Improving Standards of Care with Mobile Applications in Tanzania

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Abstract

In this paper, we present D-tree International's work with medical algorithms and mobile applications to improve the standards of care in clinical and community settings. In particular, we present a mobile phone-based application called CommCare which helps community health workers (CHWs) to provide home-based care and social support to HIV, tuberculosis and other chronic patients. The application guides the CHWs through a series of questions which they answer using the phone's number pad. The data then can be submitted directly to a central database over a cellular GPRS network.

We report on our experience developing and testing the application in Tanzania, including the iterative development process with the CHWs and training them to use the program. We include an account of some of the hardware and software issues encountered and resolved during the process, and some initial reactions from the first CHWs and clients to use the program. While the formal evaluation of the program is still in progress, initial findings show that the phone-based system is generally viewed positively by the users and by the clients as more discreet and better for privacy than the paper-based system.

Introduction

D-tree International is piloting several programs using mobile technology and decision-support software to improve medical care for patients in Tanzania. We are developing clinical algorithms for use by nurses and other health workers in the diagnosis and treatment of patients at government health facilities. The algorithms are programmed on a mobile technology platform (either cell phones or PDAs) and run using JavaRosa, an open-source platform designed for this purpose. The algorithms are in the areas of HIV/AIDS, tuberculosis, reproductive health, child health, diabetes, and community health care. The symptom-based algorithms guide health workers through a series of questions leading to a diagnosis and treatment for each patient. This use of electronic algorithms follows studies that have shown that better adherence to protocols and other clinical standards can improve health outcomes for low-income populations (Bryce *et al.* 2005).

One program for routine HIV patient triage using PDAs in South Africa has already been validated in a controlled study (Mitchell *et al.*, 2008), and several pilot deployments and further evaluations are currently underway in Tanzania. The protocols for each topic area can be customized for local language and conditions, and the HIV protocol from South Africa has already been adapted for deployment in Tanzania. Also in Tanzania, D-tree worked with the Ifakara Health Institute to adapt the widely used Integrated Management of Childhood Illness (IMCI) protocols for use on a mobile device. Our preliminary pilot study showed that clinicians using our e-IMCI system performed 84.7% of steps required by IMCI, a significant improvement over the 61% of steps observed during conventional practice ($p < 0.01$) (DeRenzi *et. al.*, 2008). A more extensive study is currently being carried out in 20 government health facilities in Tanzania, evaluating adherence, cost effectiveness and patient/client reactions to using e-IMCI instead of the paper booklet in the clinic. Other algorithms for the care of non-communicable diseases such as diabetes and hypertension as well as for reproductive health and family planning services are also in development.

A new challenge for D-tree has been to adapt protocols for use in community settings, such as in the home-based care of HIV, TB and other chronically-ill patients. To this end we are collaborating with a number of partners on a mobile application known as CommCare, which is being developed for use in several countries. Home-based care providers are community health workers (CHWs) that play a vital role in serving poor and rural populations suffering from chronic diseases. They promote preventive care and convey important health information during regular visits to a patient's home. Being embedded in the community and experiencing the reality of a patient's daily life, the CHWs are in a unique position to understand the challenges of HIV patients. CHWs also have the potential to collect information that is needed at the national level about disease burden and barriers to adopting preventative health practices.

These community-level, mainly volunteer workers, however, often receive relatively little medical training (Lewin *et al.*, 2005), have high turnover (Karab *et al.*, 2001), and have limited opportunities to reinforce their knowledge once they begin working in the field (Kelly *et al.*, 2001). They typically lack tools required to maintain accurate longitudinal records, which makes it difficult to provide truly effective care. Furthermore, while CHWs living in the communities they serve is the key to the effectiveness of their services, it also makes the programs difficult to organize and manage. Addressing these issues is our main motivation for developing and deploying CommCare with our partners in Tanzania. The overall goal of this work is to improve standards of care for patients outside the clinical setting, as well as give the CHWs a tool that can help them structure their work. Another positive outcome of the program is that it also results in better data collection and simplified reporting for both the health workers and their supervisors.

