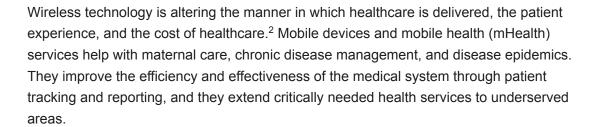# Using mobile technology to improve maternal health and fight Ebola: a case study of mobile innovation in nigeria

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## EXECUTIVE SUMMARY

Mobile is a rapidly growing area. According to a Boston Consulting Group report, this industry has created 11 million jobs and generated $3.3 trillion in global revenues.[1] The utilization of smart phones, tablets, and 3G and 4G networks has transformed communications, commerce, entertainment and other business sectors.

Wireless technology is altering the manner in which healthcare is delivered, the patient experience, and the cost of healthcare.[2] Mobile devices and mobile health (mHealth) services help with maternal care, chronic disease management, and disease epidemics. They improve the efficiency and effectiveness of the medical system through patient tracking and reporting, and they extend critically needed health services to underserved areas.

The virtues of mobile are especially apparent in emerging countries. In many places around the world, there has been an explosion of mobile apps, remote monitoring devices, and online instructional materials. This has brought new information to health workers such as midwives who are on the frontlines of care and aiding rural populations who need medical treatment and advice.

In this report, I examine mHealth applications in Africa. In particular, I focus on Nigeria, Liberia, and Sierra Leone and take a brief look at other innovations occurring in the North African country of Morocco. I look at how mobile technologies have improved maternal healthcare and helped deal with disease outbreaks.

As you will see, mobile devices have brought needed medical expertise to frontline health workers, systematized the compilation of patient information, tracked the spread of epidemics, and boosted disease training, diagnosis, and treatment. The bottom line is that

mobile solutions represent a valuable way to improve patient treatment and public health reporting in the developing world.

## IMPROVING MATERNAL HEALTH THROUGH MOBILE TECHNOLOGY

Maternal health problems pose a major challenge in many nations. Table 1 shows the numbers for selected countries. In Sierra Leone, for example, 1,100 women die from pregnancy-related causes for each 100,000 live births. This compares to 560 in Nigeria, 640 in Liberia, 400 in Kenya, and 28 in the United States.[3]

| TABLE 1 MATERNAL MORTALITY IN SELECTED NATIONS, 2013 | |
|---|---|
| United States | 28 |
| Kenya | 400 |
| Nigeria | 560 |
| Liberia | 640 |
| Sierra Leone | 1,100 |
| Source: World Bank, "Maternal Mortality Ratio (per 100,000 Live Births)", 2015. | |

According to the World Health Organization, 99 percent of all maternal deaths take place in the developing world. Globally, approximately 289,000 women died from childbirth or pregnancy in 2013.[4] Many of these fatalities could have been prevented through better medical care. Those who die or suffer unnecessary complications often do so as a result of high blood pressure, severe bleeding, infections, blood clots, or obstructed labor.

Many countries also experience high levels of infant mortality. The rate in Sierra Leone is 107 for every 1,000 live births, while it is 74 in Nigeria, 54 in Liberia, and 48 in Kenya. In contrast, the United States has 6 infant deaths for every 1,000 live births (see Table 2).[5]

| TABLE 2 INFANT MORTALITY IN SELECTED NATIONS, 2013 | |
|---|---|
| United States | 6 |
| Kenya | 48 |
| Liberia | 54 |
| Nigeria | 74 |
| Sierra Leone | 107 |
| Source: World Bank, "Infant Mortality Rates (per 1,000 Live Births)", 2015. | |

There are a number of ways in which advanced mobile technologies can help improve maternal care and aid in reducing infant mortality. They can strengthen training of medical workers by providing access to accurate and current information regarding health conditions and treatment as well as the latest ideas on treating particular problems.[6] Having this access allows frontline health workers to handle various illnesses and understand where to go when they require additional healthcare information.

From a clinical standpoint, mobile devices can empower patients. Individuals no longer need to visit doctors' offices to be reminded to take medication. Instead, mobile devices allow patients to receive personal reminders via e-mail, automated phone calls, or text messages.

