Doing More Than Asking for Opinions:
A Framework for Participation and Ecohealth in Health Information System Evaluations

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ABSTRACT

Health information systems (HIS) are used to manage information related to population health. The goal of this research was to conduct an evaluation of a HIS used at a hospital in south-western Uganda using participatory approaches. The evaluation structure was based on guidelines generated by the Center for Disease Control and Prevention and a series of theoretical and methodological concepts regarding participatory engagement that encouraged stakeholder participation throughout the evaluation. The primary objectives were to describe the areas of strength and limitations of the HIS, and develop potential system enhancements. Ultimately, engagement of local staff members throughout each stage of the evaluation resulted in the development of a series of recommendations considered relevant and feasible by local stakeholders. We build on these results by highlighting the value of stakeholder engagement and opportunities to apply participatory and community-based research methods and an Ecohealth framework to an HIS evaluation.

KEYWORDS

Community-Based Research Methods, Ecohealth, Evaluation Framework, Health Information Systems, Participatory Research Methods, System Evaluation, Uganda

INTRODUCTION

With 2.2 million inpatient admissions and 6.9 million individuals accessing outpatient services annually, hospitals and health care facilities in Uganda are constantly accumulating health information (Ugandan Ministry of Health, 2014b). To collect, monitor, and manage this constant inundation of information, health care facilities use a comprehensive Health Information System (HIS), which can also contribute to the maintenance and improvement of health care services (Brown, Patrick, & Pasupathy, 2013). According to the World Health Organization (WHO, 2010), the four key

functions of any HIS are: (i) data generation, (ii) compilation, (iii) analysis and synthesis, and (iv) communication and use.

In low resource settings, a HIS can be used to support a diverse range of health projects and has been successfully integrated into a variety of clinical settings, including health care facilities in Brazil, Haiti, Kenya, Malawi, Peru, and Uganda (Fraser et al., 2005). Each of these systems typically consist of six components, which are: (i) resources, (ii) indicators, (iii) data sources, (iv) data management, (v) information productions, and (vi) dissemination and use (WHO, 2008). The unique conditions and challenges of each health care facility operating in a limited resource setting has made it challenging to achieve uniform standards amongst these components (Braa, Hanseth, Heywood, Mohammed, & Shaw, 2007), and few low resource countries have been able to develop systems that are able to achieve all four key functions outlined by the WHO (2010). However, by understanding local needs and priorities, and determining the availability of resources, a HIS can be adjusted for barriers specific to each location, which improves its ability to aid in the provision of health care (Braa et al., 2007; Fraser et al., 2005). Specifically, in Uganda, individual health care facilities' HIS and mTrac, an SMS-based disease surveillance and health system strengthening tool, contribute data to a national data aggregation system called eHMIS-DHIS2 (Ugandan Ministry of Health, 2014a). This arrangement generates health information to monitor the health status and services at all levels (Ugandan Ministry of Health, 2014a). To ensure a HIS adequately monitors problems of public health importance, each HIS should be evaluated once it has been established (Center for Disease Control and Prevention [CDC], 2001). The completion of rigorous and effective evaluations creates opportunities for further development and improvement of a HIS (Ammenwerth et al., 2004).

An evaluation consists of an assessment of system attributes and a review of system operations, which should generate results that promote the best uses of health resources (CDC, 2001). Several HIS evaluation frameworks have been generated for assessing system performance, each focusing on slightly different components of a HIS as related to human, organizational, and technological factors (Yusof, Papazafeiropoulou, Paul, & Stergioulas, 2008). However, with HISs evolving in structure, function, and diversity, the associated complexities within its evaluations have also increased, which has created several problems for conducting adequate and consistent evaluations (Ammenwerth et al., 2004). The concept of evaluating a HIS is further seen as challenging as there is no consensus on what to measure, who to involve, or the methods that should be used (Klecun-Dabrowska & Cornford, 2001).

Existing evaluation guidelines and frameworks that predominantly examine technical aspects can lead to incomplete assessments (Yusof et al., 2008). A more comprehensive approach requires the incorporation of the cultural, political, social, and organizational factors into the evaluation (Klecun-Dabrowska & Cornford, 2001). As these context-dependent factors are essential to the success of a HIS, the evaluation must be contextualized (Klecun-Dabrowska & Cornford, 2001). However, many existing frameworks fail to incorporate these factors (Alalwany & Alshawi, 2012). The review of evaluation frameworks completed by Andargoli, Scheepers, Rajendran, and Sohal (2017) highlighted that out of 20 different available frameworks, most frameworks neglected the role of context, which was defined by two factors: (i) the reason for an evaluation, and (ii) who should be included in it. Most frameworks failed to fully identify and consider the role of stakeholders within the evaluation (Andargolia et al., 2017). Similarly, Mei, Marquard, Jacelon, and DeFeo (2013) also suggested that many frameworks limit stakeholder views and perspectives, ultimately hindering the evaluation. Limiting stakeholder involvement in a low resource setting is of further concern as their participation in health research can increase the contextual relevance and legitimacy of the findings (Viergever, Olifson, Ghaffar, & Terry, 2010).

Of the existing evaluation frameworks that do mention the engagement of stakeholders, there is little explanation of how this is to be conducted or information on the depth of engagement, which may result in inadequate participation from stakeholders to be able to contribute useful insight. A lack of participation is a concern because emphasizing communication and integrating a community-based

approach into an evaluation strengthens the quality of the evaluation and succeeding development (Minkler, 2000). Moreover, community engagement is a form of social capital, which Ebi and Semenza (2008) describe to be, "the potential embedded in social relationships that enables residents to coordinate community action to achieve shared goals" (p. 502). Social capital is a key determinant of intervention success as it ensures considerations from the local context are adequately captured (Ebi & Semenza, 2008). Lastly, participation allows for the development of cohesive relationships, which increases the chances of achieving health goals and allows health care facilities to increase their control over events that may impact them (Labonte & Laverack, 2008). Despite the abundance of literature outlining the value and importance of stakeholder engagement, especially in a low-resource setting, there is an apparent gap in existing HIS evaluation frameworks outlining the necessary steps to adequately incorporate it.

The goal of this study was to describe and understand the current HIS used at Bwindi Community Hospital (BCH), in Kanungu District, south-western Uganda, by developing and implementing methods and techniques that engaged stakeholders throughout a HIS evaluation. The specific objectives were to: (i) describe the attributes and determine areas of strength and limitations of the HIS used at BCH; (ii) identify the potential system enhancements, recommended by the staff at BCH, and describe feasibility and effectiveness of ideas to enhance the quality of the system; and (iii) propose a framework for the integration of participatory and community-based research methods in an evaluation of a HIS to develop more relevant results. Through this study, we aim to highlight the benefit of utilizing stakeholders' local knowledge and lived experiences to fill cultural gaps and generate new information.

METHODS

Study Population

In 2014, the Ugandan healthcare system consisted of 5,229 health care facilities that serviced the nearly 38 million residents of Uganda (WHO, 2014). Kanungu District is located in south-western Uganda and has a population of approximately 250,000 people (Ugandan Ministry of Health, 2013). The dominant ethnic group in the district is the Bakiga people (Labbé et al., 2016). However, several smaller ethnic groups also inhabit the area, including the Indigenous Batwa peoples, who traditionally inhabited the Bwindi Impenetrable National Forest before conservation projects resulted in their eviction from the forest and relocation to surrounding rural districts (Uganda Population Secretariat, 2013).

Bakiga, Batwa, and other minority groups from Kanungu and additional neighbouring districts such as Kisoro, Kabale, and Rukungiri are treated at BCH. The hospital is located in Buhoma and services a population of more than 100,000 people (Bishop-Williams et al., 2018; Bwindi Community Hospital [BCH], 2014). It is a private hospital that operates on a fee for service model and relies on private donations for over 90% of its' running costs (BCH, 2014). Founded in 2003, BCH now has 121 staff that treat approximately 40,000 patients annually (BCH, 2014). The Hospital requested this evaluation, with the intentions of using the evaluation results to aid in developing a strategic plan for improving the current HIS.

