



Case Study

Implementation of electronic medical records requires more than new software: Lessons on integrating and managing health technologies from Mbarara, Uganda



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ABSTRACT

Implementation lessons:

- Technology alone does not necessarily lead to improvement in health service delivery, in contrast to the common assumption that advanced technology goes hand in hand with progress.
- Implementation of electronic medical record (EMR) systems is a complex, resource-intensive process that, in addition to software, hardware, and human resource investments, requires careful planning, change management skills, adaptability, and continuous engagement of stakeholders.
- Research requirements and goals must be balanced with service delivery needs when determining how much information is essential to collect and who should be interfacing with the EMR system.
- EMR systems require ongoing monitoring and regular updates to ensure they are responsive to evolving clinical use cases and research questions.
- High-quality data and analyses are essential for EMRs to deliver value to providers, researchers, and patients.

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1. Background

The United States President's Emergency Plan for AIDS Relief (PEPFAR) and the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) began funding the Immune Suppression Syndrome (ISS) Clinic in 2004 and 2005, respectively. The ISS Clinic became a free antiretroviral therapy (ART) center, and patient enrollment jumped dramatically.¹ Clinicians relied on paper-based medical records to prescribe care for the 200 adult patients and 40 pediatric patients seen daily.

As patient volume grew, monitoring patient information over time using paper records became a greater challenge for clinicians and administrative staff. It also made using clinic data for research increasingly time-intensive and error-prone. Researchers from the

University of California San Francisco (UCSF) collaborating with Mbarara University of Science and Technology (MUST) to study treatment adherence found it nearly impossible to aggregate patient data and select study participants systematically.

The UCSF research team implemented an electronic medical record (EMR) system to increase the clinic's research capacity while streamlining patient care and stakeholder reporting. They quickly realized that the problem required more than new software. Many stakeholders, including the physicians, questioned the utility of the database, viewing it as a tool to promote UCSF's research agenda, and Ugandan partner institutions contributed limited financial support.

How could the UCSF team improve uptake of the new technology? How should they balance clinical, administrative, and research needs? To increase the database's viability they would need to convince stakeholders of its value and continuously adapt the system to meet the clinic's changing needs.

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2. Organizational context

In 1998, an American physician founded the ISS Clinic to provide care for HIV-positive patients. The clinic was located on the Mbarara University Teaching Hospital grounds and jointly managed by MUST and the Ministry of Health's (MOH's) Mbarara Regional Referral Hospital. In 2000, MUST invited Dr. David Bangsberg, an American researcher at UCSF, to help develop a pilot study on treatment adherence among poor HIV/AIDS patients. When Bangsberg saw how few patients could afford antiretrovirals (ARVs), he established the Family Treatment Fund to help finance treatment.

Bangsberg met ISS Clinic physician Dr. Mwebesa Bwana in 2003. Bwana had created a Microsoft® Excel spreadsheet containing data on the clinic's first 500 patients. He asked Bangsberg how to improve the spreadsheet to support research and reporting.

In 2004, UCSF and MUST officially launched a research partnership. Bangsberg hired a project director to manage the collaboration and supervise implementation of a new Microsoft® Access database for data collection and reporting. The project director hired a data manager and two data entry clerks to operate it.

By 2005 the database contained thousands of medical records, and system performance slowed. Concerned that Access could not keep pace with rising patient enrollment, the UCSF team seized the opportunity to be one of the MOH's three pilot sites for a new, open source EMR platform called the Open Medical Record System, or OpenMRS®. Bangsberg hired additional database staff and purchased equipment.

OpenMRS became operational at the ISS Clinic in 2007. By August 2008, the clinic had enrolled over 15,000 HIV-positive patients. That year, Bangsberg transitioned to the Massachusetts General Hospital (MGH) and launched the MGH-MUST Collaborative. UCSF continued to conduct research and collaborated with MGH.

3. Personal context

Bangsberg and Dr. Jeffrey Martin led the UCSF-MUST partnership. They had worked together previously on HIV adherence research. When Bangsberg arrived in Uganda in the early 2000s, some researchers were questioning whether patients in resource-limited settings would adhere sufficiently to ARV medications to prevent the development of ARV resistance.² Bangsberg demonstrated that these patients were equally or more adherent to treatment compared to patients in resource-rich settings and that treatment cost was the most significant barrier to adherence.^{3,4}

Bangsberg and Martin believed that a strong, well-integrated EMR system would facilitate additional research to improve interventions in resource-limited settings and assure the international donor community that funding ART in Uganda was a sound investment. They also hoped it would build in-country capacity by providing a platform for Ugandans to practice their clinical research skills.