CommCare in Tanzania

Background

This paper presents initial field investigations with a software application called CommCare that runs on mobile phones. In Tanzania, the application is being used to support Pathfinder International's home-based care program in Tanzania. This is part of a wider effort to use mobile applications to strengthen and monitor community health programs in low-income countries. Strengthening health programs at the community level can play a vital role in addressing the health situation of the hundreds of millions of people living in poverty. People living in extreme poverty often do not seek care at a facility even when dying, or they do so too late. Community-based approaches allow health workers to reach people in need of care in their homes and to provide a kind of psychosocial support that may be absent in clinic-based care. Community health workers are thus in a strong position to promote preventive care, give guidance to primary care givers, encourage safe pregnancy, and refer ill people for diagnosis and treatment at appropriate facilities. Several studies have demonstrated the benefits of CHWs, including reductions of 30-50% of infant mortality in low-income countries (Darmstadt, 2005; Baqui *et. al.*, 2008; Kumar *et. al.*, 2008).

However, there are many challenges to deploying community-based interventions. Community health workers are themselves difficult to organize and manage for the same reason they are so effective: they live and work in the communities they serve. This decentralized positioning of CHWs means they may rarely see their home office or supervisors and receive little day-to-day management. Furthermore, successful implementation requires that the outreach efforts are

properly supervised and are coordinated with other service delivery efforts. Additionally, it is crucial to analyze and monitor the activities and data of the outreach workers to assess and improve the overall performance of the program.

We are developing CommCare for community health programs to use in addressing some of these issues. The CHWs can use CommCare to help plan their day, manage household visits, and report their data. The community health program managers can use CommCare to receive real-time data, compile reports, and to keep track of work in the field. CommCare provides medical decision support to CHWs (for example, prompting a referral to the health clinic if the patient reports certain symptoms), enables feedback loops for supervision and process improvement, and taps into the tremendous potential for community-based health surveillance. The CommCare software is open source J2ME code that can run on a wide range of Java-enabled phones. It is an extension to the JavaROSA codebase (code.javarosa.org), which is being used to support many different mobile health and data collection applications in low-income countries.

Our implementing partner on CommCare in Tanzania is Pathfinder International, an international non-profit health organization working in Latin America, Africa and Asia. Pathfinder has a strong emphasis on community-based approaches and works extensively in underserved areas (both rural and urban). In Tanzania, Pathfinder oversees about 2,000 volunteer CHWs who receive a small travel allowance for a monthly meeting. Each CHW typically has 5 to 15 patients they are responsible for, meaning the program serves roughly 20,000 clients. The CHWs are expected to visit every client at least once a month, though may visit much more often if the patient requires or requests it. The CHWs serve their clients through several activities, including identifying people who are seriously sick and referring them for care at a health facility, training the people who are living with HIV/AIDS patients on how to care for the clients at home, strengthening peer support systems, and counseling the clients about the challenges they face. Sometimes the CHW may even help their clients with chores, such as cleaning the house and cooking meals.

The CHWs refer clients for various clinical services, such as testing for TB, HIV and malaria, or to Prevention of Mother to Child Transmission (PMTCT) services for pregnant woman. For some referrals, the CHW requests the client to go to the clinic or hospital immediately and they are given a paper referral form for the clinician to review and sign. The client or their care taker is supposed show the signed receipt from the clinician to the CHW to confirm that the referral was completed. If they do not report back, the CHW should follow up with the client and encourage them again to seek care if they have not already. The CHWs can also refer for social services at non-clinical facilities.

Features of the CommCare Application

The CommCare application for Pathfinder's community health workers (developed over the course of several months in the Dar es Salaam area of Tanzania) starts with a login screen. After logging in, the CHW is able to select from five different activities: fill in the Pathfinder household visit questionnaire, register a new client, view uncompleted referrals, review their previous seven days worth of work and send all unsent data to the server. As shown in Figure 1, if the CHW chooses to fill in the Pathfinder Follow-up form, they are asked questions one at a time and can answer them using the phone's keypad. The phone then displays the input as they move to the next question and the CHW can easily go back to change an incorrect answer. The

questions in the Pathfinder Follow-up form cover the data elements required by Pathfinder, including whether or not the CHW referred the client for clinical services.

Figure 1 Choosing a client and then answering the questions in the Follow Up Form (shown in English and Swahili)

If the client is referred to a facility for a particular health issue, then the CHW should track the referral until the client gets the care they need. CHWs can use CommCare to view all uncompleted referrals. As shown in Figure 2, the CHW can choose "Show uncompleted referrals" from the main menu and then would be shown the list of referrals that need to be completed. The CHW can select one and then is asked a few questions, including if it was resolved, and if they have seen the signed doctor receipt or only received verbal confirmation. If they indicate the referral was completed, then it would not show up the next time the CHW viewed the uncompleted referrals list.