Evaluation Framework

The framework for this evaluation was developed from the CDC's guidelines for evaluating public health surveillance systems (i.e., HISs and similar systems). The guidelines generated by the CDC were selected to provide the framework for this evaluation based on their standardized approach intended for managers and staff of public, private, and community public health programs (CDC, 2001). This meant the evaluation process used in this study would be reproducible in a large variety of settings, which maximizes its usability.

Qualitative Data Collection

Qualitative data collection occurred in March 2015. Of the 121 hospital staff at BCH, 28 individuals participated in the evaluation. Eleven individual semi-structured interviews were conducted with various members of the hospital's staff (n=3 women and 8 men), who had different roles and responsibilities resulting in frequent interaction with the HIS. Four head nurses, three staff members responsible for data management and analysis, two record assistants, and two additional clinical staff participated in the interviews. The semi-structured interviews were a series of informal conversations guided by exploratory questions about the HIS, which encouraged further discussion (Dunkle & Mariner, 2013). Additional exploratory questions were asked during the interview process to gain further clarification and understanding on experiences and opinions of the interviewee. All questions focused on the various system attributes, which corresponded with a list derived from CDC's guidelines: accessibility, accuracy, completeness, confidentiality, flexibility, integration, representation, simplicity, stability, timeliness, staff compliance, and patient compliance. Questions were directed to key informants within the hospital who would be most able to discuss certain aspects of the HIS. The confidential interviews were conducted in person and took approximately 15 to 45 minutes each to complete.

All healthcare workers and administrators in the hospital were invited to participate in two semi-structured focus group discussions. Approximately half of these individuals also participated in the semi-structured interviews. The individuals involved in the focus groups held positions that were involved with either data collection via patient interaction, directly involved with HIS data management, or used the data from the HIS to complete various internal and external analysis. Individuals from Hospital Management, Records Management, Nutrition, Paediatric in-patient, Adult in-patient, Sexual and Reproductive Health, Community Nursing, Diagnostics Laboratory, and Information Technology represented their departments.

The Participatory Epidemiology Toolkit, generated by the Participatory Epidemiology Network for Animals and Public Health (PENAPH), was used as a resource to develop activities used in the focus group discussions (Dunkle & Mariner, 2013). Ten individuals from the hospital participated in the first discussion (n= 3 women and 7 men), which focused on the use and applications of the data collected in the HIS. The participants co-developed a flow chart, which described where data collection occurred throughout the hospital and demonstrated the movement of patients and their information through the system. In addition, the focus group members used a proportional piling activity designed to generate conversation and discussion about their priorities and the distribution of resources for recommended changes. The proportional piling activity allowed participants to provide relative scores to various categories by distributing 100 counters into different piles that represent the possible actions to be taken by the hospital (Dunkle & Mariner, 2013). The percentage of counters in a category represented the relative importance of the category compared to others in the activity. This activity was conducted three times on three separate, but related, topics: allocation of financial resources, allocation of time resources, and priority of action, to help determine the importance and expected resource requirements of each recommendation.

Twelve staff members participated in the second focus group discussion (n= 4 women and 8 men), which was a discussion and interpretation of preliminary results obtained from prior data collection. A timeline activity was also conducted to generate conversations about the process of implementing staff generated recommendations. Participants were presented with potential recommendations to improve the HIS, which were generated from comments made in the interviews and the proportional piling activity conducted in the first focus group. Then participants were asked to come to a consensus on the feasibility and priority of the recommendations, and sort them based on the amount of time that might be needed to accomplish them.

Qualitative Data Analysis

The interviews and focus groups were transcribed and the qualitative data was systematically analysed, using a multi-step iterative process consisting of: data familiarization; identification of codes through reflecting and memoing; identification of theory-driven and data-driven codes; development of a codebook; systematically coding the transcripts by coding text; and refining, defining, and naming themes (Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006) (see Table 1).

Table 1. Overview of the steps of the systematic qualitative data analysis approach used on the interview and focus group transcripts

Step	Process of Qualitative Analysis	Reference
1	Familiarizing with the data by listening to the audio recordings and writing reflective memos.	(Braun & Clarke, 2006)
2	Generate initial codes/ideas through theory-driven (deductive) and data-driven (inductive) code development. Ideas are expanded and collapsed into reoccurring topics based on explored connections.	(Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006)
3	Generate a codebook that defines codes and provides examples. Pretest the codebook on a small subset of data to ensure functionality. The codebook is then used to code every sentence or phrase of the transcripts based on the topic of the sentence.	(Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006)
4	Collate codes into potential themes based on corresponding ideas. Refine themes and generate a thematic 'map' of the analysis.	(Braun & Clarke, 2006)
5	Analyses are reviewed by the community research team and participants to ensure reliability and accuracy.	(Fereday & Muir-Cochrane, 2006)

The codebook, which contained definitions, examples, and inclusion and exclusion criteria, was generated using trends, interesting features, and common ideas that were observed in the transcripts [Appendix A]. A systematic coding process was used to label every sentence or phrase of each interview and focus group transcript with the appropriate codes to identify themes and trends. This was completed using Version 6.2.17 of Dedoose (2018), a web application for managing, analyzing, and presenting qualitative and mixed method research data. To establish validity, member checking, triangulation, prolonged engagement in the field and collaboration procedures as described by Creswell and Miller (2000) were implemented in data collection and analysis.

Evaluation Framework Expansion

Additions to the CDC's guidelines were made to include a framework with a greater focus on community involvement and the application of participatory research methods throughout the data collection and interpretation processes. The course of action to modify the evaluation framework was collaborative and focused on integrating theoretical and methodological concepts regarding participatory engagement. The expansion focused on increasing participation and was guided by a series of Ecohealth principles, which aim to improve people's health and maintain environmental stability. These guiding principles are: systems thinking, transdisciplinary research, participation, sustainability, gender and social equity, and knowledge to action (Charron, 2012). The Participatory Epidemiology Toolkit (Dunkle & Mariner, 2013) was used as a resource for methods that would aid in the process of engaging stakeholders throughout the investigation in accordance with the guiding principles for Ecohealth (Charron, 2012).

Building on the CDC's guidelines for evaluating public health surveillance systems, each stage was expanded to include the theoretical influence of these guiding principles for Ecohealth research

and the methodological influence from tools in PENAPH's Participatory Epidemiology Toolkit (see Figure 1).

Figure 1. Expansion of the CDC's guidelines (Stages A-F) for evaluating public health surveillance systems by incorporating participatory epidemiology tools (Dunkle & Mariner, 2013) [wedge side 1] and Ecohealth Principles (Charron, 2012) [wedge side 2] throughout each stage
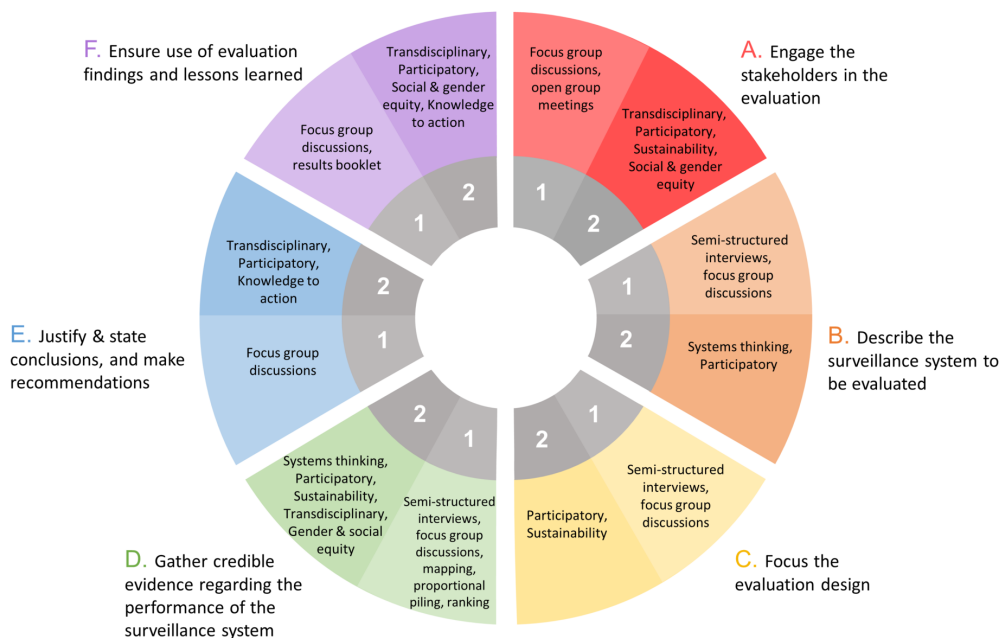
Following the CDC's guidelines, stakeholder engagement was incorporated into each essential stage of the evaluation to create a cohesive process. In Stage A, researchers completed initial engagement with stakeholders to formulate evaluation goals and develop an evaluation plan. In Stage B, C, and D, stakeholders were engaged through semi-structured interviews and focus groups to establish an understanding of the HIS, including its strengths and weakness. Lastly, in Stage E and F, additional consultations and bi-directional knowledge sharing conversations provided an opportunity to confirm preliminary results with stakeholders who could best utilize the information.

