

## SQUAD IN UGANDA: SURGICAL QUALITY ASSURANCE DATABASE (A)

In fall 2014, Dr. Paul Firth and his colleagues from Massachusetts General Hospital (MGH) in Boston arrived at Mbarara Regional Referral Hospital (MRRH) in southwestern Uganda. The five-hour trip via car from Entebbe International Airport to MRRH had given them time to think about their upcoming visit. To Firth, each Mbarara trip represented an opportunity to deepen personal and professional relationships with the MGH-MRRH anesthesia collaboration. “It’s the human interactions with people that matter most,” Firth said. “It’s the people in the system who are running the system, so engaging first and foremost with people and determining what they want to do is essential.”

Dr. Stephen Ttendo, director of anesthesia for MRRH, awaited the MGH visitors. Ttendo was the Ugandan principal investigator for the surgical quality assurance database (SQUAD). Since 2011, he had been working closely with Firth to develop SQUAD. The idea for a surgical database began with Dr. Gerald Tumusiime, a former MRRH surgeon who left Mbarara in 2012 for a position at Makerere University in Kampala. During his two years at MRRH, Tumusiime began to collect data on his surgical patients and record their demographic information and surgical outcomes in an Excel spreadsheet. Building from Tumusiime’s original work, Ttendo and Firth sought to create an electronic database capturing medical information on all patients admitted to the surgical, obstetric, gynecology, and intensive care

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wards at MRRH. SQUAD's goal was to provide analyzable data regarding patient outcomes and demographics to support quality improvement initiatives within the hospital. (See **Exhibit 1** for a listing of 160 SQUAD data fields.)

Much progress had been made during the prior 24 months, with multiple MRRH departments participating and using the SQUAD database. Physicians and staff had produced reports depicting a range of important clinical and patient variables including HIV prevalence, post-operative complications, mean length of stay, and in-hospital outcomes by ward. However, while patient data was collected and recorded in the database, it had not been validated to ensure accuracy and minimize errors.

Once a data validation procedure had been established, it was believed that SQUAD held potential to provide important information to a larger range of constituents. This included value to MRRH patients, who stood to benefit from healthcare processes and outcome improvements. Physicians and staff would gain from the practice of gathering systematic information in an electronic database, accessing both recent and longitudinal data on patients for informed decision-making, and providing quantitative information needed to publish academic research and attract funding. In addition, a successful SQUAD project would facilitate transmitting data to government officials and policymakers, thereby giving the Ministry of Health (MOH) an accurate picture of the disease burden and of areas requiring governmental support.

Although SQUAD was still in its early stages, the team was already thinking about the potential for hospital-wide, and even country-wide, scale-up. "We could have every department disseminating intra-institutionally," said Tumusiime, reflecting on SQUAD's potential from his office in Kampala. "And then maybe at the national level they could have hospitals come together." Scaling SQUAD to include other hospitals in the system remained a mid- to long-term goal of researchers and clinicians. This generated critical questions among team members: Did SQUAD in its current form represent the right model for others to follow? If not, what additional steps and practices should other hospital researchers, administrators, and clinicians follow? How might an expansion of SQUAD be funded and carried out across other low-resource locales?



Before any higher-order use of SQUAD was possible, a more refined view of current data selection, use, and measurement was required. Firth and Ttendo, as well as the entire SQUAD team, had allocated most of the visit to determining ways to optimize SQUAD's short- and long-term impact on patient health through improved management, analysis, and reporting of patient data.

## Healthcare Context: Uganda

According to World Health Organization (WHO) data produced in 2013, the prevalence of HIV in Uganda (4,262 people per 100,000) was 1.5 times the regional average (2,774) and eight times the global average (511). The incidence of malaria in Uganda also ranked high versus standard benchmarks. The incidence in Uganda (24,597 people per 100,000) stood at 1.3 times the regional average (18,579) and 6.5 times the global average (3,752). By contrast, Uganda's under-five mortality rate (69 per 1,000 live births) was favorable versus the regional average (95). Uganda's maternal mortality ratio (360 per 100,000 live births) was also favorable when compared to the regional average (500). The estimated road traffic death rate in Uganda in 2010 was 28.9 people per 100,000. This compared favorably with the rates in South Africa (31.9) and Nigeria (33.7) and unfavorably with Kenya (20.9) and Mozambique (18.5).<sup>1</sup>

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<sup>1</sup> World Health Organization, "Road Traffic Deaths Data by Country," <http://apps.who.int/gho/data/view.main.51310>, accessed December 2014.



TABLE A Uganda Health Statistics 2013

	Uganda	Regional	Global
Population living in urban areas (%)	16	39	53
Gross national income per capita (PPP int. \$)	1,120	2,594	12,018
Total fertility rate (per woman)	6	5	2.5
Life expectancy at birth (years)	57	58	70
Healthy life expectancy at birth (years)	49	50	62
Under-five mortality rate (per 1,000 live births)	69	95	48
Adult mortality rate (probability of dying between 15 and 60 years per 1,000 population, male/female)	389/360	343/298	187/124
Maternal mortality ratio (per 100,000 live births)	360	500	210
Prevalence of HIV (per 100,000 population)	4,262	2,774	511
Incidence of malaria (per 100,000 population)	24,597	18,579	3,752
Prevalence of tuberculosis (per 100,000 population)	175	303	169

Source: World Health Organization, “Uganda: Health Profile,” <http://www.who.int/gho/countries/uga.pdf?ua=1>, accessed December 2014.

Uganda’s \$40 per capita total expenditure on health lagged behind the regional average of greater than \$100 per capita. The Ugandan government had spent approximately 8% to 9% of its national budget on health costs, despite signing in 2001 the Abuja Declaration obliging “African countries to allocate at least 15% of their national budgets to health.”<sup>2</sup> In Uganda, the number of physicians, nurses, and midwives per capita lagged significantly behind the regional average. (See **Exhibit 2** for health workforce and expenditure data.)

<sup>2</sup> Tabu Butagira, “Government Spends Shs2,500 a Month on each Citizen’s Healthcare,” *Daily Monitor*, <http://www.monitor.co.ug/SpecialReports/Govt-spends-Shs2-500-a-month-on-each-citizen-s-healthcare/-/688342/1971734/-/ourux1/-/index.html>, accessed December 2014.



## *Uganda's Healthcare System*

The Uganda healthcare system comprised six health facilities. It worked on a referral basis with patient care escalated to higher-level facilities as cases required. Though medical service provided by public facilities was meant to be free of charge, it was not unusual for patients to purchase essential drugs from pharmacies or other sellers when these drugs were unavailable at hospitals.<sup>3</sup> (See **Exhibit 3** for facility types and the referral system.) By January 2015, MRRH had been updated from a *regional* to a *national referral hospital*.

Uganda's referral system relied on well-functioning links among various levels of healthcare providers but presented shortcomings. No centralized management system was in place to provide an overview of a patient's path through the referral system. Some believed an extension of a shared, electronic database resembling SQUAD could improve communication, coordination, and overall system management. A system like this would be especially important in Uganda where all government-run hospitals relied on fixed monthly supplies distributed by the government and based on the recorded activity and patient load of each hospital.