## EXAMPLES OF mHEALTH INNOVATIONS

Mobile Midwife and Text4Baby are examples of innovative mHealth programs in the developing world. Now being deployed by the Grameen Foundation (http://www.grameenfoundation.org/press-releases/grameen-foundation-and-babycenter-join-forces-support-mobile-healthcare-initiatives-d), this program uses mobile phones to deliver weekly calls to pregnant women regarding fetal healthcare.[7] The program aims to promote healthy pregnancies by encouraging women to seek prenatal care, debunking myths about pregnancy and childbirth and offering advice on topics such as delivery, breastfeeding, immunization, and good nutrition. Women also receive tips on avoiding malaria and managing pregnancy-related costs.

Findings show that these types of mHealth programs are garnering positive results. An estimated 281,000 new mothers signed up for the Text4Baby service.[8] Researchers in China have found that "text message and telephone reminders improved appointment attendance by 7 percent".[9] And in Malaysia, nonattendance dropped by 40 percent among new mothers who received text reminders of their medical appointments.

Mobile communication can aid in providing fast and accurate access to care. Consider that every day around the world 800 women die from preventable causes related to pregnancy and childbirth. Of those deaths, 40 percent are due to injuries or conditions related to placenta complications which can be detected through an ultrasound.[10]

The Mobile Ultrasound Patrol program in Morocco uses portable ultrasound machines and 3G smartphones to improve diagnostic times for expectant mothers. Implemented in cooperation with Qualcomm's Wireless Reach initiative, this program works with rural clinics throughout Morocco, providing doctors and nurses with backpacks containing devices that are wirelessly connected to maternal health specialists in urban hospital clinics.

This program aids in ensuring far-reaching, high-quality diagnostics and reduced the turnaround time for diagnosis from two weeks to less than 24 hours.[11] Having timely medical information aided healthcare providers in identifying high-risk pregnancies and reduced the number of at-home births—the most risky kind of delivery—in the developing world.

In Bangladesh, maternal mortality is declining. However, with at least 322 maternal deaths per 100,000 births, the country still has one of the highest maternal mortality ratios in the world and the highest in South Asia.[12] Neonatal deaths comprise more than half (57 percent) of fatalities under the age of five.

In response, doctors in Bangladesh launched the Mobiles4Health initiative. This program uses mobile phones to provide pregnant women with information about how to take care of themselves, early warning signs of possible infant problems, the benefits of family planning, and breast feeding best practices.[13]

## HOW mHEALTH BENEFITS MEDICAL CARE

A review of 25 studies on voice and text message interventions in healthcare management found significant benefits. In examining research on medical reminders sent to 38,060 individuals, researchers documented improvements "in compliance with medicine taking, asthma symptoms, stress levels, smoking quit rates, and self-efficacy. Process improvements were reported in lower failed appointments, quicker diagnosis and treatment, and improving teaching and training."[14]

Mobile benefits extend to workplace efficiency. A study of the U.S. wireless industry by Roger Entner found that mobile devices improve worker productivity in several ways: 1) reducing unproductive travel time, 2) improving logistics, 3) enabling faster decision-making, and 4) empowering small businesses and improving communications. Entner estimated that the wireless industry increased productivity by $33 billion in 2011 alone. One-third of this gain ($11.2 billion) came from the medical area. His research projects productivity gains of $305.1 billion over the next 10 years in medicine.[15]

An analysis of evaluation studies of mobile devices and physician practices found three benefits: 1) physicians with access to mobile devices responded more promptly to reading medical test results, 2) there were fewer errors in medication prescription and hospital discharging, and 3) doctors showed improved data management and record-keeping practices.[16]

Indeed, error avoidance may be one of the primary strengths of mHealth. While the use of mHealth applications is in its earliest stages and acceptance by medical practitioners has just begun, studies looking at the impact of mHealth have already begun.