Throughout the entire process, collaboration with stakeholders occurred through interviews and focus group discussions. It was important to include engagement throughout the evaluation, rather than only in Stage A (i.e. engage the stakeholders in the evaluation), in order to enhance the application of the guiding principles of Ecohealth. The focus groups were a tangible way to incorporate participation and transdisciplinary thinking into the evaluation. Activities completed during focus groups were used to encourage systems thinking and provided each participant with an opportunity to offer input, thus encouraging gender and social equity. Finally, the process of knowledge to action was expedited by disseminating preliminary results to the stakeholders through a conversational meeting and a results booklet, which readily provided stakeholders with accessible and useful preliminary knowledge in

formats where they were encouraged to provide further feedback. By incorporating participation into every part of the evaluation, the stakeholders can continuously enhance the evaluation through their lived experience and local knowledge of the HIS.

RESULTS

System Attributes of the HIS at BCH

The overall perception of the HIS at BCH was mostly positive. Specifically, one interviewee who had some previous experience working with similar systems said:

To me, I may say that [BCH's HIS] is one of the best systems I've ever had with my working experience, or where I've been. It makes the work easier, no much paperwork and, uh, most of the things are kept safely on the database.

Comments from the interviews about the various system attributes, which corresponded with a list derived from CDC's guidelines, were compiled to describe the strengths and limitations of the system. The results of the evaluation have been summarized below (extensive results regarding BCH specific findings are available in Appendix B).

The systematic coding process resulted in the generation of four major themes: (i) health record storage, (ii) information quality, (iii) system functionality, and (iv) system interaction and participation. Each of these themes was made up of several corresponding attributes that influenced the system's overall quality and explained how the system was integrated within the hospital.

Health Record Storage

Information collected needs to be organized and stored in a logical and safe manner. The main attributes discussed by participants, regarding the quality of data storage, were confidentiality and stability of the system. At BCH, depending on the ward, information was collected and immediately inputted into the electronic system or recorded on to paper records and then inputted into the electronic system at a later time. After being entered into the electronic database, the paper records were stored in locked rooms throughout the hospital.

Information Quality

Performance of a HIS relies on the quality of the information being inputted into it. Since the purpose of the HIS is to effectively monitor problems of public health concern, accurate records for analysis are necessary. The records collected in the HIS were described to provide a good representation of the surrounding population. However, inconsistent or incomplete records were reported to be a common occurrence within the HIS. Interviewees identified delays in data entry, lack of verification step, and complex multi-stage processing of data most frequently as challenges in collecting quality data.

System Functionality

The abilities of the system depended on various factors that impact how staff members used the system. The systems used in each ward of BCH were designed similarly to each other, but information was not generally shared between systems. One of the purposes of the HIS was to obtain information that was used by several different stakeholders to complete reports about various aspects of the health care system. The data collected in the HIS was used internally by hospital staff and externally by national public health officials through eHMIS-DHIS2 to monitor trends in public health. The overall perception of accessibility of the system depended on what stage of the HIS: data collection, data input, or data usage, was attempting to be accessed.

The apparent ease of use of the HIS varied greatly amongst the staff, which was suggested by staff to be a result of the amount of training and experience each individual had. One interviewee said:

It should be simple, uh, to enter the data, but, uh, depending on the qualification of someone who is doing it, you find if, like, it's uh, low or very low qualification entering the data, it's more likely that they will commit mistakes than if someone [is] experienced.

Of the staff members interviewed, there was a large range of experience working with the HIS and with computers.

System Interaction and Participation

Various individuals interacted with the HIS at different stages of data collection and analysis, but together these interactions were necessary in ensuring the HIS achieves its purpose. Numerous different staff positions had some form of interaction with the HIS used at BCH. The HIS was generally well accepted by staff and patients at BCH. The majority of BCH staff agreed that patients generally comply with supplying necessary information for data collection. The time between staff collecting information and inputting it into the HIS was reportedly longer than what the BCH staff perceived as ideal and reportedly resulted in inaccuracies and missing data within the records.

Generated Recommendations

Through the proportional piling activities, staff members were able to discuss and identify their priorities and their preferred distribution of resources for recommended changes (see Figure 2).

Figure 2. Photographs from the flow chart and proportional piling activities conducted during the first focus group (photos by Katherine Bishop-Williams). The flow chart in the first photograph depicts the movement of information through the hospital. Room 1 represents the Outpatient Triage Room and Room 4/5/7 are Outpatient Treatment Rooms. The remaining 3 pictures depict stakeholders' preferred resource allocations identified through the proportional piling activity.
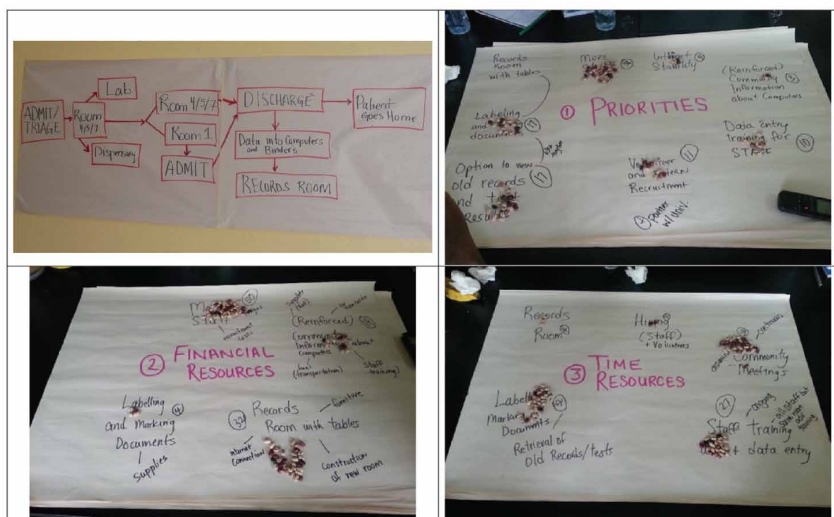
Upon completion of the first focus group meeting, seven main recommendations for improving and enhancing the HIS at BCH were generated and considered to be a priority (Table 2). The recommendations were developed by the staff members and were suggested to be the best solution to issues previously outlined. The recommendations were refined and classified during the second focus group meeting and were determined to be feasible options.

Impact of Participatory Methods on HIS Evaluation

The incorporation of participatory research methods created an opportunity for the evaluation to have a greater focus on community involvement. Within each stage of the evaluation, the additions to the CDC's guidelines increased stakeholder participation. The expanded guidelines utilized local staff members' capacity to contribute and provide input, which resulted in the collection of relevant information and quality engagement from stakeholders.