## **The MGH-MRRH Anesthesia Partnership**

Firth was tapped to help advance a partnership between MGH and MRRH because of his familiarity with and interest in the region. He had grown up in South Africa and had travelled extensively in Uganda during the 1990s. Not long after Dr. David Bangsberg was appointed director of the MGH Center for Global Health, he approached Firth about getting involved. Firth connected with Ttendo at the outset of the work. He explained, "I went to Mbarara and I met with Dr. Stephen Ttendo, head of the anesthesia department. I said to him, 'What do you need?' That was my approach. What are your needs, what do you want? He listed a number of things, and then we built a program around meeting his specific needs."

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<sup>3</sup> Excerpted from World Bank Country Data: Uganda, as drawn from Richard M. Kavuma's article, "Uganda's Healthcare System Explained," *The Guardian*, <http://www.theguardian.com/katine/2009/apr/01/uganda-healthcare-system-explained>, accessed December 2014.



The first two needs Ttendo listed were education and ultrasound-guided regional anesthesia (UGRA). The anesthesia partnership began as Firth and Ttendo collaborated to address these needs through: bi-weekly Skype lectures from MGH physicians to MRRH physicians, the creation of an anesthesia library at MRRH, and a teaching camp on UGRA in 2011. These all supported the goals to produce highly qualified graduates and to increase involvement in the perioperative process beyond the operating theater.

As the partnership developed, trips and exchanges, as well as publishing opportunities and speaking engagements, grew out of the work. For example, two anesthesia residents from MRRH attended the Harvard Educational Review in October 2013. One resident also lectured at MGH on anesthesia education in Uganda. In his presentation, he highlighted the fact that there were only 30 anesthesiologists for a population of over 30 million Ugandans.

## Developing a Surgical Quality Database (SQUAD) in Mbarara

### *The Rationale for SQUAD: Why Create Electronic Medical Records?*

For a decade or more, hospitals in developed economies had been capturing, transferring, analyzing, and reporting patient and clinical data via electronic formats. These practices had not gained traction in low-income countries such as Uganda. Before the SQUAD project, MRRH kept records by paper and pencil, with deep stacks of records accumulating on floors and shelves in a dedicated hospital storage room. Records preparation required much administrative time and attention. However, the records provided little utility once a patient had been discharged. (See **Exhibit 4** for pre-SQUAD process.)

Firth observed, “Prior to SQUAD, there was no understanding of how many patients were being treated and no tracking of patient outcomes. There was no way to keep track of records in a systematic fashion. It was a haphazard effort, and there were great inaccuracies.” Since the Ugandan Ministry of Health (MOH) determined supply numbers based on patient records, if patient visits were not accurately recorded and submitted to the MOH, it was likely that the hospital would not receive sufficient supplies. Attempts had been made to organize



and analyze data via Excel spreadsheets, but the steps taken were only rudimentary. Tumusiime explained.

It's true, the data was a bit of a challenge. It required me to take time off to look for data from different sources so that I could put it together. Some data would be incomplete...some of our patients would arrive from being picked up from the roadside, and they didn't have anything in their file apart from clinical findings. So that was the biggest challenge. I would use my laptop working in an Excel sheet, and that's it. I still had a gap of data analysis, but I would use the Excel to at least know the percentages and make a simple kind of presentation from the data.

Ttendo introduced Firth and Tumusiime during a visit in January 2011 so that surgeons and anesthesiologists could work together to improve outcomes. The two discussed building on these and other efforts to take MRRH data capabilities to the next level. Tumusiime believed in the idea, although he expected challenges. He noted, "To do a retrospective database we needed overall expertise, the right equipment, and people's time." He thought the motivation for carrying out such a project would be different, likely broader. Tumusiime had created the spreadsheets hoping to encourage financial support for obtaining equipment for MRRH.

For developing a new database, Firth and Ttendo believed in "evolution rather than revolution." Firth pointed out, "If one wants to intrude into an existing system, you're going to be in trouble. It's better to build your system *around* the existing system." To many physicians at MRRH, a systematic approach to collecting and analyzing data was appealing. Comments on using data to improve work flow and clinical care included the following:

- "You don't know how many operations you've done last month, yet you've been very, very busy." (Dr. Godfrey Mugenyi, obstetrician)
- "I'm sure the Ministry of Finance and Planning deals with numbers. If you see 10 patients, they will give you funding for 10 patients. If you see a thousand, they will give you resources for a thousand. If we expand and capture all the information, then the hospital may be better funded than it is currently." (Dr. Godfrey Mugenyi)

- “Before completing the database, we had only the records storage. And when you enter the room where we keep all the documents, you’ll never retrieve anything. You can, but only after a lifetime of searching.” (Rhina Mushagara, SQUAD manager)

### *SQUAD Leadership and Team*

The research partnership with MGH was not MRRH’s first, or its first experience working with physicians from outside Uganda. Working with outside partners had been mixed. “Some partners we’ve gotten involved with come and say, ‘Do this!’” explained obstetrician Dr. Joseph Ngozi. “You come in, you tell me to do this, you don’t want my input, you don’t want my suggestions.” Distance could grow between participants who perceived these experiences as “colonialism” and withdrew to become somewhat reserved.

Ngozi explained his view of a productive working partnership. “Getting people involved in discussing ideas at the same table, at the same level, makes a lot of sense. I know when I am talking with my colleagues, across the board, if they make a statement, I’ll not sit back and try to analyze every word. I’ll believe it. We’ve had this collegial relationship. I should believe what they are saying. So I think that makes it a true partnership, this dual involvement, respect, and goodwill on both sides.”

Firth of MGH and Ttendo of MRRH led the anesthesia partnership. Tumusiime’s involvement ended as he left Mbarara for a new job in Kampala. Forging a successful partnership across continents was not expected to be easy, given intermittent visits and face-to-face collaboration. Some SQUAD members thought Skype meetings, as well as trips and exchanges between the two sites, helped form relationships and relax cultural barriers. Nicholas Musinguzi, who had worked previously in IT for Uganda’s Ministry of Health, commented on his experience collaborating with Firth and Ttendo. “I like Paul, very careful, but gets things done. I admire his style because everyone likes him, and yet he still gets things done. Sometimes you don’t get people to do things you want them to do...he has this very friendly relationship but then also manages to push people to accomplish things. Ttendo is also very good. He pushed us at the beginning, and I think if it weren’t for his pushing we





wouldn't have achieved what we did in that time. So I think the combination of Ttendo and Paul is great.”

On the wall of Firth’s office at MGH hung photos of his SQUAD team members beside photographs of past climbing expeditions in Uganda, Alaska, Peru, and the north side of Mt. Everest. Firth was proud of the team’s accomplishments. He spoke about the team from his office in Boston, noting each member’s growth and professional development. The Uganda-based SQUAD team, assembled in summer 2013, included seven members.

