EXPERTS

mHealth Basics and Human Scalability

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Introduction

The World Health Organization estimates that 57 countries in the developing world face a collective shortfall of 4.3 million health care workers. Thirty-six of these countries are in sub- Saharan Africa[1] and Malawi, a land-locked nation in southeastern Africa, exemplifies this shortage. Malawi has a population of approximately 14 million, and has only 1.1 doctors and 56.4 nurses per 100,000 people.[2] Within Malawi, statistics concerning geographic disparities in access to health services paint an even bleaker picture. In 2007, 50 percent of physicians and 25 percent of nurses in Malawi were located in the four central hospitals, even though 87 percent of the population was living in rural areas.[3] Infrastructural shortcomings that characterize developing economies are most severe in rural areas; thus, most Malawian hospitals serve populations that are distributed across large catchment areas with patients who travel primarily by foot or bicycle.

In response to these infrastructure and geographic circumstances, many organizations supplement facility-based health services with community-based services. A substantial body of literature has demonstrated the utility of community health workers (CHWs), locals recruited from surrounding villages and trained to provide basic services and act as intermediaries between health care facilities and the community.[4] Some are employed but many are volunteers; they are subsistence farmers, retired schoolteachers, and former and current patients—laypeople who have chosen to serve their communities. Although they can improve overall patient-clinician accessibility, they are often as disconnected from health facilities as the communities they serve. Great distances and a general lack of transportation limit CHW's ability to obtain health care advice, distribute medical supplies, or access timely emergency services.

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Mobile telecommunications infrastructure

Although penetration of information communication technologies in Africa generally lags far behind the rest of the world, the continent has the highest rate of growth in mobile phone penetration, increasing from 5 percent in 2003 to well over 30 percent penetration in 2009.[5] The International Telecommunications Union recently estimated that 93 percent of the population of Malawi has access to mobile network, and 12.5 out of every 100 Malawians owns a phone.[5]

This explosive growth in mobile telephony is undergirded by several kinds of physical and human infrastructure. Access to electricity is an often overlooked barrier to using mobile phones in Africa. Few Malawians have access to grid electricity in their homes and yet a majority of the population uses mobile phones at least occasionally. The gap is explained by grass roots entrepreneurs that bring off-grid electricity to remote communities all over Malawi and the region, often by charging car batteries in cities, carrying them to villages, and connecting them to surge protectors which can charge many phones. Effectively distributing pre-paid airtime has also played a critical role in enabling mobile telephony to spread. In Malawi over 99 percent of mobile phone subscriptions are pre-paid[5] and purchased from airtime vendors that can be found in shops, sitting at plastic tables on street corners, or walking through streets, markets, and bus stops waiving packs of airtime vouchers.

Case Study, mHealth in Malawi

St. Gabriel's is a rural hospital that provides care to over 250,000 Malawians, the majority of whom are subsistence farmers living on less than one dollar per day, spread throughout a catchment area over 100 miles in diameter. To provide services in the dif-

ficult circumstances seen throughout Malawi and the region, St. Gabriel's enlists several hundred CHWs to support antiretroviral treatment (ART), home-based care (HBC), and tuberculosis treatment (TB). These CHWs are coordinated by an HBC nurse and a TB coordinator who use a motorbike to make regular trips from the hospital to villages. To improve communication between CHWs and hospital staff, the nonprofit organization FrontlineSMS:Medic[6] helped St. Gabriel's set up a text message-based communication network utilizing the FrontlineSMS platform.

FrontlineSMS is a free, open-source software platform that enables large-scale, short message service (SMS) communication. A computer running FrontlineSMS becomes a two-way text-messaging hub when it connects to the mobile phone network via a modem or a cell phone. To initiate the program, a group of 75 CHWs at St. Gabriel's Hospital were given Motorola Pebl cell phones. The HBC nurse led training sessions in Chichewa where groups of 10-15 CHWs were taught to use their phones and understand how the FrontlineSMS network would operate. The hospital was equipped with a mobile-network connected laptop running the FrontlineSMS software and hospital staff were trained to manage all communications within about two weeks. During the first four months of the pilot a total of 1,330 SMS messages were received at the central hub, spread across a number of use cases.[7]

Treatment adherence reports for TB and ART comprised 31.83 percent of all messages sent by CHWs. Whenever a patient missed their appointment at the clinic, health staff sent a tracking request by SMS to a CHW responsible for the patient. The CHW would visit the patient at their home and report the patient's status via SMS. Usually this return report included an expected return date, or a note explaining why the patient was unable to travel to the clinic (e.g. illness, death, or moved). This system increased the average number of monthly adherence reports from 25 to 67. Since the reports were no longer delivered by hand, the ART monitors saved approximately 900 hours of transportation time.