Table 2. Staff generated recommendations to improve the HIS at BCH, which were considered feasible and to have the highest priority

Recommendation	Problems Addressed	Justification (Participant Quotations)
Additional staff or volunteers to assist with IT maintenance and in data input	- Reduce current workload - Increase data quality and completeness - Increase timeliness of data input - Increase acceptability of the system	That is the only challenge we have – time, to enter the data into the system so we could possibly recommend that if there is someone who is responsible for data entry into the system that would work very perfectly. Then another thing, I would like the hospital to employ more records assistants. I would like the hospital to improve on, um, bringing up other records assistants or IT technicians that would help in entering this data.
Implementing a labeling system	- Improve organization of data storage - Increase ease of access when obtaining old records - Improve confidentiality of the data	We have failed to label and mark… The second [recommendation] is increasing the label, uh, the labeling processes, so that binders are easier to find
Additional record storage to store the paper records with a confidential space for working with the data	- Increase confidentiality and privacy of the data - Increase accessibility of old records	My suggestion, I would like the hospital to have a big records room and that contains the chairs, the shelves for, so that when the person comes in need of information, that, uh, that person don't need to take the things out like the way you are taking them to that room.
Increasing the accessibility of obtaining old records	- Increase usability and usefulness of the system	Load out the new version of this new system. I would load it out…it could be needing me now to restructure it so that it can be viewed by them all.
Additional and continuous training for staff on data entry, computer use, and information of the system's purpose	- Increase timeliness of data entry - Improve quality of data collection - Increase efficiency - Promote accessibility	Educate and maybe train everyone on the use of the, the, database around so that everyone is familiar with it… They are all trained but they still need to train, you know training is always ongoing… and another thing is always updating the person on the new system that are coming in… so that we can be, diversified and we know much a lot about our database.
Improved intranet and internet stability	- Improve accessibility - Promote stability	Another thing if they can also improve on their internet and then the IT personnel to increase on the, on the labour that is being done and the skilled labour
Community outreach programs to teach the communities about the HIS	- Increased community acceptance and compliance	There is need to sensitize the community on how we do things and on how things are done here. Yes they are already doing it but they still need more, more, more efforts to that so that people can come and understand it.

Quality of Information Collected

The theoretical influence of the guiding principles for Ecohealth and the methodological influence from tools in PENAPH's Participatory Epidemiology Toolkit augmented the evaluation by increasing opportunities for local contributions, which led to the collection of more elaborate and multifaceted results. Since a variety of stakeholders were involved and consulted, a plethora of distinct perspectives were provided. As there are several different components of the HIS, many of which were not well integrated into the facility, multiple sources of input allowed for a comprehensive overview to be established and ensured a wide-range of considerations were incorporated into the evaluation.

Furthermore, the accuracy and relevancy of the information was perceived to be of a high caliber as it was sourced from those most familiar with the HIS and who have the deepest understanding of the facility. With ideas and recommendations coming directly from those involved in the application, the information was perceived to be relevant by many of the local staff members consulted. It was generally assumed that the results from the evaluation would be useful for informing action. Specifically, one interviewee said, "Just very grateful for the data… with data you give facts and evidence, so, we are grateful, now we have evidence at least." Overall, the evaluation appeared to generate integrated outcomes and relevant results that contained details about the HIS that would only be known from frequent interactions with the system.

Quality of Stakeholder Engagement

In addition to the increase in participation, the expanded guidelines also enhanced the quality of stakeholder engagement. Most of the staff approved of the evaluation and a common perception was that the evaluation approach would result in long-term gain. This was explicitly demonstrated during the development of the potential system enhancements when one interviewee said, "When you see someone, somehow gaining interest in what you are doing, and also, uh, allowing to share ideas at some point, it's a good thing." The local staff members expressed approval of the consultation process.

As invested members in the evaluations, staff members involved with the project were keen to contribute to each stage of the evaluation and were eager to drive the evaluation forward. Specifically, one interviewee said:

Health information systems can be like this. We can do this. We are very open. We can do. Introduce it up here, and we do it, run it, and it would not take much, cause we already have the platform on which health information systems could, could run on. So, we would really be grateful, to, really implement, what you suggest for us.

The evaluation was deemed important by staff because it would generate information that could enhance their HIS, improve their work environment, and improve the quality of service they could provide. As direct beneficiaries of the evaluation, staff members were keen to ensure the evaluation was thorough and accurate.

DISCUSSION

According to the staff that interacted with the system, BCH used a comprehensive and dynamic HIS to collect vital information about community health, which could be used to improve the quality of the health care provided through monitoring trends and inform planning. Throughout the evaluation, several themes were mentioned by various participants, which identified crucial attributes that heavily influenced the systems overall usability and perception. The findings from the assessment of the various attributes and how they impacted the HIS were relatively consistent with findings from similar facilities in other low resource countries around the world (Fraser et al., 2005; Garrib et al., 2007; Lucas, 2008; Odhiambo-Otieno, 2005). Common points of weakness are evident, but

ultimately, HISs work to promote public health improvements (Blaya, Fraser, & Ho, 2010). While there were identifiable differences in perceptions of the HIS between the different stakeholders' positions, there was an overall agreement between stakeholders at BCH that accessible information, unabridged information flow, and adequate training were necessary for optimizing the success of the HIS. This is not a unique deduction, as both Garrib et al. (2007) and Odhiambo-Otieno (2005) reached similar conclusions about the HIS used at health care facilities in South Africa and Kenya, respectively. This research contributes to the evidence that supports the allocation of future resources towards implementing and maintaining a HIS in other health care facilities in low resource settings.

In addition to the development of the major themes, the second major component of this evaluation was the generation of a series of practical recommendations to improve the HIS. It was essential to involve the stakeholders in this component, as they ensured that the recommendations were feasible based on their deep understanding of the facility, rather than those recommendations that would be generated by an outsider. The recommendations are important because they address areas for growth within the HIS and allowed the evaluation to offer solutions, thus making it a more practical tool to improve health care (CDC, 2001).

The results from this specific evaluation have the potential to improve health monitoring of public health concerns of the community directly involved. Continued evaluation and development of system enhancements are essential in improving the quality and usefulness of a HIS (Fraser et al., 2005). Therefore, the results of this study are relevant for use at BCH and will be used by the staff in the development of a strategic plan to improve the HIS. By using this framework, staff at BCH can make informed decisions regarding the allocation of resources and the identification of priority areas for improvement, which can improve overall hospital efficiency. While specific concepts regarding this HIS may only be applicable to BCH, broader themes and ideas generated may be applicable to other facilities in East Africa.

In addition to generating useable results for BCH, this study aimed to expand the CDC's HIS evaluation guidelines and outline methods for engaging stakeholders in this process. The use of participatory research methods and engagement of stakeholders throughout the evaluation is a relevant and timely modification to a traditional evaluation. Outlining the necessary actions and guiding principles of engagement, the modifications reduce the limitations of the existing guidelines by emphasizing a more notable focus on stakeholder inclusion (Andargolia et al., 2017). By conducting a community-based evaluation, information collected had more relevance and usefulness for all partners involved (Minkler, 2000). The success of this evaluation suggests that the incorporation of stakeholders into each stage of the evaluation is an advantageous modification.

The evaluation used to assess the HIS at BCH was guided by the Ecohealth principles and utilized a variety of participatory research methods that engaged staff members, which was an innovative approach to conducting an evaluation and obtaining useful results. Both the involvement of stakeholders into all parts of the evaluation, and the incorporation of Ecohealth guiding principles, resulted in a more complex evaluation that examined how factors influencing the HIS were interconnected. By using a participatory approach that involves stakeholders directly, the evaluation was able to generate information that could enhance the process of implementing action (Minkler, 2000). Carman et al. (2013) describes a comparable model of engagement, where involvement occurs along a continuum and proposed improvements are found in interventions that implement multiple levels of engagement.

This participatory approach incorporated stakeholders into each part of the evaluation, which generated data that was used to determine the usefulness of the HIS and a series of feasible recommendations that can be directly used to strengthen the system. Just as Ebi and Semenza (2008) suggested, collaboration ensured outputs were more likely to be relevant as stakeholders ensured interventions and outputs adequately addressed local conditions. The increase of stakeholder engagement also inevitably enhanced the customization of the evaluation to its individual setting as stakeholders were provided with the opportunity to focus on factors they deemed as most important.

This improves the transferability of this framework to other settings as adapting to contextual needs is an important theme for completing health research in a priority setting (Viergever et al., 2010).

