Implementing Swaziland's Client Management Information System

Stakeholders' Views of the Process and Recommendations to Improve It

December 2017

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MEASURE Evaluation

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Cover art: "Friendship Fabric" created by Swaziland primary school students for the 2010 Singapore Youth Olympics; image courtesy of Flickr Creative Commons

CONTENTS

ABBREVIATIONS

ANC	antenatal care
ART	antiretroviral treatment
CMIS	client management information system
DMII	diabetes mellitus, Type II
EHR	electronic health records
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
GR	governmental respondent
HMIS	health management information system
IHM	Institute for Health Measurement
MOH	Ministry of Health
NG	nongovernmental respondent
NGO	nongovernmental organization
OPD	outpatient department
PEPFAR	United States President's Emergency Plan for AIDS Relief
PMTCT	prevention of mother-to-child transmission (of HIV)
RHMT	Regional Health Management Team
TB	tuberculosis
TWG	technical working group
USAID	United States Agency for International Development

INTRODUCTION

Swaziland policymakers and health administrators decided to change from the current paper-based health records system to an electronic health records (EHR) system. This change is being undertaken to harmonize healthcare data and improve patient care. The country's client management information system (CMIS) is an EHR system that improves patient care by improving data quality and access, reducing duplicated cases within the system, and improving patient flow and wait times within the clinic.

Swaziland is already using a CMIS for outpatient department (OPD) service modules for the main health programs: family planning, antiretroviral treatment (ART) for HIV-positive patients, antenatal care and prevention of mother-to-child-transmission (ANC/PMTCT), tuberculosis, child welfare, and outpatient curative services. It is also using registration, laboratory, and pharmacy modules.

The CMIS is being implemented in Swaziland by the Ministry of Health's Health Management Information Systems (HMIS), with support from the Institute for Health Measurement (IHM). It is being financed by the Swaziland Ministry of Health (MOH), with help from the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) and United States Agency for International Development (USAID).

The CMIS pilot began in 2014 with one site and two more were added in 2015. The MOH's goal was to have the CMIS live in 134 facilities by 30 September 2017 in the four regions of the country. To date, 82 facilities have implemented the CMIS. Of those, 69 have gone live since the beginning of 2017. The number of CMIS sites implemented in 2017 represents a rapid scale-up following delays in the implementation of the project, such as procurement of equipment and a lack of wide area network connectivity in some facilities. The project implementation was undergoing a "pause and reflect period" at the time of the interviews to address issues being experienced by the users before continuing to implement the system in other facilities in the following quarter.

MEASURE Evaluation is conducting an evaluation of the CMIS implementation process through health facility assessments and key stakeholder interviews (conducted from July 2017 through August 2017). The interviewers collected the opinions and experiences of key stakeholders of the CMIS to discover the challenges of implementation and recommend ways to improve the process, especially for the primary users of the system. The results of those interviews and our recommendations based on them are presented in this report.

METHODS

Sampling

We provided IHM and HMIS with a list of organizations to include in the stakeholder interviews to get a purposive sample of respondents. We were interested in a sample comprising staff involved with the development of the CMIS and those who were key users of the system, from clinical users at the facility level to data users at the national level. The final list of interviewees included 26 organizations and departments within the Ministry of Health (MOH).

Potential respondents were contacted by telephone to schedule an in-person interview by an IHM staff-person during a flexible two-week period, based on each respondent's schedule. Potential respondents who did not respond to telephonic contact or had scheduling conflicts during the two-week interview period were contacted by e-mail and offered telephone or Skype interviews, at their convenience. If these options were not possible, they were given the option to answer key questions over e-mail. We thought it was important to give all potential participants every opportunity to provide feedback.

In addition to the scheduled meeting, there were many informal meetings with IHM staff that provided rich context information and allowed an opportunity to clarify some of the questions that arose during the process of interviewing participants.

Setting

The in-person interviews were conducted at each participant's work place, with one exception. One participant attending a document launch meeting was interviewed in a hotel lobby after the meeting.

Data Collection and Management

The interviews were conducted in English by the researcher. An interview guide was used (Appendix 1). The guide was developed to solicit responses to the main research questions:

- Why was the CMIS developed in Swaziland? What gaps is it filling? Who are all the potential users of information generated from the CMIS?
- What are the potential benefits and limitations of using the CMIS in health facilities in Swaziland?
- What is the plan to finance CMIS roll-out and maintenance?
- How is success defined for the CMIS's implementation?

The interview guide included prompts and follow-up questions. Two versions of the interview guide were developed, one for government and one for non-government respondents, but most of the questions were similar.

An IHM staff person served as a note-taker in most interviews, and asked clarifying questions, if necessary. The in-person interviews were conducted July 18–28, 2017. The participants who responded by e-mail were given until August 31, 2017 to provide their responses. The questions sent to them were the main questions from the interview guide.

All interviews began with an introduction, during which informed consent and permission to record were obtained. The interview then proceeded using the interview guide, but the process was flexible to include other questions, as necessary. In some cases, participants were not equally knowledgeable of each of the interview topics (e.g., details about the development of the CMIS or actual use of the CMIS in facilities), so more time was spent in areas with which they were more familiar. However, some nongovernmental organization (NGO) staff whom we interviewed had previously worked for the MOH, and as a result they were very knowledgeable about all topics.

Two voice recorders were used to record the interviews. Hand-written notes were also kept. Both the audio files and handwritten notes were transcribed in Microsoft Word documents and reviewed by the interviewers prior to analysis. The audio files and transcripts were stored digitally. All transcripts and notes were imported into NVivo 10.0 for data management and analysis. Each interview was assigned an identification (ID) number based on whether the respondent was from government (GR) or outside of government (NG). These IDs are used to attribute direct quotes in the results section.

During the interviews, many respondents expressed concerns about the CMIS. It was difficult to determine at the time of the interview if these concerns were real problems with the CMIS, the respondent's perception of the CMIS, or an issue was caused by improperly using the CMIS. We kept a list of these issues and asked other respondents to confirm them. We also asked the IHM staff involved in the CMIS implementation about these issues to determine if they were real or perceived.

Data Analysis

We used framework analysis to analyze the data. The first step of the five-step process was to become familiar with the transcripts by reading them and taking notes from them. The second step was developing a coding scheme to systematically code the data (Appendix 2). Analytical axes were identified according to their respective codes, which, in turn, were grouped into key concepts. Some codes were empirical and theoretical based on what we expected to find, other codes were developed based specifically on the research questions, and some emerged from the narratives of the interviewees themselves. The third step in the analysis was indexing, or the systematic application of the codes to the interviews. NVivo 10.0 was used to code and analyze information. The fourth step was charting, which involved reviewing all the coded text by theme, codes, and type of informant. The final step was mapping and interpretation. The first draft of the report was shared with a select number of stakeholders in Swaziland for comments before finalization.

FINDINGS

At the time of this study, 82 sites had implemented the CMIS in four regions, 69 of which had been implemented since January 2017 (Table 1).

Table 1. CMIS implementation by region

Region	Total facilities with live CMIS	Facilities with live CMIS since January 2017
Manzini	27	20
Hhohho	24	20
Shiselweni	14	13
Lubombo	17	16
Total	82	69

We conducted 21 interviews for this study; 17 interviews were conducted in-person and all but two participants agreed to be recorded. One respondent scheduled for an in-person interview cancelled due to quarterly report deadlines, but provided written comments. The remainder of interviewees provided written responses to key questions over email.

Overall, 21 of the 26 organizations originally identified were interviewed or provided information over e-mail (Table 2). This included two clinicians working in facilities using the CMIS.

Table 2. Organizations included in stakeholder interviews

Government	Nongovernment
Ministry of Health Public Health Directorate	Clinton Health Access Initiative
Supplemental Nutrition Assistance Program	AIDS Free
Strategic Information Department Measurement and Evaluation unit	Management Sciences for Health
Strategic Information Department: Health Management Information System unit	University Research Company
Epidemiology and Disease Control unit	Coordinating Assembly of Non-Governmental Organizations
Monitoring and Evaluation of Tuberculosis Program	United Nations Children's Fund
Regional Rural Health Multidisciplinary Training[1]	Médecins Sans Frontières
	President's Emergency Plan for AIDS Relief
National Emergency Response Council on HIV and AIDS	International Center for AIDS Care and Treatment Programs
Health Research Unit	Global Fund to Fight AIDS, Tuberculosis and Malaria

Development of the CMIS in Swaziland

Perceived Need for the CMIS

The need for the CMIS emerged from a HMIS assessment conducted in 2012 that comprehensively reviewed the existing HMIS structures and processes operating throughout Swaziland's health sector. Several respondents were involved in the coordination or data collection of this assessment. Respondents identified three main problems discovered during the assessment that led to the creation of the CMIS: (1) existence of parallel information systems, (2) lack of continuity of care, and (3) inaccuracies generated in statistics due to the inability to identify individuals who received services. Respondents discussed the uncoordinated way information was collected in health facilities, particularly the number of registers that were used, which led to the duplication of information, and parallel systems created by various partners. For example, one respondent (NG206) said:

> … *there were parallel data collection tools. We used to struggle to compile just the annual report. Of course, HMIS has always been there. But, because there are many entry points, UNICEF* [United Nations Children's Fund] *will come in with their tools to collect EPI* [Expanded Program on Immunization] *or UNFPA* [United Nations Population Fund] *will come in with their tool to collect the same data that HMIS would have collected.*

This led to the decision to harmonize all the data collection tools and streamline the collection of information. The CMIS implementation was a way for the MOH to control what data were being collected at their health facilities.

