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The Case for mHealth in Developing Countries

While the health community debates whether a specialized field of "mHealth" exists and how to define it, most people will agree that individuals around the world are using mobile technologies to access health services and information and that health professionals are formally and informally integrating mobile technologies into public health and clinical activities. As mobile phones and other mobile devices become part of everyday life, people become better equipped to respond to emergencies, consult with peers and health professionals about health issues as they arise, and access health services that are increasingly being delivered through mobile phone based systems, such as remote patient monitoring. In developing countries, people frequently acquire mobile phones just in case of emergencies, including a taxi driver I interviewed in Upper Egypt in 2002, who shared the following experience with me:

> There had been an accident on the highway to Samalut: … a taxi .. turned upside down. That was two years ago, and the news had spread, and on that day I was working, and I returned late. I found my wife in a hysterical condition and when I asked her what was wrong, she told me that she didn't know my whereabouts, and she heard that there was a taxi accident, and that I was late. So at that moment I felt that the mobile would be useful. (Mechael, 2006, p. 126)

The term *mobile health* or mHealth, also written as m-health, describes the use of mobile telecommunication and multimedia technologies as they are integrated within increasingly mobile and wireless health care delivery systems (Istepanian & Lacal, 2003). It can also be described as "mobile computing, medical sensor, and communications technologies for health care" (Istepanian, 2004). While the term is familiar to those in biomedicine and informatics, it is only now being clearly defined and frameworks are being developed for the broader medical and public health communities, as well as for the general public and stakeholders in the mobile phone industry.

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The definition is now being broadened, exploring how mobile technologies can be best and most widely used to enhance access to health services and information and also to improve the way health professionals deliver health-related services to the general public. Though a great deal of talk has circled around the potential benefits that mobile phones can have for health and some supporting evidence is available, we need a more strategic approach in order to implement mHealth interventions on a more tangible scale and to study how the technology can improve health outcomes.

The aim of this paper is to encourage reflection and discussion around the potential of mHealth in developing countries and to consider how early experiences can inform the way forward. Toward this aim, I synthesize many reviews and presentations from the eight years I have been studying the evolution of mobile phones and health in developing countries. I include observations and discussions that are now shaping the creation of mHealth as a field, to highlight the ingredients we need to move from a series of pilot projects and isolated business opportunities to a full-scale maximization of health-related benefits.

I begin by reviewing the strategic priorities within global health, where mobile telephony can have the greatest impact, along with organic health-related uses of mobile phones, and examples of formal mHealth interventions. I then demonstrate the potential for mobile phones to become an extension and an integral component of eHealth, describing how information and communication technology (ICT) can be used in health care, as well as mHealth, as a subset of mServices: using mobile devices to deliver services such as banking and health. I also show how trends and interests are converging among key stakeholders within the mHealth ecosystem, thus forming a foundation on which we can scale up and sustain more and better mHealth activities. Finally, I present some tactical guidance for a way forward that will further the objectives of both public health and business, particularly in outreach efforts to emerging markets, the bottom of the pyramid, and the next billion mobile phone subscribers.

MHEALTH AND THE MILLENNIUM DEVELOPMENT GOALS FOR HEALTH

Over the past 40 years, great efforts have been made to highlight and address critical public health problems throughout the world, particularly in low- and middle-income countries. The Declaration of Alma Ata in 1978 highlighted health as a "most important world-wide social good"; it introduced the concept of "primary health care," which has since formed the basis for health service delivery systems throughout the world (World Health Organization (WHO), 1978). More recently, the Millennium Development Goals (MDG) were developed to provide macro-level output and outcome targets toward which the broad range of development and health stakeholders can aim their interventions.

In keeping with WHO's 1946 definition of health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity," almost all of the MDGs have some association with health. This series of tar-

gets includes those associated with poverty reduction, education, and technology. In many countries, the technology targets related to "tele-density" (number of working mobile or fixed-line telephones per 100 inhabitants) and "tele-accessibility" (number of such telephones per 100 households) have either been met or are close to being met as mobile networks are rolled out.