Moreover, community involvement in an evaluation promotes empowerment, in which stakeholders are in control over events and systems that impact them (Labonte & Laverack, 2008). By conducting a community-based evaluation, stakeholders were able to foster ownership of the results, which improved the likeliness of adoption of results (Viergever et al., 2010). The staff at BCH had the best understanding of the system and therefore were adept at determining what options would be most feasible in their facility. Considerations for financial requirements, time commitments, and perceived importance of the recommendations were all examined by staff to ensure generated recommendations were realistic and necessary. The participation from staff members to generate recommendations enhanced the usefulness of the research data and improved the quality and validity of the research due to the addition of local knowledge and lived experiences. Ultimately, there is a benefit in utilizing stakeholders' local knowledge and lived experiences to fill cultural gaps and generate new information. As such, the approach outlined herein is useful for other locales and provides an example framework on the process of how to appropriately engage stakeholders throughout a HIS evaluation in a low resource setting.

CONCLUSION

Actively implementing participatory approaches, this evaluation was able to obtain in-depth information regarding the use and impact of a HIS in a health care facility in a low resource setting. Collaboration with stakeholders lead to the development of more integrated outcomes and more elaborate results that contained details about the HIS that would only be known from frequent interactions with the system. By using local knowledge and lived experiences, the ideas generated in this evaluation were perceived as realistic and attainable by all stakeholders and partners. The staff at BCH were able to generate usable results and the feasible recommendations for addressing identified limitations and they were able to identify which ideas should be made a priority for implementation.

Stakeholder engagement has been demonstrated to add increased value to the results of a HIS evaluation in low resource settings. Using a series of theoretical and methodological concepts regarding participatory engagement, this evaluation provided an example framework of how engaging stakeholders can fill cultural gaps and generate new information. Overall, the incorporation of participatory methods throughout a HIS evaluation frameworks better identifies HIS capabilities and generates increasingly valuable health information.

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APPENDIX A

The codebook used to guide the process of applying tags or codes to the interview transcripts as part of the qualitative analysis (see Table 3).

Table 3. Evaluation codebook

Code Book				
Label	**Definition**	**Inclusion Criteria**	**Exclusion Criteria**	**Example(s)**
Confidentiality	Refers to the protection of privacy of individuals and their data within the Health Information System and the limits and restrictions on access to information.	● Any reference to privacy or security measures used to protect information ● Associations or links between data collection and storage to safety and privacy ● Referencing situations where information is exposed or vulnerable to being accessed by individuals without permission	Exclude if they do not relate the collection and storage of information to an aspect of security and/or privacy	*The security of the records. What we do, for example, the HIV str-, AIDS, the patients, the records, they are confidential. Some patients don't know, do-, don't want the other people to know about their status…* *That person don't need to take the things out like the way you are taking them to that room... according to confidentiality, we are not doing well… so that one we are not safe…*
Simplicity	Refers to both the structure and the ease of use of the Health Information System or to the conditions that make the system easy to understand or use.	● All aspects that describe the ease of use ● Any problems or challenges associated with using the Health Information System	Exclude if individual does not relate the Health Information System to their understanding of its use or experience using the system	*It makes the work easier, no much paperwork and, uh most of the things are kept safely on the database and they've even the accessibility, most of the time it's al-, it's always easy…* *It should be simple, uh, to enter the data… if someone experienced, uh, enters the data… it should be simple for one to do…*
Training	Refers to any teaching, workshops or preparation delivered to staff that provides them with the knowledge necessary to complete their duties.	● References to required training or additional training necessary to understand the system ● Individual comments on knowledge they have acquired on the system that was taught to them ● Individual comments on resources they can access that will provide a better explanation of the system	Exclude if the individual does not associate the Health Information System with the teachings needed to understand how to operate and utilize the system	*They are easy because, me I like it, cause I was trained…* *They are all trained but they still need to train, you know training is always ongoing…*
Flexibility	Refers to the ability of the system to adapt to changing information needs or operating conditions and the circumstances that allow the system to accommodate demands that were not a part of the original purpose of the system.	● Individual references uses of the system other than its original purpose ● Individual discusses situations where the system was altered to accommodate new information or additional demands ● Aspects of rigidity within the system or unchanging operating conditions	Exclude if they do not mention the Health Information System and its ability to be altered	*Ya, they are useful for other even, other purposes* *Data system has also been changed somehow so that the nutrition bit can be fit in…*
Integration	Refers to the incorporation and connections between the various systems within the Health Information System and the links that connect information from one aspect of the system to another.	● Individual references information transfer from one part of the system to another ● Individual discusses the process of information collection and how the various steps are connected ● Identifying the various parts of the system that follow separate data collection processes ● References to separate storages of information ● Aspects of connection between wards	Exclude if individual does not associate the Health Information System and the process of connection and linkages between several aspects of the system	*Since there are a lot of different databases, some of which are integrated with each other (so OPD, eQuality, Laboratory and Drugstore), and some not. With the IT development work currently underway, there should in future be much greater integration between systems…* *It will be nice if they were integrated, it would be nice, because if they're integrated together, that means all activities are captured, so, the hospital can focus on public health interventions*

Table 3. Continued

		Code Book		
Label	**Definition**	**Inclusion Criteria**	**Exclusion Criteria**	**Example(s)**
Timeliness	Refers to the speed between different processes in the implementation of the Health Information System and the length of the process to complete information input into the system or retrieve/analyze it.	● All comments related to the length of time each task related to the system requires to be completed ● Individual references gaps in time between patient treatment and data input ● Individual associates length of time to complete a task related to the Health Information System ● Barriers that prolong the procedure of inputting information into the Health Information System	Exclude if there is no statement about the time required or time used to implement data collection and input into the Health Information System	*As so it, also goes with the open MRS, where we have a bunch of papers that we need to enter because people keep postponing – no, I'll put it later, I'll put it later. You find the whole month is heaped there, no one has entered it…* *We keep postponing – ah, I'll write the birth certificate later. Then she comes the next day, you're busy, she comes another time, you're busy. So you find it's becoming so hard, to, enter peoples' names and they go birth certificates, they leave them behind, because you will be postponing and you've not done it there and then, the mother will not get it at discharge…*
Stability	Refers to the reliability and availability of the Health Information System and the conditions that ensure the Health Information System is operational and consistently functional.	● Individual references the consistency of the power supply, Intranet, Internet, or other essential components needed for the system to operate ● Characteristics of the system that make it vulnerable to malfunctions ● Individual discusses the constancy or dependability of the Health Information System	Exclude if there was no association between the Health Information System and its reliability to consistently operate and function	*Our system is reliable because the network is always on…* *Sometimes we have mistakes we find, we get stuck and the system is not working and we have to call an IT person to take some few hours, take some few minutes to work, to work upon it and then, so it's not that reliable…*
Accessibility	Refers to the ease in accessing the data stored in the record system and the ability of staff to retrieve the information from the database without struggle.	● Individual references their ability to obtain information stored in the Health Information System ● Individual discusses barriers that prevent admission into the system when attempting to complete documentation that requires information stored in paper or electronic files ● Information retrieval process by hospital staff	Exclude if the individual does not associate the Health Information System and the ability of staff to utilize the information stored to complete their duties	*So, editing is difficult. Or almost, it is actually impossible…* *Retrieving data hasn't been a big problem. But I think if we had everything in the computer system it would be easy...*
Representation	Refers to the ability to accurately describe events in relation to person, place, and time in the Health Information System equally and that collection of information on all demographics within the population are to the same level of detail.	● Individual references the degree of detail of information collected among various demographics of patients ● Individual identifies discrepancies with the volume and quality of information obtained for the various demographics of patients ● Individual discusses consistency among information collected from every patient	Exclude if they do not comment on the consistency of information collected in the Health Information System among several recognized classifications of patients	*We are all equal captured. We don't see at the skin colour or at the age and everything…* *Everyone gets equal opportunity to have their data captured…*
Patient Compliance	Refers to the willingness of patients to participate in the Health Information System and their understanding of the importance to provide all essential information to staff when requested.	● Individual references the readiness of patients to supply information to be inputted into the Health Information System ● The willingness of individuals to provide accurate, true information ● Any hesitations or concerns patients describe, in regards to the collection of their information to be saved in the hospital's records	Exclude if the individual does not mention the patients' compliance to participating in providing information for data collection	*We have not had issues with patients refusing to give us what we want…* *Someone… who has never seen a computer... they expect papers and they expect most of the things so when you take him to the OPD and he sees everything is being written on the computer, this person may think there's something maybe done… this person will get confused like are these people really seeing me or what is being done.*
Accuracy	Refers to the quality of the data to be correct and precise and the number of discrepancies between information in the database and the actual events that occurred.	● Any association to the data collected in the Health Information System and the exactness of the information ● Individual identifies errors or incorrect information present in the data ● Individual references discrepancies within the data collected ● Individual references the quality of the information collected based on the degree of correctness	Exclude individuals who do not associate data collected with the precision of the information to be exact	*So you find most of the cases, people entering the data into the, onto the, database, you find they make mistakes, they do some of the mistakes, they maybe forget other things…* *When they're trying to analyze this work, they see a mistake…*