The way data were collected also made it difficult to follow-up with patients and ensure continuity of care. Patients had patient-held, color-coded cards designating their morbidity (e.g., a red card was used to designate a patient with HIV). These cards were easily lost, making it nearly impossible to know what services the patient had previously received or where they were in the sequence of treatment or immunization schedule. As one government respondent described:

> *But then when it is lost, nobody knows about that information … what were you given, and you know how the high turnover of the service providers. Should you come to the clinic and they don't know, then they have to start afresh. And some, they will even do unnecessary tests because they don't know, they are starting you as a new patient* (G103).

This was also described in the context of immunizations. If the caregiver lost the immunization card, children would either start the immunization sequence again or the health worker would take the caregiver's word that the child had already received a dose of immunization, and would administer the next vaccine. This led to duplication of cases in the health information system. One respondent further described the problem: "… if someone is missing an appointment in one facility and they go to another facility, you won't be able to tell, and it is possible that if the patient feels like having a new ID number they can have a new one" (G106). This could result in the patient being considered lost to follow-up in the first facility. Even if the patient received all of their services in one health facility, there wasn't one comprehensive record that would allow all of the providers to understand the full health picture of the patient. When developing the CMIS, the importance of the follow-up was discussed by two respondents. One respondent spoke of "… continuity, comprehensive continuity, from one service point to another (NG210). Respondent G101 said that follow-up helps to "avoid these duplications that we have, in terms of patient, our patients, moving across facilities and accessing different services."

Another problem that respondents identified was that health data were case-based, not patient-based, which led to inaccuracies in data generated, because the system was "… counting cases instead of individuals, which compromised the quality of the data at the end of the day" (G105). Many respondents used the example of HIV testing when they discussed the issues. For example, individuals could be tested for HIV multiple times throughout their lives, but the existing system would only count the total number of tests, which made it difficult to estimate what percentage of the population had been tested for HIV. The same problem existed with immunizations, because they were not able to calculate the percentage of people who had been fully or partially immunized (i.e., the proportion that had received more than one dose of a multidose vaccine).

Situations like these led to the decision to uniquely identify patients across service points and facilities. Respondents recalled the debate of using a national ID system that created a unique ID for each patient. This system was introduced from 2007 to 2008. There were concerns that patients may not want to use their national ID to identify themselves in the healthcare system, so a study was conducted to gather opinions from Swaziland citizens.[1] The study results indicated that "… the nation did not mind using the PIN. . . [personal identification number] . . . for health care. It made it easier, and it made it such that we are able to already build on what [previous healthcare] has been done. When we got that assurance [from citizens about the PIN], it made it easier to say that let us work on CMIS" (G101).

Developing a Unique CMIS System

When asked about the decision for Swaziland to create its own unique electronic information system, rather than choosing a vendor or an established system, respondents felt that a unique system was necessary for the sustainability of the system. Another consideration was that the CMIS system needed to align with government policies and infrastructure, including the national e-government policy. The health sector wanted to capitalize on the fact that it has been "… prioritized as one of the sectors that are leading the way [in electronic modernization] within the government" (G101). According to respondent NG208, "the government strategy … chaired at cabinet level, that is aimed at modernizing all government systems to become electronic … and CMIS is in-line with the entire government strategy." A couple of respondents said that it was important for Swaziland to be able to sustain the CMIS live beyond the donors, and that this could only be accomplished by having full government buy-in. The respondents thought buy-in would be best accomplished by having a "homegrown system" that has support from various government ministries and other stakeholders.

Other electronic systems had been used in the health sector in Swaziland. Experiences with these systems made the decision-makers hesitant to adopt another ready-made system. For example, one disease-specific system was not adaptable by programmers in Swaziland, because they didn't "… have the source code of that system. People they come, they need more data. We can't do anything about it because we don't have control of the source code" (G105). This meant that they could not edit the software to meet evolving program needs. By developing their own system, the ministry would have full control of editing and improving the system and ensuring the capacity to maintain it lies in-country.

We noted a sense of pride about making the decision to develop their own system. One respondent described this as a "bold [move for Swaziland, an] innovation to solve the problems that existed" (NG210).

[1] The results of this survey are outlined in a document shared with the author in a private communication: Strategic Information Department. (2013). Unique patient identifier: Project market research. Funding for this assessment exercise was made possible through the USAID-funded Enhancing Strategic Information Project, which is implemented under the auspices of Management Sciences for Health under a subcontract to IHM.

Respondents also felt that a system of their own design would better align with the overall government infrastructure and the close connection with the Ministry of Information Communications and Technology (ICT). However, some respondents thought developing their own system was not a good idea:

> *Do you have to really come up with something that is fresh, new, and unique, that will require so much [effort]? For me that's a frustrating part. We could have used some other system that is there, systems that have been seen to be working in other countries, and all that we are left with is the task of customizing it to our own level.* (G102)

Some respondents expressed frustration with this decision given issues they were encountering with the CMIS. They questioned the necessity of testing a new system, while trying to do their daily jobs of providing healthcare or collecting data for reporting.

Stakeholders Developing the CMIS

Respondents mentioned the wide array of stakeholders involved in the development of the CMIS. One respondent identified the following ministries as stakeholders "… Ministry of Home Affairs, because they the custodians of the PINs; Ministry of ICT, because they are responsible for the network infrastructure in the country; Ministry of Public Service, because they are looking at issues of HR," (G105). The United States President's Emergency Plan for AIDS Relief (PEPFAR) and Global Fund were also mentioned as key supporters of CMIS development.

A technical working group (TWG) was commissioned by the public health directorate to bring in various stakeholders, including both public and private healthcare providers. The CMIS was being deployed in all types of facilities throughout Swaziland, so it was important to involve the private sector, as well. The TWG allowed for the clear communication of the plans which helped strengthen the health information system. They also provided input on the CMIS modules and other technical areas. Despite these efforts, there was sentiment among some responders that the process should have involved more stakeholders, particularly additional healthcare providers. This sentiment was also true for the involvement of NGOs earlier in the process, "I think, ourselves, like the NGOs, we are being left behind. You know sometimes when the government does things, they just run with it" (NG205). Some respondents felt that some NGOs were not entirely engaged at the beginning of the process.

Potential Benefits of the CMIS

Respondents discussed the many potential benefits of the CMIS, including: reducing the burdens on clinicians, improving the continuity of care for patients and reducing their time spent at the facilities, improving the timeliness of data reports, and having one data set containing all health variables of interest. However, many respondents cautioned that the full benefits of the CMIS could only be realized if the system worked optimally. These topics are discussed in the following section.

Reducing the Burdens on Clinicians

Respondents described the current paper system as burdensome to the provider, because it uses multiple registers. This means that providers have to enter information in multiple places, sometimes the same information is reported in multiple places.

> *… if you can imagine the queue which will be waiting for nurses in every facility. If you have one client, you open about five registers you have to peruse through them all the time, you find that [the registers] weren't doing the accurate thing. There were gaps [in information], many, I can attest to that because [previous providers were] rushing. But with this [CMIS], you just enter the clients once, and then from there you just click the user number or the personal ID.* (G209)

With the CMIS, data are entered only once. This should ease the burden on providers, and possibly improve their job satisfaction. As a respondent mentioned "… when you come and tell me that finally you won't be required to use your pen and opening so many registers that you have in front of you … I would be excited, of course," (G102). Another respondent emphasized the importance of the CMIS in helping healthcare providers provide better care to patients because, "[Providers] are not there for data, they are not there for indicators, they are there for delivering care," (G101). Therefore, having a system that reduces the time spent entering information could improve job satisfaction for healthcare providers, and result in improved patient care.

Improving Clinical Care

The CMIS has the potential to improve clinical care and continuity of care of patients. This was one of the identified needs leading to the creation of the CMIS. The inefficiency of the paper system discussed above did not allow for truly comprehensive patient care and "… to make sure that we have very functional, very efficient, very effective systems, or a system that then allows us to effectively support that agenda in ensuring that we are able to track those patient-level outcomes," (NG209). It is expected that the CMIS, with its unique patient identifier, will also be able to track patients, particularly those that move around "… from one visit or two visits. It is not that [the patient has] transferred out … they just decided to get [care] somewhere else on that day or the month," (NG201). The CMIS, when working well, should quickly transfer patient data from one department or health facility to the next. This will improve patient care, because the new provider will have complete information about the health status of the patient seeking services. This should contribute to providing "… holistic treatment of patients, rather than treating once disease at a time," (NG208). The CMIS will also allow for improved referrals for additional care, which is important for all health conditions, but of special interest to patients living with HIV or tuberculosis (TB). However, many patients are presenting with co-morbidities that need good referral systems to other health programs. Some respondents expressed the hope that the CMIS will track patients who miss appointments.

