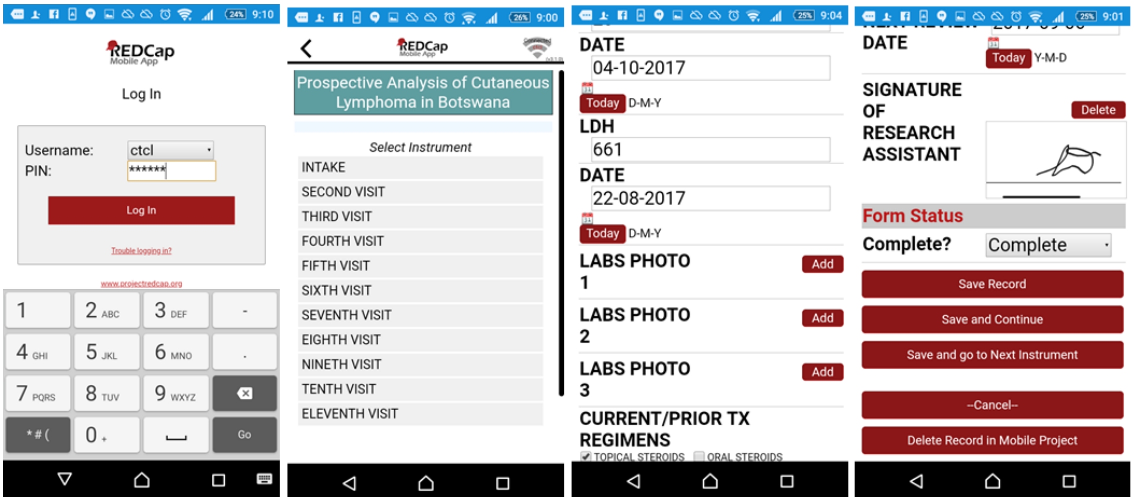
Following survey responses on a perceived ideal data management tool, we customized and piloted REDCap to host online forms for CL clinical data management across 2 public healthcare facilities (PMH and NRH) over a period of 1 year. During the implementation period, operational considerations were identified and addressed.

Prior to introducing the alternative data management platform on REDCap, two sensitization workshops were conducted at UB and NRH respectively. The workshops were targeted to healthcare workers working in the Dermatology clinic and taking part in the CL study.

The adoption of REDCap platform at these facilities did not eliminate the previous mixed data collection tools of paper, excel and cloud based data forms, rather, the 2 approaches worked in parallel to facilitate final evaluation based on the merits and detriments of each. Three healthcare workers actively utilized the REDCap platform to capture clinical data and all three took part in the post-REDCap evaluation survey.

2.4 REDCap Mobile App

The REDCap Mobile App was configured in Samsung Tablet devices SM-T211 supported by Android operating system and each clinician had a unique login credentials. The Samsung devices were password protected and encrypted with Transport Layer Security. The latter was also secured with Mobile Security (Lookout, Inc., San Francisco, CA, USA). If a mobile network or wireless Internet connection could not be established on the mobile phone/tablet or the server was down, users could store the data within the app until a later point in time. Figure 1 shows login menu and customized REDCap form for CL data collection.



Username: ctcl
PIN: ******

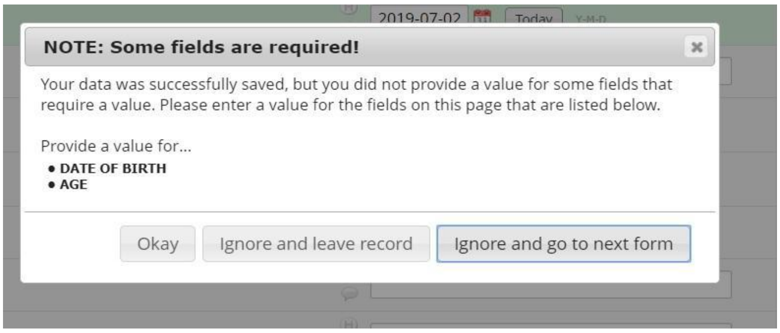
Prospective Analysis of Cutaneous Lymphoma in Botswana

DATE 04-10-2017 D-M-Y
LDH 661
DATE 22-08-2017 D-M-Y

Form Status
Complete? Complete

Figure 1. Screenshots of the mobile app - Login Menu and Customized REDCap Mobile Forms

The REDCap mobile app included corresponding fields to the paper forms used in the Dermatology clinics in Botswana (see the supplemental online appendix). If a field was left blank or completed with an illogical response (e.g., a letter value entered into a numerical field), the REDCap Mobile app displayed an error message (e.g., “Note: Some fields are required!”; see Figure 2).



NOTE: Some fields are required!

Your data was successfully saved, but you did not provide a value for some fields that require a value. Please enter a value for the fields on this page that are listed below.

Provide a value for...

- **DATE OF BIRTH**
- **AGE**

Figure 2. Error Message

In order to prevent the occurrence of missing data, users were prevented from accessing subsequent questions until preceding questions were answered in the proper format.

2.5 Post-REDCap evaluation survey

The Computer System Usability Questionnaire (CSUQ) was administered to the 3 healthcare workers who interacted with REDCap platform to evaluate satisfaction rates on system usefulness, information quality and interface quality. The fewer number of healthcare workers who participated is as a result of dermatology, oncology and specialty care in general being an extremely limited skill in Botswana and across Africa, with some countries having no local dermatology specialists. In Botswana, the number of dermatologists in the public sector has varied and at times has been zero. The CSUQ is a 19-item questionnaire designed to measure user satisfaction with system usability [6]. Respondents answer each question by selecting a score ranging from 1.0 (strongly agree) to 7.0 (strongly disagree) and elaborating on their selections with written comments. Scores are averaged to generate an overall rating and subscores for system usefulness, information quality, and interface quality. Lower scores indicate more favourable ratings, and higher scores indicate less favourable ratings. Scores for the CSUQ were averaged.

3 Results

3.1 Perceived Useful Features of a Clinic Data Management System

Following a survey to solicit healthcare workers' perception on an ideal clinic data management system, 6 (50%) out of the 12 participants completed the questionnaires, while the rest (50%) were partially completed surveys. Healthcare workers were asked to choose features they perceived important about a clinic data management system. Identified important features across all 6 respondents were Accessibility (4, 66.7%), Efficiency (3, 50.0%), Security (6, 100.0%), Ease of use (5, 83.3%).

3.2 Operational Considerations

Table 1 summarises the identified operational considerations which were addressed throughout the REDCap implementation period.

Table 1. Operational Considerations and how they were addressed

Need or Problem	Solution
Need for preventing theft or loss of mobile device	All users of devices signed an agreement to not use the mobile devices in public places. All devices were installed with software for easy tracking if lost/stolen.
Need for ensuring mobile devices are always fully charged at the start of each work day.	All devices were charged at the end of each work day.
Need to sync REDCap mobile app data to the REDCap database.	At the end of each clinic day data on REDCap mobile app collected offline was uploaded to the REDCap database server whenever WIFI connectivity was established.
Need to access REDCap online database for report generation and dissemination.	Access to the REDCap online database required internet connectivity and access privileges to generate reports and share with various stakeholders.
Need to allow for flexibility of uploading revised forms	Healthcare workers were given an authentication token of the revised forms and instructions on how to update old REDCap clinic forms.

3.3 User Satisfaction with Usability of the REDCap Approach

REDCap Mobile approach had favourable overall ratings (1.3/7.0), for system usefulness (1.0/7.0), for information quality (1.3/7.0), and interface quality (1.7/7.0). All less than 2.0 ranking according to the computer usability system questionnaire, hence a favourable rating.

Written comments provided by the two CL healthcare workers on the questionnaire indicated that REDCap Mobile approach was easy to use and simplified their work:

Positive aspects of the REDCap mobile approach included the following:

- “Easy to use”
- “It is user friendly”

Negative aspects of the REDCap mobile approach included the following:

- “Entering dates manually”

4 Discussion

Responses from the pre-REDCap implementation survey, indicated that security, efficiency, and accessibility were important features to be considered in a clinical data management system. Healthcare data is sensitive by nature, hence it is expected that healthcare workers be concerned about the security of such data. According to Ondienge and Clarke [7], patients also trust healthcare professionals to maintain the privacy and confidentiality of their healthcare data. According to the 8th Annual Industry Pulse Report, approximately half of the surveyed healthcare organisations in the study highlighted healthcare data privacy and security concerns as leading factors in why organizations were hesitant to adopt mobile and digital health tools [8]. Efficiency and ease of use were also identified as ideal features of a clinical data management system. These features could contribute to task performance satisfaction by the end user and may improve uptake and use of an innovation. Accessibility was also identified by approximately 67% of the participants. Accessibility in our case refers to the ability to access and use the system in either absence or presence of internet connectivity. In developing countries such as Botswana, internet connectivity can be erratic [4]. Lack of adequate technology infrastructure has also been noted as one factor affecting sustainable adoption of e-health technology in developing countries [9].

Implementation of the REDCap approach following healthcare workers perceived ideal features of a clinic data management system resulted in some operational issues that had to be addressed as outlined in table 1.

Notwithstanding the operational considerations that needed to be addressed, the REDCap approach was given favourable ratings by the participants according to the computer system usability questionnaire (CSUQ) used. Factors contributing to such favourable ratings could be that REDCap Mobile has a feature that allows for longitudinal data capture over time, and it allows for one unifying place for records to be kept, accessed, and updated which is especially useful for CL patients who may be taken care of by multiple providers between dermatology and oncology visits over the course of their disease. For this study, clinical visits for patients were scheduled and upon every follow-up visit, the status of the patient record was updated to either yellow (unverified) or green (complete). The color codes indicated the presence of incomplete and/or unverified records, signalling the need for specialist attention and endorsement. This feature in REDCap allows for data accuracy and quality assurance.

Some of the participants’ responses included that the system was “easy to use” as well as “user friendly”. Hence making REDCap a promising alternative solution for improved data management and quality improvement for cutaneous lymphoma clinical care in Botswana.

5 Limitations

Our study had the following limitations:

- The study consisted of a small number of patients and health care provider users due to the limited number of providers that are trained to care for CL in Botswana.

- Not all participants responded to the pre-REDCap survey. Responses that were received, however, gave an understanding of the clinic patient data management processes and healthcare workers' suggestions for improvement.
- This was a pilot-level study in which the REDCap approach was implemented and evaluated at two public healthcare facilities located in urban areas of Botswana. As a result, feedback obtained cannot be generalised to the opinion of all dermatology workers in Botswana, especially the private sector where majority of dermatology patients get their care.
- It is possible that the improved data quality observed with the online REDCap platform was due to the healthcare workers' preferences for the new approach and/or awareness that their performances would be evaluated (i.e., the Hawthorne effect). In order to account for these factors, no incentives were offered to the CL team members, and employment was not contingent on performance with either approach.

6 Future Work

This study was a pilot conducted at two public health facilities in Botswana on use of REDCap for clinic data management in dermatology and oncology. The study could be extended to solicit opinions from healthcare workers from private healthcare facilities to establish if REDCap is also a viable option in the private sector. Other future areas to be explored could be the use of patient tracking and appointment reminders on REDCap, and expansion of the current system to other complex dermatologic diseases in the public setting.

7 Conclusion

Healthcare service provision, especially when dealing with complex medical conditions such as CL in a resource-limited setting, necessitates a reliable, secure and user-friendly approach for storing patient information, tracking follow-up and generating accurate reports for strategic decision making. In this study, the REDCap Mobile app was utilized by healthcare workers to improve patient data management and reporting. The ability to securely collect patient data even when there was no connectivity was very relevant given Botswana's information communication technology (ICT) landscape. Built-in features for data quality checks in REDCap Mobile made it easy to validate data instruments prior to data collection and also during data transactions. User feedback following use of REDCap speaks to its acceptability in this study. Compared to the mixed paper, excel and non-secure cloud based approach, the REDCap Mobile approach could be efficient in capturing patient data with enhanced data security and quality. REDCap Mobile had favourable overall ratings of system usefulness, information quality, and interface quality scores on the CSUQ as assessed by our pilot group of CL healthcare workers in Botswana. As such REDCap has a potential to enhance the quality of patient care, hence alleviating health care costs due to better management of complications as well as reduction of morbidity and mortality. Further studies are needed to assess user satisfaction and long term acceptability of REDCap in a larger population of healthcare workers and for a variety of complex medical conditions.

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Statement on conflicts of interest

The authors declare that they have no competing interests.

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Use of Mobile Technology by Community Health Volunteers (Chvs) in Recruiting People Into a UHC Pilot Program. The Case of Nyeri County, Kenya

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1 Introduction

As part of the sustainable development goals, all UN member states agreed to work towards achieving Universal Health Coverage (UHC) by the year 2030. In Kenya, UHC was prioritized by the government and its piloting in 4 counties began in December 2018. All residents of the four counties were to be recruited into the program and an online Platform – MTIBA – was used.
The M-TIBA Application
The M-TIBA system – an Android based mobile application - was adopted to aid in the registration of persons into the UHC program. The application was used by CHVs to capture patient data and transmit them in real-time to the NHIF digital platform to which it was integrated. In Nyeri county, a total of 830,000 people was to be recruited. In 4 months, 85% of the population had been recruited. Below is an explanation of the M-TIBA application based on the mobile health (mHealth) evidence reporting and assessment (mERA) guidelines (Agarwal et al 2016).

2 Methods

2.1 Infrastructure

High availability of low-end Android smartphone (costing on average USD 40), and high mobile penetration of close to 100% (Communication Authority of Kenya 2018), we were able to roll out the agent application to the Community Health Workers involved in the registration process. Safaricom network with highest connectivity and customer base of 64.2% (CAK 2018), also came in handy as the network provider being one of the platform's partnering company.

2.2 Technology Platform

The system is developed on an Android application due to the operating system's large customer base and its customer friendly features with the backend in Java. No open source code was used to build the backend.
Interoperability/Health information systems (HIS) context: The NHIF provided endpoints to their database for integration purposes to enable real time registration and issuance of member numbers as well as addition of dependants. This also enabled the system to verify whether the member was already a registered and if this was the case the process would drop off after the socio-economic survey was completed.

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2.3 Intervention delivery

The system was able to send real time automated SMSs to notify the members on registration status upon completion and submission of the same> SMSs were sent on (1) completion of registration, (2) to prompt one to accept terms and conditions, and (3) whenever there was an addition of one's dependants.

2.4 Intervention content

Registration was a three-part process with Integrated Population Registration System (IPRS) validation being done the first, followed by the socio-economic survey and lastly the registration to the National Insurance Fund (If one is not already a member)

2.5 Usability/content testing

Pilot testing was conducted in 2 different counties over a 2-month period (Sep and Oct 2018) prior to engaging in the initial registration. This was also tested with other programmes running on the platform.

2.6 User feedback

From the pilot, we were able to learn and adjust accordingly which included: shortening the socio-economic survey as some members felt the questions were quite a lot, restructuring of questions perceived as intrusive, extension of the timeout period for the application users (CHWs), Mobile data costs were cut with the implementation of reverse billing. Meetings with County leadership also resulted in restructuring of the questionnaire to fit the region where non-communicable diseases were prevalent. We were also able to establish that we needed to track the registrations as they trickled to monitor the progress and change tact if need be. This was achieved by the creation of a real-time dashboard that would show the numbers as they trickled in.

2.7 Access of individual participants

Due to the need to capture all residents, the National Identification card was added as a unique identifier to complement the mobile number. Those without access to mobile phones could not receive SMS alerts. Technologically challenged CHWs had difficulties in registering people and had to be accompanied by youth from their respective community unit. Due to the stature of the verification process, the section of the population without identity card numbers and birth certificates for dependants could not be captured.

2.8 Cost assessment

Initially during the pilot testing phase, agents using the application incurred mobile data costs. This was dealt with by implementing reverse billing in conjunction the mobile service provider. The SMS notifications were zero-rated hence no costs to the member.

2.9 Adoption inputs/ programme entry

A 5-day training on how to use the application was held in groups of 100s in 5 different locations with each group receiving a full day training and a take-home manual. Social mobilization was implemented to notify the residents of the ongoing registration, advertisements were placed on local tv and radio stations. An official launch by the Health Cabinet Secretary was held to commence the registration

2.10 Limitations for delivery at scale

During registration, due to the increase in submissions per second there were downtimes and the server capacity had to be increased. Inter-reliability of the integrated systems i.e. the M-TIBA platform and the NHIF system meant that downtimes in any of the systems affected the registration.

2.11 Contextual adaptability

The application was used in three other different pilot counties where the populations were different, the socio-economic survey was different and programme rules were different. The programmes on the application were tailored to fit the needs of each of the counties.

2.12 Replicability

Being an Android application, it can be easily replicated in other settings and other programmes as android is a widely used operating system in most countries.

2.13 Data security

The application is compliant with the General Data Protection Regulations (GDPR) to ensure the safety of member data. A data lake was created to ensure that no personal data can be accessed. Access control where rights and permissions are given to relevant parties is also implemented e.g. a primary member cannot access the medical data of a dependant.

2.14 Compliance with national guidelines or regulatory statutes

The application complies with Kenyan data protection laws and the GDPR.

2.15 Fidelity of the intervention

We implemented real-time IPRS validation to check the accuracy of the member details submitted by the CHWs carrying out the registration process.

3 Lessons Learnt and Recommendations

- Mobile technology can help in mass UHC registration
- ‘Technophobia’ can affect progress
- Strong leadership is important
- Strong social mobilization (TV, radio, churches/mosques) is important
- Local administration (commissioners, administrators, chiefs) involvement is important
- Regular monitoring of progress is key (dashboard)
- Standardization of the mobile phones used can help (photos)
- Flexibility in the approach is important but can alter results (households vs adults’ registration; pay-per-person registered)

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Interfacing Research and Policy in Informing Data Management for Quality Data in Health Information Systems: Case of DHIS2 in Malawi

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Abstract. Like in many other fields, there is an ever-growing need for new knowledge in health services delivery on how we should better our decisions in delivering our services. In response to that desire of knowledge Universities and other institutions have been funding and motivating students and academicians into research. The expectation is that knowledge acquired from research will inform us how to improve our practices.
Method: This qualitative desk research attempted to answer the question how research, policy and practice in health information system interface each other to inform design and implementation of health information systems. It used DHIS2 in Malawi as a case, PhD and masters students' theses, Health Information System Policy and Strategy to explore how these resources inform each other. Data analysis was done through thematic tabular analysis, and themes were derived from predefined set of criteria.
Results: The findings showed that there is considerable effort by researchers to publish and share their findings to practitioners through conference, journals and working together in workshops. It also shows that participation in policy formulation workshop has been a key means by which researcher directly contribute to practitioners works.
Conclusion: There is considerable effort by stakeholders to create and make use of platforms that should enable the link between researchers and practitioners. Although the paper has to a considerable extent, managed to answer how research, policy and health information systems interface each other, it has most importantly, stimulated a need to conduct a detailed field study to ascertain how actually the researchers work inform practitioners on the ground.