Bangsberg hired Nneka Emenyonu as project director of the MUST-UCSF research collaboration in 2004. Emenyonu recruited a Ugandan to be the data manager, responsible for installing and managing the clinic database. In 2012, database management transitioned to a Ugandan IT professional affiliated with MUST.

Bwana, the physician who had created the ISS Clinic's first medical record in Excel, was the EMR system's most vocal clinician supporter. He had grown up near Mbarara and lost both of his parents to HIV. After completing his five-year medical training and one-year internship at the ISS Clinic in 2002, MUST hired him as the ISS Clinic's first full-time physician. Bwana saw the database's potential to increase efficiency and facilitate research that could be used to improve patient care.

Clinic Director Dr. Winnie Muyindike was enthusiastic about the database's applications for research and patient care. Ultimately employed by and accountable to the MOH, her priorities were to ensure high-quality, well-coordinated service delivery and timely reporting. She needed to balance changes in data collection and management with clinic administration and workflow.

4. Problem

The UCSF research team designed, managed, and was the primary user of the EMR system. Other stakeholders were skeptical of its clinical utility; they sensed it was the university's project and responsibility. Most funding for the Access and OpenMRS databases came from research grants that Bangsberg and Emenyonu secured from American institutions, such as the NIH, UCSF, and the Rockefeller Foundation. Other key contributors included the Antiretroviral Therapy in Lower Income Countries (ART-LINC) Collaboration and WHO (see Fig. 1 for summary of initial OpenMRS implementation costs). ART-LINC enabled the team to hire an additional data manager, a receptionist nurse, a patient tracker, and more data entry and file clerks.

Most local support was supplementary or given in kind. For example, the clinic had access to a MUST professional who helped with IT issues, and Makerere University in Kampala used WHO funding to assign three of its staff to support OpenMRS implementation. Given the newness of OpenMRS and the other demands on IT staff, however, the data manager typically turned to

Funding Source	Amount/ Type	Use	Estimated Spending Time Frame
WHO	\$80,000	Equipment: server, uninterruptible power supply (UPS) generator, photocopier, printer, computers, local area network (LAN), laptop, internet bandwidth, antivirus software, desks, chairs, and other office supplies	Early 2007
ART-LINC	\$40,000	Salaries of new full-time data manager, data entry staff, and receptionist nurse	Oct. 1, 2007 – April 30, 2008
Discretionary funds/small research grants	Variable	Unanticipated costs and miscellaneous needs, such as replacing the server when it became infected with a virus and purchasing new antivirus software for clinic computers	Ongoing
Makerere University	Staff support	Portion of 3 Makerere University IT staff members' time to provide implementation support and ongoing technical assistance to ISS Clinic data manager (funding for staff time provided by WHO)	Early 2007

Fig. 1. Estimated costs of OpenMRS implementation at ISS Clinic, 2007–2008. Note: Table does not include limited database maintenance costs covered by UCSF NIH research grant, Sept. 1, 2007–June 30, 2008.

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Doe, Jane

Clinic Id: XXXX-XX-XXXX

Female, 36yrs

Art number: KK-YYYY

Address: Rwakirore, Kikokwa, Birere, Isingiro

Last seen on: 18 Jun 2008 by: Jane, Jones

Who stage:

Toxicities:

Current art regimen:

Tb status:

Other drugs:

AZT/3TC/NVP

Other diagnoses:

Previous Regimen(s):

Allergies:

Duration(months): 49/49

First line Substitution(s)	
Date	Reason

Second line Substitution(s)	
Date	Reason

VITALS				
	Weight	Temperature	Blood Pressure	Karnofsky score
Enrollment 27 Feb 2007	46	37.7	100/60	90
Art start 24 Apr 2007	58	36.5	110/80	90
12 Mar 2008	62	36.1	100/80	80
30 Apr 2008	55	36.4	88/53	90
18 Jun 2008	62	36.2	80/60	80

LABORATORY RESULTS		
CD4	Haemoglobin	Viral load
147 27 Feb 2007	8.2 27 Mar 2007	
87 23 Jan 2008	10 23 Jan 2008	

OPPORTUNISTIC INFECTION MEDICATIONS		
Drug	Start date	Stop date
Cpt/Dapsone	27 Feb 2007	
Fluconazole		
Tb rx		

Alert! Please Repeat Cd4!