For example, a U.S. study of nurses relying upon handheld devices found that 16 percent said the mobile equipment had helped them to avoid at least one error in clinical treatment while another

6 percent indicated it had enabled them to avoid errors on multiple occasions.[17] These positive findings demonstrate that mHealth has the ability to improve service delivery and save money in the process.

## CHALLENGES AND OPPORTUNITIES FOR mHEALTH IN DEVELOPING COUNTRIES

Mobile technology has great potential to impact access and quality of care, but it is not a simple or easily implemented solution for the developing world. Many countries suffer from a range of technology barriers, including lack of access to electricity which is needed to power clinical and healthcare equipment.

In addition, it is difficult to build healthcare facilities in many places. Getting construction permits and building materials can sometimes take months or longer. Some developing nations have policies designed for an industrial era, making it difficult to navigate the legal and regulatory processes for technology innovation. Decision-making is compartmentalized and fragmented among many agencies and it is difficult to develop policies that cut across departments. In these situations, it can take a long time to get regulatory approval to build health clinics and to equip them with the materials needed for modern healthcare. This slows innovation and impedes the adoption of new technologies.

At the same time, many developing countries are not as burdened by robust regulatory systems and programs. This can result in unique ways of responding to health challenges and reverse innovation whereby developing nations inform mHealth advances globally. Out of necessity, poorer countries have had to rethink processes, interventions, and overall systems and can leapfrog technologies.[18]

Implementing mobile programs requires the cooperation of technology providers, government agencies, non-profit organizations, and healthcare experts. It is typically difficult to get all these people to work together. Barriers across agencies and organizations often create a confusing maze for implementation and adoption.

Even so, many health innovators are looking to—and working in—developing countries and are promoting the use and spread of mHealth in these nations. For example, the African Partnerships for Patient Safety (APPS) is a World Health Organization effort that builds partnerships between hospitals in Africa and Europe. It has helped introduce new technology into the healthcare sector.

## A CASE STUDY ON mHEALTH IMPACT AND BENEFIT: NIGERIA

Nigeria represents an interesting example of mHealth solutions. With more than 174 million residents, Nigeria is the most populous country in Africa. Yet, it has a poverty rate of over 54

percent,[19] and the government devotes only 5.6 percent of its total budget to healthcare – well below that of other African countries.[20]

The result is that many people lack basic access to healthcare and this makes it difficult to meet the population's basic care needs. An estimated 10 percent of the world's 287,000 maternal fatalities occur annually in Nigeria.[21] The country, though, is committed to raising its healthcare expenditures to 15 percent of its annual budget. Along with other African Union countries, Nigeria signed the Abuja Declaration in 2001 pledging to increase its spending in this area. The Nigerian National Primary Health Care Development Agency (NPHCDA) has a mandate is to conduct research on communicable and non-communicable diseases of public health importance. It is working with partners to improve healthcare through a number of clinical care facilities throughout the country.

One particular area of focus is an effort to reduce maternal and infant mortality rates. A collaborative program between Qualcomm's Wireless Reach initiative and stakeholders including NPHCDA, the mobile operator Etisalat Nigeria, Evidence for Action, Vecna Technologies, through its Vecna Cares Charitable Trust and InStrat Global Health Solutions, is a current example of the positive impact mobile technology can bring to care. This program provides midwives and other healthcare workers with tablets and connectivity to capture patient medical information at the point of care and assist in the analysis and diagnosis of clinical conditions that lead to maternal and infant mortality.

Vecna Technologies is a Cambridge, Massachusetts-based company that works in Nigeria. According to co-founder and executive director Deborah Theobald, her organization provides a mobile electronic medical record system that includes information on patient medical history, health problems, and treatments. This system, called the Clinical Patient Administration Kit (CliniPAK), tracks patient care and generates reports regarding treatment and outcomes. When combined with local wireless network capability, clinicians can accurately track and report health information with patients, each other, and public health authorities.