Keywords: Research, Health Information System Policy, Practice, DHIS2

1 Introduction

One of the areas where ICT4D has dominated debate is health service delivery. Access to quality data for decision making and telemedicine are among notable themes in literature [1], [2]. In data management, the work of Weiskopf and Weng [3] has led to the development of data quality model in health Information systems. This model and others have been benchmarks for defining practices and implementation of systems for data management with aim of attaining quality data for decision making. At individual level, Sahay and Walsham [4] demonstrated the various ways how health information systems contributes towards a better world for all. In their study titled "Building a Better World: Frugal Hospital Information Systems in an Indian State" They highlighted ability of health information systems in strengthening processes to include the disadvantaged, empowering patients through access to information and use of technology to make voice of the voiceless in the rural areas be held. Researchers have also argued that through e-health, for example, there is potential for Information and

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Communication Technology (ICT) to expand access and improve efficiency in health service delivery especially in rural areas [5], [6]. Similarly, work of Thapa and Sein [2] articulated how affordances of ICT are actualised using a telemedicine case in Nepal. What all this work shows is that there is a lot of research work towards understanding how ICT is important in health service delivery. However unlike in other disciplines like education, of late not much has been documented in relation to the link between research, policy and practice. Through Health information Systems Program (HISP), under the leadership of University of Oslo in Norway, there has been active research by students and professors which has seen the inception and evolution of the District Health Information System (DIHS) across the developing countries. DHIS, now at version 2, provides a platform for data management for Health Information Systems in many countries across the globe from Africa to Asia [7]. Despite that the research findings and recommendations have been published through conferences, journals and books, there has not been substantial research and reports on how actually these findings inform policy formulation and indeed the development of features in the DHIS as it evolve. This is what motivated this desk study in an attempt to explore how researcher and practitioners interface in capitalising research knowledge to improve health information systems using Malawi and DHIS as case.

1.1 Problem statement

Literature shows there has been a lot of research on the role information technology in health service delivery [8], [6], [9]. Health Information Systems, data quality and eHealth are among areas which have been debated by many scholars in journals and conferences. Similarly governments' health departments and health partners have been articulating health information systems policies and strategies to govern the use and application of information technology in delivery of quality health services [10], [11], [12]. However, despite the enriching research findings, policies and strategies, of late not much has been researched or say documented on how these resources interface each other in attempt to achieve a common goal of quality and accessible health service to all. This concern motivated a systematic tracking of research and related health information system policies and strategies so as to understand how they talk to each other in trying to achieve a common goal, particularly of attaining quality data which should inform decision for improved access to quality health for all.

1.2 Aim of the study

This desk research aimed to explore how researchers work practically contribute towards policy and strategy formulation and implementation. Specifically; it aimed to find out how the development of policies and strategies capitalise on the research findings. It further aimed to find out which features in DHIS2have indeed be implemented in response to the policies and strategies.

1.3 Conceptual framework

In an attempt to shape and structure the relationship among the concepts being studied, the researcher developed a conceptual framework shown in *Figure 1*. This artefact was drawn from the work of Miles and Huberman [13] who defined a conceptual framework as "*a visual or written product, one that "explains, either graphically or in narrative form, the main things to be studied"*.

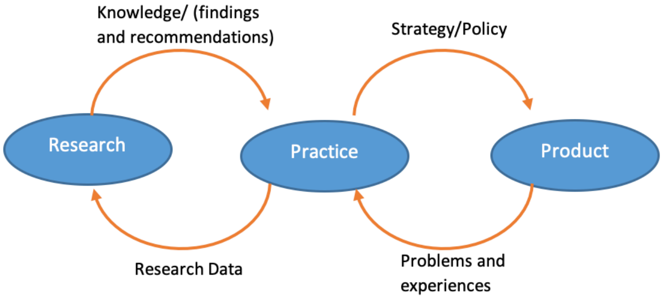

Figure 1. Conceptual Framework

The main concepts in the framework are *research*, *practice* and *product.* Where research points to the a systematic investigation to discover facts or collect information [14] and practice is being looked at as the actual application or use of an idea, belief, or method, as opposed to theories relating to it [15]. From the same dictionary the researcher defines product as a thing or person that is the result of an action or process [15], from the same, we defined a product as a thing or person that is the result of an action or process which in this case relates to such things as agreed practices and information systems.

2 Methodology

This qualitative desk research attempted to answer the question how research, policy and practice in health information system interface each other to inform design and implementation of health information systems. Purposive random sampling was used to select journal or conference articles and policy or strategic documents. PhD and masters students theses also formed part of the data sources consulted where the main inclusion criteria was that studies or documentation should relate to health information systems development and implementation with reference to District Health Information Systems (DHIS 2) in Malawi. The researcher focused on documents within 2010 and 2016 timeline and 2015 to 20118 research work and strategy documents respectively. The systematic search was however not limited to local sources and it extended to international journals as long as they conformed to the set criteria. Table 1 gives a summary of the artefacts that were consulted in the study.

Table 1. Summary of data sources

	Thesis		***Article***		***Reports***	
Title	PhD	MSc.	Journal	Confe-rence	Strategic	Policy
1. Monitoring, Evaluation and Health Information Systems Strategy (MEHIS)-2018					√	
2. Natinal Health Information System Policy-2015						√
3. Implications of Integrating Information Systems in Healthcare at District Level in Malawi: A Case of DHIS and Drug LMIS-2010		√				
4. Management and Use of Health Information in Malawi and Burkina Faso: The Role of Technology-2016				√		
5. The information transparency effects of introducing league tables in the health system in malawi-2016			√			
6. Strengthening Health Management Information Systems in Malawi: Gaps and Opportunities-2015				√		
7. Developing Integrated National Health Information Systems in Malawi: Challenges and South-South Collaboration-2011				√		
8. In Search of the Missing Data :The case of maternal and child health data in Malawi-2010	√					
9. Transformational Feedback: Breaking the vicious cycle of information use in Health Information Systems-A case from Malawi-2016	√					

9 documents were collected online and the researcher focused on the recommendations. The researcher summarised the crucial recommendations which were then used as a benchmark for evaluating the health information systems strategic or policy documents and the DHSI 2 to ascertain if these three artefacts talk to each other. For each specific recommendation, the researcher checked for either a corresponding policy or strategic item in the strategic or policy document. Wherever relevant, the implementation of the same was checked in ether DHIS 2 in form of feature or functionality. The same approach was also used to check practices in terms of use along the data processing chain in the DHIS 2.

3 Findings

The study was framed to a timeline stretching from 2010 to 2018. Research literature was one which spanned from 2010 to 2016 and the strategies or policies from 2017 to 2018. The paper titled *"Strengthening Health Management Information Systems in Malawi: Gaps and Opportunities"* [16] provided a very good structure of the findings in this study. Without being specific as to which paper, the finding in that paper guided the thematic structuring of the findings in this work. Three themes were hence drawn from the study of the various data sources presented in methodology section: (i.) improving data processing practices and use (ii.) inclusion of informal data sources (iii.) capitalising on the strength of integration in data management systems.

The proponents of improving data processing practices and use recommended support to all involved in the data processing. The support highlighted included training of personnel or providing self-explanatory kit that users can train independently, introducing mobile app for reporting, peer based reviews, league tables, transformational feedback and information behaviour culture and use especially among managers [1] [17] [18] [16] As the aim of introducing health information systems and platforms like DHIS 2 is to get quality data, others argued that data cannot be complete if informal sources are not included. This led the researchers to recommend inclusion of informal sources of data like births at Traditional birth attendants [19]. Another interesting finding was about capitalising on the strengths of integration in data management systems. In this study it was argued that several information systems especially at district levels operate independently. Duplicate data within the same institution was reiterated as a common concern arising from such a situation. Although both authors focus was more leaned towards integration approach, they articulated well the need for integrating health information system and this work focused on the latter than the former [20] [21].

Moving on to the findings in relation to practitioners, we start by defining strategy and policy. Among the many definitions, strategy is defined as "*a plan of action designed to achieve a specific goal* [22] and policy is defined as *"a set of ideas or plans that is used as a basis for making decisions, especially in politics, economics, or business"* [23]. Although there are technical differences but for purpose of our study, we focused on plan of actions or ideas meant to achieve a certain goal, which in this case is the goal is to improve data quality for decision making.

Common findings between the two documents included actions to: improve interoperability (this was meant to reduce increased independent data management platforms), enhance continuous support across all levels of data management (through training and mentorship), strengthening capacity to use data, actions to reduce workload especially to those in data collection and finally strengthening community structures including chief in supervision of data collection and submission [10] [12].

Another finding that is worth highlighting was that the strategic and policy documents demonstrated evidence of a collaboration culture among the practitioners and the researchers, where minutes of policy and the strategy development activities indicated presence of some of the researchers in the formulation workshops and DHIS 2 platform development processes. ***Figure 2*** summaries the overall findings showing the alignment of the three artefacts.

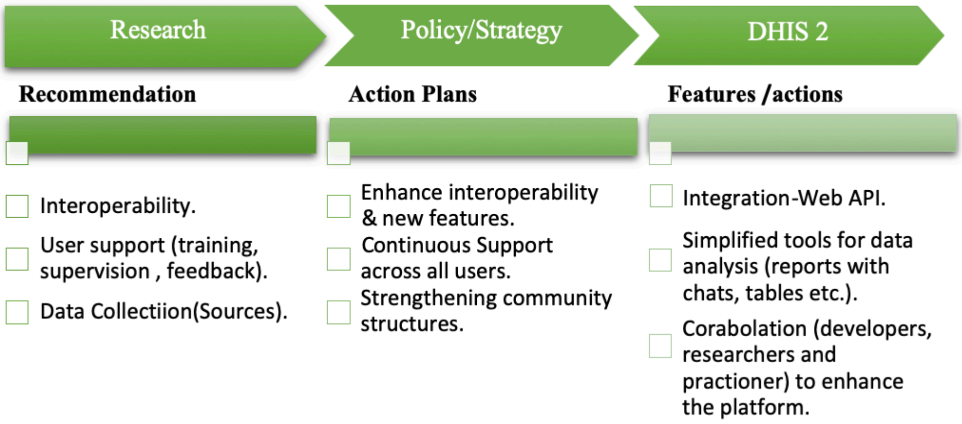

Figure 2. Graphical illustration of research, policy and strategy and DHIS2 platform alignment

4 Discussion and conclusion

Looking at how the policy and strategic action plans are well aligned to researchers' recommendations gives a substantial evidence that the practitioners work is being guided by the researchers' findings and recommendations. There is considerable effort by stakeholders to create and make use of platforms that should enable the link between researchers and practitioners [24]. The symbiotic relationship between researchers and practitioners propels the vehicle of knowledge to new destinations. Practitioners' experiences inform researchers problem who through systematic studies are able to find answers to problems faced by practitioners [25]. However, publishing research findings in journal articles, or participating in conferences or other research dissemination seminars, does not always guarantee that the knowledge will be applied, there are so many factors which may motivate practitioners to put the new ideas into use. Also as illustrated in the conceptual model, product of policy and research, may not always be tangible like an information system. At times it could be a set of practices which are difficult to observe on a desk research if they are really being implemented. We conclude by arguing that basing on the findings: research, policy and health information systems developers interface each other mostly through workshops than in conferences or reading journal articles. This stimulates a need for further research to ascertain how local conferences can best be capitalised to enhance the existing means of sharing knowledge and implementing new ideas in Malawi Health Information Systems.

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Developing Health Data Use Toolkits: Progress Made by the Capacity Building Consortium, Tanzania

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Background and Purpose: The quest for evidence planning and decision making is paramount in the health sector, where, significant information is collected in routine health care and is ultimately expected to support improvement is service delivery. Unfortunately, adequate use of data for daily management and decision making is facing substantial challenges. With huge investments now directed towards improvements in digital data collection in routine health care setting, an opportunity presents to improve the culture of data use in daily practices. The Government of Tanzania and partners created the ‘Data Use Partnership’ (DUP) to implement recommendations in the country digital health investment’s roadmap. The DUP commissioned the Capacity Building Consortium (CBC) to strengthen data use capacity across the sector.
Methods: Through review of literature, expert consultations and stakeholders’ engagement, CBC generated the draft outline of the national data use toolkit, with two major sections “Data analysis, visualization and use guide” and “Data use assessment, measurement and documentation guide”. The draft outline is now being shared to various government departments and partners for reviews.
Results: There has been very good acceptance of the need to generate data use toolkits to support data use initiatives in the country. The draft toolkits outline builds upon existing tools for data collection, analysis, interpretation, visualization and summary report generation.
Conclusions: In line with the toolkits, CBC will develop in-service short courses to support adoption of the kits in practice.

Keywords: Data use, toolkits, decision-making

1 Introduction

Data use is a topic that has recently received significant attention from many actors. For the past decade, huge investments have been made on data collection which led to improved availability of routine health data. and use of electronic data [1] [2]. The use of health data was expected to influence decisions if the quality of data was good and available to decision- makers on time [3]. However, there have been concerns from different stakeholders that the health providers and managers at primary health care do not use data they produced because of lack of capacity to analyse data and set priorities based on results.

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Various studies have shown that- use of data is influenced by availability of guidelines or manuals which could guide providers in their day to day data use practices are not always available [4] [5].

1.1 The Data Use Partnership

Noticing the gap of data use in health sector, the Government of Tanzania and partners created the Data Use Partnership (DUP) as a journey to better data for better health in Tanzania. The Data Use Partnership supports the implementation of the recommendations from the Digital Health Investment Roadmap; that outlines 17 recommendations for using data to improve health services and health outcomes (see http://www.moh.go.tz/en/ehealth-initiative). The Capacity Building Consortium (CBC) Tanzania was established under the DUP to build capacity on data use in health sector in terms of training, mentoring and coaching across the health system; to support use of data to identify and solve problems, measure performance, allocate resources, track clients and support clinical decisions.

1.2 Data use toolkits

Overall objective of developing national health data use toolkits is to guide data analysis and data use of routinely generated health services data so as to facilitate decision making at all levels of the health system and support objective assessment of the extend that data is used routinely.

1.3 CBC Data Use framework

CBC defines data use as a continuum process that involves collection od data, data processing, analysis, presentation, interpretation and demand (Figure 1). The framework indicates that there are different stages throughout the data use cycle and one stage may heavily depend on the other. For example, in patient's tracking, the health care provider need to collect attendance data, process it and analyse to reach a conclusion for practical recommendation. However, some practitioners may only few areas of the cycle, e.g. interpretation and making decisions.

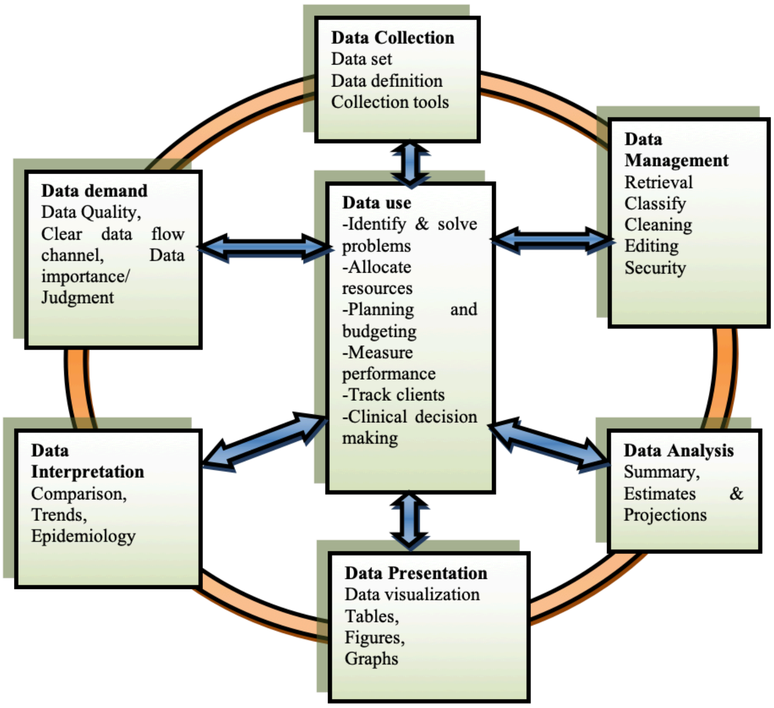

Figure 1. CBC Data Use Framework

2 Materials and methods

In 2019, CBC convened a panel of specialists and researchers to reach a consensus on the scope, structure and processes of developing the toolkits. Methods and search strategy utilized in the development of the toolkit focused on; situational analysis of existing data analysis and data use guidance, exploring knowledge and skill gaps among health care providers and policymakers. Desk reviews on a number of policies, strategies, reports and grey literature was carried out. Experts in data issues, researchers, stakeholders in data analysis and use as well as government Ministries officials were consulted.

3 Results

The draft toolkits developed are structured into two; “Data analysis, visualization and use guide” and “Data use assessment, measurement and documentation guide”. The tools integrate and build upon existing data systems and tools designed to collect, analyse, interpret, visualize and generate standard reports on progress and performance indicators. The kits are designed in 3 modules; 1) Data collection, analysis and visualization 2) Data use and 3) Data use metrics. The metrics involve uses of routine data collected at health facilities as well as periodic data collected from different survey.

Toolkits are designed to provide data use metrics needed to quantify/evaluate data use and provide an area for addressing non-use and under-use of data within the context of health sector. Furthermore, the toolkits define indicators to be tracked at each level of the health care system.

4 Discussion

The toolkits will be useful for educating and informing primary health care workers on data analysis, visualization, interpretation and application of health data in decision making and ultimately enable health workers on how to use these data to improve quality of care. As argued by Nisingizwe et al, [6] on using WHO data quality report card framework as a tool for data use in Rwanda; data use toolkits not only will stand as a guide to answer a number of data use issues in Tanzania health system but also will facilitate assessment of data use at large.

Toolkits will promote accountability to supervisors and health management teams to perform self-assessment on use of data to identify and solve problems, measure performance and allocate resources. With time and support, the kits will form part of the routine monitoring tool for health workers use of data to track clients, support clinical decisions and provide services; hence improving the culture of using data for evidence-based planning.

The proposed data use toolkits and metrics will be evaluated first to uncover their potential and improve the range of indicators for evaluating data usage practices, prior adoption.

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Statement on conflicts of interest

None

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Experience sharing on implementation of Kenya's Universal Health Coverage Digital Household Registration uptake, public education and response

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Background and Purpose: Universal health coverage (UHC) means that all people and communities can use health services they need, of sufficient quality to be effective, while also ensuring that the use of these services does not expose the user to financial hardship. The Government of Kenya has prioritized UHC as one its key development agenda. During the pilot phase of UHC officially launched in December 2018, the Ministry of Health has targeted four counties; Kisumu, Nyeri, Machakos and Isiolo. Living Goods Kenya (LG) was contracted by the Ministry through the National Hospital Insurance Fund (NHIF) to carry out identification, recruitment and registration of households for UHC pilot. This paper describes how LG was able to leverage on technology through its mobile application to carry out the assignment in Isiolo.

