Deploying a Medical Record System in Rural Rwanda

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ABSTRACT
Efficient electronic medical record (EMR) storage and retrieval systems for treating the millions of HIV/AIDS and tuberculosis (TB) patients in the developing world is largely an unsolved problem. One attempt at addressing this need is the Open Medical Record System (OpenMRS) – a framework that provides a free and flexible EMR system for resource-constrained environments.

Although OpenMRS is a step in the right direction, implementers of such systems face a question that is largely unanswered by previous work. Where in the existing paper-based workflow can such plastic technology be injected and how does one evaluate the efficacy of this intervention?

In this paper, we describe the role manual processes have played in a rural hospital in Rwanda and how we determined where to implement appropriate technology solutions.

Categories and Subject Descriptors
H5.m. **Information interfaces and presentation** (e.g., HCI): Miscellaneous

General Terms
Design, Human Factors

Keywords
Rwanda, medical record systems, paper

1. INTRODUCTION
Of the millions of men, women and children who die each year from HIV/AIDS, more than 95% of the infected, an astonishing 38 million, live in the developing world. Unlike illnesses like malaria, which can be treated with little regard for a patient's medical history, chronic diseases like HIV/AIDS and TB require efficient medical record storage and retrieval systems. Health care providers working in these impoverished environments usually do not have the resources to implement custom software and instead rely on some combination of paper charts, massive spreadsheets and simple database applications.

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The Open Medical Record System (OpenMRS[1]) addresses some of these challenges through an open source framework that provides a free and flexible electronic medical record system (EMR) for resource-constrained environments. Led by Regenstrief Institute and Partners in Health (PIH), the OpenMRS project has grown into a community of developers and users working toward better systems for managing health information.

Our work is based on the months spent deploying PIH's first installation of OpenMRS [1] – an installation that will serve as the model for the future national healthcare system in Rwanda. In this paper, we describe the role manual, paper-based processes have played in a rural hospital and how we determined where to implement appropriate technology solutions.

2. INFRASTRUCTURE
Rwinkwavu Hospital is in a remote town and has served as PIH's home in Rwanda for the past two years. Along with Rwinkwavu, PIH has five other sites: Kirehe Hospital and four smaller health clinics which together provide over 425,000 people with high-quality health care. These sites are one to two hours apart from each other and accessible only by off-road vehicles.

Rwinkwavu Hospital has stable electricity and water while Kirehe Hospital and the clinics rely on solar power and generator and have no running water. All the sites have intermittent cellular coverage, primarily used for SMS communication, and satellite connections that are used to connect PCs (one or two for clinics, fifteen to fifty for hospitals) to the Internet (and thus EMR). All sites are networked primarily with WiFi.

Many employees at each site are college-educated, speak French and English and would have at least seen if not used a computer before working with PIH. The younger staff tends to be more familiar with specific applications – including web browsing, word processing and instant messaging. The hospital provides laptops and desktops for those who need them for their jobs and also has a few machines for public use.

A two person IT team (assisted by the first and second authors) provides technical support for all the sites. Despite heavy-duty power protection, regularly updated software, and locked-down machines, computer infrastructure is still quite fragile. Power supplies are destroyed by voltage fluctuations. Viruses on USB keys spread faster than antivirus updates can be propagated. Underground cables are dug up and sold. Thick concrete used in construction weakens wireless signals. Shipping replacement hardware from Dubai takes a dedicated logistical team. Even basic functions like printing are thwarted by the rationing of paper – without a full ream, printers jam more frequently.

[1] http://openmrs.org

3. PAPER WORKFLOW

Although EMR use in the Rwinkwavu Hospital began almost simultaneously with the scale-up of health care services, paper processes played a large role from the beginning because such processes were well understood by staff and required less cost – financial and otherwise. The example scenario below describes a part of the workflow that was implemented alongside the EMR.

Alice has been coughing a lot this month and has decided to go see a doctor. The last time Alice was at a hospital, she was treated for malaria. According to national policy, the details of that visit were written in a health notebook (her medical record) as well as in a register at the hospital where she was seen. Alice finds the notebook and begins the two-hour walk to Rwinkwavu.