Several of the MDGs specifically address health as set forth by the United Nations (2000) *Millennium Declaration.* They include:

- Reducing child mortality
- Improving maternal health
- Combating HIV and AIDS, malaria, and other diseases
- Increasing access to safe drinking water

A recent UNICEF monitoring report on child health describes in more detail how major improvements in key child survival interventions—including measles immunization, vitamin A supplementation, insecticide-treated mosquito nets, and breastfeeding—are helping to significantly reduce deaths of children under five (UNICEF, 2008a). For the first time since such statistics have been monitored, the number of children under five who died within a one-year period has fallen below 10 million to 9.7 million; while this is positive, it indicates that much work remains to address deaths from preventable causes (UNICEF, 2008a).

Another report (UNICEF, 2008b) indicates similar, though less compelling, improvements in maternal mortality through deliveries by skilled attendants and increased uptake of preenatal care services. These are the areas where mobile technologies have much to offer, but little has been done to formally harness their potential. Many of the early cases demonstrating the formal use of mobile technologies for health in developing countries have focused on treatment compliance for HIV and AIDS and TB.

In addition to the MDGs for health, increasing attention has been drawn to the critical shortages in trained health care personnel throughout the world. At present, 57 countries have critical shortages in health workforce density with a global deficit of 2.4 million doctors, nurses, and midwives (WHO, 2006). Table 1, taken from the *World Health Report of 2006* (WHO, 2006), illustrates the magnitude of this gap. WHO believes that one of the most effective ways to improve health is to invest in the training and ongoing development of the health care work force. Ongoing discussions also focus on ways to shift tasks and to leverage mobile telemedicine to provide point-of-care diagnostic and treatment support to health workers in remote areas.

THE EVER-SHRINKING DIGITAL DIVIDE AND HEALTH

Alongside endeavors to improve health outcomes are concerted efforts to reduce the digital divide, or the differential access to technology of low-, middle-, and high-income countries and of rich and poor within the same country. It is at the cross section of health and technological domains that eHealth initiatives have evolved, creating an unprecedented opportunity to improve access to services and

WHO region	Number of countries		In countries with shortages		
	Total	With shortages	Total stock	Estimated shortage	Percentage increase required
Africa	46	36	590 198	817 992	139
Americas	35	5	93 603	37 886	40
South-East Asia	11	6	2 332 054	1 164 001	50
Europe	52	0	NA	NA	NA
Eastern Mediterranean	21	7	312 613	306 031	98
Western Pacific	27	3	27 260	32 560	119
World	192	57	3 355 728	2 358 470	70

Table 1. Shortages of Medical Personnel

Source: World Health Organization, *World Health Report of 2006* (Table 1.3).

efficiency within the health sector in low- and middle-income countries. eHealth, or electronic health, is broadly defined by the World Health Organization (2005) as the "use of information and communication technology for health."

The main objective of eHealth programs is to use ICT to improve health care service delivery and health outcomes through the strategic use of such technologies as computers, Internet access, satellite receivers, and Personal Digital Assistants (PDA). As free and open-source software (F/OSS) becomes more available, it will more affordably extend the benefits of a broad range of higher quality, targeted eHealth solutions to low- and middle-income countries. For many years, the mobile phone was excluded from the discourse on the digital divide and from eHealth in developed and developing countries; now, however, interest in its potential is growing as wireless networks expand throughout low- and middle-income countries and handsets become more sophisticated and affordable. In a soon-to-be-conducted survey by the WHO Global Observatory for eHealth, a series of questions are being integrated to document the uptake and implementation of mHealth initiatives among member states. These trends will make these technologies more accessible and more useful to health care providers, and the general public in more remote geographical locations, through better documentation and national-level strategic planning and integration.

At first, many eHealth initiatives in developing countries focused on computer based health information systems and on using the Internet to promote the organization of and access to health-related information. Now, however, a shift is occurring towards an ecosystem approach to using ICT for health; this approach considers the widespread appeal of mobile phones. As of May 2008, 21.2% of the world's people were using the Internet, ranging from 5.3% in Africa to 14.0% in Asia to 23.8% in Latin America and 73.4% in North America.[1] More dramatically, the number of global mobile phone subscribers has grown to over 3.4 billion, or approximately half of the world's population, with the greatest growth in Asia, the Middle East, and Africa. Mobile technologies enable eHealth systems to decentralize and thus extend their reach to remote settings, as well as to individual members

of the health sector and the general public. To begin to understand the effects of mHealth in developing countries, it is worthwhile to consider how mobile phones are being used organically, and then to look at some examples of formalized mHealth initiatives.