Methods: Borrowing heavily from its existing *Smarthealth App*, LG customized an app in-house. The offline-capable app allowed Community Health Volunteers (CHVs) to capture both household and socio-economic data. LG then built a logic layer on the app that allowed for easy capture of UHC membership information, which fed details to a UHC card to allow eligible County residents receive services at health facilities.

Results: Percentage Registered-Phase One: 65% households (90% of target population); Final phase (combined Phase One and Two): 85% households, (102% of target population)

Conclusions: Modification of the *Smarthealth* App for offline capabilities and use of CHVs, backed by an updated Community Health (Household) Information system-for reference, was critical for success.

Keywords: Universal Health Coverage, Digital Technology, Smarthealth App, Community Health Volunteers.

1 Introduction

Universal health coverage (UHC) means that all people and communities can use the promotive, preventive, curative, rehabilitative and palliative health services they need, of sufficient quality to be effective, while also ensuring that the use of these services does not expose the user to financial hardship [1].

In Kenya, UHC is embedded in the social pillar of the nation's primary development blueprint, Vision 2030, and aims to ensure 100 percent coverage for all Kenyans by 2022.1 [2]. In December 2018, the

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[1] Currently only 17 % of Kenyan households are covered by health insurance of any type. Coverage by private voluntary health insurance is only about 1% but it accounts for 10% of total health spending.

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national government officially launched the UHC Pilot Program dubbed Afya Care – Wema Wa Mkenya (health care - wellness for every Kenyan) in four counties2 - Isiolo, Kisumu, Nyeri, and Machakos.

The National Hospital Insurance Fund (NHIF) a semi-autonomous government agency which is mandated to provide health insurance for Kenyan citizens/residents. NHIF was tasked with delivering identification, recruitment and registration of households for UHC. However, the NHIF on its own is unable to “access” and recruit all intended beneficiaries for its various insurance packages, especially those in informal employment, rural and other hard to reach areas.

Living Goods (LG) supports 6 County Governments in Kenya to recruit and train Community Health Volunteers (CHVs) who support Primary Health Care at the community level. The CHVs that LG partners with are equipped with a supply of key medications and health-related products, as well as an Android smartphone that supports care coordination and diagnostics through an mHealth application-Smarthealth App.

In November 2018, LG was contracted by the Ministry through the NHIF to support the process in Isiolo County. LG is one of only two organizations in Kenya that were selected for this project.

1.3 Objective

To carry out identification, recruitment and 100% registration of households for Universal Health Coverage pilot program in Isiolo County.

2 Methodology

2.1 Technology:

Borrowing heavily from its *Smarthealth App*, LG Tech team customized an app in-house to support the process. The team created an offline capable app that allowed the CHVs to capture household and socio-economic data. The team then built a logic layer on the app that allowed for easy capture of UHC membership information, which fed details to a UHC card that would allow eligible County residents receive services at health facilities.

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[2] The decision to pilot the programme in the four counties was evidence-based considering differentiated disease burdens. Kisumu, for infectious diseases especially HIV/AIDS and TB; Machakos, for high numbers of injuries mostly from road accidents; Nyeri, for highest numbers of non-communicable diseases especially diabetes and Isiolo, for insights in how UHC can be packaged for nomadic and migratory populations.

2.2 Logistics:

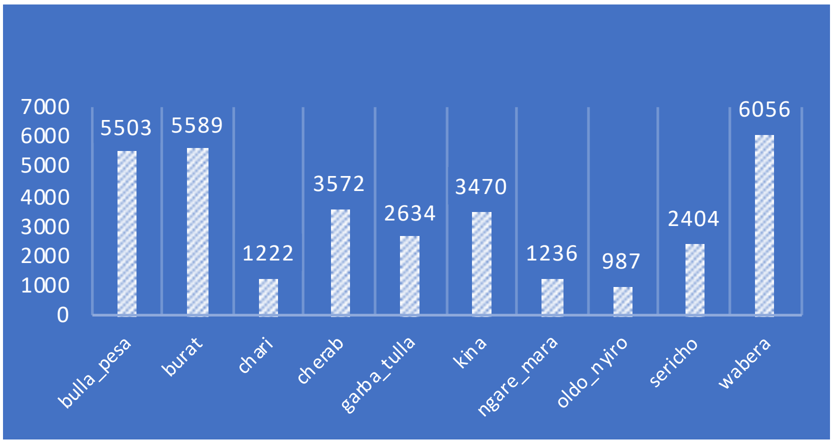
535 LG-supported CHVs drawn from all the 10 wards in the three Sub Counties (Merti, Garbatulla and Isiolo) of Isiolo were purposively selected and trained for this registration due to their closeness with the communities; especially in hard-to-reach areas. The CHVs used the App to digitally register households. See figure above. (Step 1). The target was 210,000 persons (40,000 Households) extrapolated from the Kenya National Population and Housing Census, 2009.

The process was conducted in two phases. Phase one in November/December 2018 and a 2nd (" Mop up") phase conducted in February 2019. During each of the phases, after collection of the data, verification was carried out (Step 2), including national IDs and photo image of each member of a household i.e. principal resident and any dependent(s) During step 3, the information streamed from LG App to NHIF systems was used to officially register the households to the UHC program.

3 Results

During Phase One: Total registration achieved was 65% of households and 90% of total target population Final phase (combined Phase One and Two): 84.4% households, 102% 3of target population registered. Total number of households registered in the County during the phase one and two was 33,773, (84.4%). The breakdown for the 10 wards is as indicated on the bar graph4. Wabera ward in Isiolo town had the highest registration numbers at 6056 households. Oldo Nyiro in one of the remotest parts of the County had the lowest registered total number of households at 987. However, when these figures are compared to the actual total number of households in the respective wards, the numbers show a comparable percentage. Wabera 83 % and Oldo Nyiro 85%.

Graph: Final registration figures, total number of households (per ward)



4 Discussion

Isiolo County is characterized by comparatively poor infrastructure, including internet coverage, especially in Merti and Garbatulla sub-Counties. Modification of the *Smarthealth* App for offline capabilities was critical in the success of the registration, as evidenced in the ward registration percentage rates. Lack of identification documents (national identification cards, birth certificates) from a significant number of residents hampered the registration process in many parts of the County, especially in Merti which necessitated a mop up after initial poor results in the first phase. There was a marked discrepancy in percentage figures in the enrolment (between household and total population targets) both at Phase One

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[3] The total number exceeded 100% due to review of the operational definition of household

[4] There are 10 wards in the County as follows: **Isiolo sub-County**: Wabera, OldonyoNyiro, Burat, Bullapesa, NgareMara; **Garbatulla Sub-County**: Garbatulla, Kina, Sericho; **Merti sub-County**: Chari, Cherab.

and at the end of Mop up stage[5]. This was primarily due to the challenges in the definition of household. Initially the definition used as per the NHIF-i.e. any person above the age of majority-18 years; this was however clarified during the mop up stage to be per Kenya National Bureau of Statistics definition. UHC registration was not understood in all parts of the County and was often confused with registration under NHIF. Use of CHVs, backed by an updated Community Health (Household) Information (MOH 515) system-for reference-will be critical for success during the proposed national roll out.

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[5] During “mop up” stage, the definition of household had been clarified and therefore efforts made to ensure all *eligible* members of a household were registered.

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Optimization of health sector business process towards client centered care. Opportunities in PHC digitalization in Tanzania

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1 Introduction

In Tanzania Primary health Care services form the basement of the pyramidal structure of health care services. It is made of several dispensaries, health centers and District hospital at the district level. About 90% of all health facilities in Tanzania are primary health care facilities [1].

Improved Health outcome is a result of the increased ability to provide accurate, timely and affordable health services at all levels as depicted in Figure 1. The ability to provide health service is depended on the use of correct data in making decision. According to WHO improved health information system is associated with improved management of the health sector, hence the need for a well-designed routine health information system is critical for ensuring that services are delivered according to the standards. Health management information is also key among six WHO Health System building blocks. In Tanzania, health system has been depending on paper-based system to collect, aggregate and manipulates data for decision making which has not being successful.

In recognition of the need for ICT to support health sector, Tanzania started investing in digital health in late 1990's that was followed by a series of technological events characterized by different innovation till to date where massive investment in ICT is evident in the health sector ranging from merely data management information systems to the use of ICT in diagnosis and patients management (Figure 2 & 3).

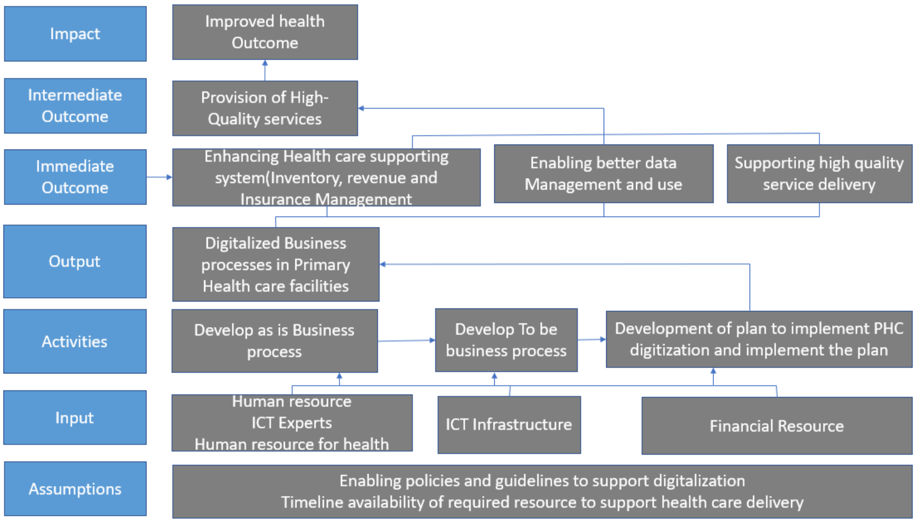

Figure 1. Tanzania Primary Health Care Digitalization Theory of Change

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1.1 Background

Health systems around the globe still fall short of providing accessible, good-quality, comprehensive and integrated care. As the global health community is setting ambitious goals of universal health coverage and health equity in line with the 2030 Agenda for Sustainable Development, there is increasing interest in developing health systems that can improve access to and utilization of primary health care in low- and middle-income countries. A wide array of stakeholders, including development agencies, global health funders, policy makers, planners and health system decision-makers, require a better understanding of primary health care systems in order to plan and support complex health system interventions. Information management is key to generate and avail data to support planning and decision making. In Tanzania little is known and documented about opportunities available in optimization of health sector business process through PHC digitalization. There is thus a need to document experience of PHC digitalization in Tanzania and associated opportunities in improving better health outcomes.

1.2 Purpose

The aim of this paper is to share lessons learned in the journey towards digitalization of primary health care. The specific objectives are therefore in two folds; 1. To document experiences encountered during PHC digitalization in Tanzania and 2. To document and avail information with regards to opportunities available in improving better health outcomes through PHC digitalization

2 Material and Method

This study adopted a qualitative approach. The process involved document review of key documents in the health sector. Authors reviewed different guidelines, standards, journals, policies, reports (WHO recommendations), books and related documents. Accessible materials were browsed from Internet sources and utilized Document review was followed by the documentation of current “As is” and “to be” Business processes through a series of consultations workshops. The documentation was informed through an interview and focus group discussion to key informant individuals from the Ministry of Health, Community Development, Gender Elderly and Children (MoHCDGEC), the President’s Office Regional Administration and Local Government (PORALG)-Annex 1, Regions and Councils levels officials and health facilities representatives (Health Centers and Dispensaries) that was followed by field work exercise to validate the developed “as is” business process and proposed “to be” business process. A validation exercise was conducted in randomly selected facilities in rural and urban settings in 2 regions. Gathered information was used to develop to be business process to guide the digitalization process.

3 Results

Currently, there is over 160 digital health or health-related systems [3] which includes a number of Electronic Medical records apart from the GoTHoMIS which is installed in more than 320 facilities. However, some of the electronic medical records have national coverage while other are institution-based. Some of them are at piloting phase while others are operational with limited interoperability. Government is working hand in hand with Implementing partners to implement a single solution, improved GoTHoMIS which will be the only Electronic Medical records at all levels from primary health care to national level.

Tanzania started investing in digital health late 1990’s when telemedicine concept was introduced aiming at providing specialist consultation in areas were there were limited number of medical doctors. Most of the time Clients (patients) were transferred from rural to urban to get care. In this mode, there was no need to transfer clients as services were provided using video conference or mobile phone from specialist who are mostly in the urban areas. Electronic medical records however were introduced in 2012 when 4Pay was used to provide registration and dispensing apart from Jeeva which was introduced at Muhimbili National Hospital in 2004 (Figure 2 and 3).

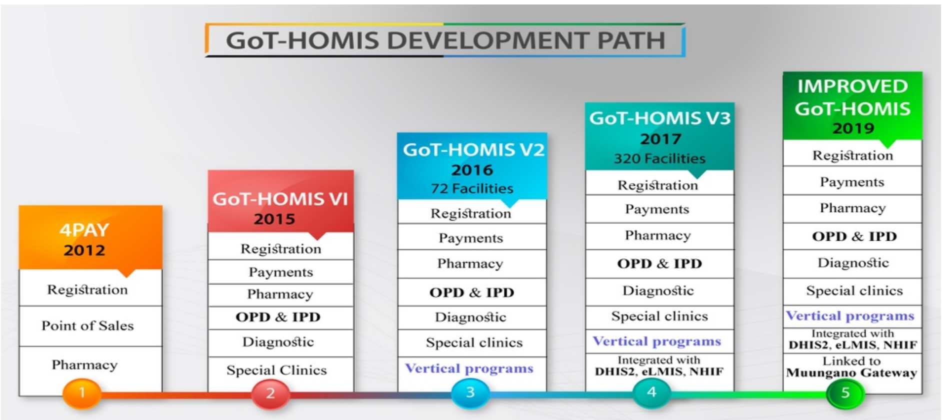

Figure 2. GoTHoMIS Development PATH

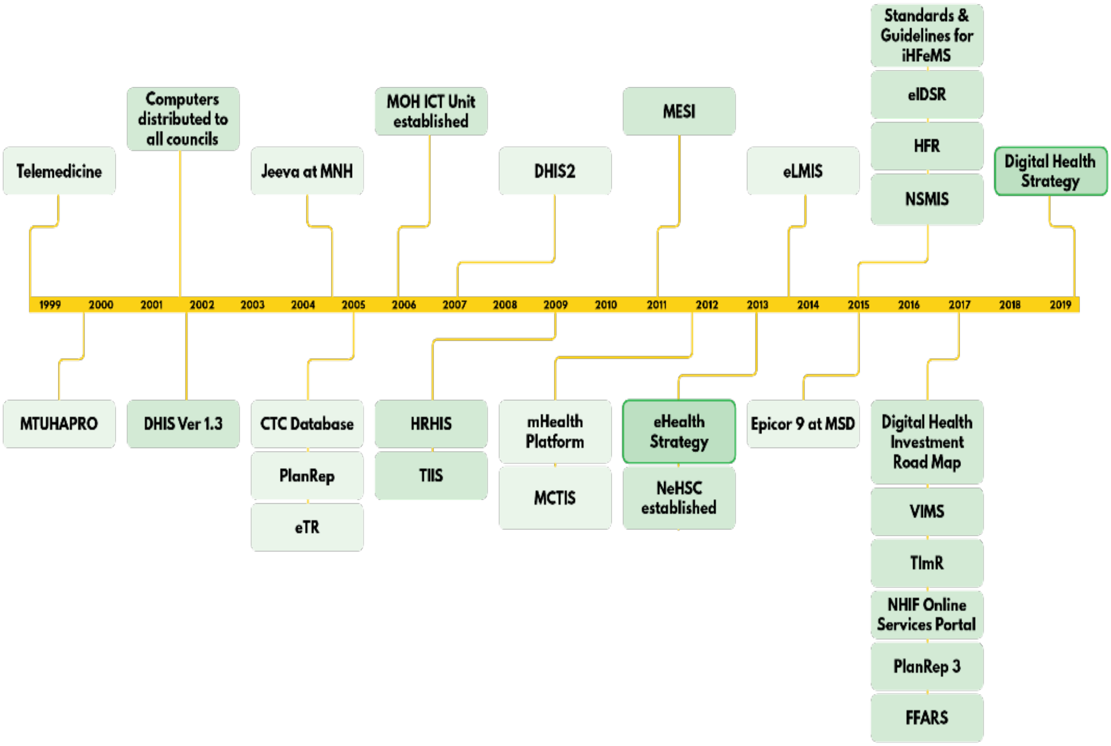

Figure 3. Digitalization Journey in Tanzania

Focus group discussion and key informant revealed that there are 15 different business processes as depicted in Annex 2.

Based on document review it was revealed that health priorities of primary health care falls into 3 major thematic areas namely; Service delivery, support systems and data management and use. Digitalization will essentially Supporting high quality service delivery, Enhancing healthcare support systems and Enabling better data management and use: Detail aspect of optimized business processes is depicted in Table 1 below.

Table 1. Opportunities of PHC digitalization in supporting business process

S/No	Health priority	How digitalization will support the process
1.	Supporting high quality service delivery:	supporting client tracking supporting continuity of care supporting appropriate sharing of individual client health data within and between points of service supporting adherence to guidelines and best practices supporting health education
2.	Enhancing healthcare support systems	Improving the efficiency of revenue and insurance management Improving the efficiency of health commodity management
3.	Enabling better data management and use	Reducing data management burdens of health workers, enabling more time for service provision and data use Improving data quality and enable comprehensive real-time data validation Facilitating data use at the point of care Providing real-time, accessible data at all levels Providing tools for analysis and visualization

4 Discussion

This paper presents the experience and lessons learned in the journey towards digitalizing primary health care systems in Tanzania. The Government of Tanzania in collaboration with PATH through Data Use DUP Initiative is undertaking a holistic approach in digitalizing health service provision from primary level to national level health facilities. The experience reveals that stakeholders' engagement in all the processes during digitalization is key in the success of PHC digitalization processes. This has been documented elsewhere in the literature (Letzia et al 2018, Wilkin et l 2018, Barrett et al 2016). In any business context, public or private the advantages of more directly involving stakeholders (customers, clients, suppliers, or partners) and creating value by identifying their needs and providing effective solutions are widely recognized. Furthermore, it is essential that a thorough document review is done to guide all the processes as some of the critical information is documented in strategic government documents such as policies, strategic plans and guidelines.

Though off-site workshop to gather information for mapping health care system produces relative desirable findings, experience shows that validation exercises in the field is critical in documenting robust evidence of business processes (Creusa et al 2011).

In optimization of business processes, the findings of this study revealed 3 important thematic areas namely supporting high quality services deliver, enhancing healthcare support systems and enabling better data management are essential priorities of the health sector that could be supported by digitalization process. In supporting high quality services, digital solution is essential in supporting client tracking (Brian et l 2011), continuity of care (Vida et al 2011), appropriate sharing of individual client health data within and between points of service, adherence to guidelines and best practices and supporting health education (Rouleau et al 2015).