Fig. 2. Sample patient summary sheet.

the OpenMRS online community for technical advice.

Emenyonu struggled to gain clinician support for the EMR system. After working with a UCSF developer and Bwana to create the Access database, Emenyonu revised the clinic's paper patient encounter forms to mirror the electronic Access forms and gathered clinician input. Several clinicians felt overwhelmed by the longer, more prescriptive forms; many were frustrated that they had to use these new forms instead of the MOH's shorter national HIV/ART care card. Collecting data that was not solicited by the MOH exceeded their clinical duties, they contended, and they should be compensated for doing so. Clinicians did not feel a sense of ownership over the data and frequently left form fields blank.

When the UCSF team launched OpenMRS, Emenyonu modified the paper encounter forms again and solicited clinicians' feedback. She explained to them why OpenMRS was a useful clinical tool; however, they still felt disconnected from the data. Data entry and reporting occurred on the second floor of the clinic, whereas clinical care took place on the first floor. Interactions between data management and clinic staff were limited, and clinicians did not directly enter or access data in OpenMRS.

Emenyonu described the clinicians' perspective on the EMR system: "They're gradually beginning to accept it, but I think the underlying concerns about access, ownership, and perhaps even compensation sometimes prohibit them from seeing the true value of an EMR system as a clinical tool. This concern is compounded by the fact that the US investigators are the first to publish papers using data from the ISS Clinic database."¹

The UCSF team knew the EMR data would only be as good as the data clinicians collected, so their participation was essential. Engaging them would require trust, buy-in, and a culture shift.

5. Solution

Emenyonu and her colleagues turned their focus to maximizing the database's potential to generate operational efficiency and process improvements for the ISS Clinic staff and administrators. They also worked to increase opportunities for local clinicians, technologists, and researchers to publish using EMR data. Over time, they hoped these approaches would improve local capacity and create a culture of quality improvement.

The UCSF research team considered installing computers for clinicians; however, there were multiple barriers to integrating OpenMRS directly into the clinic's patient care areas. Additional computers would require new fundraising efforts, and the UCSF team would need to train staff—most of whom had limited computer skills—to use the database. Accessing and entering OpenMRS data electronically would lengthen patient visits, at least initially, as clinicians adjusted to navigating an electronic interface. Any technical issues would compete for clinicians' attention and interrupt patient care. Power outages regularly occurred and could impede access, causing serious disruptions in patient care and potential data loss.

Another option was to integrate a new OpenMRS feature, the patient summary module, into the database. The module produced one-page clinical summaries of patient information and displayed care-related suggestions and reminders (e.g., “Repeat CD4 count!”). Administrative staff could print the clinical summaries prior to patient visits (see Fig. 2 for example). Introducing the summaries would be less resource-intensive than installing computer workstations in the clinic rooms and less disruptive to the workflow. At the same time, it had the potential to improve patient care by supporting clinician decision-making.

The research team planned to integrate the patient summary module shortly after implementing OpenMRS; however, technical challenges delayed integration by 18 months. Clinicians were frustrated by the lag. Emenyonu reflected, “We had a situation where the clinicians really didn’t see the clinical relevance of the data they were collecting, and they didn’t see the clinical relevance of the system because its implementation took so long. I think that was a major mistake in implementing the system...Clinicians participated in developing the forms, but we also should have made sure that the clinical components were up and running sooner than the research components.”¹

When the clinical summaries finally became operational, clinicians found them useful for prescribing treatment and overseeing patient care. Bwana, Emenyonu, and the data manager studied the impact formally and found that clinical summaries reduced the time it took clinicians to review patient data, granting them more time with their patients and shortening patient wait times by more than 30 minutes. Summaries also decreased the incidence of data errors by prompting data management and clinical staff to consult one another if they had questions about the values on the sheets (e.g., if a CD4 count was out of range, which OpenMRS automatically noted).⁵

The demonstrable impact of patient summaries for clinical care generated interest in other non-research functions of OpenMRS to optimize efficiency and improve quality of care. Muyindike decided to implement the appointment scheduling feature, which gave clinicians a sense of how many and which patients were likely to attend on any given day. Eventually, Muyindike and other clinic leaders used OpenMRS to make decisions about staffing by studying trends in patient visits. For example, when they found that Wednesdays typically had the lowest patient volume, they closed the clinic on Wednesdays so that staff could meet and complete administrative tasks. Muyindike used these weekly meetings to gather clinician input on various issues, including how to make the clinical summaries more useful for their work. The data manager regularly upgraded the summaries in response to clinician feedback, including integrating alerts indicating that a patient required a medication change or different laboratory tests.