WHY "m"HEALTH?

At the moment it feels like everyone in the field—telecommunications companies, service providers, NGOs, even commentators like myself—is eager to put a little "m" in front of any service that could possibly be delivered on a mobile platform, the most prominent being mBanking. This trend will pass, but the little "m"s are crucial to focusing sector-specific communities and policymakers on how to harness the potential of mobile technologies and related services. When people use mobile technology for health-related purposes, they often do so informally, making it difficult to ascertain its benefits. But ask mobile phone users in any context if they have ever used their devices for such purposes, and the answer is overwhelmingly yes, especially in developing countries. The uses range from mobilizing emergency support to scheduling a doctor's appointment to remotely monitoring diabetes—and well beyond.

The functional and structural properties of mobile phones make them attractive to the health sector in low- and middle-income countries. The phone's most notable feature is its capacity to communicate and transfer information within both literate and illiterate populations. Its relatively low start-up cost and flexible payment plans have put the technology into the hands of significant proportions of the general public; when subscribers share their mobile phones with others, they extend their health and emergency-related benefits even farther (Mechael, 2006). Text messaging, and more recently pre-recorded voice messaging, facilitate the quick transfer of information such as reminders to take medication or dates for appointments. With the development of health-related software applications, mobile communication technologies can provide real-time feedback, pre-programmed automated services, and support to increasingly decentralized health systems (Lacal, 2003).

Organic mHealth practices

Examining existing patterns of use might reveal areas of potential demand for more formalized hardware or software development that will enhance user experiences. In relation to mHealth, several studies have specifically explored linkages between the general public and the health sector in Bangladesh, Laos, and Egypt. They show that telecommunications improved after mobile phones were introduced, leading to a more direct link between clients and health care workers and to a perceived increase in demand for health services and health-related information, particularly from mothers and known health care workers (Micevska, 2005; Mechael, 2006).

In Egypt, for example, a newly-married 25-year-old who moved in with her husband's family, as is the custom, explained to me that in her new rural home environment, she had very few educated people whom she could consult about health-related problems. As a result, she primarily consults with her mother, whom she describes as being older, understanding, and experienced, for questions about her newborn child. Her mother regularly contacts her from a landline telephone or the household mobile phone (Mechael, 2006). This pattern of young married women consulting their mothers about health questions is common in Egypt, as documented by a study on breast-feeding behaviors in Egypt (Harrison, Zaghloul et al., 1993). The proliferation of mobile technologies has since made the process easier.

Access to telecommunications extends benefits beyond individual households; by sharing phones, people get access to emergency-related information and transportation (Micevska, 2005; Mechael, 2006). For example, a Ministry of Health representative in Egypt told how his son contacted his mother to mobilize support for a stranger he had seen experiencing an accident:

> One day my son saw an accident on the detour route, so he took the mobile of the injured person to call his mother and one of his friends, and my son stayed with him until the ambulance came, along with his mother and the friend he called. (Mechael, 2006, p. 129)

In Egypt, people who are involved in or who witness emergency situations often report using mobile phones to coordinate responses with people who have access to landline telephones, particularly family and friends (Mechael, 2006). Increasingly, people carry mobile phones as a way to ensure that they can stay safe and secure, especially in case of emergency; thus, safety and security are becoming a part of the technology's social image (Agar, 2003; Ling, 2004), especially in low- and middle-income countries with growing numbers of mobile phone users (Mechael, 2006).

It is important to note that the benefits of mHealth can only be maximized if all of the elements in the network, including health facilities and professionals, are seen as accessible. In my study in Egypt, I found that people frequently mentioned six limitations to maximized use of mobile phones for health: (1) cost, (2) perceptions of risk, (3) reliability of telephone systems in health facilities, (4) safety, liability, and cost recovery for unknown contacts as well as information and services provided at a distance, (5) lack of understanding and use of range of functions available through mobile phones, and (6) poor quality of health services (Mechael, 2006).