As is true in many parts of the developing world, there is low computer literacy in many rural areas of Nigeria. "People there weren't using modern technology," Theobald noted. For this reason, the touch screen feature of tablets makes it easy for clinical workers to learn how to use the system. When asked why this mobile solution was beneficial for Nigeria, Theobald explained that health centers in Nigeria need "a product that is patient-facing and that has easy-to-use work flows."[22]

The CliniPAK system helps clinicians and health officials keep track of medical information. Its "point of care" platform has tools that document pre- and postnatal treatment, support care summaries, child welfare, immunization, and other health information. For mothers, the system covers the "full gamut from pregnancy to under five year old care," Theobald explained.

The initial response to the tablet technology has been positive. Theobald says her firm and InStrat Global Health Solutions serve 51 medical clinics in Nigeria in four different states and they have data

on over 50,000 patient visits since July 2014. Clinicians report that the mobile tools are easy to use and that most healthcare workers can be trained in less than an hour and are "self-sufficient" after several days.

Data collected from four Nigerian states during the summer of 2014 shows considerable success in providing care to expectant mothers and tracking medical information. In Ondo state, for example, 15 percent of pregnant women visited clinics in July and August 2014, during their first five months of pregnancy (see Table 3). In Anambra, the percentage varied between 14 and 24 percent. Federal Capital Territory saw treatment levels ranging from 31 to 44 percent. Kano was able to reach between 20 and 24 percent of expectant mothers.[23]

Despite the opportunities to scale this effort more broadly, it is important to note some data limitations. The number of health facilities in each state is small relative to the medical centers in each area. Ondo state has deployed more CliniPAKs (12 in total) compared to 3 in Kano and FCT and 4 in Anambra. Since the project still is being implemented, there are no firm numbers on the percentage of total patients at each facility who are being reached.

| TABLE 3 PERCENT OF NIGERIAN EXPECTANT MOTHERS RECEIVING MATERNAL CARE DURING FIRST FIVE MONTHS OF THEIR PREGNANCY, 2014 | | | |
|---|---|---|---|
| | June | July | August |
| Ondo | NA | 15% | 15% |
| Anambra | 21% | 14% | 24% |
| FCT | 39% | 44% | 31% |
| Kano | 21% | 24% | 20% |
| Source: Qualcomm Wireless Reach, "CliniPak Mobile Health Project," June to August, 2014, p. 10. | | | |

Each patient's medical data was entered into a CliniPAK mobile medical record. The tablet also kept track of each patient's demographic background, address, contact information, and personal and family medical history. It detailed clinical consultation and treatment for natal childcare, birth summaries, nutrition, family planning, immunization, labor and delivery, mortality, and HIV counseling.[24]

An analysis of labor and delivery data shows a high level of births were performed with the participation of skilled birth attendants (see Table 4). Ondo had 87 percent of its 446 deliveries with a skilled clinician present, while the figure was 96 percent in Anambra, 90 percent in FCT, and 100 percent in Kano.[25]

| TABLE 4 NIGERIAN LABOR AND DELIVERIES IN AUGUST, 2014 | | |
|---|---|---|
| | Percent with Skilled Birth Attendants | Total Deliveries |
| **Ondo** | 87% | 446 |
| **Anambra** | 96% | 27 |
| **FCT** | 90% | 51 |
| **Kano** | 100% | 43 |
| Source: Qualcomm Wireless Reach, "CliniPak Mobile Health Project," June to August, 2014, p. 15. | | |

In relation to child mortality, immunization programs were also successful at reaching children. In Ondo state, medical clinics were able to immunize 529 children against polio (the Oral Polio Vaccine), 452 against Hepatitis B, and 800 against tuberculosis through the Bacillus Calmette-Guerin (BCG) vaccine (Table 5). The numbers were lower in Anambra, FCT, and Kano states but, overall, several thousand children were vaccinated.

| TABLE 5 NUMBER OF CHILD IMMUNIZATIONS IN NIGERIA, JUNE TO AUGUST, 2014 | | | |
|---|---|---|---|
| | Oral Polio Vaccine | Hepatitis B | TB Vaccine (BCG) |
| **Ondo** | 529 | 452 | 800 |
| **Anambra** | 276 | 154 | 289 |
| **FCT** | 79 | 84 | 86 |
| **Kano** | 56 | 55 | 53 |
| Source: Qualcomm Wireless Reach, "CliniPak Mobile Health Project," June to August, 2014, p. 17. | | | |

The CliniPAK program has helped clinicians and doctors to provide directed care in a timely manner, eliminating redundant testing or questioning which saves clinicians' time and serving the goal of driving down the number of maternal and infant deaths.