Health financing and commodities management are important inputs for ensuring equitable access of quality health care services according to WHO Health system building blocks. As proposed by key informants and document review, the literature also supports the use of ICT in enhancing health care support systems. In enhancing healthcare support systems, electronic system is important in improving the efficiency of revenue, insurance management and improving the efficiency of health commodity management (Enock et al 2012). Further more for the purpose of ensuring better data management and use, ICT solution Reduce data management burdens of health workers hence enabling more time for service provision and data use, improve data quality and enable comprehensive real-time data validation, facilitate data use at the point of care, provide real-time, accessible data at all level and tools for analysis and visualization (lucas 2008, Kasaw et al 2013).

The successful operationalization of PHC digitalization requires also enabling policies and guidelines and timely availability of required resources to support health care.

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Annex I: Key Informants

	Name	TITLE	INSTITUTION
1.	Tumainiel Macha	Ass. Director M&E	MoHCDGEC
2.	Erick Kitali	DICT	PORALG
3.	Hermes Rulagirwa	Former Head, ICT	MoHCDGEC
4.	Walter Ndesanjo	ICTO	MoHCDGEC
5.	Dr.LiggyleVumilia	Coordinator, Telehealth	MoHCDGEC
6.	Melchiory Baltazary	SICTO	PORALG
7.	Yasinta Kijuu	PST	PORALG
8.	Sultana Seiff	ICT Officer	MOH
9.	Dr. Felix Sukums	Lecturer	MUHAS
10.	Dr. Henry Mwanyika	Regional DH Director	PATH
11.	Jacqueline Patrick	Former Director, DUP	PATH
12.	Elaine Barker	Senior Programme Officer	PATH
13.	Neema Ringo	Senior Programme Officer	PATH
14.	Patrick Muro	Head, ICT	MuhimbiliNational Hospital
15.	Oswald Luoga	Product Development lead	PATH

Annex 2: PHC Business Processes

SN	Process Name
1.	Registration
2.	Billing
3.	Consultation
4.	Investigation
5.	Admission
6.	Referral
7.	Dispensing
8.	Client Tracking
9.	Mortuary
10.	Health Commodity Management
11.	Stock Ordering
12.	Stock Receiving
13.	Data aggregation, analysis and reporting
14.	Emergency
15.	Theatre

Journal of Health Informatics in Africa

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Peer-reviewed and selected under the responsibility of the Scientific Programme Committee

Using Interactive Voice Response for PLHIV on Art: Patient Interaction with Mhealth

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1 Background and Purpose

The WHO recommends use of mobile phone health technologies (mHealth) to support adherence in HIV [1], [2]. Studies on text messages (SMS) show promise in limited rigorous evaluations[3]. Increasing use of mobile phones in Africa provides an opportunity to use mHealth tools to support resource limited health systems. We used Information-Motivation-Behavioural Skills model of Highly Active Antiretroviral Therapy (HAART or ART) adherence theory of change[4] to locally adapt, implement and evaluate an mHealth tool (Call for Life Uganda – C4LU). The tool is designed to support ART adherence in people living with HIV (PLHIV) in Uganda through interactive voice response (IVR) and SMS. We describe the evolution of the C4LU projects and the interaction of patients with the health tip function of the tool.

2 Methods

Connect for Life^{TM} (CFL2015.01 or higher version) information technology software (Janssen, Global Public Health, Johnson & Johnson) is based on MOTECH open source software, and facilitates remote communication between health workers and patients through interactions of SMS/Interactive Voice Response (IVR). Connect for Life^{TM} was adapted for use in PLHIV in Uganda by Infectious Diseases Institute (IDI). Three phases of the project were undertaken 1)A pilot project with "expert PLHIV" at IDI- TAMA 2) A randomized controlled trial (C4L-RCT) at one urban site (IDI) and one peri-urban government site (Kasangati HCIV-KSG) 3) Call for Life Uganda Lite (C4LL) a less intensive version at IDI, Kasangati and Kisenyi HCIV (KIS-urban, government). C4L was linked with the Ministry of Health Uganda Electronic Medical Records (EMR) and IDI's ICEA EMR[5]. C4L-RCT ran from 3rd August 2016 to 30th November 2018; C4LL is ongoing. Figure 1 shows the timeline for the C4L projects.

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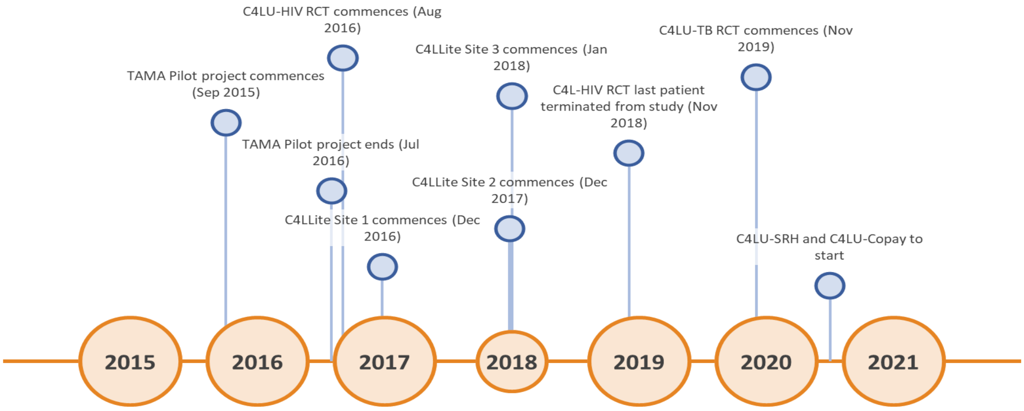


Figure 1. – Call for Life Projects timeline

C4LU offers adherence reminder calls or SMS (table 1), followed by options to report symptoms or access health information tips. In CFL-RCT, PLHIV were randomized 1:1 to receive either C4LU or standard of care (as stipulated in the national guidelines of the Ministry of Health). Those on intervention arm were offered daily calls if they had a viral load (VL) >1000c/ml, or weekly if they were stable (VL<1000). All on C4LL are stable, and so receive weekly calls only. There is also a 24-hour toll free line for PLHIV for symptom reporting or accessing health tips. Symptoms are responded to by a study doctor or nurse within 24 hours. All participants receive appointment visit reminders on a date convenient to them. Health tips are offered weekly in English or one of two local languages. Three hundred and thirty pre-recorded health tips provide information on HIV, ART and ART adherence, living positively with HIV, general health, sexuality, pregnancy and breast-feeding. The participants choose a preferred category of tips and can change category every project visit. Call flow is shown in Figure 2.

	Daily adherence reminder calls/ SMS	Weekly adherence reminder calls/ SMS	Appointment reminders	Weekly health tip calls	Toll free line for symptom reporting or health tips
TAMA	√		√	√	√
C4L-RCT	√	√	√	√	√
C4LL		√	√	√	√

Table 1. – Call schedule by project

We used descriptive data from these interventions to generate frequency distributions of the participant demographics per project and within the C4L-RCT to describe the health tip utilization and generated gender and age differences by various health tip categories.

3 Results

TAMA enrolled 105 participants, all over 25 years, 50% of whom were females.
C4L-RCT enrolled 600 participants (IDI-300, KSG-300; 300 in intervention arm, 300 in control arm), majority females (69%) and median age 32 years (IQR25-40). At baseline, 97% chose IVR over SMS. C4LL enrolled 2,506 participants (IDI-1,045, KSG–772, KIS–689). The majority (67.6%) were females and above 25 years (93.8%).

1,207,326 calls (daily and weekly adherence reminders, weekly health tips and appointment reminders, toll free inbound) were initiated between 3rd March 2016 to 21st October 2019. Of these, 463,267 (40.4%) have been successfully completed. Most common reasons for call not completed were patient not answering (44.6%), phone unreachable (26.2%), phone busy (19.1%), IVR provider errors (7.0%), call rejected by PLHIV (2.4%), other issues including network outages, server failures etc. (0.7%). Between 3rd August 2016 and 30th November 2018, 618,641 outbound adherence reminder calls were sent out across C4LL and C4L-RCT, 240,979 (38.9%) successfully completed. This was higher for C4LL (46.2%) than C4L-RCT (35.1%) (p-value=0.000).

Overall, 85% (255/300) of the PLHIV enrolled on intervention arm of the C4L-RCT utilized at least one of the health tips categories. Particularly, participants utilized mostly general health information 70.0% (211/300); followed by ART and adherence 57.7% (173/300); pregnancy and breast-feeding 45.7% (137/300), HIV disease information 45.0% (135/300), sexuality 37.7% (113/300), and positive living 32.7% (98/300). Gender differences were noted regarding use of heath tip category. ART and adherence was more popular with females (60.5%) than males (51.1%). Males (42.2%) were more interested than females (35.7%) in sexuality information, however, the differences were not statistically significant (p>0.05). Age differences were noted with general health being more popular those over 25 years (73%) compared with those younger (63%). Younger people (<25years) preferred sexuality (39% vs 37%). Again, the differences were not statistically significant.

		Gender			**Age**		
		Female	Male	p-value	Adol-escent	Adult	p-value
HIV information	Yes	45.7	43.3	0.669	46.3	44.5	0.887
ARVs and adherence	Yes	60.5	51.1	0.154	56.1	58.3	0.775
Positive living	Yes	31.4	35.6	0.454	32.9	32.6	0.992
General health	Yes	70.5	70.0	0.877	63.4	72.9	0.130
Pregnancy and breast feeding	Yes	49.0	37.8	0.117	50.0	44.0	0.395
Sexuality	Yes	35.7	42.2	0.384	39.0	37.2	0.771

Table 2. – Health tip utilization by category

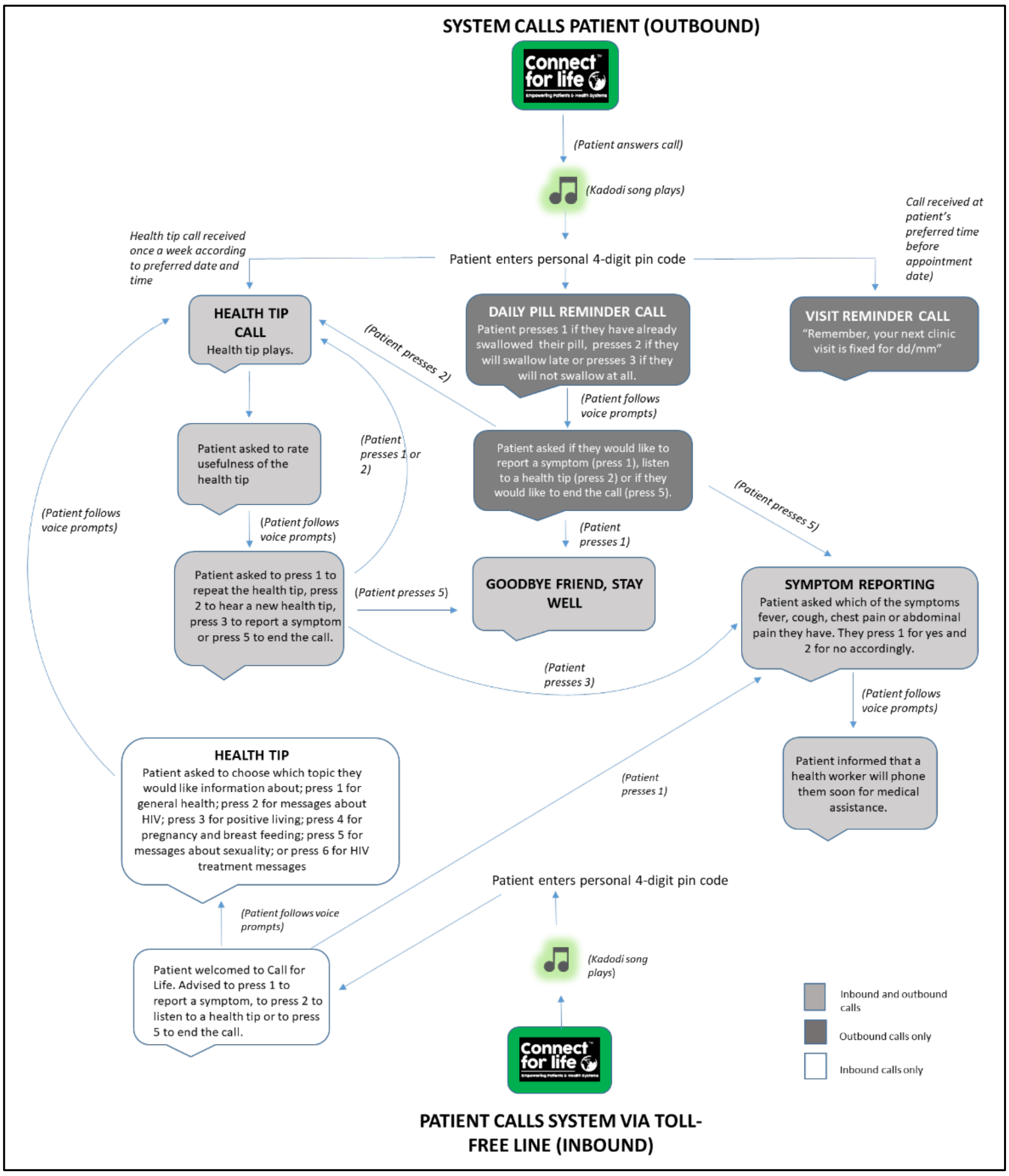
4 Conclusion

Since 2016 we have managed to send over 1.2 million IVR calls, of which 40% were completed successfully. This provides proof of principle that a regular IVR service in Uganda is feasible and PLHIV will engage with mHealth tools to support their HIV care. The higher rate of completed calls in C4LL than C4L-RCT is probably due weekly vs. daily calls leading to less participant technology fatigue. Qualitative work [6] revealed positive feedback from PLHIV about C4L.

Over eighty-five percent of PLHIV utilised health tips. These findings indicate that IVR services are a feasible and acceptable platform for delivery of health information. Preferences showed that PLHIV were interested in wider information and not just HIV specific. We are expanding C4L to other health conditions in the near future (TB and sexually transmitted diseases) and it could be used for non-communicable disease e.g. hypertension. Scale up of C4L for HIV and for other conditions relies on interoperability with other EMR/digital health systems in place. We have shown this is possible in Uganda through linkage to two EMR platforms and are confident it can be adapted to integrate in other countries that would benefit from low cost mHealth interventions.

KeyWords: Uganda, HIV, mHealth

Figure 1. Call flow diagram for Call for Life™ Project



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Community Based Distribution of HIV Self Testing Kits: A Case Study of Kisii County, Kenya

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Background and Purpose: Inadequate uptake of testing for HIV remains a primary bottleneck towards universal access to treatment and care as well as an obstacle to realizing the potential of new interventions for preventing HIV infection, including treatment for prevention and pre-exposure prophylaxis (PrEP). Kenya recently launched HIV Self testing (HIVST) approach as a strategy to increase the proportion of people living with HIV who know their HIV status. Living Goods Kenya, the implementer, in collaboration with Medic Mobile, the technology partner has conducted a HIV Self testing study to assess the effectiveness of Community health Volunteers (CHVs) in administering HIV Self Testing Kits in the communities that they serve. This approach is aimed at reaching and empowering the hard to reach populations such as partners of Antenatal Care (ANC) attending mothers, adolescents and key population groups.
Methods: Quasi- Experimental design with a comparison between a treatment and control group intervention design with baseline surveys of households and CHVs was used.
Results: An analysis carried out showed that 78% of community members prefer assisted testing compared to unassisted testing.
Conclusions: Study results revealed that CHVs have been able to successfully carry out community distribution of HIV Self -Test kits, provide health education, counselling, testing, referral and follow-up of reactive clients.

Keywords: HIV, Self-Testing, Referral, Community Health workers, Digital Technology.

1 Introduction

Kenya's HIV epidemic is generalized to be largely driven by sexual transmission, meaning it affects all sections of the population including children, young people, adults, women and men. As of 2015, 660,000 children were recorded as being orphaned by AIDS [1]. However, a disproportionate number of new infections happen among people from key populations. In 2014, it was estimated that 30% of new annual HIV infections in Kenya are among these groups [2]. In 2017, the National adult HIV prevalence rate in Kenya was estimated at 4.9% with prevalence higher among women (5.2%) than men (4.5%). Although the Spectrum results show a continued decline in HIV prevalence among the adult population aged 15-49 years over a period, the decline has been modest since 2010 [3].

Currently, it is estimated that only 75% of people living with HIV know their HIV status. Countries are looking for ways to rapidly increase uptake of HIV testing services, especially for populations with low access and those at higher risk that would otherwise not get tested. One approach is HIV self-testing, where a person collects his or her own specimen (oral fluid or blood) and then performs an HIV test and interprets the result, often in a private setting, either alone or with someone he or she trusts. In 2016, WHO published the first global guidelines on HIV self-testing, in which HIV self-testing was recommended to be offered as an additional approach to HIV testing services [4].

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HIV testing and counselling (HTC) has become a major feature of Kenya's HIV response. This is in part a response to the large number of HIV sero-discordant couples. In 2012, it was estimated that there were 260,000 sero-discordant couples (when one partner is HIV negative and one is positive) in Kenya. Sero-discordant couples significantly contribute to new infections, especially when individuals are unaware of their status [2]. Kenya has adopted several innovative approaches to HIV testing in recent years, including targeted community-based HIV testing, door-to-door testing campaigns, and the introduction of self-testing kits [5]. These efforts have led to a dramatic rise in the number of people testing for HIV. In 2008, 860,000 people were being tested annually for HIV and by 2015, this had increased to 9.9 million [6].

Living Goods (LG) is a not for profit community health organization that embraces innovation and entrepreneurship in driving impact at scale through the roll out of community health interventions geared at maternal and child health. LG leverages a powerful combination of catalytic technology, high-impact training, and quality treatments that empower government community health volunteers (CHVs) to deliver quality care to their neighbours' doorsteps. The Community Health Volunteer workflow is embedded on a mobile application (the SmartHealth App) that provides assessment and decision support for doorstep healthcare workers while giving actionable analytics for managers. This study showcases how community health workers in Kisii County, rural Kenya are educating, testing, referring using the SmartHealth application and distributing HIV Self-test kits in their community.

1.1 Objectives

i. To validate HIV Self-testing approach in the community.
ii. To establish demand and uptake of HIV Self-Test kits at community level.
iii. To establish and evaluate referral mechanisms and linkage to health facility.

2 . Methodology

2.1 Study Population and Sampling

Bomachoge Chache (Ogembo) Sub-County in Kisii, rural Kenya was identified as the study location for the HIV Self testing program. Based on projections of the Kenya Demographic and Health Survey (2014), there is an average of five people per household and an estimated population of 111,687 in Ogembo, as at 2017. The study targets included household members, Community Health Volunteers (CHVs), Community Health Extension workers (CHEWs,) and HIV Testing Service (HTS) providers at Health facilities within a select area covered by 6 Community Units (CUs). This consists of an approximate number of 7200 households, who are supported by 72 CHVs (69 are active). This translates to an estimated population of 36,000. The study begun in October 2018 and end in July 2019.