Another potential benefit of a well-functioning CMIS is decreased patient wait times. The theory is that once the system is fully implemented with registered patients, health facility workflows would improve, thus reducing patient wait times. As respondent NG 204 said, "Because if by clicking a button you can pull up all the history and everything, [you have] fewer questions that you would … want to ask the patient." For returning patients, time would be saved because their health information would be retrievable at any health facility by using their unique ID.

The CMIS could also improve clinical care by providing data to the clinical mentors to identify gaps in service delivery. However, this requires that the clinical mentors understand how to use the CMIS for research

purposes. One respondent (NG210) said, "we have tried to strengthen that component by asking the CMIS team to train our mentors."

Improving Reporting

Another reported benefit of the CMIS was the aggregation and timely reporting of required indicators. As one respondent (G211) said, "…you can generate the report, as of now, quickly [and] without looking for loose papers everywhere." This sentiment was echoed by another respondent:

> *I would say getting data through CMIS, I think, it is easier and faster, because it is just a matter of logging into the system and just running … a report, and it gives you the numbers. As opposed to actually opening a register and start counting.* (G207)

The computerized data entry system will make data available faster for health facility use, and it will speed up the availability of those data at higher levels of the health system. With the paper-based system, there is currently a lag between when data are collected and when they are reported. One respondent described, "For some services we get the data a month later …. for July, they will submit a week after July, so it will be the first week of August [before the report is available]" (G104). This delay can hinder decision making and timely response to problems or arising issues. Respondents view the CMIS as a big improvement in making data available faster. The ability to back up data was also seen as an improvement over the paper system. "And this system, I like it because you cannot lose the data for good; it has a backup system. Unlike the books…" (G209). Improved reporting will ideally lead to improved data use. One respondent described how data can be used:

> [The CMIS] *will help you make forecast logs as well, because you can more accurately forecast what the future drug use is going to be, and how many labs should you be running, how many commodities do you need to get, and all of these things are dependent on having a good number of data sets of knowing how many people are actually getting care.* (NG201)

Complete Data Sets

Another anticipated benefit of the CMIS was the availability of a data set that contains all of a patient's health information in one place: "The benefit I foresee is having a data set with almost everything in one [place], because now we have different data sets with PMTCT is there, we have family planning there, we have child welfare there, everything is in different data sets" (G104). Another respondent mentioned that limitations of the chronic care files for HIV patients, particularly the difficulties of monitoring the occurrence of opportunistic infections in these patients. This would not be an issue with the CMIS, because it captures all of the data in one place. Improving patient care should ultimately improve patient outcomes; this information will lead to better clinical decisions and treatment plans.

One respondent, a health facilities researcher, highlighted the difficulties of illegible paper records, and noted the absence of this problem with the CMIS, "We have been going back and looking at old files, and I mean, a lot of problems could be improved simply because of the fact that people don't write legibly" (NG201).

Another benefit respondents anticipate was the ability to use this comprehensive data to answer bigger research questions about the health of the Swaziland population. As one respondent (NG204) expressed, about CMIS data:

> … *colleagues will be able to deal with patient-level data and coming up with more interesting analysis and more interesting findings. And I think the epidemiology unit and research unit will benefit mostly from having such data sets and trying to ask questions from the data in trying to inform programs.*

The possibilities for using the data are many, including conducting cohort analysis of ART retention and follow-up, estimating quality of delivered care, and linking specific health interventions to health outcomes. However, some respondents were concerned about the system's capacity to export data fit for research, and the organizational capacity to conduct these types of analysis.

Limitations of CMIS Use and Possible Barriers to Implementation

When asked about limitations and possible barriers to CMIS implementation, some respondents spoke about the big picture, while those with "hands-on" experience using the CMIS discussed some of the more granular issues and everyday frustrations. The CMIS team knows about many, if not all, of the issues listed in this section. They gathered feedback from users through various mechanisms, such as, the CMIS Project Review Meeting in June 2017. Therefore, this section will discuss some of the issues presented during the interviews, with consideration given to the consequences of some of them. This section discusses specific issues of CMIS use, and then concerns about the full implementation of the CMIS in Swaziland.

System Issues

Respondents reported several system issues, either from first-hand experience or from feedback they received from clinicians. Many of the complaints were about the system being slow or frequently down (either due to power outages or system issues), resulting in the system being "… on and off." This greatly frustrated both clinicians and patients. In fact, on the day of one scheduled interview with a Regional Health Management Team (RHMT) member, who is also a provider at a health facility, the CMIS was down, and they were unable to demonstrate issues they have with it. One respondent said, "It's slow, the lines are too long or the clients that we see are too many for the processing of the whole system to move records from one service point to another" (NG210). These sentiments were strongly expressed by the two clinical respondents who not only used the system on a daily basis, but were responsible for supervising others who used it.

When the system was down or slow, it led to other issues, such as, the CMIS not recording all of their work, the unsystematic method of documenting services by hand, and increased time spent with the patient that was not for direct patient care. Almost all respondents, clinical and non-clinical, said that fewer patients were seen once the CMIS was implemented in their facilities, but this was always discussed as a possible programming problem with the CMIS. One respondent said that they saw a very large drop in the number of OPD cases once the CMIS was implemented, from around 10,000 per month to between 3,000-5,000. We did not verify these numbers, but the perception that it exists is problematic, whether it is true or not. Another respondent echoed this sentiment and said that while they expected a drop in the number of patients seen, the change was still very surprising and made them question the validity of the data:

> … *immediately when CMIS rolled out in facilities you would find that the numbers are drastically falling. Like there would be fewer cases, fewer people seen and things like that, of course we know that previously there were more repetitions…we expect that there would be a drop. However, I think the drop was so huge.* (NG204)

This is a major concern for clinical implementing partners who are responsible for PEPFAR indicators and have targets to achieve. Targets were set based on the former way of collecting health information, which was

not case-based. It may be necessary to revisit how targets are set based on individual-level data that the CMIS can collect. The drop-in client is also problematic for facilities who perceive they are seeing more clients than what is captured in the CMIS. One clinician (G210) said she has noticed this inaccuracy when she sees patients. She will remember seeing a certain number of people with hypertension in a day, but then when she checks the system, the numbers seem too low.

However, a drop in the number of patients is expected when the CMIS is implemented, because the paper-based system was believed to have many duplicated cases, which may have led to over reporting. One respondent responsible for supervising nurses at the regional level described how she explained to providers why they were seeing changes in the total numbers of patients, "This system [CMIS] can tell you if a visit is a follow-up. So, now the number [of total visits in a reporting period] will obviously be reduced, because it was a follow-up" (G209). This respondent had worked at one of the pilot CMIS sites before moving to the region where she was interviewed. She said that she tries to support the providers during the transition, urging them to be patient.

When the CMIS was not being used (because of outages or system speed), respondents continued to see patients and services were recorded on the down-time form, the old registers, or not at all. This probably contributed to the view that the CMIS was not accurate. One respondent (NG202) said, "Down-time form is not exactly the same as the modules in CMIS, hence data is lost when trying to recapture data into CMIS when the system is back on." Respondents were asked about the process of entering the data back into the CMIS once the system was functioning again, and the responses varied from the data being entered sometimes to not at all. One respondent (G211) complained that when the system or power was down, it created more work for them:

> *The down tool form is used when the power is down. So, we were given that form, so we write on that form. When the power is up again, the network is up again you have to enter those. At what time, at what time? Because even tomorrow, you will have tomorrow's work to enter.*

Respondent G210 agreed, "Because of the system being down issues, they have started doing double-entry and while in theory, there should be a back-up system for data recording, but in reality, there isn't." The main reasons provided for not entering down-time data in the CMIS were the lack of time and staff. One region reported that it decided to do double-entry because of concern that data would be lost once the CMIS was implemented. This did go over well with the nurses who, "…s] were so much rebellious. They said no way, we must choose one." (G211). Some respondents wanted staff dedicated to data entry to ensure that down-time services were entered in the system once it became operational again.

Another concerning issue was the suspicion that the CMIS was unable to correctly capture multiple diagnoses. "Furthermore, for multiple diagnoses you find that it is a challenge for the system to retrieve. There is a primary diagnosis and [an]other diagnosis and you find that you don't get that information when you generate the report of the secondary diagnosis" (G207). This issue was not verified by the researchers; it may be another example of a negative perception that could hinder the success of the CMIS.