The research teams used the database to study treatment adherence and patient retention. OpenMRS allowed them to identify and generate lists of patients who had failed to return for follow-up appointments. Martin explained, “It would have been impossible to do good research just by studying the people who don’t disappear. The database was instrumental in identifying how many people are lost and who is lost. With the paper-based systems, you wouldn’t know that.”¹ Muyindike saw an opportunity to leverage this information to aid in improving the quality of service delivery. She hired an outreach director, purchased a motorcycle for his use, and trained him to find as many of those patients as possible and bring them back to the clinic. In this way, front line clinicians and adherence counselors saw the direct impact of the database on patients and information management.

Researchers also used OpenMRS to confirm that anecdotal reports of long waiting lists described in the *New York Times*⁶ were due to systemic ARV shortages.⁷ The discovery enabled WHO and

Bangsberg’s foundation to identify supply chain issues and enroll patients.

In 2009, the MOH informed Muyindike that all public HIV/AIDS clinics in Uganda had to use the national HIV/ART care card—shorter and less detailed than the clinic’s customized encounter forms—to collect and report patient information by hand. The data manager adapted the OpenMRS data entry screen to match the paper-based care card. If researchers wanted to collect additional information, they used OpenMRS to recruit study participants and then set up a separate Microsoft® Access database to collect the data they needed.

Although UCSF continued to be the primary funder for OpenMRS thanks to the renewal of its 5-year NIH grant, Makerere University began to provide support for some of the data entry staff and computers beginning in 2011, when it received a 5-year grant through PEPFAR.

To help ensure long-term sustainability, Emenyonu regularly updated the ISS Clinic’s institutional stakeholders on how OpenMRS was being used for both patient care and research. She also met with MUST professors and postgraduate students to encourage them to use OpenMRS data for research projects. Bangsberg and other senior researchers spent time building in-country capacity by training and advising junior Ugandan researchers. UCSF secured an NIH grant to train four Ugandan investigators—including two from Mbarara—in clinical epidemiology in California. Martin explained, “We need to provide real training to people, not just invite them to be authors on papers.” They wanted people to know how to use the data they were collecting.

By 2015, more than 15 studies had been published by MUST faculty and students who used the ISS Clinic EMRs to gather data on a variety of questions, including how to take ARVs on time without a watch⁸ and the role transportation costs play in treatment adherence.⁹ A MUST-led committee was formed to review and approve all data requests from local and international collaborations. Bangsberg and Emenyonu helped establish a grants and contracts office at Mbarara University to build local research capacity and streamline the process of spending research grants. The office began receiving 8% overhead for HIV grants and up to 15% for other grants, gaining administrative capacity.

The ISS Clinic had cared for nearly 26,000 patients since opening its doors in 1998. It was serving 150–280 adult patients and 25–45 pediatric patients daily. Clinic leaders believed the EMR system had been instrumental to enrolling and managing such a large number of patients, and it had been “indispensable” to UCSF and MGH research (see Fig. 3 for a timeline of the EMR system’s implementation). From Muyindike’s perspective, the database had become central to both clinical work and research at the clinic, and Ugandan practitioners and academics were seeing the benefits: “There has been gradually increasing appreciation by more stakeholders that the OpenMRS database exists and is user-friendly, easier to access, and responsive to the clinic’s information-sharing needs.”

6. Unresolved questions and lessons for the field

The ISS Clinic’s experience implementing EMRs illustrates the complexity of introducing new technology in a health care setting. Implementation is an iterative process that requires regular technology updates to ensure responsiveness to shifting clinic, patient, and stakeholder needs; changing research questions; and changes in infrastructure.