Before the pilot, the TB coordinator reported that he was visiting seventeen patients per week for adherence monitoring, requiring three trips approximately nine hours each. The SMS system enabled the TB coordinator to outsource these monitoring tasks to local CHWs, saving the TB coordinator a total of 648 hours of transportation time.

Immediately after receiving phones, volunteers announced their ability to communicate with the hospital to their respective village councils, and the village councils would in turn refer community members to the volunteers whenever need arose. Frequently this involved reporting emergencies to the hospital to coordinate transportation.

The HBC nurse used symptom reports to triage and coordinate his home visits. This not only eliminated unnecessary check-in visits, but it also ensured that upon arrival the CHW would be available to direct him to the patient's home (in a region where most homes lack formal addresses, the HBC nurse relied on CHWs to locate patients homes, and prior to SMS notification the HBC nurse's visits were often fruitless because the CHW was in another village and unable to guide him). The HBC nurse estimated a time savings of 500 hours as a result of this triage system.

Finally, the TB coordinator was providing care to 100 patients before the pilot, seeing seventeen per week as

AT A GLANCE*

mHealth & FrontlineSMS:Medic

- *mHealth: mobile-health*
- *FrontlineSMS: Free short message service (SMS) platform used to expedite communication between hospitals and community health workers.*
- *Required devices: mobile-network equipped laptop running FrontlineSMS and text-enabled cell phones*
- *Case study: During four-month trial in rural Malawi, saved 2,048 worker hours and $3,000 in fuel costs*

Community health workers at St. Gabriel's Hospital in Malawi use mobile phones as part of FrontlineSMS:Medic's mHealth program.

Photo courtesy of Frontline:SMS

noted above. With the free time that he gained during the pilot, he was able manage care for more patients as well as work with CHWs to report TB associated symptoms via SMS. This SMS referral system enabled the program to enroll an additional 100 patients, effectively doubling the size of the hospital's TB treatment program.

St. Gabriel's provides basic medicine kits for their CHWs to keep and use in the villages. Previously the kits were restocked quarterly and stock outs were common because the hospital lacked information about which supplies needed to be replenished and where. When CHWs began using SMS to notify the hospital of stock outs, staff were able to deliver supplies during regular field visits. We did not measure a baseline of stock outs prior to the SMS program, but CHWs and the HBC nurse reported a qualitative reduction in stock outs and the amount of time spent walking to the hospital to request necessary supplies.

Human scalability

In the case study above, a rural Malawian hospital saved an estimated total of 2,048 worker hours and about $3,000 in motorcycle fuel over a four-month period. This trend is apparent in most of FrontlineSMS:Medic's projects: saving time is perhaps the most valued consequence of communication technologies for overburdened health workers. Time efficiency aligns the agendas of frontline health workers and health system administrators, a chimeric and overlooked necessity in global health IT.[8] Unfortunately, most discussions of scalability in the global health IT community still revolve around theoretical load bearing capacity (e.g. how many milliseconds slower would the page refresh be if the system contained one million patient records and needed to send ten thousand messages per day?). In contrast, we find that the proliferation and impact of health IT programs are more frequently limited by the speed and ease with which ordinary health workers can appropriate a new technology and make it useful in their local context.

Community health workers learn to utilize mobile phone technology as part of a FrontlineSMS:Medic project in Malawi.

Ordinary CHWs usually prefer learning from their peers, rather than asking questions of the medical hierarchy. These peers include other minimally trained health workers, family and friends, and vendors of electricity and airtime. Only about one in five of the St. Gabriel's CHWs had used a mobile phone extensively prior to this program, yet they were well aware of low-cost mobile phones and SMS being used in their communities. For tasks that were already common in the community, such as basic phone use, charging phones, using airtime, and sending SMS, we found that CHWs preferred to learn from their peers rather than the hospital. This may be due to the difficulty of traveling to the hospital and/or due to a culture that de-emphasizes self-advocacy directed at people of a higher social position (i.e. hospital staff). Our experience with smart phones, Internet over the mobile phone network etc., is that CHWs have fewer opportunities to continue learning in their communities, so they often require more time and follow-up training from hospital staff. This extra training can offset the time savings described above. Potential initiators of mHealth programs should consider which specific technologies are prevalent in the communities where they work, who currently employs those technologies, and whether CHWs are likely to access free assistance.