Figure 2 Logging into CommCare, and checking for uncompleted referrals.

Rapid Iterative Development Methodology

The CommCare application was developed in rapid iterative cycles working closely with five CHWs over the course of several months in Tanzania. The technical team first generated a very simple system that allowed all of the home visit information that was normally recorded on paper to now be filled out by the CHW on a mobile phone. The technical team met regularly with the CHWs and quickly made changes to the electronic form based on their feedback. By making the requested changes promptly, they were able to engage the CHWs who could see that their input was being incorporated into the application and that CommCare was becoming a system that really served their needs.

During the process, is seemed very important to make the simple changes that the health workers were requesting quickly so that they were able to see that their suggestions were being taken seriously. This type of investment by the CHWs helped lead us to a product that they were happy with and felt a sense of ownership over. Often the changes were very simple (like moving from a grid format to a list format for the menus), but resulted in increased usability for the CHWs. Before adding complicated features for tracking referrals, the technical team storyboarded (see Figure 3) how the features might work using paper drawings of the phone screen. The CHWs then provided valuable feedback about the workflow, including requesting that we omit client names on the client list to increase privacy. This cooperative, iterative development process helped us come up with a CommCare system that serves the needs as well as the preferences of the CHWs, while still providing all the functions that Pathfinder needs for data collection, management and supervision.

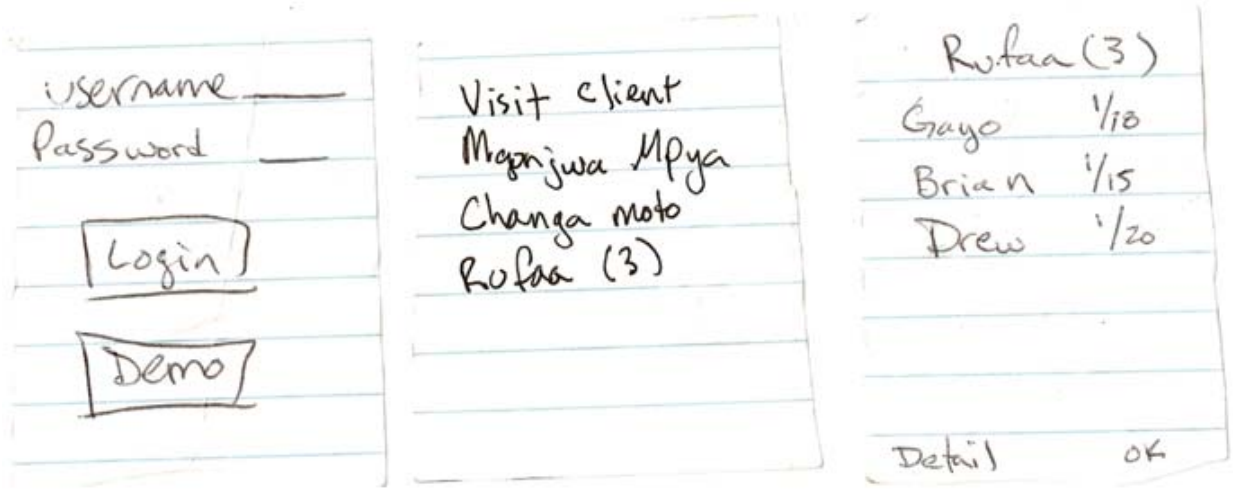

Figure 3 Paper Prototype Used to Design Referral Functions with CHWs

Training Process and Lessons Learned

We worked with a group of five CHWs for the first training on how to use CommCare. The models of phones we used during the development phase (Nokia 3110c, Nokia 3500c and Nokia 6085) were more expensive (about US$120 locally) and had more features than phones typical to the area, so the training included careful instructions on how to use the phone, starting with how to turn it on and off. Our trainer also wrote a step-by-step, two-page guide in Swahili about how

to use the telephone and how to navigate the CommCare application. The initial training for the simplest version of CommCare took about two hours of group instruction. This included introducing the phone model and its various functionalities, as well as going through the simple training manual. This was followed by about 30 minutes in which the CHWs worked in pairs to practice the use of the system. The team work portion of the training helped the trainer to identify who was learning quickly and who was learning slowly, so he was able to focus his attention appropriately. One approach was then to pair the CHWs who understood the program easily with CHW who were having a harder time with the application. Additionally, about two hours were spent on follow up visits with each CHW. A trainer went with each CHW during a routine home visit to observe how the CHW interacted with clients and make sure he or she was using CommCare correctly.