While other studies provide valuable and practicable insights on software, infrastructure, human resource and training needs,^{10–12} EMR implementation in resource-limited settings also requires a

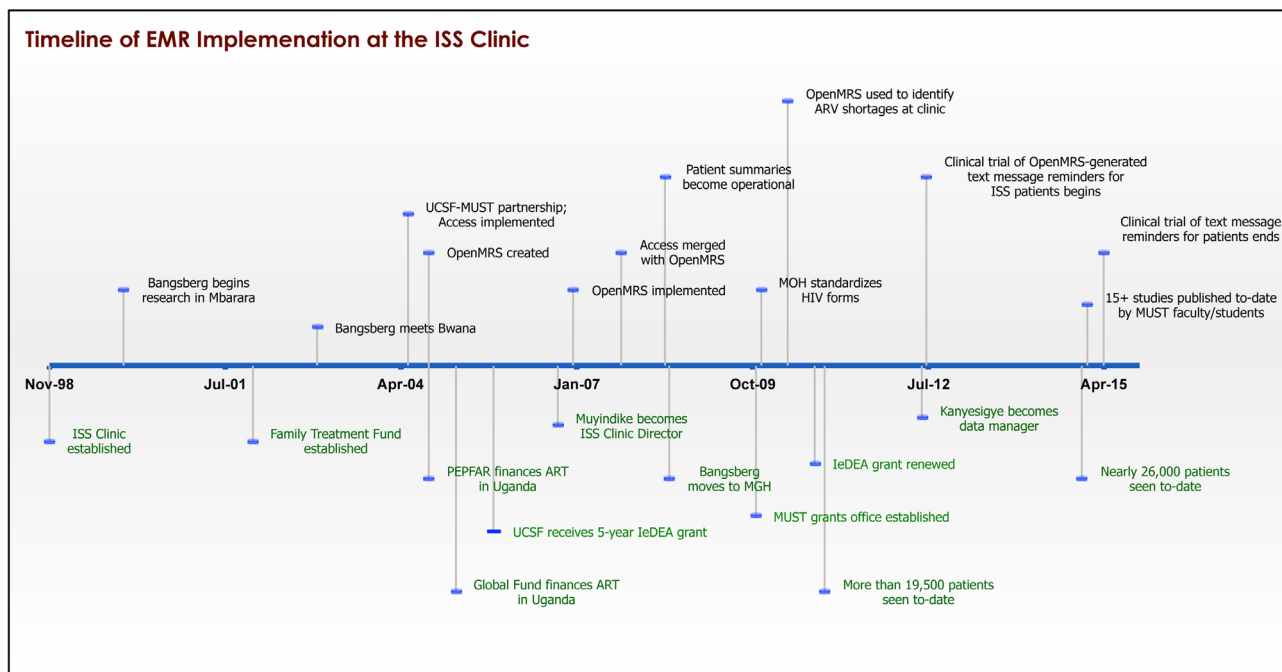


Fig. 3. Black text above the timeline bar denotes data collection and EMR events; green text below it denotes clinic, funding, and HR events. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article).

strategic approach to change management and the development of a culture of quality improvement. Continuous engagement of users and other stakeholders is essential to uptake and long-term sustainability. Front line providers, in particular, are essential partners in the collection, interpretation, and application of patient data—even if they are not direct end users. EMR systems are only as strong as the information they contain; thus, it is paramount that the people who are responsible for contributing to and/or operating them feel invested in the data collection.

Given resource limitations, decision-makers must prioritize and balance the clinical and research applications of an EMR system. Careful consideration should be given to the sequencing of database upgrades and the message that such decisions send to stakeholders about the hierarchy of needs and the database's overall role within the health care delivery setting.

Moving forward, the ISS Clinic leaders are considering providing touch screen devices and computer tablets in all of the areas where data capture occurs in the clinic, including the nursing triage station and patient consult rooms. Each room is already connected to the clinic's local area network (LAN), which would allow data entered to be shared and synchronized between rooms via the database without an Internet connection. However, the clinic continues to face considerable obstacles to implementation, including insufficient funding for new devices, limited computer skills among staff, and frequent power outages. If the clinic is able to surmount these resource constraints, another key consideration will be how to prepare staff for transition.

The presence of an EMR system has positioned the clinic to be a productive contributor to the knowledge base for HIV care in resource-limited settings. The academic recognition and financial resources that this work brings to the clinic have broader implications for HIV treatment advances and funding in the region, as the increasing availability and quality of data help fuel the international imperative to reduce disparities. The clinic must continuously evaluate how to optimize the information it collects for both direct beneficiaries as well as those benefiting from its

research findings.

The ISS Clinic's transition to an electronic patient database demonstrates that the potential of EMRs is dependent not only on software, hardware, and human resource investments, but also on careful planning, adaptability, integration with service delivery, and ongoing engagement of direct and indirect users.

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