Progress on Making Health Care More Accessible To Rural Communities In Waslala, Nicaragua Using Low-Cost Telecommunications

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ABSTRACT
In rural Nicaragua, access to health care professionals and medical facilities is limited. Minimally trained community health workers (CHWs) and understaffed clinical outposts serve rural communities. Rural residents rarely see a doctor except in emergencies. This can lead to situations where treatable medical conditions become life threatening. The goal of our project is to preempt such situations through: better training of CHWs; using cellular short messages (SMS) to encode and transmit basic health information such as vital signs and health symptoms into an electronic medical record (EMR) system located on a computer; monitoring of the data entering the EMR system by a doctor; and system generated notifications informing the community health worker of the appropriate response related to the inputted vital signs and symptoms. At last year’s NCIIA Open 2011 conference, we gave an overall description of the project and reported on an initial pilot phase implementation and thoughts on how to make the project sustainable. In the present paper, we provide an update on the project, issues that have arisen during implementation of the system, and further updates on our thinking regarding sustainability of the program. We also provide an important progress report regarding partnership development.

Introduction
Nicaragua is the second-poorest country in the Americas, with a nominal per capita annual income of approximately $1,000 in 2009. Long years of civil war have ravaged the country’s infrastructure and industrial capabilities. Although urban dwellers have access to doctors and hospitals, rural communities such as those surrounding the town of Waslala are served mainly by health outposts and volunteer community health workers. The health outposts are staffed by recently graduated nurses and physicians with minimal experience. The average educational level for a Nicaraguan is 3rd grade, but many of the community health workers (CHWs) in the region surrounding Waslala have not received any formal education. Furthermore, the CHWs have very few medical supplies and, at best, have received little beyond basic first-aid training. The already low ratio of doctors to population (just 1 doctor for every 2,700 people) is skewed against rural communities (U.S. Department of State 2011).

Our health care initiative targets the rural communities surrounding the town of Waslala, with a population of approximately 10,000. Waslala is located in the rugged, mountainous region of north-central Nicaragua. It is surrounded by some 85 rural communities, with a total population of approximately 45,000. The roads are largely unpaved, and some of the communities are reachable only by horseback or on foot. It takes several hours and much hardship to travel to the town’s only serving hospital. Therefore, rural dwellers avoid this journey if possible, relying largely on the community health worker that serves their particular community. Since the CHWs are minimally trained, potentially emergent medical conditions can go unnoticed for too long and CHWs may be ill-equipped to handle an emergency situation that they are potentially capable of addressing.

A practical solution to this problem is to train the CHWs to record the raw medical data in the field and to transfer it to a remotely located computer system using a mobile phone. By choosing to transfer the medical data over the short messaging system (SMS), the ongoing operational costs of this tele-health program are minimized. Once the raw medical data is transferred to the remote computer, a health care professional can review the data and address any concerns directly with the CHW. Finally, in a region where medical (and even birth-
death) records are rather sparse, the system provides an opportunity to record not only individual medical histories, but also statistical data on the large population. In our initial phase of the program, we will generate census information for each community and use the system to collect birth-death records and the tracking of health indicators for pregnant women and their newborn children through the child’s first two years of life. This modest first effort addresses one of the UN’s Millennium Development Goals related to maternal and child health. Furthermore, this will provide essential baseline data and will provide the building blocks for goal-setting and extending the program throughout the region.

In order for a human development project to create a real and measurable impact, it must be scalable. Scalability is rooted not only in sound design and engineering, but also in good economics. Thus, unless such a project can somehow meet its own operational and maintenance costs, it is not sustainable.

Finally, any such initiative must meet the needs of the community itself and gain its acceptance. A close relationship with the community and its leaders is essential. For eight years, Villanova University Colleges of Engineering and Nursing have partnered with the local Catholic parish in Waslala to design and implement water-related engineering systems and to conduct community health education programs for the CHWs. For this reason, we chose to work in the communities around Waslala with the Catholic parish as our main partner.

Project Dimensions
This tele-health project has challenges in three dimensions:

- Health component (including the social and cultural aspects)
- Technology component and affiliated challenges
- Business model and sustainability

The first dimension is the human component in enhancing the effectiveness of the CHWs. Here, the nurses and CHWs play a significant role in 1) understanding the local situation, customs, and attitudes toward health care, 2) identifying in-field effective health care approaches, 3) training CHWs in basic health assessments and response to health findings, 4) identifying the supplies required to meet a minimal standard of preventive care and treatment of simple ailments, and 5) identifying health priorities and health indicators to measure.

The second dimension involves the use of readily available technology to transmit a patient’s medical data and to automate much of the simple diagnostics and long term monitoring. The primary motivation to do so is the acute shortage of trained manpower to handle tasks that are routinely performed by nurses and other medical personnel in developed countries. This then becomes an engineering and system design task.