During the study time, the CHWs conducted a total of 52 visits using CommCare. During the 52 visits, there were two hardware problems and five software or system problems. Two of the three hardware problems involved charging the phone. Since none of the five CHWs involved in the first training had electricity in their homes, they would occasionally pay 20 US cents (provided by us) to charge the phone at a community charging point. In one case, the original Nokia battery was switched at the charging station during charging with a non-functional battery. From this we learned to mark the batteries and have the CHWs check them upon retrieving from a charging station. We are also testing several kinds of solar-powered and hand-crank chargers as alternatives to using the charging station. In a second case, a CHW went to a visit with a small charge left on the phone that she hoped would be enough. However, during the visit, the charge ran out and the system shut down. There were four problems in which the CHW could not log in, but once corrected early in the development period, these problems did not recur.

There was one other problem in which a client refused to allow the CHW to use the phone when she saw the CHW had a different phone than was used at the previous visit. During this development period, we were testing several models of phones to find the one with the best functionality for the CHWs, so the health worker was trying a new model. This client's concern was that private health information collected on a different telephone might be accessible to someone else. We explained that the data has been securely transferred to the new phone and was accessible only by entering the CHW's password, but to respect the client's wishes, the CHW did not use the telephone for the visit. This was an important lesson in understanding client perceptions of the system.

Comparison to Paper-based System

From the initial observations, it seems clear that CommCare will save time and result in faster and more accurate reporting than the paper-based system. On average it took the CHWs two minutes and 10 seconds to fill a form on the phone. This is probably about the same as with the paper-based approach. However, the CHWs spend a substantial amount of time completing aggregate monthly forms, which can be tedious and time consuming. The process involves manual calculation and transcription, and there are a number of points where errors can be introduced (for example, forgetting to ask all questions, forgetting answers before recording them, or errors in aggregating the visits). The CHWs report spending at least four hours each month compiling reports, which are later turned into supervisors and manually entered into the database. We expect to completely eliminate the time required for compiling monthly reports once CommCare is fully operational. We will be able to send the data directly from the phone to

the server using GPRS after each encounter, and then automatically compile the reports from the data received.

Qualitative interviews were conducted with seven clients whom had been visited by CHWs using CommCare. Six of the respondents recalled having been visited more than three times and one client has been visited once by CHW using CommCare. Overall, the clients spoke positively of the phone-based system and the results suggest there are no serious client concerns with using CommCare. The phones were seen by the clients interviewed as better for privacy than paper records, given that they are more discreet than paper notebooks and that information cannot be as easily read off of phones as paper. One person mentioned that having a telephone on a home visit is much less conspicuous than a health worker who comes with a big notebook to visit, which has implications for patients who wish to maintain privacy about the care they are receiving in the home. They also saw the phone-based system as advantageous because the records are not as vulnerable to destruction (by rain or even by children who might come across the notebooks in their homes). When asked which they preferred, three clients said they preferred the phone-based system and four had no preference either way.

Conclusions

This experience of developing and piloting CommCare in Tanzania has reinforced several lessons. First, simplicity is paramount. We took a conservative approach and restrained from adding in too many complex features. We believe that this helped lead to a system that the CHWs are able to use quickly and easily and indeed is based on the specific functions they request, rather than making a product that tries to do it all. Additionally, it is impossible and unproductive to try to anticipate all the issues or design a perfect system before testing it in the field. We found many unexpected problems (like battery swapping) and some things we would expect to be problems (such as phone literacy or learning to navigate the program) were not.

Perhaps the most important lesson learned is to form a true partnership with the users throughout the design process. We are very grateful for the enthusiasm and effort shown by the CHW volunteers who worked with us to tailor the application to their specifications. In particular, we noticed that we got some of the best feedback from most basic users. The person who struggled the most to learn how to CommCare often helped us find ways to improve the interface and gave a great deal of interesting feedback during our sessions.

Our next steps include extending the system to work with other Community Health Programs, developing modules to support community-based safe motherhood and family planning programs, and scaling up to a larger number of users. We see the opportunity for mobile applications such as CommCare to have a positive impact on the standard of care delivered in communities as well as make community health programs easier to implement and manage.

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