## AIDING THE FIGHT AGAINST EBOLA

As the CliniPak mobile health system was being implemented in Nigeria to help with maternal and child care, the country started to see signs of an Ebola outbreak. Ultimately, 21,000 people were afflicted worldwide and approximately 8,500 people died, including nearly 8,000 in Sierra Leone, 7,700 in Liberia, 2,000 in Guinea, and 20 in Nigeria.[26]

Public education and the training of healthcare providers was a crucial part of the Ebola response. Authorities needed to rapidly disseminate medical materials and information to medical personnel and patients, and they realized that they could do this using the mHealth platform that was already

established in Nigeria through CliniPAK. The system also supported the development of a number of mobile apps designed specifically to educate people about the disease.[27]

During this outbreak, it was particularly crucial to educate frontline health workers. "Those workers are the most at risk," explained Okey Okuzu, the founder and chief executive officer of InStrat Global Health Solutions.[28] "Primary healthcare often takes place in rural communities. Workers there sometimes are not very informed on how the disease develops and what to watch for."

A survey of 282 frontline health workers in the early days of the Ebola crisis found that 81 percent of them were very fearful of the Ebola virus. In addition, 68 percent indicated they were not unwilling to work in units involving Ebola patients, 23 percent were willing, and 9 percent responded with a maybe.[29]

Part of the problem was that a number of healthcare workers were not well-informed about the causes or treatment of Ebola. In a survey taken early in the epidemic by InStrat and Anadach Group, 36 percent of respondents believed that using gloves when handling patients could protect people from the virus, while 63 percent were unsure or did not think gloves were helpful. In addition, 85 percent believed you could avoid Ebola by avoiding handshakes or touches, while 14 percent were unsure or felt that was not the case. Seventy-two percent of respondents believed that infection was less likely if you washed your hands after contact, while 28 percent were not sure or thought that was not the case.[30]

The lack of knowledge among those responsible for providing care made it vital to educate health workers quickly. One of the virtues of mobile campaigns is their ability to scale rapidly. Once a problem is identified, up-to-date information can be disseminated swiftly and broadly in a varying array of locations and geographies. Vecna worked with Anadach Group to create a mobile tutorial on Ebola and InStrat distributed it to healthcare workers across Nigeria. The tutorial discussed the causes of Ebola, how it spreads, ways to diagnosis the disease, and how to treat it.

The informational material generated a positive response from Nigerian healthcare providers. A number of them felt it raised awareness of disease screening and treatment and gave workers valuable treatment information. Okuzu pointed out that "our tutorial gave them a sense that they weren't so isolated. Health facilities often are in places that are remote. When we came in, they found that others were interested in their well-being."[31]

As a sign of its impact, he noted that "for each person who viewed our tutorial, approximately four other people in the community were influenced. There are incorrect myths about the disease. Following the tutorial, people could refute these myths because they had good knowledge of the disease." Okuzu's sense was that the tutorial had "very strong impact and was very well received."[32]

In addition, Okuzu pointed out that "the data collected so far have begun to impact the way healthcare is delivered in the communities from ongoing deployments, as follows:

- Service gaps are now better highlighted leading to introduction of new services for 2015;

- There is now better capacity planning for anticipated demand;

- Delivery forecast [is] possible;

- Immunization demand forecast is being contemplated;

- Patient triaging at point of care is now possible at facilities given easy access to patient records;

- Health workforce capacity gaps have been identified and assessments are currently being made on how best to address those gaps;

- And nurses and midwives now save a few days every month compiling reports and instead focus more on patient care."[33]

Informed by its evaluation of clinical data from CliniPAK, the Ondo State Ministry of Health launched a Medical Records Officer (MRO) knowledge assessment survey across its 550 health centers. It plans to provide MROs with appropriate training to bridge the gaps identified by the assessment.