Issues of the system being down or slow also contributed to the perception that the time with the patient has increased, but not being spent on direct patient care. Two clinical respondents said they now spend about 20 minutes with a patient, when it used to be 5 to 10 minutes. Respondent G210 said, "… [this extra time] is not spent engaging with the patient, rather [it is] spent on the computer". This has increased the patient wait time,

Box 1. HIV Issues in the CMIS

- Linking antiretroviral therapy patient monitoring and reporting data with the CMIS
- Linking the CMIS with lab system (Rxsolution) for viral load testing
- Inaccuracies in reports for PMTCT cascade and HIV testing and counseling
- No clear capturing of some important indicators (Retesting, inconclusive results, discordant results, referrals)
- Difficulties extracting individual patient data
- Retention reports sometimes report blanks (one was observed)

resulting in people still waiting for service after 5 p.m. Healthcare providers feel that this is hurting the patient-provider interaction.

Training and Support for Users

Respondents were asked about the level of training and support CMIS users receive. The initial training of CMIS users is conducted at an off-site facility over two days, with some additional on-site training and refresher training occurring at the health facilities before the system goes live. Many respondents felt the need for ongoing training to ensure the CMIS is being correctly used, and to train new staff as they are hired. "We have to review our training plan because of the high staff turn-over, so that people are trained on-time and there is no disruption in terms of service provision at facility level," said one respondent about the need for continuous training. One respondent felt healthcare workers were not confident about maneuvering through the CMIS system. A respondent who spends a lot of time mentoring CMIS users agreed, and feels that it is important for providers "to understand how to use it," because they become frustrated when the system does not allow them to continue if they encounter a problem with an entry. The respondent (G209) said, "…that is why they are complaining most of the time that the system is very difficult." Another compliant is not being able to find the correct diagnosis in the CMIS system. This issue was described by two respondents, one of which said:

> *Another challenge that we have seen gathered from the nurses who work with CMIS, the diagnosis… they are pre-entered and if you have your diagnosis but it's not in the list of CMIS it's a challenge. And you end up entering other or …I don't know if they can type the diagnosis or they have to choose from the list.* (G207)

The prepopulated list of common diagnoses in the CMIS does not include all diagnoses, and many providers do not know how to search for other diagnoses. Additional training on how to correctly search for diagnosis is needed. For example, one interviewed provider complained that they could not enter the diagnosis of diabetes in the CMIS. It was not in the prepopulated list, and when she searched for diabetes, she only found diabetic complications (e.g., diabetic retinopathy), but Type I or Type II diabetes did not appear in the list of options. She was unable to demonstrate this on the day of the interview because the CMIS was down. We later asked the CMIS developers about this situation, because it was surprising that a common disease like diabetes was not in the prepopulated list of diagnoses. The CMIS developers demonstrated the CMIS to the researcher, who observed during that, indeed, Type I and Type II diabetes were not on the prepopulated list. A search for those diagnoses was conducted, and as the provider had reported, only the diagnoses for diabetic complications appeared. One of the developers remembered the International Classification of Diseases-9 abbreviation for diabetes (DMII: diabetes mellitus, Type II) and searched DMII and this brought up the Type II diabetes diagnosis. This demonstration confirmed the difficulties described by providers regarding the challenges of finding the correct diagnosis in the CMIS.

Respondents were also asked how users reported problems with the CMIS. A help desk was set-up with a toll-free number that allows providers anywhere in the country to request assistance. The help desk is managed centrally by two staff who assign people to attend to reported issues. We reviewed the help desk report from June 1, 2017 to July 27, 2017. The logged complaints included the following: inability to print

reports, inability to turn on computers, deactivated CMIS accounts, and CMIS not loading. We asked three clinical respondents about the help desk, and none of them had heard of it. This help desk issue was also identified as a problem during the CMIS Project Review Meeting. One respondent said that complaints or problems with CMIS came to her (at the regional level) and she re-directed them to the regional HMIS office. One respondent was extremely frustrated with the lack of ongoing support her facility received after CMIS went live:

> … *initially they told us there will be somebody who would be on-site, monitoring and mentoring the people around. We had some [help] for a week or so when it was still new. After that they left. There is no one that is supporting us here. You are stuck right here.* (G211)

She said they relied on data clerks from the Elizabeth Glaser Pediatric AIDS Foundation who were stationed at their public health unit for help with CMIS, but that these staff were often too busy to help. At the same time, respondents stressed the importance of providing support and ongoing mentoring to help health workers maximize the benefits of the CMIS. Respondent NG202 discussed working with clinical mentors to ensure they could help providers use the CMIS to improve the quality of care provided. Another respondent emphasized the importance of providing support to providers to focus on patient care, "I mean the focus should be on patient care rather than reporting. Because if you have a good patient care system, you can easily create data sets from this" (NG201).

Missing Health Program Data in the CMIS

Some respondents raised concerns that CMIS did not capture all health programs or all health data equally. Some respondents felt that HIV had received preferential treatment in the development of CMIS, and that it dominated discussions when stakeholders met to review data from CMIS. One respondent stated:

> … *we tend to clean up the HIV data, because most of the stakeholders want HIV data, and then we ran out of time and it's the end of the day. Then the following month, it still comes back to HIV, so we feel like for the people who are not even supporting the HIV program, most likely it's a waste of time, because we still don't get to the non-communicable disease, we still don't get to family planning, we still don't get to immunizations* (G104).

But even within the HIV program, respondents mentioned concerns that have been raised before in other meetings. These concerns are summarized in Box 1, but this report does not provide more detail. A couple of respondents raised the issue of how much data the CMIS should accommodate. As NG204 said, "I think the health services across the spectrum are really so many, and I have a concern about how far can CMIS stretch in terms of trying to accommodate everything." Other respondents were concerned about overloading the system, but this concern conflicts with users who need to report specific data that CMIS is not collecting. In these situations, workers still rely on paper forms.

The data capture issue in the TB program was mentioned in several interviews. Tuberculosis is a complicated disease that requires the collection of a great deal of information, both for patient care and for monitoring and reporting. Yet, respondents who raised the issue of TB during their interviews, believed it was not included in the CMIS beyond the initial TB screening questions. The screening questions were also considered inadequate, because TB screening is often done in the waiting area or somewhere without a computer. Because of this, cough officers or other TB screeners record the screening outcome on paper forms, and then have to enter the information in CMIS to capture this information within the system. It is uncertain how consistently this is done across facilities. But this process still leaves many unanswered

questions, as one respondent noted: "What if the person is screened for the TB, and then what happened? Did you check the lab? Did you check the sputum? What was the outcome of that diagnosis? And then what has been done after that? And then all that information is not available" (G102). Respondents understood that TB was complicated in its diagnosis, treatment, monitoring, and record-keeping.

> *TB is so elaborate, it's just one program, but there is so much going on. Having the module … I think that it's one of the things that has delayed CMIS to really pick it up as soon as the other programs, because there is just so much that they need to make sure they have up for TB to be provided and recorded in CMIS*. (NG204)

Therefore, the TB program has asked the health providers to continue to use the paper forms for TB after CMIS goes live, even though health facilities have asked them to stop.

Surprised by news of the absence of a TB module in the CMIS, the researcher queried the CMIS developers about it. The developers were able to demonstrate to the researcher that a TB module does, in fact, exist in the CMIS. The developers reported to the researcher that a multidrug resistant module was under development. But we were unable to verify if this would meet the TB program's needs.

The CMIS developers also shared some challenges encountered during the development of the TB module. Surprisingly, although the TB module exists, the respondents were not aware of it after it was added to the CMIS. This was another theme of several interviews: there is a disconnect between the CMIS developers and the users of CMIS. Often, the issues discussed by respondents were being addressed or had been addressed by the CMIS developers, but this information was not always communicated to the users.

Concerns about Full Implementation

The interviews elicited several concerns that may affect the full and successful implementation of the CMIS, including the state of the infrastructure in the country necessary to support it, human resources and capacity building, future financing, and the attitude of health workers. Infrastructure issues were primarily the speed of the network and unstable electricity supply. "We live in a country where we are not really completely out of the risk of having shut-downs in terms of electricity, so we anticipate that our systems can have those issues because it runs on electricity," said respondent NG210. Some respondents felt this was an even bigger issue in rural areas, "…the infrastructure is not suitable for this system, which is still a challenge I think at the health facility or clinics in the rural area" (NG205). Respondent NG208 agreed: "… network coverage in the rural areas might be a challenge."

In a country with developing infrastructure, it is a major challenge to implement a fully functional electronic health record that should be sharing information across facilities, and needs to be connected to the wide area network. But some health facilities have gone live without having the wide area network connection and these require a manual synchronization, to occur weekly, every two weeks, or monthly (answers varied). This means that if a patient registers in facility X, and then tries to get services at facility Y before the synchronization has happened, the patient will not be found in the system. A couple of respondents complained about this, and the CMIS team verified it. One respondent even tried to test it using her information.