In that study, one respondent, a pediatric surgeon and professor with a private clinic, summarized the sentiments of most health professionals. He explained how he makes efficient use of mobile phone calls for emergencies and general health service coordination, but still prefers a landline for consultations:

> If it is an emergency they [other doctors] call me. Also, if a colleague needs me to help him with a surgery, he calls me. They can reach me any-

> where…. It has facilitated … communications and shortened distances between my colleagues, my patients, and my students. They can reach me anytime and anywhere…. I prefer to use the telephone [for] long calls, if I am going to discuss something with a colleague in a medical case. But if I don't find him, I have to use the mobile to tell him to call me where I am, meaning that the call from the mobile doesn't exceed a minute. In one day I can use the mobile to receive calls and make calls for 5 to 6 minutes in total. (Mechael, 2006, p. 164)

It is critical to understand such calling preferences and patterns in order to understand the natural role of mobile phones within the health sector. Once we see the natural patterns, we can begin to formally integrate the technology in order to maximize health benefits. Overcoming barriers is a strong feature within the literature on technology for health and development in poor countries; the primary objective is to ensure effective use of the technology to improve outcomes. This area of technology study explores aspects of barriers such as literacy level, hierarchical access to technology, appropriate infrastructure to support the use of technology, and cultural factors that inhibit the use of technology (Mechael, 2006). A key barrier is cost. Throughout developing countries, efforts are being made to alleviate some of the cost burden facing health professionals; one approach is giving them a stipend for their mobile phones. A more formalized approach is used in Ghana: physicians registered with the Ghana Medical Association can have unlimited calling through the mobile service operator OneTouch.

While mobile phones are being used throughout the world to support health activities and organic uses, they also serve as an excellent foundation for formalized programming. A primary area where direct two-way communication can significantly improve health care is in reducing maternal mortality. One approach is to create referral systems that combine communication and access to emergency transportation, as well as consultative relationships between birth attendants, midwives, and obstetricians so they can better manage labor and delivery complications. In addition to personal two-way communication, newly developed automated systems can provide recorded health-related information.

Formal mHealth initiatives

The more formalized uses of mobile phones and other technologies for health can be divided into two broad categories: mHealth as an extension of eHealth, and mHealth as a subset of mServices. mHealth as an extension of eHealth broadly encompasses the formal integration of mobile devices within the health sector; as a subset of mServices, mHealth is used to engage the general public in health-related activities. Examples of the former are text-message appointment reminders, data-collection systems, remote patient-monitoring devices, and mobile medical records: formalized uses that sit within or are generated by the health sector.

mHealth as an extension of eHealth often begins with small pilot projects that, if successful and well-funded, may then be replicated and scaled up to larger pop-

ulations or sets of facilities. But this progression has been slow. Health-related call centers and hotlines, mass mobilization campaigns, and mobile phone-based games fall within the realm of mServices, as they are often provided through mobile phone operators in partnership with NGOs and software development firms. While it is more difficult to assess the direct health outcomes of mServices, they are proving to have a broader reach with a modest investment within a shorter period of time.

All these factors are making it increasingly important to examine the linkages between mobile technologies and health, to explore opportunities for larger-scale implementations, and to engage in research that will enable the health sector to become more strategic as it leverages enhanced connectivity and increased access to mobile phones, both within the health sector and across the general population. In order to maximize health benefits, it is crucial to establish the field of mHealth, at least temporarily, as an extension and integral part of eHealth, as well as one of a newly emerging range of mServices. As mobile technology becomes strategically integrated and implemented at a noticeable scale over a period of time, the field of mHealth will no longer be necessary, and will revert back to a generalized approach to the use of emerging technology for health.

mHEALTH AS AN EXTENSION OF eHEALTH

Beyond basic voice communication, data access for health is primarily focused on the transmission of static text, but it can also extend to interactive decision support algorithms, other visual image information, and to communication capabilities, as email and SMS features become integrated into basic mobile service. A recent commentary in the *Lancet* highlights the need for actively managed efforts to reduce child and maternal mortality through better use of data; it heralds the uptake of mobile phones and declining costs of computers as strategic opportunities (Shankar, Bartlett et al., 2008).