Overall, the campaign to train and educate health workers on Ebola was remarkably effective. Unlike other African nations which have suffered as a result of various epidemics, Nigeria was largely spared the devastating impact of Ebola. Twenty cases of Ebola were diagnosed in Nigeria. These cases were quickly isolated and treated and, in a short period of time, the World Health Organization declared Nigeria "free of Ebola."[34] By early 2015, news reports noted that West African Ebola treatment centers were "nearly empty."[35] Social media and text messaging were vital to the Ebola education and training campaign. These tools helped to dispel rumors and false information about the disease.[36]

## MOBILE HEALTH SOLUTIONS IN LIBERIA AND SIERRA LEONE

Infrastructure limitations hampered responses to the health crisis in a number of places. It forced technology innovators to deploy "low resource" solutions to deal with Ebola. Uyi Stewart of IBM Research Africa explained that "there are infrastructural challenges in Sierra Leone, there are infrastructural challenge sin Liberia, but this is needed there so what is the work-around so that we can have an impact. This is the concept of Africanised solutions, the idea of localizing innovation to make it relevant to the conditions of use"[37]

With the success of the Nigeria CliniPAK mobile project, other West African countries extended mHealth applications to their own nations. One such place was Liberia, a country that was hit hard by the Ebola epidemic and needed effective solutions that could be quickly implemented. Sierra Leone was another place hard-hit by the epidemic. Both countries were at the epicenter of the Ebola crisis. At the height of the outbreak "28 new Ebola cases [were] arriving daily in Liberia."[38]

In fall 2014, 175 Nigerian healthcare providers went to Liberia and Sierra Leone to aid those nation's responses.[39] Health experts deployed Ebola tutorial content in each location, and the mobility solution helped them deal with an outbreak that was far more serious. Vecna worked in tandem with Nigerian partners to use its CliniPAK system to teach frontline health workers about the illness and track the outbreak.

mHealth innovations grew. In Liberia, a tech startup called Ushahidi developed a mapping tool that tracked the spread of the disease. Through crowd-sourced data, it compiled information on where the illness was spreading and how public health authorities should respond.

For example, the International Red Cross sent two million text messages each month about Ebola. This effort provided people with much-needed information about screening, diagnosis, and treatment. "Simple technology like a basic SMS phone can support and strengthen the additional communication efforts that are already happening by connecting people to better, more accurate information faster than before," said Dana Zucker of UNICEF's Innovation unit.[40]

In an interview, Theobald stressed that the CliniPAK system was valuable for dealing with the epidemic across the region. "This system is critical to fighting the outbreak," she said. "This is the first time they'll be using digital records at all in any of the ETUs [Ebola Treatment Units]. Everyone has been using paper. If they have had a tablet, all the information they're capturing is stuck on that tablet because they haven't been able to data share across tablets."[41]

Paper-based systems are quite limited. "If the patient is isolated, so is their paperwork," Theobald added. "The doctors try to remember information about the patient and then rush out and write it down. And, they're doing that in patient wards that could hold anywhere from 20 to 100 beds".[42]

Once electronic systems are established and connected, healthcare providers can learn from one another. Theobald believes that "it's about daily care but it's also about learning. People are talking with each other so as we collect more data, we're able to share that information across other treatment centers so we can improve clinical regimens and change outcomes for more people."[43] Continuing, she pointed out that, "Doing this kind of data sharing and filtering, and doing data drill downs, it just wouldn't have been possible without the data system they're using now."[44]

## EXAMPLES OF THE IMPACT OF mHEALTH IN OTHER AREAS AND OTHER PARTS OF THE DEVELOPING WORLD

Nigeria, Liberia, and Sierra Leone are not isolated examples of mHealth impact. It is well-documented that electronic medical record systems improve the efficiency of medical delivery. According to research, "adopting digital records in one project in Kenya shortened patient visits by 22 percent, doctor time per patient was reduced by 58 percent, and patients spent 38 percent less time waiting in the clinic."[45]  It has also been shown that providing mobile phones to women increases their visits to health facilities, and this utilization reduces levels of maternal fatalities.[46]