A quasi-experimental design was adopted, where CHVs were purposive selected at Community Unit (CU) level, then assigned to either Experimental or Control groups and used as the unit of statistical analysis. The non-target CHVs were indirectly affected by the introduction of the digitized referral and follow-up system to CHVs in the treatment group through social interactions, which could see an improvement in referrals and follow-ups due to social proof.

1.1 Study Groups Configuration

Table 1. Study groups descriptions

Groups	Study Arms	Interventions
i. Treatment group	17 CHVs	• This group was introduced to the new digitalized referral and follow-ups App workflows and supportive tools. • This group conduced HIVST Kits distribution and gave support for home-based HIV self-testing.

ii. Control group	24 CHVs	• Status quo was maintained as per the existing referral and follow-up processes. Referrals done were aided by paper based MOH 100 forms.

2.2 ADR Phases

The Action Design Research consisted of 2 cycles, each constituted a diagnosis phase (observing, evaluating, formulating hypothesis)-research validation (in-depth qualitative work) acting phase (designing and rolling out interventions). ADR process included quarterly analysis of data flows from the Medic Mobile application system and database in the diagnosis phase, qualitative data collection conducted monthly since the beginning of the program in October 2018(e.g. individual and group interviews, observation research, expert interviews) in the Research validation phase, and Human Centred Design participatory workshops for the Acting phase. An end-line evaluation was conducted comprising of quantitative assessments, in the form of surveys, of the treatment group and the control group to assess the impact of the initiative.

2.3 Testing and Referral Approach

Ethical approval was sought and approved by Kenya Medical Research Institute (KEMRI) Scientific and Ethics Review Unit (SERU) in 2018 before the study begun. In the HIV Self testing initiative, the CHVs were trained on how to approach community households' members and test consenting adults above the age of 18 years. The CHVs first introduced HIV topic to the household member, and later screened for Intimate Partner violence (IPV). The CHV then carried out HIV education once the household member consented. The CHV then conducted pre- test counselling and asked the household member if they would prefer assisted or unassisted HIV Testing. The CHV were required to refer any client for 3 different scenarios; any client/patient who opted for unassisted testing as the CHV would not have known the patient's HIV results; any client whose results were reactive, and any client whose results were invalid.

Once a CHV referred the client, they gave them a referral note (MOH 100) which they then took to the link health facility. In this study, there were 2 link health facilities, and 4 trained HTS providers who digitally confirmed referrals from the community which had been submitted by CHVs. Once a nurse received the MOH 100 from the client, they automatically knew that this was a referral from the community and that the patient required confirmatory HIV testing. The HTS provider was then meant to confirm the referral on the digital health facility app asserting that the referred patient had visited the health facility. This automatically generated an SMS which was sent to the CHV phone confirming that the client they referred had sought medical care. The CHV then followed up with the client 3 days after they referred them to check on how they were progressing. The role of the CHEWs in this study was to ensure that CHVs distributed kits as required so that many community members had an opportunity to be tested and to follow- up on whether CHVs were offering timely follow-up on referred clients.

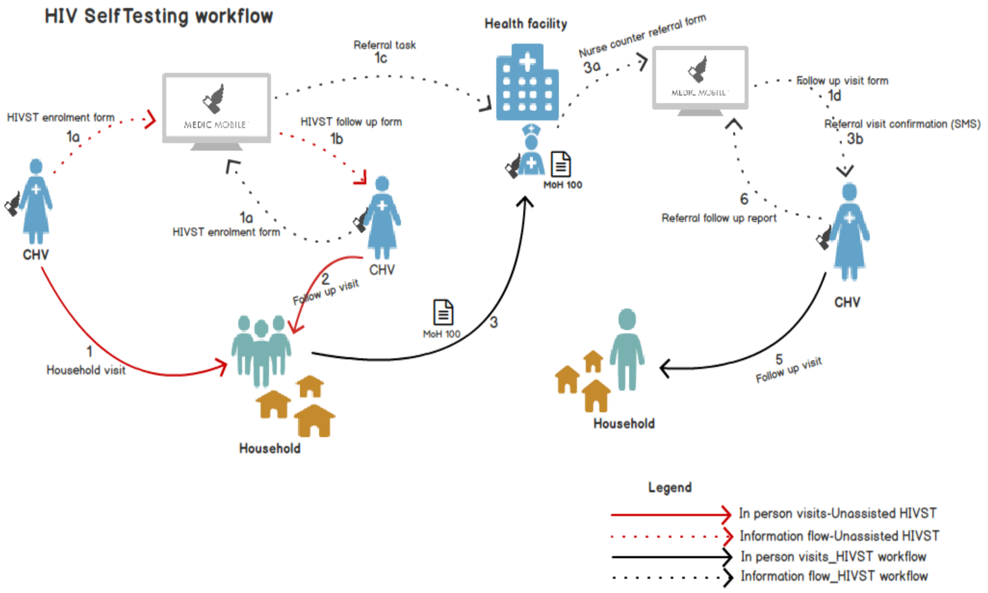

Figure 1. HIV Self Testing Workflow

3 Results

This section shows data that was analysed from the data that was collected using the SmartHealth application.

3.1 Male vs female testing

The study found that there were 62% female were tested compared to their male counterparts who accounted for 38%. One of the main reasons could be that because the community health workers visited households during the day, they found women in their households. Most of the time, the men would have gone to work.

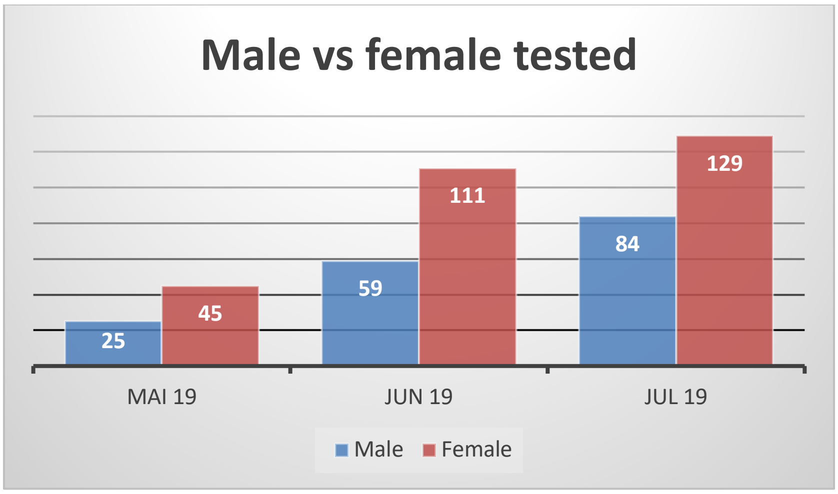

Figure 2. Male Vs female tested

3.2 Assisted and unassisted testing

After conducting HIV Education and counselling, the CHVs either helped the patient/client in conducting the HIV Self-test or left the kit with the client to test themselves at their own time. Results revealed that 56% of the clients preferred that the CHV assisted them in testing while 44% were comfortable testing themselves.

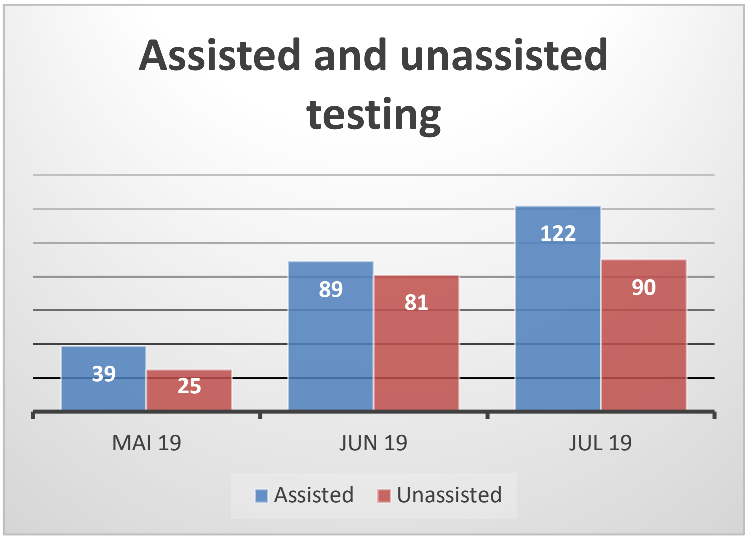

Figure 3. Assisted testing and Unassisted Testing Method

3.3 First time testers and repeat testers

CHVs were restricted to only test clients who had not been tested in the last 3 months. It was important for CHVs to ask clients the last time that they tested and record this on the SmartHealth application. Analysis from the data showed that 92% of the clients had previously done a HIV Test. Qualitative data collection showed that this group had previously tested in health facilities in the Antenatal and Postnatal Care (ANC/PNC) or from request by a doctor when they visited the health facility when they were sick. The system did not allow for a client who had been tested by the CHV to be tested again even after 3 months have lapsed.

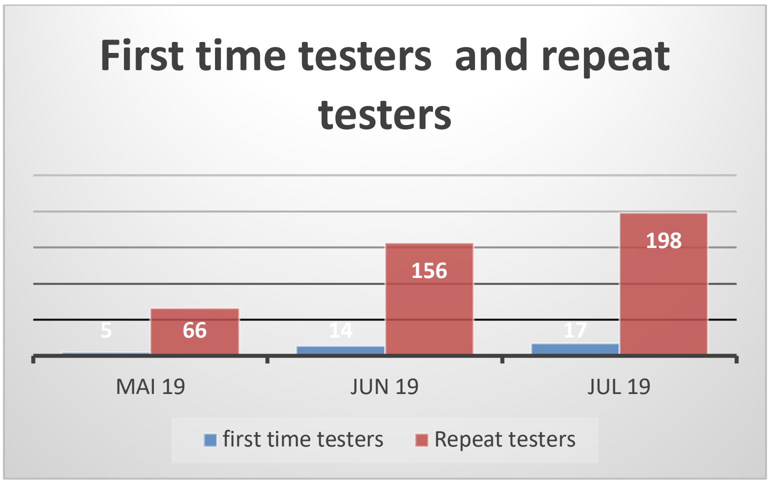

Figure 4. First time testers VS Repeat testers

3.4 Persons tested for HIV and those referred

97% of clients who CHV tested did not require to be referred to a link health facility for confirmatory testing. 3% of those who were referred implied that they did not disclose their test results to the CHV or their tests was reactive.

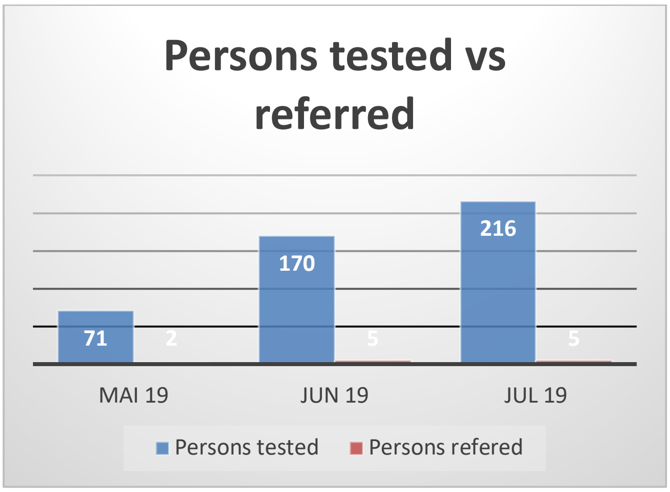

Figure 5. Clients who had been tested and those referred for confirmatory testing to link health facilities

4 Discussion

Community health workers played a huge role in ensuring that the study was a success as they were able to not only test people in their community, but also give them HIV education so that they can be able to protect themselves from the disease. Even though there were more female tested compared to male partners, there was been an increase in number of men tested over the past few months. CHVs encouraged women to test together with their partners so that in case one of them is reactive, they could seek medical care immediately. The number of those tested compared to those referred was also low which would imply that HIV education in Kenya has been well received and that more and more people are taking care of themselves while engaging in sexual activities. Clients also preferred to be assisted by CHV to carry out the test even though they could do this in their own privacy. This showed that the community members had established trust in CHVs to carry out HIV tests and not disclose the results to their neighbours or they were wary of conducting the test alone, especially if the results become reactive; and hence they prefer to be assisted by a CHV. As the study was only conducted in 2 community Units in Kisii county, this induced demand from other regions who also wanted to benefit from the same services as most household members found it more private to test themselves in the comfort of their homes. The study also required for the referred patients to go to the two link health facilities in this study and this proved a huge challenge as most referred clients preferred going to other non-link health facilities where no one knew them due to stigma. The National Aids and STI Control program (NASCOP) has highly supported this program as its one of the ways of reaching the first 90 goal of UNAIDS target of 90-90-90 by 2020 which aims at having more people knowing their HIV status.

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Reducing the turn-around time for supply of health commodities in public health facilities using mobile technology in Kenya

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Background: Under-stocking, stock-outs, counterfeits and delays in delivery of commodities are key challenges to the health sector supply chains in low-to middle-income countries. The health sector supply chain process in Kenya has numerous systems supported by complex combination of parallel logistics systems. Kenya Medical Supplies Authority (KEMSA) is mandated to manage forecasting, procurement, warehousing, distribution and inventory control for health commodities for the public sector. With funding from the United States (US) President's Emergency Plan for AIDS Relief (PEPFAR) through a Public Private Partnerships (PPP) grant, the US Centers for Disease Control and Prevention (CDC) Foundation in collaboration with KEMSA and mHealth Kenya developed the KEMSA eMobile/Logistic Management Information System (LMIS). The KEMSA eMobile/LMIS is a mobile technological application which rides on the KEMSA Logistic Management Information System (LMIS) and is integrated in the Enterprise Resource Planning (ERP) platform. The system enables facilities to order, track and confirm their receipt of supplies, measure turnaround time, fill rates and view order status and county statements. The system was launched in 2013 and is in use in 47 counties.

Methods: In 2019, with funding from PEPFAR through Cardno, a global infrastructure, environmental and social development company, implemented through a PPP, an evaluation of the project was conducted using a one arm before-and-after design with a three months washout period. Data were retrieved from ERP and LMIS databases. A total of 1688 orders from 69 health facilities were collected. Inclusion criteria for health facilities were i) Public health facilities ii) All facilities within counties that had performed at least 45 facility orders 6 months before and 6 months after intervention. ii) Facilities within counties that had received the KEMSA eMobile training iv) Facilities that had used the KEMSA eMobile for at least six months. A paired-samples t-test was conducted to compare differences in key mean turnaround times (mTAT) before and after intervention as follows: 1. Facility order to County receipt. This involved the differences in days between when the facility made an order and when the order was received by the County 2. County Order to KEMSA receipt, which involved the differences in days between when the county made an order and when KEMSA received the order 3. Overall order TAT from facility order to actual facility receipt of commodities which included off system processes and delays in payments by counties. For pairing purposes, the t-test analysis was based on 58 health facilities that had both before and after intervention data.

Results: There were statistically significant differences in the various turnaround times between the two time points (before and after) as follows: mTAT from facility order to county receipt improved by 13.5 days at 95% CI (12.8-14.2); (t_{57} =38.083, $p < .01$); mTAT from County order to KEMSA receipt improved by 22.7 days at 95% CI (19.7-25.6); (t_{57} =15.257, $p < .01$) and overall mTAT from facility order to facility receipt of the commodities improved by 29.4 days at 95% CI (24.1- 34.6); (t_{57} =11.255, $p < .01$). Analysis by county showed that almost all counties had improvements on all turnaround times apart from Homa Bay. Whereas KEMSA's target is to achieve a mTAT of 7 days from ordering to receipt of all commodities at facilities, there were still challenges attributable to manual processes which take place off the KEMSA eMobile/LMIS system and delays in payments by counties.

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Conclusions: Key lesson that was learnt from the KEMSA eMobile/LMIS implementation was that technological innovations have great potential to positively impact health supply chains. Improvements in turn-around times indicate that the system is a worthwhile intervention. Although the overall turnaround time has significantly improved, there are still some bottlenecks caused by factors outside the system which include order rationalization, consolidation and local purchase order generation at counties as well as KEMSA order processing which include picking, loading, routing, dispatching and physical transit.

Recommendations: There is need to strengthen on-job training for the users, extend the use of the system to lower level facilities and automate the remaining tasks which are still being done manually. For forecasting purposes there were calls to technologically enhance the system to be able to provide monthly average consumption data at health facility level.

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Use of SMS Reporting to Improve Program Monitoring and Performance: A Case Study of EGPAF Kenya

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Introduction: Monitoring is an integral part of project management. Data are collected routinely to provide continuous feedback on the project implementation to assist in the identification of potential successes and constraints to facilitate decision making. PEPFAR funded programs require intense implementation and quick decision making to ensure achievement of targets hence the need for timely availability of results by site. Most of the existing data transmission systems are paper based and data is reported on a monthly basis that leads to delayed decision making and program reorientation.

Kenya is one of the countries with an increased penetration of mobile technology at 82% driven by a continuing availability of affordable smartphone industry brought on by a result of increased competition with market players. The use of mobile technology has been demonstrated in the past to be one way to transmit information within the shortest time; it has been used to improve HIV clients' outcomes through appointment reminders. Due to low cost and wider coverage compared to mobile data, Short Messaging Service (SMS) for reporting leverages on technology to collect and send data from wide geographical location. The purpose of the abstract is to demonstrate the effectiveness of the SMS reporting system on program monitoring for timely decision making.

Methodology: Elizabeth Glaser Pediatric Aids Foundation (EGPAF) Kenya is funded by PEPFAR to support implementation of HIV prevention, care and treatment services in 159 health facilities in Homa Bay and Turkana counties. Data are availed to the program team on a monthly basis through the District Health Information System Software (DHIS) platform that has been configured into an in-house EGPAF's Knowledge Management system (EKMS). The data are visualized through different templates like excel Performance Monitoring Plan (PMP) and PowerBI dashboards; program decisions could only be made on a monthly basis. In order to closely monitor performance against targets, there was need for data to be availed on a more frequent basis to enable responsive and targeted programming.

In April 2018 just after the first Semi-annual performance reporting, EGPAF program team identified key "Hot" indicators which are key PEPFAR performance monitoring indicators that would be monitored weekly to drive overall performance by the end of the year. The indicators included clients newly identified HIV, clients newly initiated on ART, appointment keeping, viral load uptake among others. EKMS-SMS android application was developed and availed on Google Play Store to facilitate reporting to EKMS through SMS weekly. EGPAF Strategic Information and Evaluation (SI&E) team rolled out the application by installing and configuring it on selected health facility staff smartphones. The team also sensitized the facility staff on how the solution works and provided technical support on need basis. Messages sent on a weekly basis from the application incurred no cost to the health facility staff. A confirmation message was sent upon successful delivery of the data into EKMS. The SI&E team would then monitor the reporting rates of all facilities for completeness as per the set timelines.