The third dimension is the business side of the system, which is essential if the system is to be economically sustainable. Without a viable business model, such a system would be eternally dependent on its “foreign benefactors.” We hope to not only put a viable system in place, but to also undertake to train community members in running their own system in order to gradually build up their skill set, create a new means of livelihood, and to foster an entrepreneurial attitude and financial literacy.

These three dimensions of the project are currently being managed through an interdisciplinary team of collaborators from the College of Nursing, the College of Engineering, and the School of Business. These three dimensions of the project were described in detail in our last NCIIA paper (Singh et al. 2011). In the next section, we will provide our progress in all three of these dimensions.

Update on Pilot Phase Implementation
Our initial visit to Waslala for this project took place in May 2010, when an interdisciplinary team of students and faculty from all three colleges made an assessment trip. Seven CHWs were interviewed to determine the health needs for their communities and the resources they needed to do their work. The technology assessment included studying the availability of cell phone signals in rural communities, as well as power reliability and internet access in the town of Waslala. The business assessment focused on visiting two microfinance institutions in Waslala and learning more about how money flows in the rural communities surrounding the town. The team also learned about the cultural relationship between people and money in the region.

In subsequent trips made in October 2010, March 2011, May 2011, and October 2011 we provided supplies (including a backpack, blood pressure cuff, stethoscope, thermometer, tape measure, binder and notepad, and pen) to record information manually on charts, prior to texting the information to CHWs. In addition, the CHWs were provided with locally purchased boots so that they could walk safely in their communities to visit patients, particularly in the muddy terrain prevalent in the rainy season. The CHWs were trained to make accurate blood pressure measurements using their newly acquired equipment and to measure pulse, temperature, and respiration. They were also trained to measure and document infants’ and children’s height and weight. Five CHWs were selected to be the pilot group for initial testing of the system. The criteria used to select the initial trial participants included quality of cell coverage in CHW’s service area and their capability to learn quickly and retain the health assessment data, and whether they had an active pharmaceutical enterprise. They were provided with basic cell phones that were purchased in Managua. Funding to allow 100 SMS messages to be sent per day was also provided to the CHW. Each CHW who received a phone was also provided a portable solar charging unit to charge their cell phones. Instruction manuals were prepared in Spanish to teach users how to format and text health data. A double-sided language instruction “cheat sheet” for the texting commands, along with a video for training new CHWs, were also brought to Nicaragua on our last visit in October 2011.

Technical details of the computer hardware, software, and communications system implementation were provided in reference (Singh et al. 2011). In summary, the design philosophy emphasized hardware reliability and low power consumption. Thus, we selected a ultra-small form factor Dell computer with a 10GB hard drive and a 50!W solar panel. We chose Linux as the operating system and MySQL as the database software, since they are both open source. In addition to being free (and thus saving substantially on licensing costs), these software components are also mostly resistant to acquiring computer viruses. The cellular system connectivity was provided by a rugged industrial quality modem connected to the serial port of the computer.

When we originally set up the computer, we used the Parish’s satellite internet connection for communicating with the computer from a remote site. However, the Parish recently discontinued their internet service because it had become too expensive to run. We acquired a local cellular modem from the local telecommunications company (Claro) to obtain internet access and will use that for remote access to the computer. Another issue that arose was the lack of sufficient backup power for the computer. This past summer, the power outages were particularly severe. Typically, power was out for 2½ days. We planned to increase the size of the backup power system to include two 7.5Ah lead acid batteries in series being recharged by a 500W solar panel. This should give us over 3 days of autonomy for the computer. We are also considering setting up a redundant computer system in Matagalpa, located about 100 km from Waslala but having a more reliable electrical supply that can be backed up by a standard uninterruptible power supply (UPS) system.

Another issue that is still a problem is network reliability. Messages often accumulate without being sent out over the network. Eventually, the messages do get sent out, but it can be disconcerting to the CHW if they do not receive an acknowledgement for the text sent in. We are training the CHWs to realize that this may happen periodically.

The business model development is progressing more slowly, but we are making headway. Two options are being considered at this point. The first is to demonstrate the project’s viability and have it take it over by the Ministry of Health (MoH). We have been in discussion with the MoH in Nicaragua and they have expressed an interest in the program. The problem with this approach is that the MoH is already under-funded and we are afraid that this program could lose its effectiveness if not properly funded.

The other approach that we are considering is to make our tele-health system part of a larger system that delivers services to the target population. If that larger system had its own capacity to generate funds, the tele-health program could survive as an ‘add on’ to the existing services. We met with representatives of such an organization (Pro Mujer) in May 2011. It is a microfinance organization focused on women that delivers substantial social services, in addition to encouraging savings. We are in the process of discussions with this organization to see how our systems could become another service they would provide.