Maternal health and primary care solutions have been implemented in Kenya, Morocco, Sierra Leone, Northern Africa, and many other parts of Africa. A mobile rollout in Kenya, for example, helped 10,691 patients in eight different clinics.[47]

Mobile platforms are helping address existing healthcare issues and those that emerge suddenly. They bring leading, international informational resources to underserved communities in both rural and urban areas quickly and efficiently.

mHealth is also making an impact in other parts of the world. For example, projects in India and Sri Lanka have found mobile devices to be very helpful in monitoring outbreaks of Dengue Fever.[48] In the world before mobile communications, it generally took provinces in these countries anywhere from 15 to 30 days to report data on disease outbreaks to central authorities. The time lost here slowed treatment responses and aggravated the spread of infectious diseases.

However, with the onset of mobile and digital communications, the wait time on infectious diseases has dropped considerably.[49] Through the Real-Time Biosurveillance Program, public health authorities in India and Sri Lanka use mobile devices to gain unprecedented access to collected information and use digital data mining techniques to look for "anomaly detection" in patient disease patterns.

As a result, areas reporting major outbreaks receive additional resources for diagnosis and treatment which, in turn, helps to limit the spread of the disease. In dealing with epidemics, experts Ruxandra Paul and Kenneth Sherrill say, "Communication is essential: decision makers need to exchange information on a constant basis, while at the same time, educating and informing the general public about the disease."[50]

## RURAL VERSUS URBAN CARE

Nearly every nation has disparities between urban and rural areas. Healthcare providers and specialists are more likely to be located in densely populated jurisdictions because that is where hospitals and advanced equipment are found.

The lessons for mHealth are clear. Mobile devices improve access to medical care in many nations, regardless of the population count in a particular area. In India, for example, rural-dwellers gain access to medical care far from their hometowns through videoconferencing. Using broadband connections, doctors who are geographically remote from patients can still examine them and diagnose particular problems. In countries where physicians are in short supply in rural areas, this enables patients in underserved locales to get needed medical treatment.[51]

Singapore has a mHealth application called Health Buddy which provides a list of medical symptoms and possible treatments, along with tips and videos on ways to promote good health. Patients use this application to ask specialists detailed questions about particular illnesses and who they should see for medical care. Health Buddy provides access to SingHealth, the government health portal with more than 40 different medical specialties available.[52]

In Malawi, Josh Nesbit of Medic Mobile developed software that allowed healthcare workers in the field to text in medical information for rural patients to clinics and doctors located elsewhere. Rather than spend hours commuting to clinics, health workers could use this software to receive quick diagnosis on routine symptoms and suggested treatments. Nesbit said, "Within six months of the system going live, the number of patients being treated for tuberculosis doubled, more than 1,200 hours in travel time were eliminated, and emergency services became available in the area for the first time."[53]

In Bangladesh, 90 percent of childbirths in rural areas occur outside of hospitals or healthcare clinics. After the launch of a mobile birth notification system that calls health clinics when a woman in labor starts asking for a midwife, 89 percent of births now take place with trained health workers in attendance.[54]

Researchers at Johns Hopkins University have extended the Bangladesh model through a mCare initiative that schedules prenatal care visits for expectant mothers, helps during childbirth, and checks in after childbirth to provide assistance with any health issues.

As these examples show, mobile technology allows people to overcome geographical limitations in healthcare and access information at a distance. Doctors can work more efficiently in that they don't need to be in the physical presence of a patient in order to judge the patient's condition. Patients can obtain a second opinion simply by sending the second doctor relevant medical tests electronically. If a personal conference is required, doctors can use videoconferencing to speak to patients located in another city, state or country.