Table 3. Continued

Code Book				
Label	**Definition**	**Inclusion Criteria**	**Exclusion Criteria**	**Example(s)**
Completeness	Refers to the amount of records being filled out entirely and having all parts present and the quality of data available to provide an accurate representation of the patient's condition.	● Individual makes reference to areas of incompleteness and missing information among the data in the Health Information System ● Individual discusses quality of the data in relation to the extensiveness of information collected ● The quality of data available to be used for additional tasks necessary for BCH (e.g. reporting)	Exclude if the individual does not relate data collection to the quantity and wholeness of the information collected	*Of course, sometimes there are inaccuracies, some data is missed, it is not entered…* *Ya, it is not very accurate. Because, uh, sometimes we find when some charts are not entered…*
Staffing demands	Refers to the quantity of staff needed to assist in completing tasks related to the record system and the demand for more or less personnel necessary to be responsible for specific duties.	● Individual discusses the usefulness of additional staff to complete tasks related to the Health Information System ● Aspects of data collection that could benefit from several individuals assisting in managing the system ● Requests for aid relating to IT, data input or other aspects of system management	Exclude if they do not associate the Health Information System with the need for more individuals to help maintain it	*It would be helpful if they trained other people to do that job…* *And also maybe if they can also inc-, increase on the IT personnels because we have, like now we having one… Bringing up other records assistants or IT technicians, that would help in entering this data…*
Recommendations	Refers to the suggestions made for improvement of the Health Information System. Any submissions, requests or ideas that could be implemented to enhance the efficiency and quality of the system.	● Individual recommends a suggestion or idea ● Any aspects of improvement or enhancements to the hospital or specifically the Health Information System ● Individual discusses features of the system that could be improved	Exclude if no suggestions on how to enhance the system are provided	*My suggestion, I would like the hospital to have a big records room…* *I have suggestions. But it is telling that we even need more space…*
External Data Use	Refers to the use of the data in the Health Information System by organizations outside of BCH or the use of the data in reports that will be presented to outside organizations.	● Individual references an outside partner or organization that BCH provides data to ● Individual discusses the information that is collected in the Health Information System, which it then presented to a separate institute ● Reports made from data collection that are sent to external partners	Exclude if the individual does not associate data collection and providing information to an outside organization or partner	*In-patient therapy care is being supported by USAID. And, uh, we have to provide, provide reports.* *Every month we send a report… we have weekly reports which we send at the district. And then we send information to **stas southwest***
Internal Data Use	Refers to the use of the data in the Health Information System within the facility or used by the staff at BCH to complete reports and duties directly for the hospital.	● Individual references using the data in future planning or auditing of BCH ● Individual associates data collection and a program or reporting process directly within the hospital ● Comments that explain how the data is used within the various wards of BCH ● Individual discusses the use of the data to monitor trends/patterns within BCH	Exclude if the individual does not associate the Health Information System and its use in improving, monitoring or understanding BCH and its patients	*Quarterly reports are for our own, you know, internal digestion, because, that also tends to, uh, fit into our, our work plan, evaluation, you know, um, timetable…* *After a period of time this work is analyzed, and statistically, for quality improvement… So we can even know the workload… So we know which period of the year we have maximum staff*
Data Flow	Refers to the series of procedures that a patient undergoes once admitted to BCH and the process of data collection and data input that is associated with the patient.	● Individual references the process of diagnosing, treating and distributing medication to a patient that attends BCH ● Any aspects of the procedure to collect information and input it into the Health Information System ● Individual comments on the interconnections between the various parts of the system and explains when each aspect of the system is used	Exclude if the individual does not associate the Health Information System and the procedure a patient follows when seeking treatment from BCH	*Data moves along with the flow of patients… From the clinician, they either come to the lab or they go to, pharmacy… From the pharmacy, they are good to go… after the whole cycle, the data is collected…* *When the patients come in, they come through our outpatient department and data is collected and captured… So, all this is entered in the system, at the time when they are going home…*
Financial Cost	Refers to the monetary cost to implement and maintain the system and the financial resources allocated to running the Health Information System.	● Individual references the cost of maintaining, updating, or using the system ● Any comments regarding the use of hospital funds allocated to an aspect of the HIS ● All comments regarding the distribution on funding	Exclude if the individual does not associate the Health Information System and the financial resources required to implement and maintain the system	*It's primarily financial. So it is, because, mm, the hospital management tells me to axe it because they are in financial crisis, that's why I'm not going to employ anyone else soon…*

Table 3. Continued

Code Book				
Label	**Definition**	**Inclusion Criteria**	**Exclusion Criteria**	**Example(s)**
Financial Impact	Refers to the financial situation that has been influenced by the presence of the Health Information System and the impact the system has on decisions made related to funding.	● Individual references the system influences on distributing funding ● Comments related to the financial situation of BCH	Exclude if the individual does not associate the Health Information System and the impact the system has on BCH's finances	*When it comes to primary health care funding, uh, at the ministry level, uh, they want to give money depending on the outputs…* *A variety of statistics derived from the data are used in PR, fundraising and proposal writing work…*
Identification and labels	Refers to the process of identifying a patient and the system used to match information collected to an individual either immediately or at a future date.	● Individual discusses the process for linking individuals with their record ● References to labels or identification procedures used to classify and record data ● Individual comments on the retrieval of information from within the Health Information System by identifying the case number, patient name, etc.	Exclude if the individual does not associate the Health Information System and identification systems used to connect patients and cases with the appropriate record	*We would know that Kanyanshande patients have attended twice with a typhoid case, and you would go back through the community team to go and educate and even go ahead to particularly identify the patient cause you have all the details…* *Just we use the abbreviations and the numbers for us to identify and classify which patient is this, we give even cards that identify for, for, for secrecy…*
Computer use and impact	Refers to the influence computers have on the Health Information System and the transition from paper to electronic data collection.	● Individual references the electronic portion of the Health Information System ● The use of computers by staff and comments on how using them as a tool is perceived ● Comments on the influence electronics have on data collection ● Individual discusses the transition from paper to electronic data collection	Exclude if the individual does not associate the Health Information System and electronic data collection or the impact of computers on the process of data collection	*These inaccuracies that don't make the system prefect but if I think, if everything was electr-, electronized, then everything would be okay…* *I think if we had everything in the computer system it would be easy. You click you find what you want… So I think the computer system would be the easiest to retrieve data…*
Valence - Positive	Refers to a useful attribute that strengthens the Health Information System or any characteristics that is considered good or helpful in enhancing BCH.	● Individual references a strength of the Health Information System ● Characteristics that improve the efficiency of the hospital ● Individual comments on their satisfaction with an aspect of the Health Information System	Exclude if the individual does not associate the Health Information System and a positive attribute	*Our system is reliable because the network is always on…* *They are easy because, me I like it, cause I was trained…*
Valence - Negative	Refers to a limitation or a characteristic of the Health Information System that could be enhanced.	● Individual references a characteristic of the Health Information System that could be improved to help enhance BCH ● Aspects that make the system vulnerable ● Limitations that make the system less effective or more difficult to use	Exclude if the individual does not associate the Health Information System and a negative attribute	*That person don't need to take the things out like the way you are taking them to that room... according to confidentiality, we are not doing well… so that one we are not safe…* *So, editing is difficult. Or almost, it is actually impossible…*
Valence - Neutral	Refers to an aspect of the Health Information System that does not have either a positive or negative characteristic or component.	● Individual references an attribute of the Health Information System that is neither positive or negative ● Individual expresses an opinion that is indifferent on the topic ● General comments on processes or aspects of the Health Information System	Exclude if the individual does not associate the Health Information System and a neutral attribute	*In-patient therapy care is being supported by USAID. And, uh, we have to provide, provide reports.* *A variety of statistics derived from the data are used in PR, fundraising and proposal writing work…*
Unconnected	Refers to conversations unrelated to the topic of the interview, such as polite small talk or introductions.	● Individual comments or questions the interviewer about something unrelated to the Health Information System ● References to something occurring in the surrounding, but is not related to the topic of conversation	Exclude if the individual is commenting on something related to the Health Information System	*Some people say we have a strong accent, that people, you know I was surprised, when I visited the States, and we were there from different countries, some from Bangladesh, Yemen, where, and we all thought we were speaking English…*
Question	Refers to a question about something related to the HIS asked by the interviewer.	● Interviewer makes an inquiry about some component of the system or hospital ● All questions or requests made by the interviewer to the interviewee	Exclude if the comment is not a question being made by the interviewer	*So do you think that everyone who comes into the hospital is being equally captured?* *Are there other things that you wish the data could be used for that it's not currently being used for?*