(See **Table B** for team members and **Exhibit 5** for team photo.)

TABLE B SQUAD Team Members in Uganda

Name	Title	Background Experience
Dr. Stephen Ttendo	Director of Anesthesia, Uganda PI for SQUAD	Anesthesiologist
Rhina Mushagara	Project and Data Management Coordinator	Experienced Project Manager
Manfred Amany	Data Clerk	Data entry experience
Walter Mugabi	Data Clerk	Psychiatry Nurse
Dorothy Kayaga	Data Clerk	Nurse Mid-wife
Phiona Naturinda	Data Clerk	Data entry experience
Nicholas Musinguzi	Biostatistician/IT (part-time)	Built electronic database for HIV clinic

Source: Provided by SQUAD Leadership Team.

### Paving the Way for SQUAD

Funding for SQUAD was obtained in 2012 from the Harvard Milton Fund and from General Electric Foundation to establish a computerized quality assurance database for surgical services. The project had to pass MUST/Partners Internal Review, as well as Presidential Council registration.



In the meantime, MGH provided a stipend of \$10,000 to support a retrospective study of Tumusiime's Excel files to determine which baseline data existed in the hospital. This work clarified opportunities for refining and advancing the project. There was no clear understanding of patient outcomes as revealed through the data, and the number of patients tracking through the system could not be determined. Firth commented, "Treating surgical disease is like a production process. You need all these little chains: you need a diagnosis and resuscitation of the patient. You need to properly anesthetize them and operate. Then recover from the anesthesia, recover from the operation. You don't need complications and infection. You need to get the patient properly discharged. And different people doing all these things in concert. If anything falls apart, your outcome will be bad."

### **MGH Team Visits MRRH: May 7-11, 2012**

In May 2012, four MGH physicians travelled to Mbarara: Firth; Dr. Lars Hagander, global surgery fellow in the Program in Global Surgery and Social Change (Harvard Medical School); Dr. Peter Fagenholz, MGH trauma surgeon and ICU attending; and Dr. Mark Preston, MGH urologist. The time MGH spent with colleagues from MRRH would be used to accomplish research and education objectives: carry out preliminary work relating to SQUAD, follow up on prior projects, and explore the expansion of surgical ICU collaborations and capacity-building.

Throughout the five-day visit, formal and informal discussion ensued with MRRH physicians and staff. The primary working group for the visit included Ttendo (anesthesia), Tumusiime (surgery), and Ngozi and Mugenyi (obstetrics-gynecology). The MGH team also met with other doctors and key hospital employees.

### **MGH Team Visits MRRH: March 3-6, 2013**

A second MGH trip to Mbarara in March 2013 set conditions for launching SQUAD. Tasking was required to build an administrative team in Uganda, select an operating system to support the database, and ready the team for SQUAD implementation. SQUAD would be developed from Open Medical Record System (OpenMRS), a "software platform and a reference application which enables design of a customized medical records system with no



programming knowledge (although medical and systems knowledge is required).<sup>4</sup> Providers at Mbarara were familiar with this platform which was already in use at the MRRH HIV clinic.

OpenMRS was also used in a number of developing countries including Kenya, Rwanda, Lesotho, Zimbabwe, Mozambique, Tanzania, and Haiti. Organizations that used the freely-available software formed a global community committed to creating a “robust, scalable, user-driven, open-source, medical record system platform.”<sup>5</sup> (See **Exhibit 6** for OpenMRS mission, values, and vision.)

At MRRH, Nicolas Musinguzi assumed responsibility for creating and managing the SQUAD operating system using OpenMRS. He held a bachelor’s degree in statistics and data management as well as a master’s degree in medical statistics, and he had direct experience in the field including a prior role with Uganda’s Ministry of Health. He commented, “This role developed because I worked with the Immune Suppression Syndrome clinic, the open environments-based ISS clinic database. ISS is the HIV clinic within the hospital. I also worked with the Ministry of Health customizing OpenMRS for local needs. That’s how Paul probably got to know me.”

After Firth and Ttendo explored the many free and proprietary operating systems that existed at the time, they decided to use OpenMRS because of existing local expertise and compatibility with the Uganda HIV IT structure. Open-source platforms were a popular choice in developing settings. (See **Exhibit 7** for EMR systems in developing settings.)

At the time of the trip, it was determined that the SQUAD team, overseen by participants at MGH and MRRH, would review monthly data, improve the database, suggest clinical improvements, review requests for data access, and oversee the project. The hospital director asked that SQUAD expand to include the entire hospital (pediatrics, medicine, psychiatry) as well as the head of medical records. This move was considered appropriate, given that SQUAD was essentially the medical records for the hospital, aligned to provide feedback to

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<sup>4</sup> OpenMRS website, “What is OpenMRS?” <http://openmrs.org/about/>, accessed December 2014.

<sup>5</sup> Ibid.



clinicians. This interdisciplinary committee mirrored that of the MGH SQUAD advisory committee, also an interdisciplinary group that provided advice and support.

Long-term goals included expansion to other hospitals. Firth commented, “Long-term, we may expand to other hospitals, in line with our academic approach of modeling reproducible initiatives. We will aim to integrate this with other systems that can talk to each other (e.g., stocking inventories, cell phone outreach), in collaboration with IT specialists with an overview of the IT ecosystem. The current focus is establishing a solid functional platform in the immediate future.”

### *SQUAD Goes Live in Mbarara*

On August 1, 2013, SQUAD went online in Mbarara, recording data from the surgical wards (surgery, obstetrics-gynecology, ICU) and operating theaters. The objective was to generate information allowing MRRH clinicians and administrators to improve the process of surgical care. After many months of careful preparation, multiple on-site visits, and great effort to secure funding and put together an appropriate team from MGH and MRRH, the official launch of the database was cause for celebration. Firth summarized the event.

Congratulations to the team in Mbarara – Stephen, Rhina, Dorothy, Phionah, Walter, Manfred, and Nicholas—who worked tirelessly to impose order into data capture. Over two months, they set up an office in the hospital, built a computerized network, established a system to determine how many patients had been admitted, collected all the charts and tracked missing ones, worked out how to enter the data, started a quality control system, kept track of expenditure, and generally made it happen.