## ENABLING EFFICIENCIES USING mHEALTH

Mobile solutions have strong value for healthcare both in terms of effectiveness and efficiency. For example, research by the Telnor Group has found that mHealth efforts can reduce the cost of

medical care among elderly patients by 25 percent, double access to physicians by those living in rural areas, and improve tuberculosis treatment compliance by at least 30 percent.[55]

Wireless technologies help move medicine towards data-based decision-making. "Mobile health technologies present a new paradigm for healthcare management," said Okuzu.[56] "It presents the basis for evidence-based medicine. But that is nonexistent in many communities. People make medical decisions based on gut and experience. They are struggling to make decisions based on data."

## KEY TO CONTINUED mHEALTH IMPACT FOR DEVELOPING COUNTRIES

While there is progress being made, it is crucial to overcome policy and regulatory obstacles. Providers must overcome policy barriers in terms of reimbursement, regulation, and research.[57] In many countries, neither public nor private insurance plans cover mHealth applications. Physicians, for example, often are not reimbursed for e-mail or phone consultations, the use of text messages, or data gathered through remote monitoring devices. Reimbursement policy is skewed in favor of face-to-face medical treatment over digital or mobile applications. This limits physician interest in and reliance upon innovative treatment and reduces the benefits of the mHealth revolution.

Furthermore, there needs to be new policies that recognize the changing landscape of medical care and the benefits of remote monitoring devices, preventive medicine, text reminders to take medication, and electronic consultations. Unless physicians are reimbursed for these practices, they will be less likely to make use of these and other new techniques.

Poor infrastructure remains a major problem.[58] Many clinics exist in places where there is little reliable electricity, making it difficult to deploy mobile and digital technology solutions. One solution is to have a portable power source that enables, through tablets and phones, care-givers compile medical information and communicate with people at a great distance.

In addition, according to Okuzu, "The biggest challenge of improving healthcare is not so much technology but more around the human factor. More attention needs to be paid to that. We need educational campaigns that help people."[59] He noted that it is important to understand the decision-making process in the developing world and how to encourage practitioners and health authorities to make decisions through data. If people can learn to understand the value of data analytics for healthcare, it will enable them to take advantage of the mobile revolution and bring new tools to improve medical service delivery.

Overcoming policy and regulatory barriers requires the development of trusting relationships.[60] In Nigeria, for example, national authorities were not sure how to handle mobile health since it took a different form from face-to-face consultations. Innovators such as Vecna Technologies and InStrat

Global Health Solutions initiated conversations with the national health ministry but eventually realized "they needed to be at the district level."[61] It became clear that local nurses and midwives were the ones who could see the value of the mobile solution and put it into the clinics. Combining technology innovation with a keen understanding of organizational and political dynamics is vital in order to move forward with mHealth.

## THE FUTURE OF mHEALTH IN THE DEVELOPING WORLD

Today, many emerging countries struggle to provide healthcare to their citizens. The demands of the population and the risk of epidemic can compound the problem.

When looking at the front line of providing care, clinicians are the first and often only link to healthcare and preventative health services. The lack of quality maternal, infant and child care has a devastating impact in developing countries. Most maternal deaths in developing countries are preventable through access to proper healthcare, adequate nutrition and the presence of a skilled birth attendant during delivery.

This paper provided examples of mHealth programs that are using mobile technologies and having a positive impact on the health and welfare of people in underserved parts of the world. As these examples show, mobile technologies offer an opportunity to strengthen the capacity of clinicians and increase the quality and timeliness of delivery of critical maternal and child health services.

Medical practitioners, government agencies, and private industry are beginning to understand how mobile technology can be harnessed to develop and inspire solutions to aid the health of people and nations. The rapid expansion of mobile technologies and its use in mHealth is making it possible to greatly improve the day-to-day lives of people in Nigeria, Africa, and worldwide.

# ENDNOTES

*Note: I wish to thank Hillary Schaub for her helpful research assistance with this report.*

1 Boston Consulting Group, "The Mobile Revolution: How Mobile Technologies Drive a Trillion-Dollar Impact," January, 2015, p. 4.

2 Hao Wang and Jing Liu, "Mobile Phone Based Health Care Technology", *Recent Patents in Biomedical Engineering*, Volume 2, 2009, pp. 15-21.

3 World Bank, "Maternal Mortality Ratio (per 100,000 Live Births)", 2015.

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