Health facilities throughout Africa are understaffed; staff receive small salaries relative to the extended family they often support, and even those with impeccable work ethic find it difficult to manage the expected case load. In this context, extensive training, which does not pay, is seen as an unwise use of time. In contrast, health workers seek financially compensated trainings to supplement their salaries, and too often succumb to the financial incentive to not retain training material, and therefore require additional trainings (with additional money stipends for each training). Whether compensated or not, trainings become more efficient and less onerous when they focus on technologies and practices which comprise the everyday lives of ordinary health workers. Throughout Malawi and much of Africa, the vast majority of salaried health workers own a phone and can teach others the basics of phone maintenance, SMS and voice communication. Most district level and many smaller facilities have at least one employee who is familiar with computer use, but familiarity with Internet applications varies widely and is much less com-

mon in Malawi. A simple mHealth system can enable health workers to institutionalize skills with which they are already familiar. Trainings which redirect or sequentially build on existing skills tend to be shorter, and are more likely to ignite creative participation and ownership than training material which is so foreign that it must be learned by rote rather than being appropriated and adapted to pre-existing technological customs.

These considerations apply mainly to programs that revolve around ordinary health workers and are willing to accommodate human and programmatic imperfections in order to harvest low-hanging fruit. This approach is optional for many research projects and smaller health programs which receive a higher-than-ordinary level of funding and expertise per patient served, but it is necessary for regional or national programs which, due to their scale, must rely on ordinary human and financial resources. The inefficiency and poor coordination, which are ubiquitous across the African continent, are matters of communication as much as data acquisition, and they will be addressed largely by Africans employing technologies with which they are proficient. Wherever we experts wish for our solidarity to help ordinary Africans solve their own problems, an awareness of everyday technologies and their many uses should be the primary factor which helps us understand when and how to keep mHealth simple. ■

Footnotes & References

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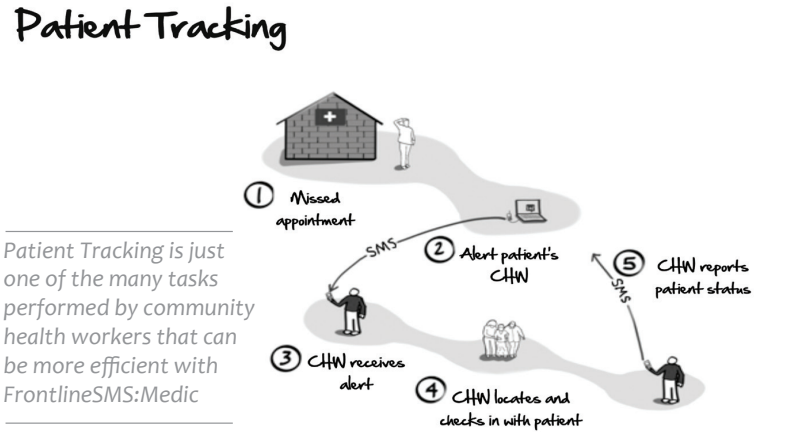
**AT A GLANCE: mHealth & FrontlineSMS:Medic* content compiled by Florence On



Patient Tracking is just one of the many tasks performed by community health workers that can be more efficient with FrontlineSMS:Medic

Community health workers learn to utilize mobile phone technology as part of a FrontlineSMS:Medic project in Malawi.

Photo courtesy of Frontline:SMS

Author Bios

Josh Nesbit and Isaac Holeman are cofounders of FrontlineSMS:Medic, a nonprofit organization using low-cost, mobile technology to create connected, coordinated health systems that save more lives. Since founding Medic during the fourth year of their bachelors programs, Isaac and Josh have led the organization to produce three software projects and leverage existing open source software with 18 organizations in 10 countries. Collectively these projects involve over 1,500 health workers who serve approximately 3.5 million patients. FrontlineSMS:Medic's work has been covered by a variety of news outlets including The Economist, CNN, The Discovery Channel, Reuters, and The Guardian.

Josh Nesbit is FrontlineSMS:Medic's Executive Director, based in Washington DC. As an international health and bioethics student at Stanford, his qualitative research focused on access to pediatric HIV/AIDS treatment. Josh has implemented text message networks in Malawi, Uganda, and Cameroon, advising ICT development projects in more than 15 countries. After the 2010 earthquake in Haiti, he helped coordinate the 4636 project, an SMS-based emergency response system. He is a PopTech Social Innovation Fellow, Echoing Green Fellow, Rainer Arnhold Fellow, Strauss Scholar, and Haas Public Service Fellow. Josh also received the Truman Award for Innovation from the Society for International Development and was recently named in the Devex inaugural list of 'top 40 international development leaders under 40 years of age.'

Isaac Holeman is FrontlineSMS:Medic's Director of Strategy. While studying biochemistry and molecular biology at Lewis & Clark, Isaac conducted honors thesis research in ribosome biogenesis and was named a Pamplin Fellow, the highest honor Lewis & Clark awards its students. With a suitcase as head quarters, Isaac travels throughout East Africa to oversee the organization's key program areas of research, product development, and implementation, ensuring that each area is in tune with the bigger picture for health systems strengthening as well as the local contexts of the places Medic works. Isaac is an Echoing Green and a 2009 Compton Mentor fellow. His research interests revolve around the social circumstances and technology that influence changing means of subsistence in low-income communities.