This is Alice's first visit to Rwinkwavu Hospital and upon arrival is assigned a patient ID from a list of available IDs. She is seen by Dr. Chris a few hours later. Dr. Chris looks over her health notebook, takes her vital signs and after listening to her symptoms, fills out a lab request test form for TB and HIV tests. He asks her to wait another few hours for the test results.

When the tests are ready, Dr. Chris sits down with Alice to explain the results. The cough is a minor infection, but the blood test reveals that Alice is HIV+. Dr. Chris now fills out the long intake form and schedules a CD4 test. He notes his findings in her health notebook, schedules a return visit, and sends Alice home.

A few days later, Alice returns to the hospital. Dr. Chris fills out a shorter return visit form to gather new information. He tells Alice that because her CD4 count is low and she will receive patient training and be put on antiretroviral (ARV) drugs immediately. Every morning, Alice's medications will be delivered to her house by an *accompagnateur* who will help her through the complex regimen. If she does not have access to food, she will also receive a food package. Finally, a community health worker will also visit Alice occasionally and note her progress on yet another form.

4. PLASTIC WORKFLOW

Because of lessons learned installing EMRs in Haiti and Peru, very specific choices were made at the beginning of our deployment about where to add technology and where to abstain.

Patients come to the sites with everything from malaria to hippopotamus bites, but the EMR is primarily used for five thousand chronic care patients. This decision was made due to the importance of longitudinal records in chronic care, and because resources did not allow for maintenance of all patient records.

Once Alice starts ARVs, she will visit the hospital every month. After each visit, the data entry team will enter all her new data into the EMR. Rather than incur the cost of training and equipping each doctor to perform point of care entry (for example, using mobile devices), we find it more effective to rely on a dedicated data entry team using PCs.

A lot of time is spent with the clinical team ensuring the paper forms are concise, but still ask the medical and research questions necessary for good medical care. The design of the forms and specific questions has evolved over many years and is optimized for easy data entry and unambiguous analysis. The forms also allow for longer, free-text clinical notes that are best entered manually. Our data entry team is thoroughly trained and is provided incentives to enter data quickly and accurately.

The EMR is also used to generate patient IDs. Because of spelling variations in names and the lack of a postal addressing system, duplication of patient records is prevalent in rural hospitals. Without a system to authorize and check IDs, hospital staff wastes considerable time processing old patients. Importantly, by uniquely identifying patients, hospitals can demonstrate real impact for the government and other donors. For example, Alice's issued ID will link her data in the pharmacy and food program to her clinical care and show the impact of generic drugs and free food on patient outcomes.

Once patients are tracked, it is also easier to generate program management reports and to trigger alerts when dangerous trends are found. For example, it is important for the hospital director to be alerted via email if a particular clinic is not doing biannual CD4 tests for every HIV-positive patient.

Entering lab data is another place the EMR is used. Although Dr. Chris' request for lab data is written down and handed to a lab technician, who transcribes it into a notebook, the actual test results, once generated, are automatically submitted to the EMR. Abnormal lab results also can be immediately sent via SMS to clinical staff. Low latency is essential for lab results, and thus test reporting was one of the first processes to be digitized.

The final role the EMR plays is in generating consult sheets. When Alice's HIV group is scheduled to visit the hospital, Dr. Chris will get one-row-per-patient consult sheets with weight, CD4 and regimen information. One-page patient summaries can also generated on demand, including graphs of weight, CD4 count and lab results; a history of symptoms, allergies and drug regimens; and alerts about dangerous trends. Clinicians find these summaries essential to their work, and so computers with simple interfaces to the EMR are also slowly being deployed.

5. CONCLUSION

In this paper, we have described the role manual, paper-based processes have played in our rural hospital in Rwinkwavu, Rwanda and how we determined where and when to implement technology-based solutions.

While we firmly believe that contextual knowledge is essential in determining how to build and deploy such systems, there is also a need for more general guidelines about the appropriateness of technology interventions in manual, paper-based workflows. We believe that some of the choices we have made, and the reasons for them, could be applied in other contexts. For this reason, we are currently developing tools and methods that can inform system designers and implementers about the tradeoffs in replacing paper processes with plastic technology.

6. ACKNOWLEDGMENTS

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7. REFERENCES

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