Furthermore, as Brough Turner wrote in a recent report on mobile citizen media in developing countries, mobile phones are becoming smarter and the increasing availability of mobile broadband provides more opportunities for real-time monitoring of a broad range of health data (Verclas & Mechael, 2008). Integrating the use of GIS and GPS with mobile technologies adds a geographical mapping component that lets users "tag" voice and data communication to a particular location or series of locations. This functionality is already being used for disease surveillance to better mitigate outbreaks and to map gaps in demand for services and service providers so they can make better informed allocations of resources. The Nokia Data Gathering platform, as deployed in Amazonia in Brazil to collect health-related data—although proprietary and built for optimal use on Nokia phones—is one such application that combines data collection with mapping functionality.

These combined capabilities offer potential solutions to health-related problems in low- and middle-income countries; before mobile phones had spread so

widely, the use of information and communication technologies such as computers and the Internet was hampered by limited access to landline telephones for dial-up connections and electricity. Mobile communication technologies are already being used to facilitate access to emergency health services, to survey infectious diseases, to map and research health facilities and services, and in decision support and mobile telemedicine.

Moreover, sensor-aided telemedicine devices should generate significant cost savings for the health sector by reducing the number of patient visits to health facilities and enhancing doctors' ability to detect problems that require treatment. When this happens, as Fuscaldo (2004) puts it, the patient becomes the point-of-care, rather than the doctor or the hospital. For low- and middle-income countries, many such solutions will likely become available in urban centers and then be used for the extended care of the elderly as the global population ages (Lacal, 2003). By contrast, rural areas, where infectious disease continues to be the priority and human resources are limited, will require more basic technological solutions, such as voice-based tele-consultation between health care providers and citizens (Mechael, 2006).

A comprehensive report from the wireless industry (Wireless Healthcare, 2005) lists 101 specific health-related activities that can be conducted using mobile phones; it highlights many of the newly emerging opportunities to take advantage of the health sector's increased access to the technology. Among the many examples are reminders about appointments and medication, the use of a SIM card to hold medical data, peer support for patients via mobile phones, support for health professionals making a diagnosis, and many types of data collection, along with using phones to control inventory and to contact emergency services.

Such documentation, however, provides very little specific evidence on how the use of mobile phones leads to improved health outcomes (Kaplan, 2006; Vodafone, 2006). The evidence base in relation to mobile phones and health is limited, largely because the technology is so often integrated as part of a broader health intervention, and the role of telephones is not necessarily a critical aspect of the particular study. According to a policy paper from Vodafone (2006), recent studies of mobile phones and health have largely focused on the potential benefits of the technology within the health sector and on their use in developed, rather than developing, countries. Moreover, the paper notes, many of the existing studies look at how the voice and text functions improve access and efficiency within health care and how young people can access confidential health-related information. As other reviewers observe, many of the examples of applications are in the pilot stage and have yet to be implemented or evaluated on a significant scale.

In a more thorough review, however, Kaplan (2006) explored studies, primarily conducted in developed countries, that looked at direct interventions in which mobile and landline telephones were used to address a wide range of health conditions and situations, including diabetes (patient blood sugar level monitoring), breast cancer (telephone counseling), tuberculosis (adherence to medication), treatment compliance for a variety of conditions, attendance at health facility

appointments, depression outcomes, immunization rates, asthma management, and smoking cessation. Kaplan specifically explored how people used mobile phones for the "express purpose of supporting or altering one or more health outcomes" (p. 2). The studies he found were primarily small pilot projects that offered mixed results in terms of demonstrating the potential of landlines and mobile phones to serve as a support for more effective delivery of health care services.

The main feature of mobile phones that has been most significantly documented in the context of health is text messaging, which has garnered increasing attention in the United Kingdom, the United States, Norway, and Sweden as a means of reminding patients about their appointments (*The Economist*, 2006). The preliminary results from such studies indicate that more people show up at their scheduled appointments, yielding significant savings in health costs for facilities and practitioners. In this case, the benefit is related to costs rather than to health outcomes.

A related use of text messaging for health is the SimPill system, initially developed in South Africa to manage TB patient treatment compliance. A device attached to a medicine bottle sends a text message to a central computer database when the cap is removed. When the cap is not removed according to the specified treatment regimen, the system sends a text message to the patient, with a reminder to take the medication; thus it may improve treatment compliance (*The Economist*, 2005). SMS text messaging has also been highlighted as a preferred means of communication for those mobilizing support and communicating during emergency and disaster situations, largely because the landline networks may not be reliable (GSM Association, 2005).