> *I asked the nurse to take me through CMIS, I gave that nurse my patient number. Before then I was being seen at Mbabane public health unit, I was expecting to see my records in … but surprisingly my name was there, but the records were not there … and he said something like maybe it's still updating but I was like, but I've been there, like I think it was three days ago, for family planning. I wanted to see if it showed in the system.* (G207)

It is unclear if the decision to go live in facilities without the wide area connection was communicated to users of the system. The consequences of people registered twice between synchronizations is also unclear. But, even in places where there was network coverage, there were many complaints that the network was slow, "… nurses are complaining that there is a lot of work to enter here the system is slow, the network too slow" (G211). Respondents recognized the network issues were beyond the control of HMIS, but considered it a major problem.

Human resources and capacity to support the CMIS becomes of greater concern as more facilities go live, as discussed by respondent NG206:

> *I think there are some lessons shared by HMIS that once you leave a facility and they experience a glitch, then they just quickly, slowly drift back to wherever they were. So, you will need a team that will rally behind, be able solve those problems and support them until the facility can stand firm, and then you move. So, I foresee for five, six years huge costs to really support the installations and the mentorships following behind.*

Respondents were unsure if there was enough staff or financing to support CMIS. These two issues were closely linked, because more funds would need to be allocated to support the recruitment, training, and salaries of staff to provide technical support. But other types of capacity building are also needed, such as, training for supervisors on how to use the data from CMIS, to make decisions, and to provide feedback to health workers. Capacity also needs to be increased to determine how to conduct analyses with the large quantities of data the system will provide.

> *We need more capacity for analysis, because when we were analyzing summarized data there was minimal you could do there, but now that we have this type of data base, which is going to be huge, I believe we need more capacity building in terms of how you analyze this type of data.* (G104)

But this lack of capacity to analyze the data is worrisome, because respondents feel they are not fully able to appreciate what data are within the system (or not), and what could be done with the data. This also means they cannot provide feedback to the CMIS developers, which respondents feel is very important, because the developers and the users of the system think in different terms about data and data capture, and have different needs for the data. As one respondent said:

> *You will find a situation where the developers will sit alone and develop this and all of a sudden when you go there and want the data … it is pulling off … this is the funny thing about data. Once data is generated, as the person receiving it, it is really tough to start questioning the script. It is really tough. You need to have the IT or the developer person questioning it with the same understanding as you.* (NG210)

However, another respondent acknowledged that improvements in how information is being communicated to the developers were being made through the data management committee within the HMIS unit. He said clinical partners were involved, and that during these meetings "… we are able to directly interact with the developers, as well as the HMIS managers, in terms of what we are seeing as we implement on the ground, and what changes can make it easier, both from a program perspective, but also from a clinician's perspective on the ground" (NG204).

Some respondents expressed concerns about the sustainability of CMIS without donor funding. There will be many added costs, e.g., staff, new equipment, replacing obsolete equipment, training, mentoring, and transport. There are already plans to work with the Global Fund to procure equipment for the remaining

facilities. A respondent (G105) reported, "… [a concept note has been] submitted and we are hoping that eventually that it will be approved, and we are counting on that, and we are also pushing even with government." Respondents emphasized the need for more government support for the CMIS.

> *But also, we need government to understand that for this to roll-out fully, they should prioritize the infrastructure, enabling the environment for CMIS, and that is very difficult, because it's also dependent on other ministries, and they have different priorities.* (NG206)

So far, the government supports the CMIS verbally, but whether they provide the resources to fully support it remains to be seen.

The final major concern that respondents identified as a barrier to successful CMIS implementation was the attitude of the health workers. The researcher did not visit a representative sample of health facilities during the interviews, but did visit two sites: one of the pilot sites, where CMIS has been live for 26 months, and a site that went live late last year, so CMIS had been live for 8 months. The researcher found negative attitudes about CMIS at both sites. (Note: The staff with whom we spoke were also members of the RHMT.) The frustrations stemmed from many of the issues already discussed: the system is too slow, power outages are a challenge, there is duplication of efforts, they do not believe data are being accurately captured, and technical support is lacking.

Frustrations with CMIS were exacerbated when staff at these two sites spoke with providers in other facilities who are experiencing similar problems. When these problems are communicated with staff at other sites, it can result in resistance to the CMIS before it even goes live in their facility. Conversely, staff can also become frustrated when they hear that other facilities are not having the problems with CMIS that they are experiencing. It is important to address the concerns of the users and let them know their issues have been heard. One respondent (NG210) said, "Because when someone complains about having seen something, what you do next becomes the answer to whether the person will be comfortable moving forward with the system. … You want create a certain level of trust this early."

The respondent from the pilot site felt that the issues they experienced during the pilot were not fully addressed, and that the relationship between the health facility and the developers was strained, but improving. Another respondent felt that their concerns were being put aside while implementation moved ahead, "Every day you complain. They say this is a system, it's still new, these are trending problems they are going to be outgrown as we go on. So, we are still nursing hopes, but they are busy opening other sites" (G211). The need to address the attitudes of the health workers was summarized by respondent NG206:

> *These challenges that are being cited and are frustrating the health workers … a health worker should not be frustrated with the system, because their main concern is the patient standing at the door. So, the system should not hinder them to do their work, otherwise they will leave the system aside and continue doing their work.*

Additional Concerns: Assessing Data Quality and Accessing Data for Research

The need to incorporate data quality mechanisms in the CMIS is another topic of concern. For this electronic system, no one has experience conducting data quality audits (DQA) and regular data checks. This is unchartered territory for many. One respondent expressed his concerns this way:

> *Someone enters data you can't really double check to make sure the data was entered in correctly or the data that was entered was actually correct. So, like wait, if I write down 140 and it was [actually] 120, nobody can come back and say this was supposed to be 120. So, I think it [has] the same limitations as any electronic data collection system … not being able to go back and recheck your data.* (NG201)

One clinical partner devised their own protocol to capture suspicious records within the system and account for data errors. Another respondent said, "SOPs [standard operating procedures] on how to conduct DQA on CMIS data must be urgently finalized and fully operationalized in all sites" (NG202).

Research respondents expressed concern about how the CMIS would change access to the data. They are accustomed to extracting data from chronic care files available in health facilities for their research, but they are unsure about the procedure once the paper forms are gone. Research data clerks do not have CMIS log-in information, so they must wait until a nurse can provide access to the system to obtain data for their research.

Defining Success for the CMIS

Respondents have high hopes for the CMIS, but their definitions of success varied. Some reflected the various needs CMIS is trying to meet, from improving patient care across the country to generating better data for national programs. For some, a successful CMIS would "… [allow you] to treat patients across facilities within the country. That is, you would be able to, of course reduce duplication" (NG204). One respondent defined CMIS implementation success by the number of facilities that are running a fast system, with health workers who are satisfied with the system and can use it correctly, and with client satisfaction with the system.

Having CMIS implemented in every facility was a factor for success among some people interviewed. One respondent (G105) said success would include "… all the facilities in the country having CMIS [which would be achieved though political will at the highest levels, and the] ownership and buy-in from the users of the system, and the support, the timely support, they need as they are implementing the system." This respondent added that success would also include a clear maintenance plan that ensures the sustainability of the CMIS in all facilities across the country. Another respondent (NG203) said success would be defined by the "flexibility for CMIS to optimally integrate with other health information systems in Swaziland" and the "capacity to influence learning and the delivery of health services aligned with Swaziland's e-government vision."

For some respondents, success means the potential to get accurate data for programming, budgeting, and decision making at the national level. "CMIS will give us a correct, or close to, real-time coverage of core interventions and near accurate immunization coverage in Swaziland. When we get it from CMIS we know it's not double counting" (G101). This sentiment was echoed by another respondent (NG204), who said:

> *CMIS will help national programs mostly to focus on coverage at population level, instead of just looking at just cases, you are looking at individuals who are accessing services, and at that point we are able to make better estimates and better-informed programming targets going forward.*

But some respondents cautioned that the data had to be of high quality with verifiable data outputs with improvements observed on data quality. Other respondents defined success as a CMIS that fully incorporates all of the health programs, thus allowing for the abandonment of paper registers.

Discussion and Recommendations

The CMIS is a major intervention being implemented in Swaziland to fundamentally change how clinical care is delivered and reported within the country. Therefore, it makes sense that there are many strong opinions about it. We conducted interviews to capture those opinions and determine the success of the ongoing implementation program. At the time the interviews were conducted, the CMIS implementation was suspended, in a "pause and reflect" period, to address the issues experienced with the facilities that have implemented and are currently using CMIS. Therefore, no additional sites were going live in this period. As one respondent (NG209) said, "Eighty sites is a huge number of a small country like this, and so it was strategic to then say let's go back, let's meet these stakeholders from facilities, from the regional level, from the national level, the partners, and all those several stakeholders to then say what exactly are your concerns."