### *Towards Data Analytics*

During the first six months of operation, SQUAD captured data on 8,023 chart entries. Most occurred in obstetrics (61%), followed by surgery (27%) and gynecology (12%). Questions about data validity arose. One potential problem was the high number of data fields (160) composing the database. Some SQUAD team members wondered whether it was feasible to



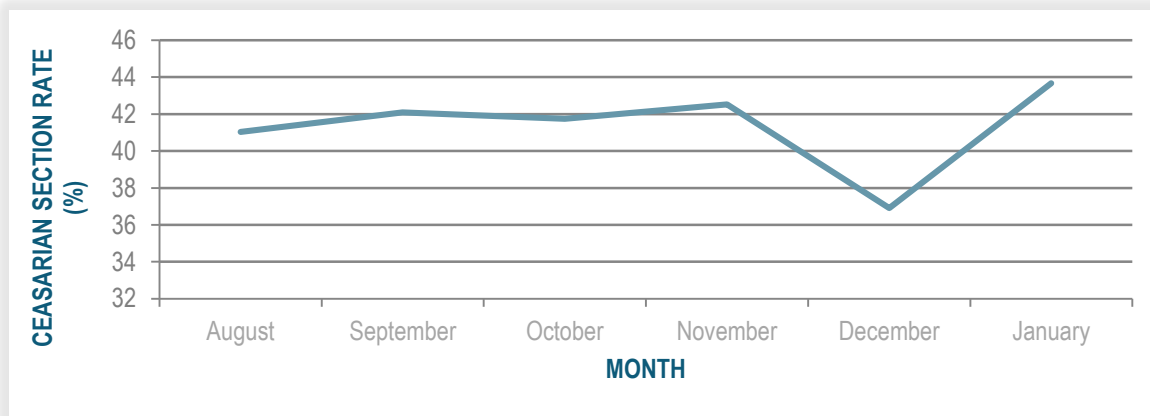
collect all 160 elements for each incoming patient. (Refer to **Exhibit 1.**) No system was in place for correcting data entry errors such as misspelling, misreading of handwriting in a patient chart, or misinterpretation of clinical findings recorded in the chart. However, issues relating to data validity were expected in the early months of a data-intensive project, and the SQUAD team was pleased to have reached the stage where improving data validity was important. “Once you’ve collected the data, you’ve got to validate it, but you can’t validate it until you get it,” said Firth. For example, Dr. Adeline Boatin, an obstetrician and gynecologist (OB-GYN) and global health research scholar, compared the overall admission and mortality numbers generated by SQUAD to those generated by the existing medical records system to identify discrepancies. She also developed an innovative color-coded dashboard to improve overall data quality and utility in OB-GYN.

As the SQUAD team improved data validity by setting up a feedback mechanism for MRRH physicians and staff, departmental reports were beginning to run monthly, semi-annually, and annually. Data elements in the reports included patient demographics, disease status (e.g., HIV-positive or not), interventions (e.g., whether a blood transfusion was required), post-operative complications, as well as outcome and disposition. Initially departments began running reports on an ad hoc basis. They investigated results they found noteworthy or interesting and began informally discussing which data elements might help improve clinical care over time. Data elements on process and health outcomes generated interest from clinicians. (See **Exhibits 8A, 8B, 8C, and 8D** for select reporting.)

One use of data was to identify unusual patterns over time, resulting in discussion of potential underlying causes. For example in obstetrics, the monthly rate of caesarean sections was tracked and reviewed. A monthly dip in the rate, as occurred in December, could be analyzed as to whether it represented a deviation resulting from chance or from an identifiable cause.



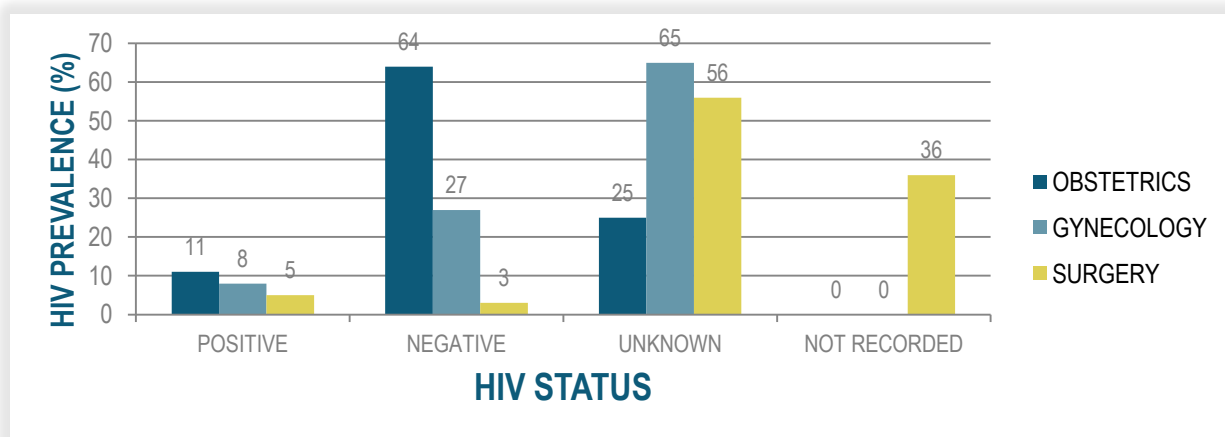
TABLE C Example of SQUAD Data: Caesarean Section Rate, August 2013–January 2014



Source: Data prepared by author, fictitious and provided for illustrative purposes only. Based on a presentation by the SQUAD team to the obstetrics department at Mbarara Regional Referral Hospital.

The SQUAD team used the new data to examine trends. One point of focus was the number of unknowns reported for HIV prevalence. In the first six months of data collection, there was great variation between rates of unknowns reported in gynecology (62.75%) versus obstetrics (22.33%). The SQUAD team could put together hospital-wide benchmarks to monitor and improve performance at the individual level. Thus, departments performing well could share their experiences and practices.

TABLE D Example of SQUAD Data: HIV Prevalence in Obstetrics, Gynecology, and Surgery



Source: Data prepared by author, fictitious and provided for illustrative purposes only. Based on a presentation by the SQUAD team to the obstetrics department at Mbarara Regional Referral Hospital.



Preliminary data for obstetric complications suggested the potential power of the database, once validity issues were resolved.

**TABLE E** Example of SQUAD Data: Obstetric Complications – Maternal Outcomes

	N	% (OUT OF 168 TOTAL OBSTETRIC COMPLICATIONS)
Maternal Death	6	3.6
Uterine Rupture	33	19.7
Postpartum Hemorrhage	35	20.8
ICU Admission	15	8.9
Reoperation	14	8.3
Infection	65	38.7

*Source: Data prepared by author, fictitious and provided for illustrative purposes only. Based on a presentation by the SQUAD team to the obstetrics department at Mbarara Regional Referral Hospital.*

## Moving Forward

The SQUAD team knew much work remained for the database to fulfill its potential. Ttendo stated, “Honestly, SQUAD still needs a lot of work. We can clean it up every day and modify it.” To SQUAD leadership, two critical questions emerged. How could data be used at the facility level, and how should it be communicated to stakeholders at MOH, WHO, and others? Most team members believed creating data dashboards showing information would be most useful to clinicians. Doing so would likely help improve clinical outcomes and buy-in from clinicians and nurses working at MRRH.

Questions emerged during the fall 2014 team meeting in Mbarara. There was disagreement about whether the 160 data elements represented the right information to be collected, or whether it was advisable instead to reduce the number to a smaller subset. Mugenyi suggested a more focused database. “I would just gather the things you do routinely. So if I’m with Children’s Hospital and want to know about children, I should look at the things I



commonly need to know and include them in the database. It shouldn't be a standard you must collect on A, B, and C. It should be geared to things we do commonly and routinely."