SMS is also being used increasingly in data collection systems that use encoded SMS strings; organizations such as UNICEF use them to manage the supply chain and monitor key health-related data, such as the availability and quality of pit latrines for preventing diarrhea. Open Source developers have also responded to the overwhelming demand for data collection systems by developing PDA platforms that are increasingly being migrated to smart phones, including EpiHandy and EpiSurveyor. OpenRosa, a community of java-based mobile phone developers, has formed to reduce the duplication of efforts and to ensure that common standards are adopted. And both corporate and social interests are driving the development of more robust data collection platforms, such as Nokia Data Gathering, mentioned above, which recently completed a trial in the Brazilian Amazon with health workers; through a partnership with the Ministry of Health, it will be implemented on a national scale.

Mobile phones are also being used within the rollout of broader health-related technology systems. For example, Voxiva has developed a proprietary system called TracNet; it enables health care workers in Rwanda to use their mobile phones to send health monitoring reports to a centralized database for real-time health information analysis on HIV and AIDS.[2] TracNet was designed to leverage the existing telephone infrastructure, which includes an inadequate landline infrastructure, more plentiful mobile phones, and some satellite telecommunications

systems. The program, which tracks patient diagnostic and treatment information in Rwanda, is among the first of its kind to be implemented on a national scale; it covers 75 percent of the country's 340 clinics (32,000 patients) and allows health care workers to access patient information even when they have moved from one clinic to another (Crampton, 2007).

But no one solution is available everywhere. As a result, health administrators and technology developers have started combining different technologies based on the environments where they are used. For example, in South Africa a shortage of qualified pharmacists is creating a serious bottleneck in treating people with HIV and AIDS, and rural clinics often cannot distribute medication. Cell-Life, a recognized leader in the mHealth field, developed a system that combines a cell phone, the Internet, and computers in various locations; it allows pharmacists in better-equipped clinics to package drugs for rural clinics that do not have a pharmacist (Mechael & Sloninsky, 2008). Similarly, a project with which I have been involved, the Millennium Villages Project, which operates in ten countries in Africa, is integrating mobile technologies as part of a broad-based mHealth strategy in partnership with Ericsson and key operators; it aims to extend existing eHealth systems to support the work of community health workers and facility-based staff to achieve the MDGs for health from the ground up. A consortium of Open Source developers and program implementers, currently known as the OpenMobile Consortium, is forming to develop a toolkit of mobile phone-based applications that can be used in a similar ecosystem approach; their focus goes beyond health to all aspects of social development in low- and middle-income countries. Many of these platforms, when applied to mHealth, span eHealth as well as mServices.

mHEALTH WITHIN mSERVICES

In a recent push to identify "the M-PESA of mHealth," the business community has been eager to assess the case for mHealth as part of a broader range of mServices. The business case for mHealth will likely come in two streams. The first will identify revenue-generating services and applications that provide a profitable return on investment, as people buy specialized handsets and subscribe to value-added services, or networks carry increasing amounts of voice and data traffic. Viewed as a win-win for industry and health, in this stage more hotlines and call centers will be created that allow people to access general and targeted health information and to use text messaging creatively for social mobilization. A key benefit of call centers is that they require little investment up front but have the potential for a broad reach.

One such call center in a developing country context is the health-related extension of the Grameen Bank's Village Phone Program, called the Grameen Healthline, which launched in November 2005.[3] The system provides a number for the general public; it connects an individual to a registered physician who provides advice and referrals for both emergency and routine health conditions. The costs of the call are subsidized, but paid by the caller. As of October 2007, the pro-

gram was providing medical advice to approximately 10,000 callers per day.

Beyond voice, a few emerging programs are using text messaging to engage the general public for health promotion. One example, in Mbarara, Uganda, is a partnership between the AIDS Information Center (AIC) in Uganda and Zain, a local mobile phone network operator, in collaboration with Text to Change, a non-governmental organization that uses a bulk short message service platform for HIV/AIDS education (IRIN PlusNews, 2008). The pilot program, launched on February 14, 2008, sent an introductory SMS to a list of 15,000 subscribers asking if they would like to participate in a no-cost interactive quiz about HIV, and approximately 2,500 participated (IRIN PlusNews, 2008).

