Innovation cases study proposal for Nairobi Innovation Week 2016

From paper to data: taking medical health records into the future

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***Abstract* - Rural health clinics in Kenya are commonly under-resourced and over-stretched, leading to long waiting times that can greatly inconvenience patients. The problem is exacerbated by the use of inefficient paper-based patient records systems: forms take time to fill out, handwriting can be hard to read, and handling paper takes up valuable clinic staff time. Inability to access patients' information outside the clinic also hinders follow-up care and planning, and may affect patient safety. When patients visit different clinics – a common occurrence – the records remain separate, and each provider may lack crucial information about the conditions treated and care given by the others. Patients with chronic conditions are particularly harmed by this situation.**

In a pilot project in Siaya County, we are now testing a potential solution: to build and implement a system that records patient health data electronically and makes it portable and shareable via personal NFC (near field communication) cards and readers in each clinic. Patients "touch in" on each visit, and their data are transmitted to the clinic's online system via SMS messages. The record is later completed with information from the clinic's exchange with the patient.

This system has the potential to demonstrate how Kenyan health authorities can leapfrog directly to portable electronic health records, streamlining access to health services and providing more accessible and reliable patient information. This could save time, money and, ultimately, lives.

We are now piloting the system with about 4,000 pregnant women in 50 clinics in Siaya County during the next 18 months. The project is funded by the Bill and Melinda Gates Foundation, and implemented by Stockholm Environment Institute, Nailab and the Safe Water and AIDS Project.

***Index Terms*—Access to healthcare, pro-poor, empowerment, electronic medical health records, rural health.**

I. Challenges of the existing health system

A robust health care infrastructure is crucial for protecting public health, particularly during crises such as epidemics, civil wars and disasters [1]. Kenya has made substantial efforts to improve health care, but outdated record-keeping systems undermine those efforts.

Health care providers in Kenya record patient data on medical data logbooks. The books are inexpensive and require little

training to use, but as demands on health services increase, their limitations are becoming evident. Studies from across sub-Saharan Africa show this is a common problem in the region.

Even day-to-day updating of health records is a challenge. A large study of health system data management in rural South Africa [2] found two major deficiencies: 1) data were incomplete – 50.3% of the clinics studied had gaps in one of six key data points over the 12 months; overall, data were missing 4.5–41% of the time; and 2) data accuracy – the rate of error in completed data was 0.4–8%.

In Kenya, a national study of Voluntary Counselling and Testing (VCT) services [3] showed that 90% of the clinics studied were missing data in their logbooks. The main reason cited for these deficiencies was a lack of time due to higher priorities. After further investigation, clinic staff were found to be required to fill in five different forms for the VCT services alone. Indeed it has been widely found [1]–[4] that the time taken to fill in logbooks is a burden, doesn't fit into realistic workflows by clinic staff, and doesn't serve to visibly improve patient care.

Research has also shown that even where records are present and correct, errors will occur in the readability of the record [1], the tallying and collation [2], and in the transfer clinic and national office locations [3]. In general, unnecessary complexity is caused by a multiplicity of records. The World Health Organization (WHO) has recommended [5] simplified data collection tools, a minimal set of common key indicators, and a reduced number of registers.

II. Benefits of electronic health records

Electronic health records have been widely embraced in industrialized countries as a way to improve medical data collection and the sharing of information across providers. Well-designed electronic systems can save time, increase accuracy, and thus save money and improve health care outcomes. In addition, when (anonymized) data are also combined and analysed, they can provide crucial insights to improve patient care and guide national health policy and investments. This makes it possible to allocate what are often limited resources based on demonstrated needs.

Research has identified three key areas in which improvements in health records systems would be most valuable [1], [2]. **Patient care**: Better data can ensure effective and appropriate management of cases, which leads to quicker treatment and recovery. This, in turn, leads to reduced costs for unnecessary procedures such as repeated diagnostic testing. **Planning and management**: Access to accurate, correct and timely information can be a source of information on growing epidemics and disasters and prevent loss of life. In the provision of maternal health, it can enable providers to plan future services, such as deliveries, ahead of time, and thus ensure that the necessary equipment and specialist staff are available. **Research**: Electronic records can further enhance medical research by providing a wider pool of accessible data which can end up providing solutions at a reduced cost.

The size and scope of the health system in Kenya is massive, with such high rates of migration between regions and high levels of AIDS/HIV and pregnancy rates. A widely used, uniform, easy-to-access electronic health records system implemented on a national scale would leapfrog many localized IT systems onto one more in line with developed countries.

It would provide scope for a potential reduction in costs across the country, while simultaneously improving the provision of supply side services such as the treatment for chronic health conditions.