Delaying the implementation was not necessarily a popular decision, but it was needed to address current problems before moving forward with the implementation at other sites. Some of the activities that took place during the implementation delay included, soliciting feedback from stakeholders through various meetings and forums, developing a list of concerns to address, and working to improve project management. A CMIS version 2 is currently under development to address issues of speed and system performance, and to include more health programs and in-patient modules. Yet, it is also important to resolve the HIV issues within CMIS (see Box 1), and to determine how data quality will be assessed with the CMIS. These efforts may not resolve all reservations that stakeholders have with the CMIS, so this section will provide some general observations and recommendations.

Managing Expectations

For a project that promises to make fundamental changes to the healthcare system, it is important to manage the expectations of the stakeholders. Promoting the advantages of a new, innovative system has over the current system is natural, but people also must understand there are limitations, so they will not be disappointed when the system does not always work as they had hoped. It is also important to place CMIS in the context of the wider health sector. One respondent (NG210) said, "[The adoption of the CMIS should not have changed many of the other clinical processes because] …this is more of a data management tool. In fact, it's a data collection tool, just like the registers." Therefore, it should not be expected to resolve existing problems with how data are collected, or services provided.

There are six core functions of the health system and the CMIS will be affected by and will affect the other core functions of the health system. One intervention in one of the core functions will only be as strong as the health system that surrounds it. Table 3 provides some illustrative examples of how the core functions of the health system can interact with the CMIS. So, it is important to keep this in mind when considering CMIS's successes and challenges.

Table 3. Health system strengthening core functions and how they can interact with the CMIS

Core function	Affected by	Affects
Health information	Indicators for health programs available	Quality of reporting
Service delivery	Rotation of nurses within health facility	Changes provider/patient interaction
Health finance	Resources allocated for equipment, training, and support	Financing of specific health services based on data
Leadership and governance	Existence of standard operating procedures for data management and security	Coalition building around a health problem
Medical products, vaccines, and technologies	Availability of proper technology to implement system	Distribution of commodities
Human resources for health	Capacity of staff to use and maintain the system	Job satisfaction

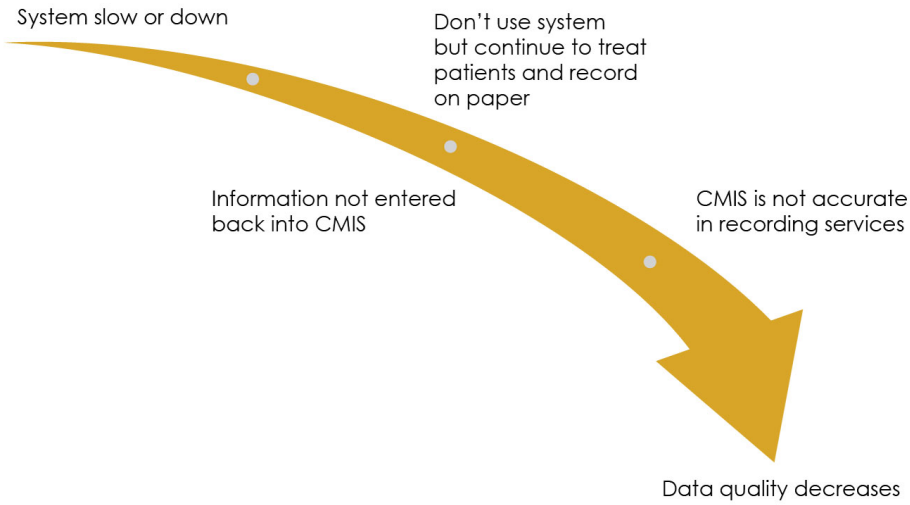
A couple of other examples come to mind. First, some respondents cited one of the benefits of the CMIS would be to help improve ART-patient retention and loss to follow-up. While this is true (if the CMIS provides a clear list of people who have missed their appointments), it will not improve ART-patient retention all by itself. Asked about existing policy or guidelines for following-up with patients who have missed appointments, respondents could not identify any national guidelines. Not having national standards can result in staff across the country using different procedures to conduct follow-up with clients who have missed an appointment. Before we can assess if the CMIS assists in this process, you first must assess the strength of the current patient follow-up system.

Viral load data was another issue discussed by several respondents during the interviews, who noted it was missing from the CMIS. This was identified as a limitation of the CMIS: it is not linked to the lab information system (LIS). This means viral load tests do not automatically appear in the CMIS when results are available. That is a valid issue, but we observed that collecting viral load data is a new development, and a process has yet to be put in place to systematically report the results. Until the CMIS is interoperable with the LIS, there has to be a procedure for entering viral load in a client's CMIS record once the results are returned. The LIS also doesn't have a unique client ID, which makes it difficult to match-up clients with results. This is another example where an issue is part of the wider health system, and not one that the CMIS can resolve on its own.

Many respondents complained that the CMIS data were inaccurate and that services were reduced in number once the CMIS was implemented. Yet, they all mentioned that there were downtime forms to use when the system was not available. It is true that the data quality dimension of completeness has probably decreased since the start of the CMIS implementation, but respondents did not appear to make the connection between staff not following procedures and the inaccuracies they later observed. Figure 1 depicts how this can happen. It begins with the CMIS being slow or down or the electricity being out. Despite this, clients are still waiting

for services, so the providers continue to see clients, and they may record these services on the down-time form or another paper form. This information should be entered in the CMIS when the system is up and running. But, it is not clear how consistently this is done. If the information gathered during the outage is not entered in the CMIS after an outage, then the reports produced by the CMIS will not be accurate or complete, and data quality declines. Ensuring that information is entered in the CMIS should be the facilities' responsibility; supervisors need to encourage this. There should be a process of reviewing submitted data and providing feedback to facilities. If this process was in place when the registers were used, then there should also be a mechanism for data review and feedback once the CMIS is implemented in facilities. Data quality improves when people responsible for data entry understand that the data are being reviewed and used.

Figure 1. How data quality decreases when the CMIS is unavailable



Improving Communication and Collaboration

Some respondents perceived a lack of communication and collaboration between the CMIS team and the stakeholders. This was despite evidence that attempts had been made to improve communications and collaboration with key stakeholders. Even when stakeholders felt their input was requested, some still felt they were not being heard, and several respondents felt the CMIS team was defensive when presented with negative feedback. Complete transparency about changes and improvements to the CMIS are necessary and should be broadcast often, loudly, and widely. This can't be said enough; people get very annoyed if they perceive they are being left out, and first impressions can be difficult to change. As discussed above, some respondents were unsure if the CMIS was able to accurately capture data that were entered, and therefore, was inaccurate. To address this, the CMIS team held a logic check meeting to look into these issues with representatives from all of the regions, which demonstrated that the CMIS was properly working. But how was this information cascaded down to the health worker? This is but one example. There needs to be a clear plan for how to get information to the users once changes have been made.

Given all of the concerns, CMIS needs an aggressive public relations campaign to win over the skeptics, particularly the healthcare workers, who are the frontline users of the system, interact with the patients, and are the key to obtaining valid and reliable data on the various health programs. Healthcare workers were not surveyed across the country for this study, so it is not possible to say what percentage of workers feel one way or the other about the CMIS. The respondents were reporting feedback they had heard, but some participants were healthcare workers who worked in health facilities. Based on this, it appears there is a serious problem

with health worker attitudes about the CMIS. Health workers from different facilities talk to one another, so health workers in facilities that have not implemented the CMIS may be biased against it well before it arrives. There were some reports of health facilities that were not experiencing any problems, but unfortunately, it is often the dissatisfied voice that is the loudest and garners the most attention. As with implementing partners, when changes are made to address complaints from the health workers, it should be broadcast to them, so they understand that their concerns have been heard and addressed. It was surprising to learn that some of the respondents who work in health facilities were unfamiliar with the CMIS help desk number that had been set-up to log their complaints and requests.

The public relations campaign should also extend to clients who have been part of the CMIS implementation and have experienced the delays and frustrations of the health workers first-hand, and who may have developed their own negative opinions of the CMIS. Their participation and satisfaction will also be a key to success. This campaign may require the help of an outside firm that focuses only on promotion and marketing, but it may be necessary to improve the image of CMIS and facilitate its success.

Improve Training and Support

Another noteworthy topic was health workers' lack of confidence in using the CMIS, and their lack of confidence in other health workers correctly using the CMIS. Concerns included knowing what to do when the system or power was down. These are issues of training and mentoring. Currently, CMIS training happens off-site over two days, with some refresher trainings happening before CMIS goes live in the facility. To our knowledge, there has not been a formal evaluation of the effectiveness of the training. In a previous trip, the researcher attended one day of training to get a sense of what information was covered and how it was delivered. There was an exercise at the end of the training to assess how well trainees understood how to use the system, but it was done in pairs or small groups and only addressed a few scenarios. Individual assessments with multiple scenarios would better identify individuals who need additional training. Individual assessments and user feedback should also be part of the support received once health workers are back in their facilities. Additionally, no paper training manual accompanied the training. This was being remedied, the distribution of paper and electronic copies of the manual were scheduled to be distributed during the "pause and reflect" period. Paper-based manuals serve as good reference material, even as the push intensifies to go electronic. In general, people still like to have manuals they can flip through, take notes in during the training, and refer to when they are back to work.