Would policymakers at the Ugandan MOH be interested in the same indicators as staff from international groups such as the World Health Organization? How might data be used to attract future funding for expanding the system to other parts of Africa? What concerns might SQUAD team members have, beyond funding needs, for expanding the system to other regions? The possibility of expanding SQUAD to other areas in need was growing, though not part of an immediate plan.

"We had a small discussion in Ghana earlier this year," Ngozi said. "We were talking about the experiences with SQUAD and the whole audience went wild. They said, 'Wow, you mean this is being done?' And so there was a lot of excitement. It's very relevant, and I believe it can be replicated elsewhere."



**EXHIBIT 1** Data Fields for the SQUAD Database 2014

DEMOGRAPHIC INFORMATION	ADMISSION	DISPOSITION
<p><i>(for all patients)</i></p> <ul style="list-style-type: none"> <li>• Given name, Middle name, Family name</li> <li>• ID number</li> <li>• Gender</li> <li>• Birthdate (estimated or not)</li> <li>• District</li> <li>• Subcounty</li> <li>• Parish</li> <li>• Village</li> <li>• Admission ward</li> <li>• Tribe</li> <li>• Telephone number</li> <li>• Who owns telephone</li> <li>• Occupation</li> <li>• Education level</li> <li>• Next of kin name</li> <li>• Kin telephone</li> <li>• Deceased (check box)</li> </ul>	<p><i>(for all patients)</i></p> <ul style="list-style-type: none"> <li>• Admission date</li> <li>• HIV status</li> <li>• Gravity and Parity</li> <li>• Ward (Surgery, Gynecology, Obstetrics)</li> <li>• Admission diagnosis</li> <li>• Procedure done</li> <li>• Laterality</li> <li>• Referral (from where)</li> <li>• Referred in reason (Lack of skills, nonfunctional equipment, lack of supplies/drugs, other)</li> <li>• Surgery performed prior to admission (yes or no)</li> <li>• Date and time surgery scheduled for</li> <li>• Surgery decision date and time</li> <li>• Pre-operative care:                             <ul style="list-style-type: none"> <li>- Transfusion (yes, no-not required, no-blood not available, other)</li> <li>- Blood work (yes, no or other)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Discharge diagnosis</li> <li>• Outcome</li> <li>• Date</li> <li>• If referred (out):                             <ul style="list-style-type: none"> <li>- Referral center</li> <li>- Referred out reason (lack of skills, nonfunctioning equipment, lack of supplies/drugs, other)</li> </ul> </li> <li>• If death:                             <ul style="list-style-type: none"> <li>- Cause of death</li> </ul> </li> </ul>
<p><b>TRAUMA/ONCOLOGY</b></p> <ul style="list-style-type: none"> <li>• List injuries</li> <li>• Trauma system (Neuro, Ortho, Abdominal, Chest, Perineum, Skin, Head, Neck, Other)</li> <li>• Date of injury</li> <li>• Trauma classification (Blunt, penetrating, burn, other)</li> <li>• Mechanism of injury (Assault, pedestrian, boda boda rider, vehicle driver, fall, boda boda passenger, vehicle passenger, other)</li> <li>• Mode of transport (walk, boda boda, bus, car, ambulance, other)</li> <li>• Initial trauma assessment (temperature, heart rate, systolic BP, diastolic BP, respiratory rate, O2 saturation, FiO2, GCS)</li> <li>• Diagnostic studies (Head CT, abdominal CT, abdominal ultrasound, XRay)</li> <li>• Oncology:                             <ul style="list-style-type: none"> <li>- Cancer site (breast, esophagus, lung, skin, larynx, nose, colon, prostate, bladder, oropharyngeal, other)</li> <li>- Diagnosis (pathologic or clinical, with date of clinical diagnosis if applicable)</li> <li>- Cancer pathology</li> <li>- Cancer stage</li> <li>- Surgery (yes or no)</li> <li>- Chemo (yes or no)</li> <li>- Radiation (yes or no)</li> <li>- Cancer disposition (cancer clinic, referral, home, palliative care, other)</li> </ul> </li> </ul>	<p><b>OBSTETRICS</b></p> <ul style="list-style-type: none"> <li>• Best estimate of gestational age (weeks)</li> <li>• Baby gender</li> <li>• Baby weight</li> <li>• APGAR at 1 minute</li> <li>• APGAR at 5 minutes</li> <li>• Still birth (yes or no)</li> <li>• Macerated or Fresh Still birth</li> <li>• Neonatal death before discharge (yes or no)</li> <li>• Maternal death before discharge (yes or no)</li> <li>• Postpartum hemorrhage required transfusion (yes or no)</li> </ul>	

EXHIBIT 1 (continued on next page.)

EXHIBIT 1 (continued: second page of three)

**OPERATIVE RECORD**

- Date of surgery
- Time of surgery
- Urgency (elective, emergency, urgent)
- Reason for delay (no delay, surgeon/anesthesia availability, patient decision, logistical (power, supplies), other)
- Surgeon and level of training (intern, SHO (resident), specialist, other)
- Theatre (Surgery or Obs/Gyn)
- Assistant (training level)
- Indication for surgery
- Surgical Procedure:
  - Surgical procedure
  - Site (ear/nose/throat, abdominal, urologic, plastic, neurosurgical, perineum, orthopedic, ophthalmologic, thoracic, urogynae, cutaneous)
  - Anesthetist and level of training (anesthetist officer, SHO (resident), specialist, other)
  - Anesthetic type (GA, spinal, block, GA+block, GA+spinal, local, other)
  - Anesthesia duration (minutes)
  - ASA score
  - Prophylactic antibiotics (yes or no)
  - Operative time (minutes)
  - Re-operation (yes or no)
  - Reason
- Post-op diagnosis:
  - Post-op diagnosis
  - Surgical outcome (good, fair, poor, died in OR)
  - Pathology sent (yes or no)
  - Pathology findings
  - Operative comment
- Post-operative complications (yes or no for the following fields):
  - Wound infection
  - Dehiscence
  - Pneumonia
  - Urinary tract infection
  - DVT or PE
- Detailed nerve block:
  - Block date and time
  - Block performed
  - Laterality
  - Block indication (primary versus post-operative)
  - Block approach (ultrasound, nerve simu, landmark, single shot, catheter, other)
  - Needle employed (25mm insulated, 50mm insulated, 80mm insulated, 25 gauge, other)
  - Block complications (none, intravascular, intraneural, failed block)
  - Anesthetic used
  - Block performed by (and their level of training: resident, student, staff)
- Post-operative nerve block:
  - Date/time block resolved

EXHIBIT 1 (continued on next page.)