III. Pilot area

The system in focus will be piloted in Siaya County in Western Kenya. The County is mostly rural, with a population of 8.3 million people which is projected to grow to 9.6 million by 2017 [7] [12]. This is because despite the high mortality rate in the county (40 years against Kenya's average of 56.6 years), the County also has high fertility rates, which is currently 5.5 children per woman compared to a national average of 4.6 children per woman. The unmet need for family planning for 25% of eligible population is a major contributor to this. Nearly three quarters of the population is under 30 years old, and 45 percent is under 15 years [11]. The country is also characterized by high maternal mortality rates (695 per 1000 live births), and high infant mortality rate (111 per 1000 live births) [9]. A variety of factors contribute to this. The county has a Human Development Index (HDI) score of 0.46, which is below the national average of 0.56 [8]. It has the highest HIV (20% vs. 6% national rate), tuberculosis, and malaria rates in Kenya; and is one of the most poorly served counties in terms of public health facilities [11]. The entire County is served by 124 health facilities, two of which are referral hospitals. The rest are mainly dispensaries and health centres that are staffed by nurses or clinical officers. Doctor to population ratio is 1: 62,000, while nurse to population ratio is 1: 2500 [7].

An electronic health record (EHR) system can offer several opportunities for intervening on some of these trends. The pregnancy period is a good potential area for applying such a system, as maternal mortality remains one of the global health challenges and a top development priority, both nationally and at the County level. There is consensus that a "Continuum of Care" for reproductive, maternal, newborn and child health (RMNCH) can significantly improve the lives of mothers and newborns [10]. It is this type of recognition that has resulted in the recommendation to deliver antenatal services in 4 focused visits (focused antenatal care). For women whose pregnancies are progressing normally, WHO recommends a minimum of four ANC visits – ideally, at 16 weeks, 24-28 weeks, 32 weeks and 36 weeks [6]. The care should however continue beyond ANC, to also safe facility delivery, as well as postnatal care during which interventions such as family planning and prevention of mother-to-child HIV transmission (PMTCT) can be offered.

The current health information systems are however not currently equipped to handle this continuity of care. Women present for care at different facilities for different stages of pregnancy and postnatal periods. Where a woman attends her ANC is different from where she will have her delivery, and her postnatal care [13]. Because the health records for different facilities are not integrated, it means that for each presentation, a fresh maternal profile has to be taken, and new screening tests and treatments offered. This not only impacts significantly on time and resources, but also poor treatment outcomes.

At the same time, the long continuity of care also presents challenges for already stretched staff in the rural health facilities. For instance a study in Southern Tanzania revealed that with the introduction of focused antenatal care, the average time health workers spend for providing ANC service to a first visit client had increased from 15 minutes to 46 minutes [14]. With the very low provider – client population ratio, this time increase is highly significant. In our recent study in Siaya County [13], it was also revealed that the time taken to fill in paper records by the staff was much higher than the time they spent on providing care to patients, as there were new paper records being introduced in the County. Ideally, the lengthy time taken with the first visit should be offset by the short time needed for subsequent visits; as most information would have been collected during the first visit. This does not occur

however when clients make subsequent visits in other health facilities and there are no records of these prior visits.

An electronic based medical record system therefore has a considerable scope of ensuring better accuracy of records thus ensuring quality of care, freeing more time for the providers that would go towards patient care, and saving the resources being wasted in repeat tests.

IV. System

We developed the EHR system as part of a project to explore whether financial incentives – a small payment for each clinic visit – would make pregnant women likelier to seek regular prenatal care. The payment system was difficult to implement with clinics using paper records, as it is time-consuming to track visits that way. With that in mind, we set out to deploy a system that would make it possible to track each participant visit and issue payments for approved visits.

In the pilot study area, Siaya County, internet penetration is low, but GSM mobile phone connectivity is widely available. The phone app will verify the ID of the patients and monitor their attendance to clinics during pregnancy. Upon each visit, the web portal records the details and initiates a payment to the patient. The portal is able to record an unlimited number of distinct information fields relating to the health of the patient, and can be accessed securely from any internet-connected location.

V. Technical design

To fit the available connectivity limitations, the system was built to rely on SMS as the transport mechanism. A Terminal Reader Device (TRD), which communicated with the server via SMS, was installed at each of the participating clinics. Transaction messages from the TRD are sent via an SMS gateway, which connected to the server via an Internet connection. Responses from the server are packaged as SMS and transmitted via a separate Bulk SMS gateway back to the TRD.

During deployment, a unique clinic ID was assigned to each device, tying it to that particular clinic. Each TRD was deployed with a battery bank to withstand long hours of power disruption in the clinics. In case of device failure, the system administrator would first decommission the failed device from the server through an administrator's portal, and then deploy a new device to the clinic by registering it with the clinic ID of the replaced device.