One respondent, who worked at the first pilot site, was one of the most enthusiastic supporters of the CMIS. However, she described a setting where they received a great deal of training and had ongoing support to address their concerns or technical issues. This is critical to help health facilities adopt the CMIS. One way to do this is to have more teams providing ongoing support to facilities once they go live. Another possibility would be to select and train individuals at each health facility to be the CMIS expert for their facility, although this may meet with some resistance, because it could increase the workload of the selected individual. Nonetheless, support and mentorship to facilities is important in ensuring that health workers gain confidence in using the system, use the system correctly, and fully adopt the CMIS.

Limitations

One potential limitation of this study was what appeared to be a reluctance among some respondents not to be too critical of the CMIS. Since a separate MEASURE Evaluation activity had provided technical support to the CMIS, some respondents felt that this evaluation was biased, but we explained to respondents that

these two activities were separate from one another. It would have been helpful to interview some respondents a second time to further clarify or explore topics that arose from other interviews, but this was not possible given the time frame. Stakeholders are busy people, and we felt it was important to respect their time.

CONCLUSION

Swaziland decided to develop the CMIS to harmonize data collection and improve patient care. Prior to CMIS they had parallel information systems, a lack of continuity of care, and inaccuracies generated in statistics due to the inability to identify individuals who received services. The decision to create their own system was made to ensure that a sustainable system was developed and maintained that was aligned with government policies and infrastructure. The potential benefits of a well-functioning CMIS include: reducing the burden on clinicians, improving continuity of care for patients and reducing their time spent at the facilities, improving the timeliness of reporting, and having one data set containing all health variables of interest. Limitations cited by users included CMIS issues that cause the system to be slow or down, the absence of health programs in the CMIS, and the lack of technical support for users once the CMIS is implemented. Other potential barriers to full implementation mentioned by respondents were the general infrastructure of the country, human resources and capacity building, future financing, and the attitude of health workers towards the CMIS. The CMIS has the potential to transform Swaziland's healthcare system, but it is important to manage stakeholders' expectations, improve communication and collaboration, and strengthen training and support for users.

APPENDIX 1. INTERVIEW GUIDES

In-Depth Interview Guide: Key Stakeholders, United States Government and Other International Partners

Interview Questions

First, I am going to ask you some general questions about your organization and your role in it

1. Can you tell me what your organization does here in Swaziland?

   Prompts:
   - In what areas does it focus?
   - How long has it been working here?
   - What is the relationship between your organization and MOH/other partners?

   Follow-up: What is your role in your organization?

2. Can you talk to me about your organization's data needs?

   Prompts:
   - What kinds of data do you have to collect and report?
   - What is the frequency of data collection?

3. Can you describe how you have been collecting and reporting data?

   Follow-up: what have been some challenges with this method?

4. Are there data quality concerns? If so, what are they and how are they being addressed?

Okay, let's talk now about the design and development of the CMIS

5. Can you tell me how you have been involved with the CMIS?

   Prompts:

   Follow-up: can you tell me if you had any prior experience working in a setting that was using an electronic health record?

6. Can you describe to me the development process for CMIS? Not the technical aspects but how the idea of having an electronic health record began and evolved in Swaziland

   Probes:
   - When was it first discussed?
   - What organizations (or people) were involved in the original concept?

Follow-up: What were some of the reasons this system was needed?

- Was data collection disorganized?
- Lack of unique IDs
- Need for a system that could be used across service points
- Was there a champion?

7. What other options were considered besides CMIS?

   Follow-up: Do you know why it was decided to develop the system here rather than going with a vendor-developed system? If so, what where the reasons?

8. From your organizational perspective, what do you need the CMIS to do?

   Prompts: provide data in a specific format? Collect data for reporting?

9. Did you or others in your organization have a role in the design of CMIS? If so, how?

   Probe about whether they or others in their organization were consulted about data that should be collected, how the EHR should look and feel, including menu choices, data reporting, and so on.

Let's move on to talk about the implementation

10. Can you describe to me the process of implementation?

    Prompts:

    - Who are the different stakeholders and what are they responsible for?
    - What are the steps to set up CMIS in a facility?

11. What is the plan to finance and support CMIS in the long-term?

12. What are the benefits of the CMIS for the Swazi health care system?

    Prompts:

    - Improved ways to collect, aggregate, and check data for errors
    - Improved clinical care
    - Increased provider satisfaction
    - Reduction in patient duplication

    Follow-up: What are the benefits for your organization, specifically?

13. What do you see as potential problems and limitations of the CMIS?

    Prompts:
    - Hybrid system with only some facilities using the system
    - Sustainability
    - Not enough capacity nationwide to maintain the system
    - Concerns about data not meeting stakeholder needs
    - Privacy concerns
    - Infrastructure issues like power outages that can disrupt system use

14. Earlier you mentioned [XYZ from Questions 6 & 7] as needs for CMIS to address. How well do you think CMIS is addressing these needs?

15. What, if any, changes do you recommend for CMIS moving forward?

16. How do you think success will be defined for CMIS?

Closing script

That is the end of this interview. Thank you very much for taking the time to do this interview with me. Your knowledge and experience working in the health system will be truly helpful to us to better understand the effectiveness of the Electronic Health Records in Colima, and to make improvements in the system in the future.

Would you like to see the transcript of your interview after it has been transcribed?

[If the person wishes to see the transcript]: We will start working on the transcription after the interviews have been completed. We can email your interview transcript once it is ready. What email address would you like us to use?

Thank you again for your help with this study. We look forward to being in touch.

In-Depth Interview Guide: Key Stakeholders, Swaziland Ministry of Health

Interview Questions

First, I am going to ask you some general questions about your department/unit and your role in it

1. Can you tell me the responsibilities of your department?

   Follow-up: What is your role in your department?

2. Can you talk to me about your department data needs?

   Prompts:
   - What kinds of data do you have to collect and report?
   - What is the frequency of data collection?

3. Can you describe how you have been collecting and reporting data?

   Follow-up: what have been some challenges with this method?

4. Are there data quality concerns? If so, what are they and how are they being addressed?

   Okay, let's talk now about the design and development of the CMIS

5. Do you know how CMIS developed?

6. Can you describe to me the development process for CMIS? Not the technical aspects but how the idea of having an electronic health record began and evolved in Swaziland

   Probes:
   - When was it first discussed?
   - What organizations (or people) were involved in the original concept?

   Follow-up: What were some of the reasons this system was needed?
   - Was data collection disorganized?
   - Lack of unique IDs
   - Need for a system that could be used across service points
   - Was there a champion?

7. From your organizational perspective, what do you need the CMIS to do?
   Follow-up:

Let's move on to talk about the implementation

8. Can you describe to me the process of implementation?

   Prompts:
   - Who are the different stakeholders and what are they responsible for?
   - What are the steps to set up CMIS in a facility?

9. What are the benefits of the CMIS for the Swazi health care system?

   Prompts:
   - Improved ways to collect, aggregate, and check data for errors
   - Improved clinical care
   - Increased provider satisfaction
   - Reduction in patient duplication

   Follow-up: What are the benefits for your organization, specifically?

10. What do you see as potential problems and limitations of the CMIS?

    Prompts:
    - Hybrid system with only some facilities using the system
    - Sustainability
    - Not enough capacity nationwide to maintain the system
    - Concerns about data not meeting stakeholder needs
    - Privacy concerns
    - Infrastructure issues like power outages that can disrupt system use

11. Earlier you mentioned [XYZ from question 6 and 7] as needs for CMIS to address. How well do you think CMIS is addressing these needs?

12. What is the plan to finance and support CMIS in the long-term?

13. What, if any, changes do you recommend for CMIS moving forward?

14. How do you think success will be defined for CMIS?

Closing script

That is the end of this interview. Thank you very much for taking the time to do this interview with me. Your knowledge and experience working in the health system will be truly helpful to us to better understand the effectiveness of the Electronic Health Records in Colima, and to make improvements in the system in the future.

Would you like to see the transcript of your interview after it has been transcribed?

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Thank you again for your help with this study. We look forward to being in touch.

APPENDIX 2. INFORMED CONSENT FORM

Principal Investigator: Eva Silvestre (Tulane University)

Study Title: A Case Study of Electronic Health Records Implementation in Swaziland – In-depth Interviews

Performance Sites: Swaziland

Sponsor: United States Agency for International Development

The following informed consent is required by Tulane University for any research study conducted by investigators at the University. This study has been reviewed by the University's Institutional Review Board for Human Subjects.

Introduction

You are invited to participate in a research study investigating Electronic Health Records in Swaziland. More specifically, we are studying the Client Management Information System (CMIS), which has been implemented in some of Swaziland's public hospitals and health clinics in order to improve various aspects of health system functioning. The study has been funded by the United States government, and is being conducted by researchers at IHM and Tulane University in the United States. We are interested in learning about how the system is being used, and how the system might be improved.

Why is this study being done?