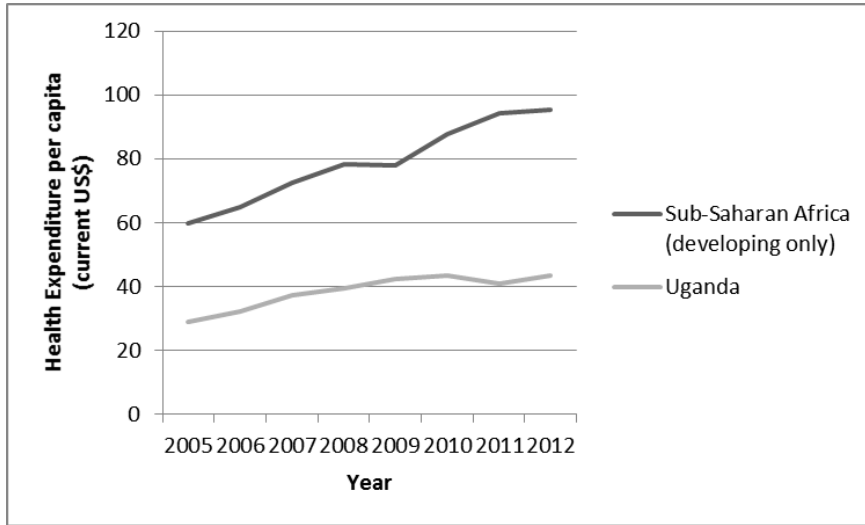
**EXHIBIT 1 CONTINUED:** (third page of three)

**INTENSIVE CARE UNIT (ICU)**

- ICU actual diagnosis
- Post-op (yes or no)
- If post-op: Scheduled (yes or no)
- ICU admission date
- ICU origin (from which ward)
- Admit type
- ICU admission (Sepsis, hemorrhage, immunosuppression, respiratory failure, altered mental status, trauma, hypotension, acute renal failure, seizure, other)
- Systems diagnosis (cardio, renal, hematologic, pulmonary, malignancy, neurological, gastro, endocrine, infectious, other)
- Vital signs on admission (temperature, heart rate, systolic BP, diastolic BP, mean arterial pressure, O2 saturation, FiO2, GCS)
- Diagnostic studies (CXR, CT abdomen, CT head, ultrasound, lumbar puncture)
- Laboratory studies and the date (WBC, Hgb, Na, K, HCO3, Cr, pH, PaO2)
- Gram stain (positive or negative, source)
- Culture (positive or negative, date, source)
- Malaria (positive or negative, date, source)
- TB (positive or negative, date)
  
- Treatment (yes or no for each option below):
  - IV fluids
  - Blood transfusion
  - Antibiotics
  - Oxygen
  - Vasopressors
  - Tube feeds
  - Ant-seizure medications
  - Magnesium
  - Anti-hypertensives
  - Insulin
  - Steroids
  
- Intervention (yes or no for each option below):
  - Mechanical ventilation (with start and stop date if applicable)
  - Arterial line
  - Central access
  - Dialysis
  - Thoracentesis
  - Paracentesis
  - Surgery
  - Delivery
  
- ICU outcome (drop-down list)
  - Cause of death
  - ICU discharge date

*Source: Provided by the SQUAD Leadership Team from an internal document with the same title.*

**EXHIBIT 2** Uganda Health Expenditure Data



Source: World Bank, <http://data.worldbank.org/indicator/SH.XPD.PCAP/countries/ZF-UG?display=graph>, accessed December 2014.

**EXHIBIT 3** Uganda’s Referral System

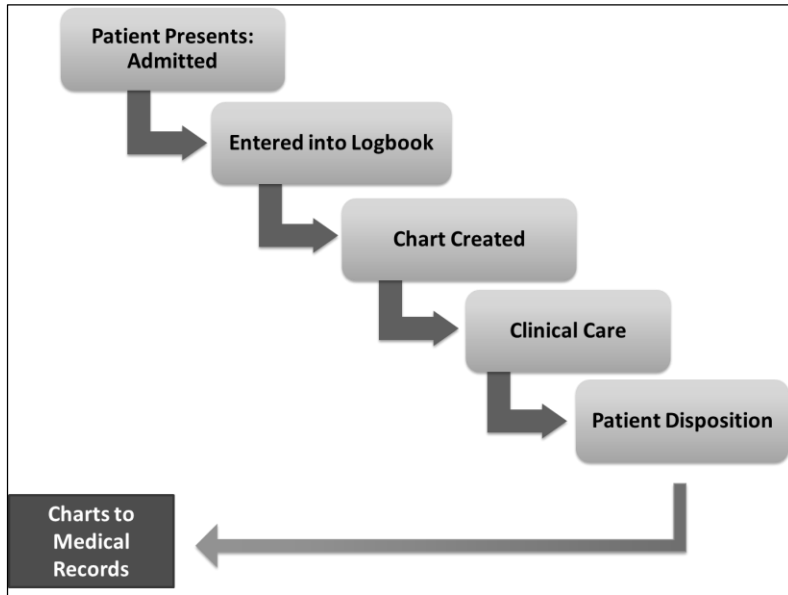
1. **Village Health Teams/Community Health Workers:** The first contact for someone living in a rural area. Village Health Teams were composed of unpaid volunteers. Each village was expected to have these first points of contact to provide drugs and treatment for common ailments and diseases. This level of care did not exist in some villages, or a village lacked basic drugs for diseases such as malaria.
2. **Health Center II:** Every parish was to have a center II facility meant to serve a few thousand people. Typically led by an enrolled nurse working with a midwife, two nursing assistants, and one health assistant. Operated as an outpatient clinic treating common diseases and offering ante-natal care.
3. **Health Center III:** A facility found in every sub-county in Uganda. Composed of about 18 staff, led by a senior clinical officer. Included an outpatient clinic, a maternity ward, and a functioning laboratory.
4. **Health Center IV:** A “mini-hospital.” Admitted patients to separate wards for men, women, and children. Led by a senior medical officer and one doctor. Included a theater for emergency operations.
5. **Regional Referral Hospital:** A district-level hospital offering the same services as a Health Center IV, plus consulting physicians and specialized clinics such as for dentistry and mental health.
6. **National Referral Hospital:** Located at Mugalo in the capital city Kampala. Top of the referral chain in Uganda. Many Ugandan medical leaders worked here, as well as in private clinics to supplement low government salaries.

Source: World Bank Country Data: Uganda, as drawn from Richard M. Kavuma’s article, “Uganda’s Healthcare System Explained,” *The Guardian*, <http://www.theguardian.com/katine/2009/apr/01/uganda-healthcare-system-explained>, accessed December 2014.