Hot indicators data in EKMS are transformed into data visuals using PowerBI application which is a Microsoft Business intelligence and analytics solution. This platform allows the user to visually explore data, share dashboards and interactive reports and deliver quick insights for informed decision making

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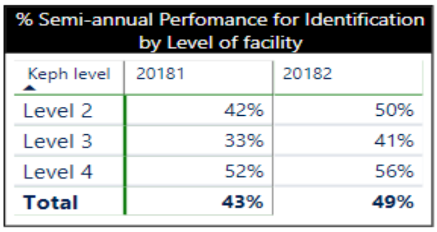
across an organization. These visuals are refreshed daily and reviewed by the program team on a weekly basis to monitor performance and identify gaps that would require interventions. The data reported on a weekly basis was triangulated and compared with what is reported on a monthly basis for validity.

Description of the application

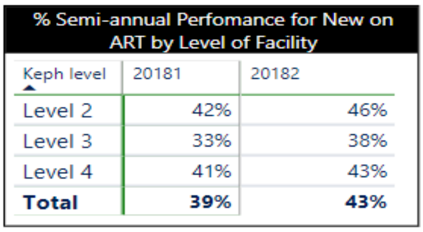
The SMS system has three main components. The EKMS application that is responsible for data capture from the end-user. This application encodes and encrypts the entered data and sends it via SMS messaging. There is also the SMS middleware which is responsible for decrypting and decoding the SMS message sent from the android application. The middleware uses a modem or an SMS gateway service to receive the message. Finally, there is the EKMS instance where the data is loaded and stored for use.

Results: The implementation of SMS reporting to avail data to the program team on a weekly basis ensured 100% seamless and timely reporting for all the 159 facilities by end of every week as compared to the manual monthly reporting. This enabled improved, timely, and accelerated review of program data for quick guided technical assistance that saw the improvement of second semi-annual performance compared to the first semi-annual. The improvement was also observed in facilities across the different cadres as classified in the Kenya Master Health Facility List (KMHFL)



% Semi-annual Perfomance for Identification by Level of facility

Keph level	20181	20182
Level 2	42%	50%
Level 3	33%	41%
Level 4	52%	56%
Total	**43%**	**49%**



% Semi-annual Perfomance for New on ART by Level of Facility

Keph level	20181	20182
Level 2	42%	46%
Level 3	33%	38%
Level 4	41%	43%
Total	**39%**	**43%**

Conclusion: The use of SMS reporting improves timeliness and use of data for decision making for program improvement.

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Improving PEPFAR and Ministry of Health data reporting and alignment through an interoperability solution in EGPAF supported sites in Homa Bay and Turkana County, Kenya

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[2] Ministry of Health, Kenya

1 Background and Purpose

The U.S. government, through the President's Emergency Plan for AIDS Relief (PEPFAR) supports Government of Kenya to accelerate progress toward achieving HIV/AIDS epidemic control. Through this support, Kenya has over 30 PEPFAR supported implementing partners (IPs) providing comprehensive HIV prevention, care, and treatment services. PEPFAR rolled out Data for Accountability, Transparency and Impact Monitoring (DATIM) system though which IPs submit data to PEPFAR on quarterly basis. In addition, the Ministry of Health (MoH) uses the District Health Information System Software (DHIS2), a free and open source database application, to collect health service and commodity data. Differences exist in indicator definitions, age and sex disaggregation between MoH-DHIS2 and DATIM presenting challenges in IPs reporting. Consequently, IPs usually maintain separate databases that facilitate project monitoring and evaluation as well as reporting to PEPFAR. Reporting across these platforms result in additional resources and data demand. Therefore, systems interoperability is critical to achieve timely, effective and concordant data reports in IPs', MOH and PEPFAR systems. Additionally, this would play a pivotal role in contributing towards the principle of having one agreed country-level Monitoring and Evaluation (M&E) system in line with "three-ones" principle.

2 Methods:

Elizabeth Glaser Pediatric AIDS Foundation (EGPAF) through PEPFAR support is implementing HIV prevention, care and treatment in 159 sites (136 in Homa Bay County and 23 in Turkana County). Part of EGPAF's support include facilitating sites to report service and commodity consumption data in MoH-DHIS2 platform. In response to additional PEPFAR data requirements, EGPAF implemented a harmonised data management system known as EGPAF's Knowledge Management system (EKMS) built on DHIS2 platform. To ensure that the data contained in EGPAF EKMS are aligned with data from EGPAF supported facilities in MoH-DHIS2, the Foundation has

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developed an innovative DHIS to EKMS (D2E) solution that allows for interoperability across the two systems and any other DHIS platform.

D2E is a third party interoperable web application for DHIS2 platform that allows for bidirectional pulling and pushing of data from MoH DHIS2 to EKMS. This application provides a simple intuitive user interface for users to pull and push data across different DHIS2 platforms. The solution has validation checks and provide email alerts to users in the event the data in their respective facilities fail validation checks.

2.1 How the system works

The D2E application provide users with the ability to access data from EKMS from a web application powered by Hypertext Pre-processor (PHP) scripting language. D2E has a web application designed to work on any browser and it communicates with Application Programming Interface (API) endpoints for MoH-DHIS2 and other DHIS2 platforms. This application is hosted on a Hypertext Transfer Protocol (HTTP) apache server. Upon logging into EKMS users are directed to the app via a link. Users are assigned different rights and privileges. For example, super user can create, edit, delete users as well as assign user to specific data sets and facilities.

2.2 Key D2E components

a) user Login & Account management

The web app user must have two login credentials; one for EKMS and the other for D2E. The user navigates to the browser and accesses EKMS and once they log in they navigate to the D2E link on the dashboard

b) Fetching Data from MOH DHIS and posting into EKMS.

To fetch data user specifies period, dataset and facility parameters, clicks on fetch data button and data are pulled from MoH-DHIS2 and are ready for transmission to the receiving system. Once the data are pushed into receiving system the user receives a notification via email.

c) Data validation

D2E allows for comparison across indicators reported in DHIS and data collected as per the finer PEPFAR disaggregation using EGPAF's M&E systems. The validation process is set to check for completeness and concordance of the reported data. Discordant data is flagged by the system and an email with list of discordant data elements (errors) is sent by the app to the site support team comprised of M&E and program officers. If the source of the error(s) is our program data, then program team does the correction. On the other hand, if the error(s) is with MoH-DHIS2 report(s) then this is flagged with the sub-county management team for correction. Once the error(s) is resolved then the M&E officer updates into the system and marks the error as resolved.

3 Results

Use of D2E has ensured 100% complete and timely reporting EGPAF supported sites. Because data reported to PEPFAR are validated before they are pushed into EKMS from MoH-DHIS2, EGPAF has achieved 100% concordance between DHIS, EKMS and data reported to PEFPAR through DATIM.

4 Conclusions:

D2E if adopted and implemented with fidelity by IPs whose databases run on DHIS platform would allow for Interoperability between MoH-DHIS2 system and IPs' data management systems. This will ensure full data concordance between MoH-DHIS2 and DATIM and hence contribute towards ensuring that the country achieves full PEPFAR-MoH data alignment.

Keywords: Kenya, PEPFAR-MoH data alignment, Health management information systems, DHIS 2, DATIM, Interoperability, EKMS.

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Nairobi County NCDs Technology: Use of an Electronic Medical System towards improving health outcomes of Diabetes and Hypertension patients in Nairobi county Kenya

Susan Gathu

IT PM, Kenya

1 Background

Nairobi City County Health Services Department with support from Malteser International (MI), through the German Ministry for Economic Cooperation and Development, in collaboration with the African Institute for Health and Development (AIHD) and IntellISOFT Consulting have implemented a Non Communicable Diseases Quality Management electronic medical system (Nairobi County NCD QM EMS) technology to build the capacity of healthcare workers to adhere to clinical guidelines in the management of hypertension (HTN) and Diabetes Mellitus (DM) within Nairobi's informal settlements. The EMS provides a platform to easily digitize & avail NCD data in 4 select sub-counties in Nairobi County, Kenya. The EMS users are primarily clinicians, other users include data clerks and administrators at facility, sub-county & county levels. Users access the system through the Android mobile application and/or the web application to collect data online/offline, manage data and report

2 Methods

The EMS is built on the OpenMRS platform with custom modules for the provision of care for DM & HTN clients designed for use in low resource environments. The design & implementation of the system uses the Principles for Digital Development; designing with the user, understanding the existing ecosystem, using open standards and open source innovation. Additionally, a multiprong training approach is in use and entails the use of a threefold training module approach covering the clinical guidelines, Ministry of Health(MOH) tools and the EMS jointly, On-the-job training, Training of Trainers(ToT) and mentorship of champions.

3 Outcomes and discussions

Through the collaboration of the stakeholders including end-users, county & sub-

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county teams, the system complements the newly rolled out MOH tools on DM and HTN and further supports the capacity of healthcare workers to adhere to the national clinical guidelines whilst ensuring privacy & security concerns are addressed. The system features include In-built clinical decisions, resources, intelligent recalls for follow-ups, patient notification and communication via SMS, offline capabilities, location & role-based access, integration with existing e-Health tools including DHIS2 and extensive indicator reports.

4 Conclusion

Effectively leveraged Open Source technologies can be used to reinforce the capacity of health care workers to adhere to national clinical guidelines and facilitate NCD data collection, management and reporting, proving that technology can fortify non-technological innovation and avail data for health service delivery programs.

Keywords: Adherence to clinical guidelines, EMS, NCD data, reporting

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Harmonizing Minimum Competencies for Masters in Health Informatics Programs in Africa Leveraging University Accreditation Bodies and Professional Societies

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Keywords: Keywords: Health informatics; Education, Graduate; Capacity Building; Africa

1 Introduction

With increasing adoption of health information system across Africa, there is an increased demand for highly-trained individuals to lead and support these systems. Multiple universities now have degree-level health informatics (HI) programs, with many of these being post-graduate Masters in Health Informatics (MSc HI) programs. Given that HI is a multidisciplinary field at the intersection of health and information sciences, MSc HI programs can be hosted in different types of schools or departments within Universities, with the degree programs emphasizing vastly different areas of the HI space - from clinical, computing to public health emphasis. As such, a significant risk exists for emerging and existing MSc HI programs to cover vastly different competencies, while defined international competencies might not directly translate to regional needs.[1] Differences in competencies for the same degree program poses a risk for this emerging HI field, as employers cannot have a clear understanding of what an MSc HI degree entails. In addition, differences make it difficult for students to transfer credits across institutions and faculty to teach across institutions. A key purpose to establishing benchmarks for minimum competencies in MSc HI programs in Africa or within its regions ensure several outcomes, namely: (1) comparable quality levels of the graduates, (2) comparable chances of graduates in the labour market, especially with regional free flow of labor, (3) understanding by labour market of competencies that MSc HI graduates possess, (4) increased national and international mobility of students; and (5) increased national and international mobility of faculty. (248 / 250)

2 Materials and methods

Addressing the above challenges requires collaborative efforts between higher education institutions (HEIs), in-country commissions of university education, regional accrediting bodies for degree programs, Ministries of Health, private and public sectors, and health informatics professional bodies. Each of these bodies plays a key role in ensuring that identified benchmarks meet international standards, while being responsive to the local, regional and continental needs. Further, the developed harmonized minimum

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standards have to be enforceable to ensure that universities can be evaluated against these benchmarks as part of quality assurance mechanisms for university education. (90/250)

3 Results

Leveraging the above stakeholders, a multi-step curriculum harmonization process for MSc HI curricula was conducted for East African Universities, after evaluation of similarities and differences between the eight existing accredited MSc HI programs in the region. This process was led by the Inter-University Council of East Africa (IUCEA) as part of a process called the Credit Accumulation and Transfer (CAT) System, which also includes a two-day CAT workshop involving all key stakeholders. Participants for the CATS workshop were drawn from HEIs, including Deans, HODs, and the field experts. There were also representatives from professional bodies such as International Medical Informatics Association (IMIA) and the Pan-African Health Informatics Association (HELINA), as well as from the Ministry of Health. Institutions involved included those from Kenya, Tanzania, Rwanda, Uganda and Ethiopia, with Ethiopia participating by invitation, given that it had two Masters of Science in Health Informatics programs. The final 'Benchmarks for the Master of Science in Health Informatics Programmes in East Africa' document is currently undergoing quality assurance review by the IUCEA, and ratification by IUCEA is anticipated in December 2019. Thereafter, all existing and new MSc HI programs in the region will have to conform to the defined minimum competency standards. We anticipate that the experience from the East Africa MSc HI CATS exercise can inform the process of harmonization of curricula in other African regions. (225/250)

4 Discussion

Through this session, we have constituted panelists with various competencies representing health informatics curricula expertise, representatives from IMIA and HELINA, and experts on regional-level University accreditation and quality assurance. Panelists will describe experiences and lessons from the East Africa CAT process, outline emerging international HI competency standards and articulate potential mechanisms for promoting continent-wide minimum standards for MSc HI. The ultimate goal is to ensure that HIEs within countries can train graduates who can adequately meet the increasing needs of HI specialists in the continent. (85/250)

Acknowledgements

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Statement on conflicts of interest

No conflicts of interest.

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A syndromic Surveillance Framework for Resource Limited Settings: Case Study of Health Facilities in Eldoret Town, Western Kenya

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[c] Vanderbilt University Medical Centre, Nashville, USA

Background and Purpose: In resource-limited settings, disease outbreaks are increasingly becoming common. This is often due to delayed detection and analysis of disease indicators in the general population. To counter these outbreaks, innovative surveillance modalities need to be implemented. Given the rapidly changing landscape in which electronic health information systems (e-HIS) are being increasingly implemented, the surveillance environment can be greatly improved through implementation of electronic syndromic surveillance to hasten detection of outbreaks. As such, an understanding of the electronic e-HIS landscape is imperative for understanding the shortfalls and optimal strategies for electronic syndromic surveillance implementation.
Methods: The study was conducted in two phases. Phase 1 involved interviews with 36 purposively-selected health workers across six health facilities to assess e-HIS readiness for syndromic surveillance. Thematic analysis was used to identify factors likely to impact electronic syndromic surveillance implementation using the existing e-HIS systems, and to identify gaps and opportunities in implementation. Phase 2 involved use of Phase 1 findings to inform the design of a syndromic surveillance system framework tailored to the region.
Results: Syndromic surveillance leveraging existing e-HIS is likely to be impacted by data standardization, interoperability and connectivity challenges. Availability of relevant e-Health policies, technical staff for systems support, infrastructure, and financing are other considerations. On this basis, a syndromic surveillance framework modelled on the existing e-HIS landscape can be implemented.
Conclusions: e-HIS landscape in resource-limited settings offers an opportunity for syndromic surveillance implementation but observed barriers should be addressed and guiding principles developed for successful implementation.

Keywords: Syndromic Surveillance, Electronic Health Information Systems, Developing Countries.

1 Introduction

Communicable disease outbreaks continue to pose a big threat to the health service sector in resource-limited settings. In 2017 and 2018, over 50 disease outbreaks were identified in sub-Saharan Africa, with more than five outbreaks of cholera in East Africa alone. [1][2] These outbreaks are being seen despite development and implementation of robust disease surveillance strategies like the Integrated Disease Surveillance and Response (IDSR) framework which is recommended in such settings. [3]

Over the past decade, many countries within low- and middle-income settings have seen increased adoption and implementation of Electronic Medical Record Systems (EMRS). In recent years, open-source EMRs, like OpenMRS™, have been rolled out in a number of health care settings, with over

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fifteen different African countries currently in various stages of large-scale implementation of this system.[4] In fact, a number of these countries have moved beyond pilot projects to active implementation of EMRS as part of their national health service provision programme.

Digitalization of health data through EMRS promise to improve the quality of patient care offered, and reporting to Ministries of Health. In addition to these roles, EMRS have the potential to improve approaches to disease surveillance, especially with application of novel syndromic surveillance techniques. Syndromic surveillance systems strive to “identify illness clusters early, before diagnoses are confirmed and reported to public health agencies, and to mobilize a rapid response, thereby reducing morbidity and mortality’.[5] When appropriately used, and leveraging data analytics and decision support systems, EMRS data can be useful for syndromic surveillance determination. For appropriate use of EMRS systems for syndromic surveillance in LMICs, an evaluation needs to be conducted to assess readiness of the settings for use of these systems. This includes assessment of policies, people, processes and infrastructure needed to leverage EMRS for syndromic surveillance in these settings.

2 Materials and Methods

A qualitative cross-sectional study was carried out in six health facilities in Eldoret town with three of these facilities being private and three being public facilities. Facilities included a major referral hospital in western Kenya. Aspects of the implemented EMRS pertaining to syndromic surveillance were examined through interviews with both the primary and secondary users of the EMRS at the six study facilities. Eldoret, Kenya, is home to one of the earliest implementations of OpenMRS, through the AMPATH program.[6][7] Other systems have since been adopted, with several private and public facilities having EMRS of their own.

For this study, selection of health facilities was done purposively, with a focus on facilities which served the largest component proportion of the population in Eldoret, and guided by data gathered in prior reconnaissance interviews, as well as data by the Uasin-Gishu County Health Index. A total of 36 respondents including facility administrators, system administrators, public health officers, health information officers, clinicians, physicians and nurses were enrolled into the study based on the presumption that at this sample size would be adequate to reach a point of theoretical saturation, as well as data saturation.[8][9] The interviewed participants were distributed evenly between the study facilities, with six respondents interviewed from each health facility. Subjects were selected based on their possession of adequate experience in use and management of the implemented EMRS.

Data collection was done between November 2017 and February 2018 through in-depth interviews with the respondents. Interviews were carried out at the respondents’ places of work at such times as were convenient with them. Informed consent was sought from all respondents prior to commencement of interviews and interviews lasted between 30 to 45 minutes. Interviews were carried out based on an interview guide grounded on the World Health Organization validated tool for assessment of surveillance systems.[10] This tool included components for examining timeliness of reporting, accuracy of reporting, frequency of reporting, existing challenges, as well as opportunities for improvement of surveillance systems. Interviews were audio- recorded and all recordings were checked for audio clarity immediately after the interviews. Recordings were then transcribed verbatim and all transcripts were exported to Atlas ti.7 for secondary thematic analysis as illustrated by Clarke and Braun through modelling and examining relationships between syndromic surveillance and the various factors that can impact its implementation.[11]

3 Results

The readiness assessment of existing EMRS revealed a number of opportunities, as well as challenges, to comprehensive syndromic surveillance implementation. Identified issues fell into several categories, namely: health information standards, health system financing, technical expertise, e-health policy, interoperability and information exchange, collaborative implementation concerns.

3.1 Identified opportunities and challenges in using EMRS for syndromic surveillance

3.1.1 Health Information Standards

Apart from the referral hospital, all public facilities assessed used the same EMRS (*UG-Afya care system*) with clinical observations and medical diagnoses coded using ICD 9 and ICD 10 standards. It was reported that the system employs Current Procedural Terminology (CPT) for laboratory and pathology procedures. As noted by one interviewee who said;
"Here at the hospital, the system used has ICD9 and ICD10 standards implemented in the system for collection of encounter and pharmacy data. For the case of laboratory findings, CPT is implemented." – Information officer.