The results of the study will be used to provide 1) an assessment of the benefits and limitations of the CMIS, 2) recommendations for improving the system, and 3) recommendations for other African countries to help ensure that a) EMR interventions are appropriately designed and implemented to improve health systems functioning and b) resulting EMR information is used effectively. Your participation in this in-depth interview will help understand whether and how this system has benefited the health services in Swaziland.

What are the study procedures? What will I be asked to do?

If you agree to take part in this study, you will then be asked to answer questions regarding CMIS. Specifically, you will be asked questions based on your experience in the Swaziland health system, and your knowledge and opinions of certain aspects of the CMIS.

If you agree to take part in this study, then you will be interviewed in a private location at your workplace or some other location where a private interview can be conducted. We value your honesty and openness and encourage you to ensure that you are able to speak freely. If you agree to take part in this study, the interview will be conducted after you sign this consent form.

The interview is estimated to take one hour in total. We will be interviewing 20-25 people.

It is possible that you may be contacted again in the future for a follow-up interview. If a follow-up interview is necessary, we will contact you in advance.

What are the risks or inconveniences of the study?

We believe there are no known risks associated with this research study; however, a possible inconvenience may be the time it takes to complete the study. A breach of confidentiality is not considered a risk in this study, due to the procedures in place to ensure confidentiality is maintained.

What are the benefits of the study?

You may not directly benefit from this research; however, we hope that your participation in the study may further understanding of the role of CMIS in the health system in Swaziland.

Will I receive payment for participation?

You will not be paid to be in this study.

Are there costs to participate?

There are no costs to you to participate in this study.

How will my personal information be protected?

The following procedures will be used to protect the confidentiality of your data. The researchers will use a respondent identifier instead of your real name. Data that will be shared with others will be coded as described above to help protect your identity. At the conclusion of this study, the researchers may publish their findings. Information will be presented in summary format (such as by provider type) and you will not be identified in any publications or presentations.

You should also know that the Tulane University Human Research Protection Office and the Biomedical Institutional Review Board (IRB) may inspect study records as part of its auditing program, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people who review research studies to protect the rights and welfare of research participants.

Can I stop being in the study and what are my rights?

You do not have to be in this study if you do not want to. If you agree to be in the study, but later change your mind, you may drop out at any time. There are no penalties or consequences of any kind if you decide that you do not want to participate. In addition, you do not have to answer any question that you do not want to answer.

Who do I contact if I have questions about the study?

Take as much time as you like before you make a decision to participate in this study. We will be happy to answer any question you have about this study. If you have further questions about this study or want to voice concerns or complaints about the research or if you have a research-related problem, you may contact the principal investigator, Dr. Eva Silvestre (+1-504-988-7293 or esilvest@tulane.edu) or Mr. Patrick Shanbangu of the Institute for Health Measurement (+52 777 329-3064). If you would like to discuss your rights as a research participant, discuss problems, concerns, and questions; obtain information; or offer input with an informed individual who is unaffiliated with the specific research, you may contact the Tulane University Human Research Protection Office at or email at irbmain@tulane.edu.

Consent to Audio/Videotape:

This study involves audio recording of your participation. Neither your name nor any other identifying information will be associated with the audio recordings or any transcripts created from them. Only the researcher(s) will be permitted to listen to/view the recordings.

Immediately following the interview, you will be given the opportunity to have the recordings erased.

Please initial one of each pair of options.

___ I consent to have my participation recorded.

___ I do not consent to have my participation recorded

___ I consent to have my recorded participation transcribed into written form. ___ I do not consent to have my recorded participation transcribed.

The recordings will be transcribed by the researcher and erased once the transcriptions are checked for accuracy. Transcripts of your participation may be reproduced in whole or in part for use in presentations or written products that result from this study. Neither your name nor any other identifying information (such as your voice or picture) will be used in presentations or in written products resulting from the study.

___ I consent to the use of the written transcription in presentations and written products resulting from the study provided that neither my name nor other identifying information will be associated with the transcript.

___ I do not consent to the use of my written transcription in presentations or written products resulting from the study.

The above permissions are in effect until July 15, 2019. On or before that date, the tapes will be destroyed.]

Subject _____ Date _____

Documentation of Consent

I have read this form and decided that I will participate in the research project described above. Its general purposes, the particulars of involvement and possible risks and inconveniences have been explained to my satisfaction. I understand that I can withdraw at any time. My signature also indicates that I have received a copy of this consent form.

Subject _____ Date _____

Person Obtaining Consent _____ Date _____

I am unable to read but this consent document has been read and explained to me by _____ (name of reader). I volunteer to participate in this research.

Subject _____ Date _____

Witness _____ Date _____

Person Obtaining Consent _____.....Date _____

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APPENDIX 3. CODEBOOK

Code	Description
Development of CMIS in Swaziland	Need for the CMIS and how the system was developed in-country
Need for CMIS	Descriptions of what the issues were in health care settings and for reporting that led to decision to develop CMIS
Paper registers	The different number of paper registers that are used in health facilities
Duplication of clients	Problem that arose from paper registers and lack of unique ID, patients were counted more than once
Parallel reporting	Descriptions of the various health programs that collect health information from health facilities which led to having multiple systems at once collecting similar information
Lack of continuity of care	Descriptions of the inability of the paper system to follow a patient across services, across health facilities, and across treatment plans
Inaccurate statistics	Descriptions of the inaccurate statistics generated by the paper-based system because of duplication of cases and inability to count individuals receiving services
Developing own system	Descriptions of why Swaziland decided to develop own electronic system
Experience with other electronic systems	Descriptions of other experiences the Swazi health sector had with other electronic health systems
e-government	Descriptions of the importance of having CMIS be aligned with government policies including the e-government strategy
Sustainability of system	Need to develop own system to ensure it is sustainable financially and to develop national capacity to maintain it
Unique ID	Descriptions of need for unique ID and how one was developed
Stakeholders in developing CMIS	Different government, non-government, and other partners involved in development of CMIS
Potential benefits of CMIS	Descriptions of what stakeholders see as potential benefits of having CMIS
Reduce burden on clinicians	Descriptions of how the use of CMIS can reduce burden on clinicians in terms of having to write on multiple registers and speeding up the process of accessing patient information
Improving clinical care	Descriptions of how the use of CMIS could improve the provision of clinical care
Access to patient information	Improved access to patient information could improve clinical care
Improved referrals	Descriptions of how CMIS could be used to strengthen referral systems

Reduced wait times	Descriptions of possibility of CMIS reducing the wait time for patients due to improved clinical efficiencies
Clinical mentoring	Descriptions of how CMIS can enhance clinical mentoring which could lead to overall improvements in patient care
Improve reporting	Descriptions of expected benefits of CMIS on reporting
Reduction in time for report	Descriptions of decreased wait times to generate reports using CMIS
Back-up information	Descriptions of ability to back up data
Complete data set	Descriptions of CMIS generating a complete data set for health research and overall patient care
Limitations of CMIS use and possible barriers to implementation	Descriptions of limitations, problems, and possible barriers to full implementation
System issues	Descriptions of system issues users have experienced or have heard have been a problem from other users
System/power down or slow	Description of the CMIS being down, slow, or power going out which resulted in service disruption
Not capturing data	Belief that the CMIS was not accurately capturing all the services that are provided
Data quality declining	Issues around the decline of data quality since the implementation of CMIS
Paper/electronic double-entry	Need to record services on paper forms when system is out or the need to keep both records
Increased time with patients	Users felt the CMIS increased time with patients but not for clinical care
User dissatisfaction	Descriptions of dissatisfaction with the CMIS
Support to users	Descriptions of the type of support CMIS users receive or need in order to operate CMIS correctly
Training	Training received to use CMIS
On-site support	On-site support given to sites once CMIS goes live in a facility
Issues training/support	Issues that may be addressed by strengthened training or ongoing support to users
Health program data missing from CMIS	Descriptions of how the CMIS is missing modules to capture some health program data
HIV focus	Discussions about how HIV seems to get preferential treatment in CMIS development and use
HIV issues	Discussions about problems users are experiencing with HIV modules, data collection, or reports
Tb	Discussions about TB modules missing or inadequate in CMIS
Concerns for full implementation	Descriptions of concerns stakeholders have for a successful full implementation of the CMIS
Infrastructure	The issues with the electricity, connectivity and other infrastructure issues that still affect Swaziland
Human resources	Issues with having enough people trained on maintaining, using, supervising, and analyzing data from CMIS
Financing	Concerns about how CMIS will be financed past the initial phase of implementation

Capacity	Capacity of people to analyze and use data from CMIS
Health worker attitude	Negative health worker attitudes towards the CMIS that may affect the success of CMIS
Additional themes	Additional themes that emerged from interviews
Assessing data quality	Concerns about how data quality will be assessed once all data is electronic
Accessing data for research	Concerns about how data can be accessed via CMIS for research purposes
Providing feedback	Discussions about how CMIS team receives feedback on CMIS issues

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