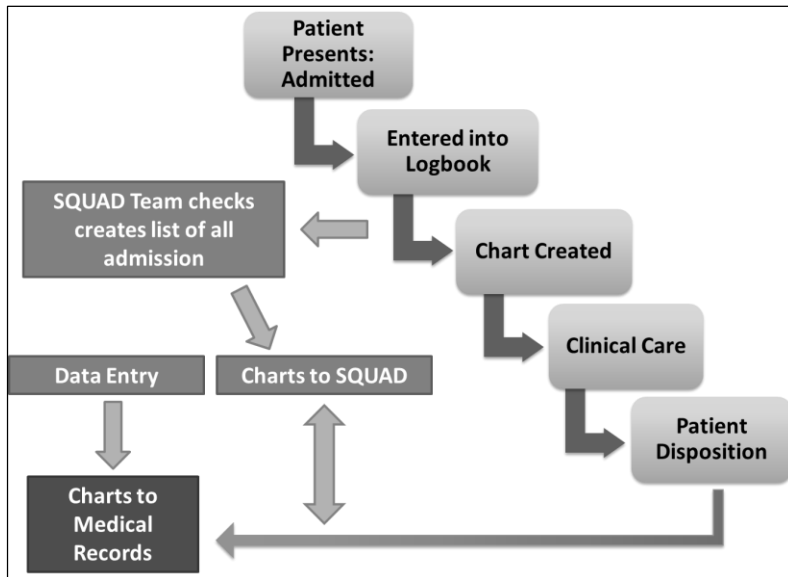


EXHIBIT 4 Pre- and Post-SQUAD Process

Pre-SQUAD



Post-SQUAD



Source: Slides prepared by Adeline Boatin for a presentation to the obstetrics department at Mbarara Regional Referral Hospital.

## EXHIBIT 5 The SQUAD Team



*Back Row: Paul Firth (Anesthesiologist), Manfred Amanyana (Data Clerk), Nicholas Msunguizi (Biostatistician/IT), Stephen Ttendo (Director of Anesthesia, MRRH), Walter Mugabi (Data Clerk); Front Row: Dorothy Kayaga (Data Clerk), Phionah Naturinda (Data Clerk), Rhina Mushagara (Project and Data Management Coordinator).*

## EXHIBIT 6 OpenMRS Mission, Values, and Vision

OpenMRS values patient care as the basis of everything we do.

The mission of OpenMRS is to improve health care delivery in resource-constrained environments by coordinating a global community that creates a robust, scalable, user-driven, open source medical record system platform.

**We are:**

- **User-Centered**
  - Design decisions are driven by real, not perceived needs.
  - Our software works in the most challenging health care delivery environments. We create a platform that is adaptable to the unique needs of our users around the world.
- **Open**
  - We are open, honest, and transparent in both our processes and our software.
  - Our software serves as a platform that empowers both users and implementers to innovate.
  - We publicly document and share our knowledge, skills, experiences, and failures.
- **Community-Driven**
  - We believe the best ideas come from people with different backgrounds and talents, and we build a community where these people can come together and innovate.
  - We believe in harnessing the wisdom of our software development community by creating a safe place to raise concerns, discuss failures, improve existing ideas, and solve problems.

**We envision a world where:**

- Models exist to implement health IT in a way that decreases costs, increases capacity, and lessens the disparities between wealthy and resource-poor environments.
- Open standards enable people to use health IT systems to share information and reduce effort.
- Concepts and processes can be easily shared to enable health care professionals and patients to work together more effectively.
- Medical software helps ease the work of health care providers and administrators to provide them with the tools to improve health outcomes all over the world.

*Source: OpenMRS website, "OpenMRS Mission, Values, and Vision," <http://openmrs.org/about/mission/>, accessed December 2014.*



## EXHIBIT 7 Examples of EMR Systems in Developing Settings

System Name	Launch Year	Developers	Implementation Sites	Software	Implementation Process	Notable Features
Open Medical Record System (OpenMRS)	2004	Partners in health and Regenstrief Institute	25+ countries; national implementation by Rwandan Ministry of Health	Open-source	Free software download, trained implementation team required, free online support community	Flexible platform, global support community
IQ Care System	2004	Constella Futures Group, Catholic Relief Services, and Futures Group (AIDS Relief)	Kenya, Uganda, Nigeria, Tanzania	Open-source	Free software download, custom options available, train the trainer program available	Used to administer PMTCT, antiretroviral therapy
SmartCare	2005	Zambia Ministry of Health, US Centers for Disease Control	National Implementation in Zambia, including CIDRZ, Ethiopia, and South Africa	Not open-source	Data unclear	Works with paper-based systems, durable design and limited Internet touch-screen option for easy learning
Care Ware	2000	US Department of Health and Human Services and PEPFAR; jPROG-developed the software	United States, Nigeria, Uganda, and Vietnam	Freeware	Free software download, free technical support, limited adaptability	Originally designed for HIV prevention and treatment
Baobab	2001	Baobab Health Trust	Malawi	Open-source	Offers a suite of services, such as: open-source software and low-cost hardware and operational support	Touch screen available for easy use, hardware designed for harsh environments, Malawi-based
OpenEMR	2005	Open-source Medical Software	United States, Puerto Rico, Australia, Sweden, Holland, Israel, India, Malaysia, Nepal, and Kenya	Open-source	Free software download, options for customization, free online support, commercial support and licensing available	Multi language support, large online open-source support community
OpenVista	2002	US Veterans Health Administration	All VHA sites: 163 hospitals, over 800 clinics and 135 nursing homes; also used at sites in Mexico (over 100 hospitals), and 11 other countries around the world	Open-source	Support license typically required for hospitals and larger clinics, commercial set-up available	Synchronization with multiple locations, management performance tools

# SQUAD in Uganda: Surgical Quality Assurance Database (A)

BAB303 / MARCH 2015

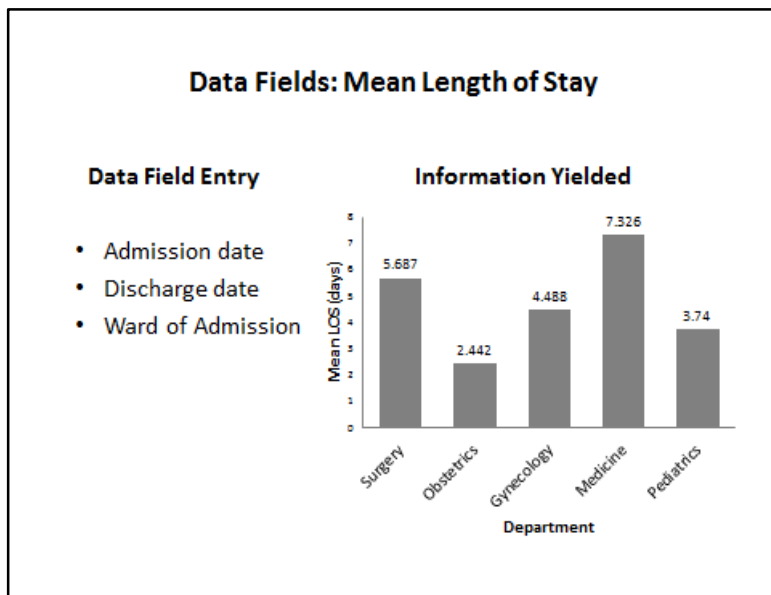
Community Health Tracking System (CHITS)	2004	UP Manila-National Telehealth with support from the Canadian International Development Research Center	Philippines	Open-source	Free software download, training and certification through UP Manila National Telehealth Center	Rapid access to patient data, Internet connection not necessary
Hospital OS	2003	Thailand Research Fund, Thai National Health Foundation, Thai Medical Informatics Association, Software Industry Promotion Agency (Thailand)	75 hospitals throughout Thailand	Open-source	Free software download, online support community, requires IT specialists to set up and run	Designed for rural Thai hospitals with limited IT budgets
Health Information Systems Program (HISP-SA)	2001	Government of South Africa, Norwegian Agency for Development Cooperation, USAID	South Africa, Kenya, Rwanda, Ghana, Lesotho, Zimbabwe, Mozambique, Sierra Leone, Uganda, Tanzania, and Latin America	Open-source	Collaborative development for South Africa, implementation across African continent and Southeast Asia	South Africa-based; language options for Portuguese, Swahili, Spanish, Telugu, Russian, Mongolian, and Chinese
SIGA Saúde	2004	Centro de Estudos em Informática em Saúde [Center of Health Information Studies], Prefeitura da cidade de São Paulo [Prefecture of the City of São Paulo]	Brazil: Cities of São Paulo, Camaçari, and Campinas; other sites in the State of São Paulo	Open-source	Developed for the city of São Paulo, costs for software development and hardware	Utilized by every public healthcare facility in the City of São Paulo