At the private facilities, different types of EMRS were in use. These EMRS do not have any health information terminology standards implemented, and as such, data is entered into the system and stored based on lists built-into the systems guided by the facility's needs or entered as free text.

3.1.2 Health Information System Financing

All facilities studied relied on some form of external funding, including initial significant donor funding for some of the facilities, with relevant support tapering off over time. Public institutions also received support from the government. For both public and private facilities, revenue generated as part of care provision also helped to finance operations. It was evident however that little to no finance is dedicated towards EMRS maintenance, research and enhancements.

3.1.3 Technical Expertise

Public facilities managed by the county had only one informatician based at the county in charge of all instances of their EMR employed at the different facilities as noted by one user who stated;

*"We only have one IT expert responsible for overseeing all the **UG Afya care** implementations and their maintenance and, he visits our facility every Wednesday of the*" –Nurse, Public facility.

All other facilities studied had on-site personnel to manage their systems. However, there were capacity gaps in these personnel, especially on how conversant they were with some core system functionality such as clinical decision support and basic health information standards.

3.1.4 Knowledge of eHealth policies and standards

Respondents perceived eHealth policies as primarily being meant for only use at public entities, as noted by one respondent;

"You know… most of the county policy is made for users of their UG-Afya care system. Their policy is not inclusive of other systems other than UG Afya care that are used in the county." –Administrator, Private facility

None of the correspondents expressed comprehensive knowledge of key components governing EMRS implementation at both the county and country levels in Kenya. As such, they were not aware of the standards needed or implementation strategies recommended. All implementations were primarily guided by individual organization's policies and standard operating procedures.

3.1.5 Interoperability and Health Information Exchange

The various systems at private facilities and the system used at the main referral hospital have are also not interoperable with any other external systems. County facilities use the same EMRS and do not have interoperability concerns across public facilities. The implemented system however does not interoperable with any other external systems, including DHIS2 system which is the major data aggregation tool by the ministry of health.

"Currently, this ***UG Afya*** *system is not compatible with the DHIS2 system used by the MOH so we can't send data directly from the system to DHIS2,"* –Public health officer**.**

All implementations operate as silo implementations, with no active health information exchange using a network infrastructure. As such, data cannot be electronically sharable or utilized beyond the points of generation.

3.1.6 Health IT infrastructure

All facilities studied had adequate electronic health information infrastructure including workstations, handheld mobile devices (like smartphones and tablets), network cabling and others. However, even in the presence of adequate infrastructure, most of it was redundant and unused by health information systems, owing to connectivity concerns and lack of personnel to install the required applications for use.

3.2 A syndromic surveillance framework for use in Eldoret, Kenya

Based on findings from the assessment of status with EMRS implementation and existing opportunities and challenges in Eldoret Kenya, a syndromic surveillance framework was proposed for implementation in the region, as a demonstration of what is feasible within existing constraints. The framework proposed was adapted from the system architecture of Real-time Outbreak and Disease Surveillance (RODS) System.[12][13] The RODS system is a free-and open-source Public Health Surveillance system that uses a variety of health data sources for surveillance purposes.

The syndromic surveillance system leverages data from facilities that have EMRS systems implemented. The system can also make use of laboratory findings and pharmacy medicine sales as well as emergency departments information. Other health information sources with functional electronic health information systems can also be harnessed and be incorporated into the system. Data collected at facilities, such as patient demographics and chief complaint, are first normalized by the standards resolution platform into a unified standard understandable by the syndromic surveillance platform and then generated into an HL7 ADT (admission, discharge and transfer) message. The consequent HL7 message is then transmitted to the HL7 message router (e.g. Mirth connect) and on receipt, all protected health information (PHI) is deleted from the message, which then is cued for transmission to the surveillance system through a secure virtual private network.

The surveillance system HL7 listener maintains the connection with the facility HL7 router and parses arriving messages. The same also occurs for laboratory results and pharmacy sales whereby sales (drug type and composition as coded in the data dictionary) are encoded into an HL7 RDE (Pharmacy encoded order message) message and then transmitted to the surveillance system. The chief complaint part of each received message is passed to the Bayesian text classifier which then assigns it to specific syndrome category. The classified category data are stored in a secure database, and availed for use by the system applications including detection algorithms (to detect changes in the occurrence of events based on pre-set thresholds) and to geographic information tools (for mapping). Detected syndromes through this system are availed to end-user systems through a 'Warning API' for incorporation into user interfaces that then leverage visualization to disseminate syndromic surveillance information (Figure 1).

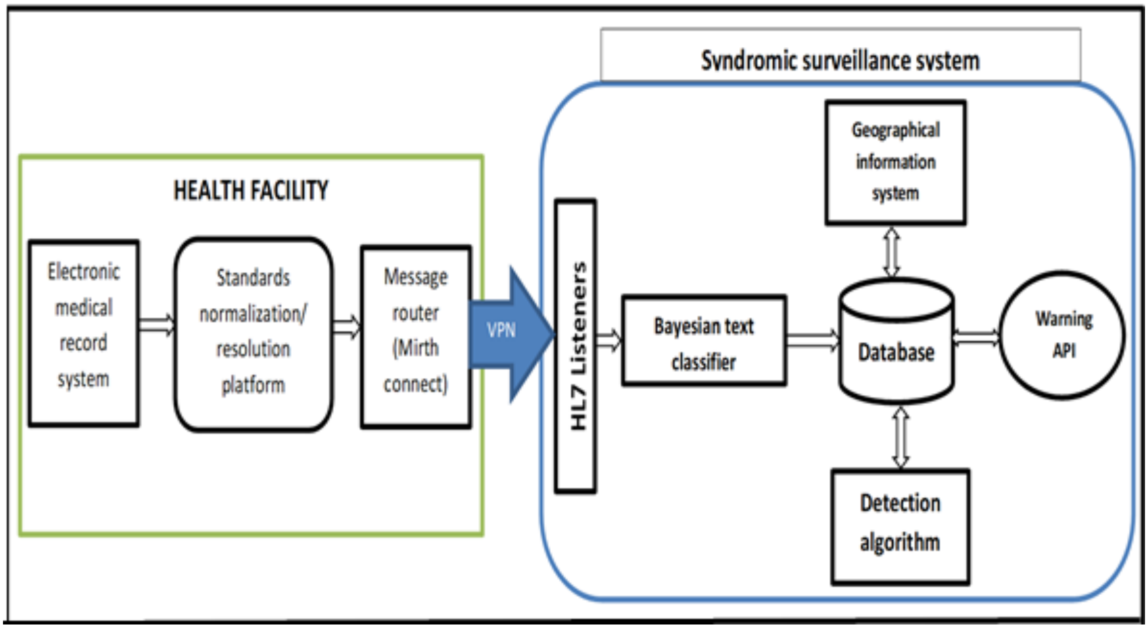

Figure 1: The proposed syndromic surveillance framework for implementation in resource limited settings based on The Technical Description of RODS10 [12]

4 Discussion

In this study, we conducted a systematic readiness assessment of implemented EMRS for syndromic surveillance in a low-resource setting in Western Kenya. Our study suggests that multiple issues need to be addressed if existing EMRS are to be used for syndromic surveillance detection. Key to these issues is the need to ensure that existing and implemented EMRS conform to standard-based approaches to storing clinical data, and that implemented systems are able to exchange data using clinical messaging such as HL7. It is observed that the lack of standards-based approaches to existing EMRS implementations is largely due to a lack of awareness of the prescribed standards in the country, with implementers and users unaware of national policy and standards requirements. Such challenges are not unique to sub-Saharan Africa, as the same challenges have been observed in other settings.[14] Ideally, incorporation of standards should be considered well before the system is in use.

Other considerations to successful EMRS implementation with relevance to syndromic surveillance include adequate financing, availability of relevant personnel to support the system, good networking infrastructure and capability for information exchange within systems, with primary focus on use of standard terminology and messaging services. Technical shortfalls impact functioning of electronic health information systems which are the primary sources of data for syndromic surveillance. As such, great emphasis needs to be placed on acquisition of adequate technical expertise to address any shortfalls in an adequate and timely manner. The pragmatic inadequacy of technical expertise is partly due to the shortage of experts with health informatics experience.[15]

Even in the presence of all other factors, to achieve standardized development and implementation of EHRs in resource-limited settings, there needs to be a supporting e-Health policy. As such, the policy development strategies should be inclusive of all concerned stakeholders. This in many scenarios is not the case for many resource-limited settings, with observed reluctance and lack of awareness of existing policies.[16] Just like standards, interoperability and connectivity form the basis for data transfer and data sharing central to successful EMRS-based syndromic surveillance systems.[17] Connectivity deficiencies even in the presence of interoperability render data sharing impossible and will likewise need to be addressed.

Once issues related to standards, infrastructure, networking are addressed as part of EMRS implementation, it should be feasible to implement a comprehensive syndromic surveillance system for these settings. For this, there is no need to reinvent the wheel, and adapting existing approaches provides an easier channel to successful implemented. When well implemented, these syndromic surveillance systems will help bridge the shortcomings observed in existing integrated disease surveillance systems, that often have low timeliness and low data accuracy.[3]

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Statement on conflicts of interest

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Characterizing Data Errors in a Pediatric Clinical Information Network

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Background: Medical errors represent a serious public health challenge. It is estimated that up to 10% of hospitalized patients experience adverse events related to errors in medical management. In this analysis, we describe the magnitude and nature of errors captured from data collected from paediatric inpatients in 14 Kenyan hospital.

Methods: Clinical Information Network (CIN) is a collaboration between the Ministry of Health, 14 participating county hospitals, Kenya Paediatric Association and KEMRI-Wellcome Trust Research Programme designed to promote the use of routine data to promote clinical behavior change. In addition to direct clinical audit and feedback, measures to ensure data quality in CIN include automated query generation on the database, independent double data entry, weekly data monitoring through dashboards, and training and mentorship of data clerks. Errors emerging from the data reported in this analysis were classified as clinical (medical errors in the primary patient record), missing data (data points that are not documented) and transcriptional (due to data entry).

Results: CIN receives approximately 300 episodes of paediatric inpatient data captured on a daily basis. For the period January 2018 to December 2018, 23814 data episodes were screened. Out of 23814 data episodes, 1061 (4.5%) data points had errors. Of these 243 (22.9%) were a result of missing data, 302 (28.4%) were transcriptional and 49% clinical. Clinical errors were classified based on the nature of the field: Biodata – 5%, Examination- 41.9%, History - 11.6%, Supportive Care-31.6%, Treatment – 9.9%.

Conclusion: Data errors were infrequent. Clinical errors (mainly arising from documentation of fields related to physical examination and supportive management) accounted for almost half of the errors observed. Minimizing data errors of all types is a priority activity that has implications on the quality of reporting, patient safety and ultimately the outcomes of patient care.

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Using a mobile, web-based platform to find and track lost cases of people living with HIV and linking them back to care and treatment in Mozambique

Humberto Nelson Muquingue, Argentina Balate, Jose Come

Jhpiego Mozambique

Introduction:
Retention in HIV care and treatment (C&T) has been a global challenge in the management of individuals living with HIV (PLHIV). Mozambique is not an exception. In February 2019, the retention rate was just 70% (the goal is above 90%). To support the Ministry of Health in the implementation of activities aimed at improving the retention rates, specific focus was put on 66 health facilities classified as priority in 4 provinces. The core activity was to locate each patient identified as lost to follow-up (LTFU) and link them back to C&T.

Methods:
To improve the tracking and re-linkage of those LTFU, Jhpiego developed a mobile, web-based, online/offline platform known locally as PISAUDE. PISAUDE includes mapping capability and is simple enough to be daily used by the 212 lay counselors (LC) carrying out the HTC activities, enabling the collection of both the reported address and GIS coordinates gathered by the LC. PISAUDE was also used to support the retention during this period.

Results:
From the 13,314 LTFU patients, 12,355 (92.8%) were located, of which 9,772 (79.1%) were indeed true LTFU, 1,355 were falsely labeled LTFU due to delayed data updates at the HFs (1,303); unreported deaths (19); silent transfers (18); and patients enrolled in more than 1 HF (15). Of the true LTFU, 5,512 (56%) were relinked to C&T. Of the total LTFU, 959 individuals (7.2%) were not found, mainly due to incorrect or changed home addresses.

Discussion and Conclusions:
This application was able to support LCs in finding LTFU (even when the patient addresses and names were incorrect), improve the return of PLHIV to C&T, and serve as a monitoring tool for HIV-related activities. It also showed that there were stakeholders in the retention process at the facility level who should be in tune to reduce the occurrence of falsely classified LTFU.

This is a showcase that a mobile, web-based platform may be able to handle complex data but be simple enough for LCs with basic formal education to use for such critical activities such as locating individuals who were LTFU, sort out the causes for LTFU, and return those eligible to HIV C&T.

Keywords: AIDS; Retention in care; Lost to follow-up;

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An experience on engagement, sustainability and scale up of digital solutions: the case of a pre-service information system in Mozambique

Humberto Nelson Muquingue, Julio Tualufo

Jhpiego Mozambique

Introduction:

Many countries implement human resource information systems (IS) to support better health workforce use and management. One challenge is the continuous need to update data following development and roll-out phase. Other challenges are poor sustainability and difficult scale up of such systems.

This abstract is about an IS designed to allow Mozambique Ministry of Health (MOH) to track the delivery of core competencies to trainees in health training institutions (HTI), and ensure the competences are standardized to assure capacity in priority areas of the health service delivery. This IS, named SIFIn, is web-based and manages data on pre-service education (on students, lecturers and facilities).

The aim of the abstract is to explain how the IS was appropriated by both the central level of the MOH and the lecturers in the HTIs. The appropriation resulted in fast institutionalization and scale-up, given that the IS fulfilled data needs at both ends: aggregated data for the MOH; pedagogical data for the users.

Methods:

SIFIn development initiated in 2011. At that time, the HTIs used Excel spreadsheets and manual processes to collect and report training data, which the MOH accessed by individually calling each HTI. For this abstract, access log and data completeness reports from SIFIn were used to estimate SIFIn coverage and identify issues associated with the use of SIFIn, over the past 8 years.

Results:

A year after full SIFIn deployment, only one fifth of the HTI used SIFIn, given limited engagement of HTI directors and MOH officers, therefore data incompleteness and delays still prevailed, while resistance to abandon own tools threatened SIFIn. As a concerned MOH moved to gain from its investments on SIFIn and curtail resistance, directives were issued mandating the use of SIFIn for data collection and reporting; this political was complemented by continuing consultation with HTI staff to ensure SIFIn accommodated all data needs. By 2017, all 17 major MOH training facilities implemented SIFIn.

Currently, SIFIn is the main source of pre-service information. Four private HTIs are also using SIFIn now.

Discussion and Conclusions:

This abstract describes both a practical solution for monitoring the educational priorities needed to have a competent and capable workforce, as well as how engagement with the MOH can help to achieve institutionalization, sustainability and scale-up. These are all challenges faced in several low-resource countries that have been resolved, as presented, in Mozambique. When the system become part of the MOH core practices it was easier to incorporate it and to move towards mandatory use. Subsequent data updates then require continued follow-up and rigorous review of data quality. Both the approach and initiative would likely be of high interest to countries with a similar disposition as Mozambique.

Keywords: Information systems; pre-service education; sustainability

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Centralizing Patient Level Clinical Datasets: The Government of Tanzania Health Operations Management Information System – (GoT-HOMIS)

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The complex business process of health facilities has resulted into pitfalls in sustaining and or improving the provision of better health care and health outcomes in Tanzania. One of the major challenges facing the Government of Tanzania in applying correct interventions on time are the collection and availability of correct patient level statistical data from health facilities. The well-established paper based Health Management Information System – HMIS (famously known as MTUHA) has faced some challenges in attaining the required level of clean and correct data due to manual processes involved in the data management chain. The introduction of DHIS2 as an electronic means of aggregating the HMIS data has also introduced yet another user point of introducing new errors during data entry from HMIS summary forms to the corresponding DHIS2 screen forms. This has led to a low quality of health data that is responsible in national level decisions regarding such a sensitive health sector where human life is at stake. The introduction of Government of Tanzania – Health Operations Management System (GoT-HOMIS) in health facilities is now facilitating the collection of patient level clinical datasets responsible for generating the HMIS datasets linked to DHIS2. Not only this has set platform for correct and retrievable patient level statistical health data; but also introduced an Electronic Medical Record (EMR) system which is providing ease inter-facility sharing of patient profiles. This paper discusses the genesis and successes of the implementation of GoT-HOMIS in Tanzania health facilities as a system capturing, centralizing and managing patient level clinical datasets and its ability to integrate with other systems across the health sector via various information mediators. The guiding e-Health Strategy, inclusion of development partners, planning, implementation successes and challenges are also articulated in this presentation.

Keywords: GoT-HOMIS, HMIS, DHIS2, EMR, clinical datasets, health facilities

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Using a geographical information system to map and find new HIV cases in communities through an integrated digital health platform in Mozambique

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Jhpiego Mozambique

Introduction:

Working in a heavily HIV-burdened country, identifying and delivering services to as many new clients as possible is of the highest priority. Delivering integrated services is equally important in the era of the Sustainable Development Goals. Being able to not only identify cases with HIV and TB, but also those who suffer other non-communicable diseases which can complicate their clinical picture becomes a larger challenge. As an approach to attempt to better orient efforts, geographical information system (GIS) tools have emerged and have been used to help map disease and gain insight about the real picture of public health. GIS is now widely used to solve some issues and further our understanding of the prevalence of disease within a given area as well as its respective trend through time. In Mozambique, Jhpiego has been using GIS to strengthen its ability to identify new cases of HIV infection.

Methods:

Through the use of an integrated digital health system, PiSaude platform, geographic data helped to strategically target communities and areas seen to be HIV “hotspots”.

Results:

The system interlaces the GIS coordinates of cases to be able to identify concentrated areas over a Google Maps application to orient teams into specific areas where new cases are likely to be found. Because data is captured in an integrated health system, conditions such as TB and non-communicable diseases can also be tracked among this vulnerable population. All maps were dynamically generated with only a few clicks of the mouse. By analyzing these maps, services could be better oriented to target specific and priority areas among those who may benefit the most.

Discussion and Conclusions:

This abstract presents a unique, locally-owned solution for identifying new cases of HIV infection, TB and non-communicable disease by using GIS technics and maps from the innovative idea used within integrated platform called PISAUDE. This information is provided in real time and can dynamically optimize the provision of service and improve the outcomes. This is innovative way to work strategically in health system.

PISAUDE also had novel approaches to monitor disease progression; if data reached a threshold, even estimates of incidence are possible, which are challenges in countries with limited budgets and sparse populations, often living in rural locations.