Table 3. Continued

Code Book				
Label	**Definition**	**Inclusion Criteria**	**Exclusion Criteria**	**Example(s)**
Staff role and responsibility	Refers to the employee's role at the hospital and the tasks they are responsible for completing related to their position.	• Individual comments on their position and responsibilities associated with their job • Any reference to the role of other staff members • Individual comments on who should be accountable for a specific task	Exclude if the individual does not comment on assigned responsibilities and tasks or does not comment on their position or others' position within the hospital	*Even if we have eight people in the department, and only three people are willing to take up the duty, or others, if they do it, forcefully because it's a must do, you must enter the data…* *So if you had someone responsible for the data, and, this person knows it's my job and enters every detail, it will be helpful and, the data will have more value because people enter inadequate information.*
Understanding data use	Refers to the amount of knowledge staff have on the internal and external uses of data collected and the staff's understanding of the importance of quality data collection.	• Individual references their knowledge about data uses after information has been collected • Individual references other staff's knowledge about the use of data after entry into the system • Any aspect of understanding the purpose and use of the Health Information System	Exclude if the individual does not associate the Health Information System and the understanding of the purpose and uses of information that has been collected	*Actually I don't have a lot of comment because, I, even I, I don't know much about the data system…* *So what happens with the data after, when we have sent, when they get into the system, we don't know what happens…*
Staff compliance	Refers to the willingness of staff to participate in the Health Information System and their understanding of the importance to input all essential information into the system promptly	• Individual comments on the obedience of staff to complete required tasks related to data collection and the Health Information System • References to staff's opinions on the adoption of the system within the hospital as a form of data collection and record keeping • Comments about the patterns of compliance demonstrated throughout the staff within the various wards	Exclude if the individual does not associate the Health Information System and the compliance of staff to use the system properly	*Most of us now understand and we know how to use the computer and everything. It becomes easier to and acc-, the acceptability of it ro us, as we really comply with it… I think that uh, the acceptability is high…* *There have been various problems at various times over the last few years with compliance. Compliance in SRH has been particularly poor…*

APPENDIX B

Results of the expanded evaluation specific to the system used at BCH in Kanungu District, Uganda, as of March 2015.

Hospital Overview

There were several different wards that made up BCH in March of 2015: paediatrics, male and female adult in-patient, sexual and reproductive health (SRH), human immunodeficiency virus (HIV), and tuberculosis (TB) wards. In addition, the hospital managed a series of satellite sites within the same District and an outreach team that travelled amongst various communities each day. The HIS was used to track and monitor every patient in each ward of the hospital.

Hospital Data Acquisition

The process of collecting information and generating a health record began when a patient was admitted to the hospital through one of the multiple entry points, most typically via triage or the Out Patient Department. An electronic record was generated when a patient was entered via the Out Patient Department and all necessary data regarding the patient and their treatment had been collected and inputted prior to discharge. All other in-patient departments generated a paper record to document patient related information, which was then inputted into the computer system after the patient was discharged. Both types of records traced a patient's movement between wards and the progress of their treatment in a similar fashion (see Figure 3).

Figure 3. The movement of a patient and patient's corresponding health record through BCH in Uganda, March 2015
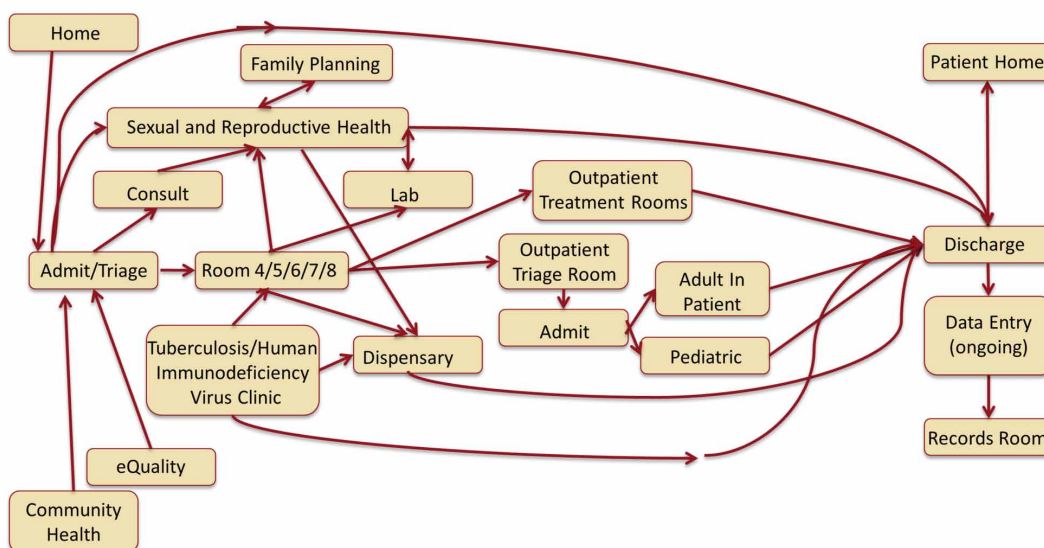
System Attributes

Four major themes were generated from the thematic analysis of the data collect, which were: (i) health record storage, (ii) information quality, (iii) system functionality, and (iv) system interaction and participation. Together, these themes determined the system's influence and overall quality.

Health Record Storage

The main attributes discussed by participants, regarding data storage, were confidentiality and stability of the system (see Table 4).

Table 4. Information Storage: Evaluated attributes of the BCH Health Information System and the frequency of reoccurrence of each code throughout individual interviews

Attribute	# of Negative Codes	Example Quotation of Negative Comment From Interviews	# of Positive Codes	Example Quotation of Positive Comment From Interviews	# of Neutral Codes
Confidentiality	8	*That person don't need to take the things out like the way you are taking them to that room... according to confidentiality, we are not doing well… so that one we are not safe…*	11	*The security of the records. What we do, for example, the HIV str-, AIDS, the patients, the records, they are confidential. Some patients don't know, do-, don't want the other people to know about their status…*	31
Stability	13	*Sometimes we have mistakes we find, we get stuck and the system is not working and we have to call an IT person to take some few hours, take some few minutes to work, to work upon it and then, so it's not that reliable…*	14	*Our system is reliable because the network is always on…*	37

Electronic records were stored on an electronic database and paper records were stored in locked rooms throughout the hospital and the record assistants and security guards were responsible for the keys. Data collected and stored in the HIS was reported by interviewees to be relatively insecure. Precautions were made by hospital staff to enhance confidentiality, but available space to store paper records, storage rooms being frequently left unlocked, improper labelling, and lack of privacy for data entry or reviewing records were reported to be major challenges for confidentiality of paper records. Ensuring confidentiality was also a limitation when accessing the records electronically because it was reported by interviewees that user names and passwords were often shared among staff members and many activities required assistance from IT technicians, who didn't have authorization to view records, to actually access the electronic files.