*Source: Excerpted from Harvard Medical School Case Study, GHD-026, "Electronic Medical Records at the ISS Clinic in Mbarara, Uganda," May 2012.*



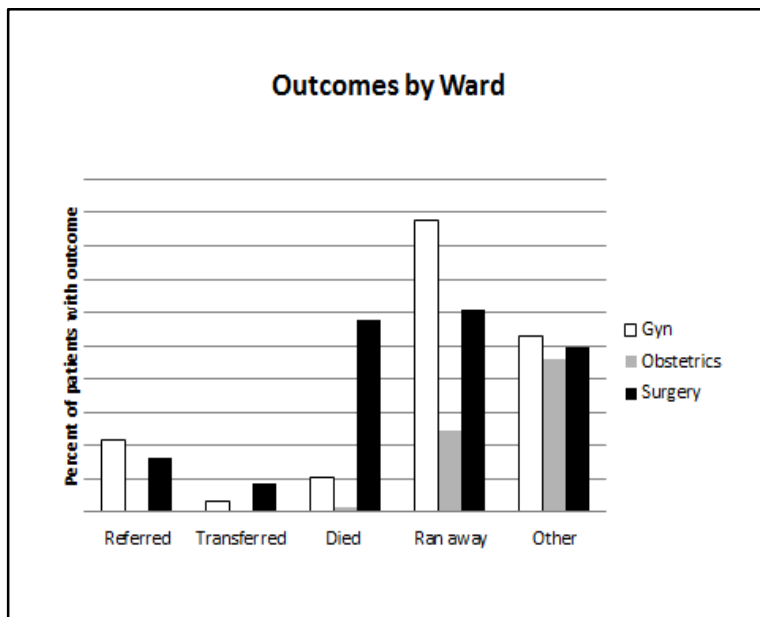


**EXHIBIT 8A** Example of SQUAD Data: Mean Length of Stay



Source: Data prepared by author, fictitious and provided for illustrative purposes only. Based on a presentation by the SQUAD team to the surgery department at Mbarara Regional Referral Hospital.

**EXHIBIT 8B** Example of SQUAD Data: Outcomes by Ward

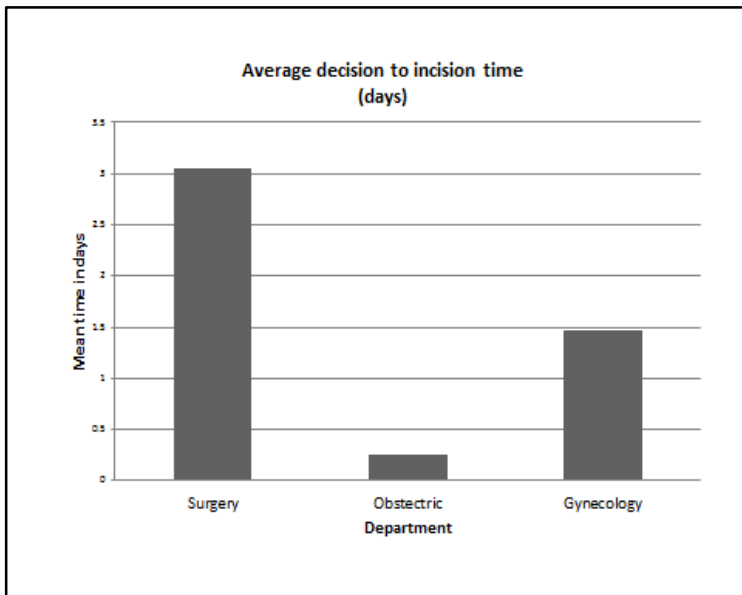


Note: Ran away referred to patients who left the hospital on their own without formal discharge.

Source: Data prepared by author, fictitious and provided for illustrative purposes only. Based on a presentation by the SQUAD team to the surgery department at Mbarara Regional Referral Hospital.

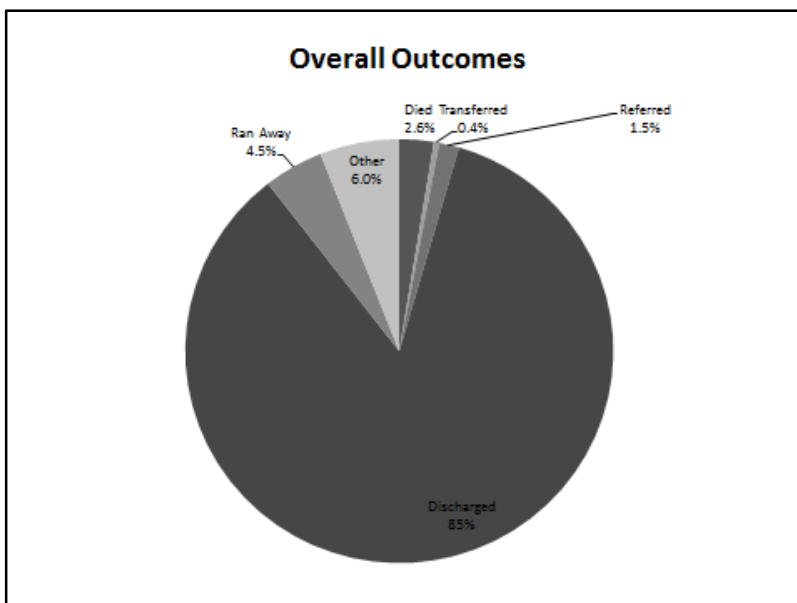


**EXHIBIT 8C** Example of SQUAD Data: Decision to Incision Time



Source: Data prepared by author, fictitious and provided for illustrative purposes only. Based on a presentation by the SQUAD team to the surgery department at Mbarara Regional Referral Hospital.

**EXHIBIT 8D** Example of SQUAD Data: Overall Outcomes



Source: Data prepared by author, fictitious and provided for illustrative purposes only. Based on a presentation by the SQUAD team to the surgery department at Mbarara Regional Referral Hospital.