The lessons learned with PISAUDE may also be transferable to support south-south learning exchanges and well as south-north learning exchanges where this level of active data analysis does not yet exist.

Keywords: Digital platform; HIV infection; geographical information systems

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Best Practices for Electronic Health Record System Implementation: A GEEKS project in Zambia

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Abstract. A number of studies have shown the potential of electronic health record systems (EHRs) to improve to access to information and quality of care, which subsequently improve health outcomes. Although still limited, the use of EHRs has increased in developing countries, for patient management, data management, program monitoring and reporting. However, development and implementation of such systems are marred with a myriad of challenges that affect growth of the system and long term sustainability.

Growing Expertise in E-Health Knowledge and Skills (GEEKS) is an applied, project-based informatics training program patterned after the Field Epidemiology Training Program. One of the GEEKS projects in Zambia aims to establish best practices for EHR implementation in limited resource settings. This paper will describe the progress made so far and the methodology used to understand the factors affecting sustainability of EHRs from the development phase, deployment phase and maintenance phase. The study plans to employ a cross-sectional survey using both quantitative and qualitative methods for data collection and analysis. Semi-structured interviews, focus group discussions and hands-on skills assessments using graded standard scoring tools will be conducted for health care workers in all the ten provinces of Zambia. The study has already received ethical approval from the National Health Research Authority of Zambia.

The study will review the implementation of SmartCare, the national EHR for Zambia. SmartCare is implemented by the Ministry of Health (MOH) in collaboration with development implementing partners with support from President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC). Since its inception in 2005, SmartCare has evolved into a complete her system, supporting all primary health care services. This system is deployed to about 750 out of the 2900 facilities across the 10 provinces of Zambia and has more than 3,000,000 unique patient registrations. The authors aim to use the findings from this study to improve SmartCare uptake, use, and sustainability in Zambia. The findings will be shared with the scientific community through a conference presentation and journal publications.

1 Introduction

Zambia is a developing country in Sub-Sahara Africa with a population of 13.1 million in 2010, projected to be 17.4 million by the end of 2018 (1). Zambia's Ministry of Health (MOH) has pursued a strong vision aimed at providing quality health services that will lead to a healthy and productive population. MOH thus strives to ensure that there are cost-efficient, effective, and accessible health services available to all citizens. Currently, Zambia has over 2,900 health facilities nationwide (2). The majority of the facilities are owned by the Government of the Republic of Zambia (GRZ) (77%), while 23% are owned

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missions, private companies and the military (2). The vast majority of these health facilities are health centers (95%), while first, second, and third level hospitals comprise the remainder of the nation's health facilities (2).

Zambia has a high disease burden, which is mainly characterized by high prevalence and impact of communicable diseases, particularly, malaria, Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS), Sexually Transmitted Infections (STIs). According to the Zambia Demographic and Health Survey of 2013/14, the HIV prevalence rate was estimated to be 13.3% among adults (15-49 years) (1).

Despite the severity of the HIV/AIDS epidemic, Zambia has made significant progress towards epidemic control. In 2003, GRZ began subsidizing antiretroviral treatment (ART) to make the medication free and available to all citizens in need. Subsequently, the country saw a substantial rise in the number of clients initiated on treatment. At the time, all patient medical records were part of a paper-based system, which created numerous challenges in monitoring patients on ART. To mitigate these challenges, Zambia adopted SmartCare electronic health record (EHR) system to monitor and analyze the performance of ART patients.

SmartCare is an integrated EHR system designed to help Health Care Workers (HCW) follow up patients in need of HIV Care and all other out-patient clinical services. SmartCare promotes continuity of care as patients travel between different communities and health facilities with their health record on a Smartcard and is useful in health facilities with large patient volumes as the calculation of the number of clients is done automatically. It is also able to link clients to others services they are receiving either internally or from other health facilities.

Since its inception in 2005, SmartCare has evolved from an ART monitoring tool to a full-fledged EHR system supporting the following health services: Voluntary Counselling and Testing (VCT), Labor and Delivery (L&D), Pharmacy, Laboratory, Tuberculosis, Registration, Out-Patient Department (OPD), In-Patient Department (IPD), and Death Registration. There is also a portable version of SmartCare, SmartCare Lite, developed for use by Community Health Workers (CHW).

SmartCare is an important component of the National Health Management Information System (HMIS), which collects, compiles and aggregates data on Zambia's disease epidemiology and service delivery indicators coordinated by the Monitoring and Evaluation Unit of the MOH. The system is based on MOH and cooperating partners' existing data collection tools and it collects patient-level data generated at health facility service points. SmartCare has been developed and deployed in collaboration with the Centre for Disease Control and Prevention (CDC) and many other implementing partners.

Growing Expertise in E-Health Knowledge and Skills (GEEKS) is an applied, project-based informatics training program patterned after the Field Epidemiology Training Program (6). One of the GEEKS projects in Zambia aims to establish best practices for EHR implementation in limited resource settings. The paper describes the process that will be taken to carry out a study that will review the implementation of SmartCare to establish the best practices for EHR implementation in Zambia and to develop a framework for sustainability. It is envisioned that findings from this study will improve SmartCare uptake, use and sustainability in Zambia. The findings will be shared with all key stakeholders in the country and the scientific community through conference presentation and journal publications.

2 Background

EHRs help providers better manage care for patients and provide better healthcare by supplying accurate, up-to-date, and complete information about patients at the point of care (3, 4, 5). Additionally, EHRs help promote legible, complete and accurate documentation that is useful for both internal and external analysis. As noted by Tierney et. al., EHRs are becoming a necessity for managing and monitoring patients and health care systems while providing funders with data on the care provided and outcomes achieved. An electronic-based health records system is able to meet these needs more efficiently than paper-based systems. Additional benefits, when implemented effectively is that they are able to: enhance privacy and security of patient data, reduce costs through decreased paperwork, improve safety, and reduce duplication of testing (4, 5).

A survey done by MOH in the Copperbelt Province in 2017 & 2018 (8) found that: 75% (113/151) of the sites where SmartCare was deployed are still actively using SmartCare. Nonetheless, 25% (38/151) were no longer using SmartCare EHR. A total of eight factors were identified by the facilities as directly affecting SmartCare operations in a negative way. The five major challenges are as follows: equipment breakdown, staff attrition, software issues, lack of training, and inadequate equipment.

The survey results in this respect were consistent with findings from SmartCare technical support and mentorship visits undertaken by Provincial Health Office to the districts between January and December 2017. These visits also identified the following as critical issues:

1. Availability of alternative power sources – lack of alternative power sources was a major issues especially in the model sites. Out of the 13 model sites, only three had reliable generators for backup power.
2. Inadequate funds for technical support, maintenance and replacement parts – many sites had reported challenges with hardware that had malfunctioned and needed replacement parts but could not be attended to adequately due to constrained funding.
3. Negative staff attitude – in some sites/ departments, it was observed that all equipment was operational but SmartCare was not being utilized.

The main goal for this assessment of best practices for EHR implementation is to elucidate the lessons learned and prospect from SmartCare implementation in Zambia. The aim is to identify factors and underlying mechanisms affecting EHR implementation in Zambia and develop a sustainability framework that can lead to maturity of EHRs starting from the development process, right through to maintenance of the system.

3 Methodology

The project started with putting a team together comprising of health informatics practioners with diverse backgrounds. The study design to be used will be a cross-sectional survey with both qualitative and quantitative components; and a hands-on skills assessment. The study will involve sites from all the ten provinces of Zambia, purposively selecting about two facilities from each province using a set criteria. The data will be cleaned and analyzed immediately after collection with results ready for dissemination within one months of collection.

3.1 Facility-Based Healthcare Survey

To outline factors influencing sustainable use of EHR at all levels Zambian Health System in the selected sites, we will perform cross-sectional facility surveys.

The facility survey will have three components:

1. The Structured Questionnaire will include use, functionality, perception and acceptability of SmartCare in facilities.
2. The Focus Group Discussion (FGD) will focus on challenges affecting SmartCare operations. It will be administered to all health and allied personnel the use SmartCare EHR in their facilities.
3. The hands-on skills assessment will be done using graded standard scoring tools, will be used along-side the health care cadres who interact with the SmartCare.

The data collection period is approximately 15 working (business) days. Site selection criteria used purposive sampling, choosing sites that represent all levels of health facilities and use SmartCare System in either point of contact and retrospective data entry mode.

3.2 Facility Data Collection Methodology

We will interview those using SmartCare for the quantitative facility survey. This will involve randomly selecting responsible SmartCare users in an event where they are many. Semi-structured interviews will utilize a purposive sampling approach, ensuring that all health facilities and relevant cadres of health staff are represented. Numbers of participants will be selected to reach data saturation on the topics of interest, as per standard qualitative interviewing methodology for the FGD (9).

3.3 Facility and Participant Selection and Sample Size Determination

For the semi-structured interviews, we will use the following eligibility criteria:
Health facility staff currently working at the health centers, health posts and the referral hospital in the named districts who are managing or supporting clinic-based patient care or performing the responsibilities of the following cadres: medical officer, clinical officer, nurse, midwife, and community health worker. About five (5) healthcare workers will be interviewed from each facility, making it a total of 100 participants. The study used purposive and maximum variation samplings to identify participants with diverse demographics who would provide relevant information to the area being investigated (7); factors influencing EHR implementation that include best practices in the software development, system deployment, system use and system maintenance.

3.4 Survey Procedures and Data Collection

Staff participating in the facility survey will be trained. Interviews will be conducted by trained interviewers using both structured and semi-structured interview guides. All participants will be asked to provide written informed consent before interview initiation. Potential participants will be approached on an individual basis. It will be made clear to participants that their choice to participate or not will have no bearing on their work position. The participant will sign a consent for before interviews. This is the recommended standard for rigorous semi-structured interview methods (10). Interviews will be conducted in English. We expect the interviews to take approximately one hour each. If saturation has been achieved within a particular cadre, interviewing of that cadre for that period will cease.

3.5 Data Management

Facility Survey Data Management.

For the Facility Survey Semi-Structured Interviews, these will be kept in a locked box when not in use. Interview notes will be kept in a locked box or locked filing cabinet. The survey will also maintain anonymity for all participant.

Data Analysis.

The collected data in this study will be both qualitative and quantitative in nature. Completed questionnaires will be checked daily for accuracy, consistency and edited before being entered into the computer. STATA will be used for data entry and analysis. Descriptive statistics in terms of means, frequencies, percentages, and standard deviation will be generated. Inferential statistics such as chi square test will be used to establish any association between categorical variables. A p-value of less than 0.05 will be considered as being statistically significant. Thematic analysis will be used to analyze the qualitative data to discover emerging themes for best practices for EHR implementation in Zambia (11).

Data Use and Dissemination of Results.

The data from this study will be owned by the Government of Zambia and responsible ministry, i.e. MOH. Following completion of a facility survey assessment, descriptive analysis of the collected data will be conducted and shared with program implementers.

It is further intended that the results of this study will be published in a peer-reviewed journals and/or presented at conferences. As per United States Government (USG) policy when it is funding a study, the USG will review and clear dissemination of the results. As per the policy of the Zambia Ministry of Health (MOH), any publications will be reviewed by the MOH before submission for publication. All active members of the study team, including GRZ, USG, and those from implementing staff will be invited to contribute as authors in the writing of peer-reviewed manuscripts. Authorship and publication plans will be discussed explicitly with all stakeholders before writing commences.

3.6 Ethical Considerations

Ethical Review.

Ethical clearance has already been granted from both the Tropical Disease Research Center (TDRC) and the National Health Research Authority (NHRA). We are currently in the process of getting clearance from Directorate of Science from CDC Zambia office and CDC Headquarters in Atlanta. Respondents will be briefed on the topic, study objectives, benefits of the study and how to respond to the questionnaires. Informed voluntary consent shall be solicited from all respondents and they shall be guaranteed of confidentiality and anonymity

4 Conclusion

Now that we have received ethical approval from the TDRC and NHRA, the next step is to get CDC clearance. The team already finalized the data collection tools and they are currently being piloted in three facilities in Lusaka. After CDC approval, the teams will go out to all provinces for data collections, which will be followed with data cleaning and analysis. The findings from this study will help with identifying EHR implementation best practices for the development of a sustainability framework that can enhance system adoption, usage and maturity. The findings are envisaged fill in the knowledge gap on sustainability of electronic systems, especially the EHR, in the Zambia. These findings will be shared with MOH and other key stakeholders to inform policy formulation. Though the study has a limitation of using one case study of Zambia implementation, we hope that the findings can apply to low resource settings since contextual factors seems to be the same.

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Feasibility of implementing a mobile maternal monitoring application in a nomadic community in Kenya

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Abstract. Background: Maternal mortality rate in Kenya is still high with 362 maternal deaths per 100,000 live births. These deaths could be avoidable and it has been established that by implementing timely and appropriate evidence-based practices, Antenatal care (ANC) can save lives. The aim of this study was to explore experiences and perceptions of a mobile maternal monitoring application end users.

Methods: A qualitative study which included 3 focus group discussions with mothers, community health volunteers and community health volunteer's assistants and 5 key informant interviews with nurse-in charge, nursing officer, community health extension workers, Sub-county community health services focal person and Deputy Director of Health. Data was analyzed thematically.

Results: The mobile maternal monitoring application was perceived to be useful in improving early initiation and completion of ANC visits, skilled birth attendance and linkage to the health facility. The application was also perceived to be easy to use. It was noted that the application makes it easy to enter and upload data. The main challenges encountered while using the application during the initial stages included slow learning curve in usage of the vital signs monitor and challenges logging into the platform. The other main challenge experienced after this stage was long duration of power outage at the health facility.

Conclusion: The mobile maternal application is perceived to be useful and easy to use, though thorough training is required during the initial implementation phase. More rigorous research should be done to ascertain the effectiveness of the application on maternal health outcomes.

Keywords: mHealth, Hard to reach areas, Community Health Volunteers

1 Introduction

Maternal mortality rate in Kenya is still high with 362 maternal deaths per 100,000 live births [1]. These deaths could be avoidable by implementing timely and appropriate evidence-based practices. The World Health Organization (WHO) envisions delivery of quality care throughout pregnancy, childbirth and postnatal period. Antenatal care (ANC) provides a platform for health promotion screening and diagnosis and disease prevention [2].

In large sparsely distributed rural communities technology can be exploited to mitigate the challenge of access to health services. There is need for health care providers to learn to think of new ways of using of technology to improve health outcomes among the hard to reach populations such as the nomadic communities. Philips Mobile Obstetrics Monitoring (MOM) is a software solution that allows community health volunteers to perform antenatal risk stratification, receive diagnostic assistance, and assess a patient's progress via a mobile device with an aim of enhancing maternal care in community settings. With MOM, nurses (at the health facility) and community health volunteers (at the community level) can facilitate timely referral of the patient to an appropriate healthcare center for further management if

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needed. All the above analysis and inferences are possible through the review of data made available in MOM [3].

A larger quasi-experimental study sought to introduce the MOMS solution software to community health volunteers to perform antenatal risk stratification, receive diagnostic assistance, and assess patients' progress via a mobile device with an aiming of enhancing maternal care in community settings. This qualitative study was conducted to explore experiences and perception of end users (pregnant women, CHVs and health providers) on MOMs.

2 Methods

2.1 Study design

This was an exploratory qualitative study conducted at Alimaow Health Centre in Wajir County, Kenya. Selection of study participants was though purposive sampling Study sites.

2.2 Data Collection

Qualitative data was collected in the first week of December 2018 and the table below shows a breakdown of the data collected:

- 3 FGDs were conducted with mothers, CHVs and CHV assistants
- 5 KIIs were conducted with the nurse in-charge, nursing officer, the Community Health Extension Worker, the Sub-county community health services focal person and Deputy Director of Health.

2.3 Data Management

All FGDs and KIIs were recorded on a digital voice recorder. The recordings were transcribed verbatim and translated to English where appropriate. All data collected and stored on electronic devices was encrypted with access restricted to study personnel only.

2.4 Ethical considerations

Ethics approval was obtained from Amref Ethics and Scientific Review Committee which is a multi-disciplinary independent committee accredited by the Kenya National Commission of Science Technology and Innovation (Protocol number P342-2017). Prior to conducting interviews with all respondents written consent was obtained. Confidentiality and anonymity of the collected data was ensured through storage of the data in encrypted computers with access to the study team only. During transcription, content was anonymized by removing any identifiable information.

2.5 Data Analysis

Data was analysed thematically. A coding framework was developed deductively using pre-existing themes identified in the interview guides and also inductively by reading of transcripts and noting emerging themes. Transcripts were coded using NVivo 12 and presented using narrations.

3 Results

3.1 Perceived usefulness

Trimester when women initiate ANC visits: Prior to the study, most women initiated ANC from the second trimester, however during the study, most women initiated ANC visit during the first trimester.

Completion of four ANC visits: Prior to the study, the completion of 4 ANC visits was very low. This was attributed to the late initiation of ANC visits. However, during the study, most mothers completed the four visits and this was credited to the close follow up of pregnant women during home visits by CHVs.
Skilled birth attendance: Most respondents preferred facility based delivery although there were few cases that delivered at home with the assistance of traditional birth attendants. The main reasons given for facility based delivery were ability to receive medical assistance in case of complications during delivery and capacity building of existing traditional birth attendants to become birth companions who referred pregnant women for delivery at health facilities. The main reason for home delivery was long distance to the health facility.

Linkage to the health facility: A respondent mentioned that the application played a role in reviving the linkage between the community and the health facility

3.2 Experiences and perceptions of using MOMs:

Perceived ease of use: CHV assistants noted that the application makes it easy to enter and send data. They specifically cited that the vital signs monitor was the easiest to use with majority indicating that there was no feature or equipment that was difficult to use.

Challenges with MOMs application:

The main challenge encountered was that most of the CHVs were illiterate hence could not operate the MOMs application. This was resolved by pairing the CHVs with assistants who were younger and with at least high school education to help them operate the application. The pair conduct home visits together, with the CHVs focusing on mobilization while the assistants focused on taking the vital sign, capturing data on the mobile phone and uploading it to the server.

Other challenges experienced while using the application during the initial stages included inability to use the vital signs monitor, facility computer crashing and challenges logging into the MOMs platform (this was mainly due to forgotten login details). The other main challenge experienced after the initial learning stage was long duration of power outage at the health facility which affected electronic data collection (using a computer) and uploading into the server.

4 Discussion

The MOMS application is perceived to be beneficial, easy to use and liked by the users. A number of challenges were encountered during the initial learning stage with most of them amicably resolved. CHVs and their assistants should be rigorously trained on the use of the application especially during the initial stages. For mHealth projects great care and focus should be made when recruiting CHVs to ensure they have some level of formal education. Emergency power back-up plans such as generators should be put in place at the health facility for smooth running of operations.

This being a qualitative study, a more rigorous research should be done to ascertain the impact/ effectiveness of the application on maternal health outcomes. Cost effectiveness study should also be conducted to inform scale up of the mHealth intervention.

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Statement on conflicts of interest

The authors declare that they have no competing interests

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