Partnerships
A major effort over the last year has gone into developing local capacity to support this program. The periodic visits of Villanova students and faculty to Waslala are useful in that they maintain a strong connection between Villanova and the Waslala community. CHW. However, these visits are not frequent enough to move the project along effectively. We have therefore hired staff in Waslala, including a project manager, a technical support person, a nursing student to go out to the communities to work with the CHWs, and a part-time doctor to review the medical records. They are all hired through the Parish health program.

We have also developed a partnership with the local telecommunications company, Claro. The company has donated 20 cell phones, a cell phone modem for internet connection, and three smart phones for remote access to the computer for our project. We are still trying to work on obtaining donation of air time services from the company.

To provide more frequent training of CHWs, and particularly to have trained personnel to go out to the communities to conduct more one-on-one training and health assessments, we have established links with the nursing schools in Waslala and Matagalpa, the closest major town to Waslala. When we initially visited the nursing school in Matagalpa (UNAN) on our May 2011 trip, we talked to the director of the nursing program and several students, including a student from Waslala. The student, Yolanda, was so inspired by our discussion that she immediately packed her bags and joined us on the trip to Waslala! She contributed very impressively to our training workshops with
the CHWs, giving us a lot of confidence that we could get good support for conducting training workshops for the CHWs in our absence. Four nursing students from UNAN Matagalpa went up to Waslala in August 2011 to conduct a workshop for the CHWs, which was orga-
nized by our program manager following discussions over Skype during the summer. The same four nursing students and the director of the nursing program joined us on our trip to Waslala in October 2011, and again were very important contributors to the program.

We have also partnered with the Universidad Nacional d'Ingeniera (UNI), the National Engineering School in Managua. This is the major engineering school in Nicaragua and we have had ongoing discussions with them for the last two years. We visited them on our trips: in May 2010 and October 2010. One of the authors (PS) taught a class in their Master's in Renewable Energy program in February 2011 and representatives from UNI, including the Rector, came to Villanova University to sign a Memorandum of Agreement for cooperation between Villanova and UNI. A professor and student from UNI accompanied us on the trips to Waslala in May 2011 and October 2011. They were very helpful in providing good engineering technical support as well as translation for the CHWs. They were able to also provide cultural insights that we were not able to discern on our own.

As mentioned earlier, we have had several discussions with the organization Pro Mujer, which has a number of offices in Nicaragua as well as several other Central American countries. On our May 2011 trip, we met with the country director, Gloria Ruiz, as well as the director of the newly opened Matagalpa office. Pro Mujer is a microfinance institution that supports female entrepreneurs but also offers health services to women. We had discussions over the summer with one of the founders of Pro Mujer, Lynne Patterson, and their newly hired director of women's health services, Gabriella Salvador. There was real interest on their part in potentially teaming up with us on some of our work, because of the synergies between our activities. We are in the process of discussing the best ways that we may be able to col-
laborate.

Conclusions
We have made significant progress on our tele-health project over the past year. We have equipped five CHWs with medical equipment and cell phones and spent significant time working with them to reliably measure and record vital signs and transmit that data via text messaging to an electronic medical record system housed in a computer in Waslala. We have resolved some of the infrastructure prob-
lems, including installing a solar backup power system to ensure that the computer remains operable even during extended power blackouts.

We have hired staff to oversee the project work and have partnered with both nursing and engineering schools in Nicaragua to provide support to the program. Our initial engagement with students and faculty from these universities has been extremely positive. Building this local capacity is critical to the long-term sustainability of the program.

We have entered discussions with the Ministry of Health in Nicaragua and are in the process of signing a Memorandum of Agreement with them. We have also started discussions with a local NGO, Pro Mujer, to see how we may be able to link up with them by piggy backing our tele-health program onto their women’s microfinance and health programs. Since Pro Mujer has offices throughout Central America, this approach could provide us with an opportunity to expand our tele-health program into other Central American countries.

In our next phase, we plan to equip another ten CHWs with cell phones and solar chargers so that they can contribute to the data collec-
tion. We expect to have these CHWs equipped by the end of this year. These CHWs have already attended training sessions. However, with some of the technical problems that we have been having with power and communications (and most recently, the computer stopped working?) we did not want to expand the pilot phase until we had a robust, working system. Another training program is being organized for the CHWs in December and will be conducted by our in-country staff as well as our new nursing and engineering colleagues from the universities in Nicaragua.

While much progress has been made over the past year, many challenges still remain. There are still significant technical and cultural issues that need to be overcome. However, we remain confident that we can substantially improve the health of community members in underserved communities in Nicaragua through the use of low-cost, cell-phone based technology.

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