VI. The process

A first time a patient is present at the clinic they are informed about the system as part of the project and if the agree to participate they complete an on-the-spot registration by the on-call nurse. The patient's basic personal, contact and payment information is input into the Terminal Reader Device (TRD). The participant is then issued a card, which upon touching on the TRD, records the input details on the card, thereby linking the card to the participant. Each issued card is linked to the clinic of issue, also referred to as the 'home' clinic.

During any subsequent visit, the nurse will ask the participant to touch in and out with their card on the TRD to mark their visit. This transaction would be recorded on the device while simultaneously sending an SMS to the server. Contact helplines were set up to handle any problems during the onboarding period.

VII. Data collection

Two systems were built to manage data collection; an android application running on the TRD and a web portal

A. The android application

Based on the user interface (UI) testing, the majority of the nurses in the study own feature phones with basic functionality and

have not had much experience with smart phones. This meant that the user experience in application had to be easy to understand and explain not least for ethics reasons. For these reasons the default home screen defined a tiled interface with the basic operations that the nurse could undertake. This included issuing, re-issuing a card and recording a visit.

Function 1 - To issue a card, the nurse pressed the corresponding tile, input the basic participant information and then swiped the NFC-enabled card assigned to the participant. Each card had a unique id printed on it and which also doubled as the participant's ID.

Function 2 - To re-issue a card in case of corruption or loss, the nurse pressed the re-issuance tile and entered the participant ID of the card being replaced. The nurse then swiped the new card. This triggered the old card to be deactivated in the server and the new card to be assigned to the participant.

Function 3 - Recording a visit required no input from the nurse to record a transaction. The participant only had to swipe the card to trigger the device and swipe a second time to confirm the transaction.

Additionally, during deployment, each nurse was assigned a unique PIN number. This ensured basic authentication was built into the application so that only authorized nurses could initiate device operation.

B. The web portal

In addition to the visit logs collected by the TRD, an online portal was built to allow for more detailed data collection. This portal allows nurses and administrators to manually input information such as chronic illnesses, AIDS status and other relevant information collected during a clinic visit. It is this web portal side that has been developed with the functionality to add in additional fields of information, such as test results, X-rays, prescriptions, which can be added by distinct users in different locations. This project is the first evaluation of a system, with up to 4000 test cases.

VIII. Anti-fraud measures

In the current maternal health study context, each participant is expected to visit the clinic approximately once per month during and after the pregnancy. Multiple swipes/visits within a month are therefore highly unlikely and in such a case a visit would be flagged in our system for further follow-up. Multiple subsequent swipes, would be flagged both in the device and on the server for the system administrator to follow-up.

The system also monitors for duplicate name (fairly common) entries and also for duplicate phone and ID entries. Whilst it is possible that due to the lack of their own phone, or due to the age of the patient being under 18 they would not have an ID or phone, so in these cases, the patient would be followed up with for clarification and a note would be added to their profile.

IX. Conclusions

As studies in Kenya and across Sub-Saharan Africa have shown there are great gains that can be made from an electronic health record (EHR) system. The single fact that patient health record data can be accessed from multiple sites, and that data can be input from multiple sites, means that test results, X-rays, prescriptions and alike can be added without the need for a paper record, with all the risks that brings. However, it is not entirely risk-free switching over to an EHR system either. The costs of such a shift would be large, as would be the need to upgrade all health facilities throughout the country with the necessary technology to make the system work – meaning reliable electrical and internet connectivity. This could of course go hand-in-hand with a wider public amenity roll-out. There would also be the need for training and updating medical and admin staff on procedures and processes, however anecdotally within this study it has been

widely commented that these staff do have time and willingness to learn any new processes if it will enable them to be more productive in their work and save time ultimately, so it is the opinion of the authors that this factor, would not be a problem. The gains that would be made in terms of efficiency would be more present than the problems any transfer to the new system would pose, done correctly. In the design of the system the risk for over-complexity is high, to create a system for all parts of the health services, that ends up serving a very few is entirely possible and cases of this are widespread. The WHO has developed a toolkit for strengthening health systems in a straightforward manner, which can readily inform such an undertaking [5]. Finally, a lack of coordination within the Kenyan Ministry of Health itself could result in two or more EHR systems being designed and implemented within different areas of the service, which would create additional complexity in trying to match them up. A call to develop the system properly from a single point of departure would be best.

Improvements in healthcare in a country such as Kenya are both necessary and possible. This case study shows a glimpse of what can be achieved with comparatively small resources and usage of newer technologies. Should this system be explored it would save many things but above all lives.

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