The majority of the aspects regarding the stability of the HIS, which refers to the ability of the system to function without failure, were reported to be reliable since it did not require waiting for an IT person to assist if an error occurred. However, the electronics of the system were reported to be relatively reliable, since power outages were described to be rare, back-up power was available, and the Intranet was consistent.

Information Quality

The quality of the information in the system depended on how accurate, complete and representative of the population the health records were (see Table 5).

Table 5. Information Quality: Evaluated attributes of the BCH Health Information System and the frequency of reoccurrence of each code throughout individual interviews

Attribute	# of Negative Codes	Example Quotation of Negative Comment From Interviews	# of Positive Codes	Example Quotation of Positive Comment From Interviews	# of Neutral Codes
Accuracy	18	*So you find most of the cases, people entering the data into the, onto the, database, you find they make mistakes, they do some of the mistakes, they maybe forget other things…*	8	*However, in my career, I've seen plenty of instances of much worse data…*	44
Completeness	32	*Of course, sometimes there are inaccuracies, some data is missed, it is not entered…*	4	*Actually we capture everything that takes place down there, drug consumption, disease prevalence, the time, time audits as in how long can a patient take to be attended to…*	33
Representation	2	*This hasn't been the case in SRH, and the inconsistency in recording of eQuality numbers means that full clinical histories are generally not currently available…*	10	*We are all equal captured. We don't see at the skin colour or at the age and everything…*	17

Inconsistent or incomplete records were reported to be a common issue within the HIS and it was reported that many departments struggled to complete data input into the electronic database and that many records were only available in hard-copy. Delays in data entry, lack of a verification step, and complex multi-stage processing of data were identified by interviewees most frequently as challenges in collecting quality data.

The majority of staff reported that equal quality of information was collected about all patients entering the facility. Except for one individual, all individuals interviewed made only positive comments about the representation of the surrounding population among records such as, "We are all equal captured. We don't see at the skin colour or at the age and everything."

System Functionality

Perception of system functionality was based on comments about attributes that influenced how the system was used by staff members (see Table 6).

Certain wards were reported to be less integrated than others, which often resulted in multiple records being generated for the same patient if they moved between several of these wards resulting in redundancies in the data. All of the data collected in all of the wards was readily available for analysis and was used internally and externally. Unlike the differences between wards, information collected internally was readily shared to external partners and affiliates who used the information for a variety of purposes (see Figure 4).

Table 6. System Functionality: Evaluated attributes of the BCH Health Information System and the frequency of reoccurrence of each code throughout individual interviews

Attribute	# of Negative Codes	Example Quotation of Negative Comment From Interviews	# of Positive Codes	Example Quotation of Positive Comment From Interviews	# of Neutral Codes
Accessibility	11	*It is not easy, or it requires a lot of time for someone to go through the hard copy…*	11	*All of us, we are, we are accessible, it is accessible to, it is accessible to all of us so we are free to use it at anytime.*	33
Flexibility	8	*Other things, are not captured in this, so we find, it was basically designed for hospital settings, not public health or community health interventions. So we have to work on another data system to capture what we want…*	9	*Data system has also been changed somehow so that the nutrition bit can be fit in the, that in the, database…*	23
Simplicity	8	*When the interns come also they normally help us in entering this information, because it's not a simple thing…*	20	*It makes the work easier, no much paperwork and, uh most of the things are kept safely on the database and they've even the accessibility, most of the time it's al-, it's always easy…*	19
Integration	14	*However, there will still be limited integration of the SRH and HIV data with the rest of the hospital's databases. There are also some limitations with the data recording on the eQuality database which make it less valuable than it could be…*	9	*Since there are a lot of different databases, some of which are integrated with each other, so OPD, eQuality, Laboratory and Drugstore…*	60

The apparent ease of use of the HIS varied greatly amongst the staff. It was reported that training and skill level influenced the simplicity of the system. Having efficient computer skills allowed for proper use of the system and was a crucial component in making the system easier to use. The process of collecting and inputting data into the HIS was generally a straightforward process and was easily accessed by appropriate staff. Conversely, accessing or altering information that had already been inputted into the HIS was described to be more challenging.

System Interaction and Participation

Several staff positions had to use the HIS in some capacity with their role (see Table 7).

Various hospital staff, such as clinicians and nurses, were expected to collect and enter information about a patient and their treatment into the HIS. Information Technology technicians were responsible for maintaining the electronic record system. Records Assistants were responsible for the storage, filing, and retrieval of the paper records. Several members of the hospital administrative staff were responsible for managing the HIS, analyzing the data within the system, and used the information for reporting and planning within the hospital.

Staff compliance was reported to vary between wards, but a large proportion of the staff felt the system was beneficial. Staff described hesitations about using the HIS being mitigated after training or experience working with the system. In one interview, a participant discussing the data entry

Figure 4. Current uses of data collected in the Health Information System at BCH, Uganda (March 2015)
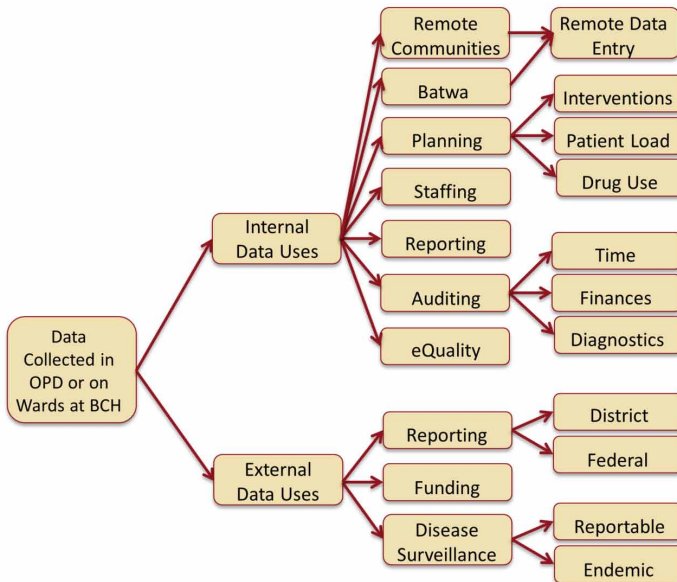

Table 7. System Interaction and Participation: Evaluated attributes of the BCH Health Information System and the frequency of reoccurrence of each code throughout individual interviews

Attribute	# of Negative Codes	Example Quotation of Negative Comment From Interviews	# of Positive Codes	Example Quotation of Positive Comment From Interviews	# of Neutral Codes
Timeliness	20	*We keep postponing – ah, I'll write the birth certificate later. Then she comes the next day, you're busy... they leave them behind, because you will be postponing and you've not done it there and then, the mother will not get it at discharge…*	6	*Some of them are done on a daily basis, like in maternity and family planning, we have to work as we record so it's entered there and then…*	27
Staff Compliance	8	*There have been various problems at various times over the last few years with compliance. Compliance in SRH has been particularly poor…*	7	*We really comply with it... I used to prefer writing. But as I got used to the computer, I find using a computer is more acceptable than writing…*	9
Patient Compliance	1	*Someone... who has never seen a computer... they expect papers... so when you take him to the OPD and he sees everything is being written on the computer, this person may think there's something... being done... then this person will get confused like are these people really seeing me or what is being done.*	3	*Here, we have not, we have not had issues with patients refusing to give us what we want…*	38

process said, "We really comply with it... I used to prefer writing. But as I got used to the computer, I find using a computer is more acceptable than writing."

Participants continuously identified timeliness of data entry as a primary point of weakness and emphasized it most frequently. One staff member described an example of the consequences of delayed data entry, "We keep postponing – ah, I'll write the birth certificate later. Then she comes the next day, you're busy... they leave them behind, because you will be postponing and you've not done it there and then, the mother will not get it at discharge." Staffing shortages and a lack of understanding the importance of the system were commonly blamed for the lack of participation in actively inputting information.

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