The aim of the program was to increase voluntary counseling and testing for HIV; in fact, HIV testing at AIC's central facility in the Mbarara district increased by 100 percent over the six-week period of the trial program. The project could also track knowledge about HIV through people's responses (IRIN PlusNews, 2008). This shows how valuable it is to strengthen the health sector's capacity to develop mobile technology-based solutions and to help operators provide more comprehensive and affordable services to the health sector. Many more such projects are needed. This platform can also provide other subscription-based services that will generate revenue alongside its social purpose for self-sustainability.

The second business stream will explore the social marketing of technology to the health sector in a way that encourages governments to invest in mHealth-related services so they can both reduce the cost burden of service delivery and improve health outcomes. Here a key effort will be exploring how mobile technologies and related services can be integrated within government strategies to strengthen health systems. As companies involved in mobile telecommunications increasingly seek to expand their market to the health sector, they will have to develop a practical way to use technology to solve key health-related problems and then scale them up so they both create efficiencies and generate positive health outcomes.

For middle- and low-income countries, where health care resources are often stretched already, it becomes even more critical to begin by defining the problem, exploring existing technology solutions, and then identifying and testing the most appropriate solution, or a combination of solutions. Such efforts are best approached as a public-private partnership between governments, non-governmental organizations, and telecommunications companies.

These points lead to my set of recommendations for implementing mHealth at the national scale:

- Assess the current state of eHealth, telemedicine, and mHealth. Then use these assessments to identify informal/organic practices and formal mHealth implementations, opportunities to strengthen or extend existing eHealth systems to more remote areas, and gaps in information and communication flows that can be supported through mobile technologies.
- Identify and document existing eHealth/telemedicine initiatives and systems, to ensure that they are interoperable and use an ecosystem approach, as well as formal and informal mHealth practices.

- Identify priority diseases and health conditions, including country-specific MDG targets, and explore critical pathways for integrating or extending technology.
- Examine and document current workflow and working relationships (information and communication).
- Identify the role of voice and visual data or other media and channels.
- Identify eHealth capacity and business cases for services including software customization, project management, monitoring and evaluation.
- Develop a short- and long-term strategic plan, implementation plan, and budget and define roles and responsibilities as well as mechanisms for accountability.
- Develop guidelines, policies, and accountability systems.
- Establish targets and measures of success.
- Monitor and evaluate and adapt to findings and changing environment.

Three factors will likely contribute to making mHealth solutions scalable, as would be true for any sort of service: (1) increased demand for the services from consumers; (2) strategic partnerships between industry, governments, implementers, and researchers to support large-scale implementation and evaluation of bottom-up and top-down mHealth systems and applications, and (3) an enabling policy and operational environment. For example, one mHealth system that shows promise for implementation at national scale is a current effort in Tanzania to link an Open Source mobile data collection platform with the computerized District Health Information System (DHIS), and also with clinical records databases; the database can then submit data to the DHIS to allow decentralized but comprehensive reporting of household and clinic-based data.

CONCLUSION

The specific potential of mHealth lies in its ability to offer opportunities for direct voice communication (particularly valuable given the literacy and language capacity in many countries) along with capabilities for information transfer that previous technologies did not offer. This is predominantly beneficial for work in remote areas where the mobile phone, and now increasingly the wireless infrastructure, can reach more people more quickly. As a result of such technological advances, the capacity for improved access to information and two-way communication becomes available at the point of need and for healthcare workers at the point of care. Mobile communication technologies are tools that can be leveraged to support existing workflows within the health sector and between the health sector and the general public.

Studies on technology and health provide a critical lens through which to review existing technological trends and applications, and four findings from those studies are particularly important here. First, mobile technologies are not objectives, but tools that should be applied in order to achieve local, national, and regional health objectives (Shields, Chetley et al., 2005) and to help improve the

lives of individuals (SatelLife, 2005). Second, we do not have enough impact data to understand how mobile technologies are influencing health outcomes, so a challenge remains: how to identify and replicate best practices (Mechael & Sloninsky, 2008). We will need more impact evaluation in order to move beyond discussions of the potential impact that they might have and anecdotal examples of how they are already being used. Third, mobile technologies are only as good as the information and communication to which they provide access (Shields, Chetley et al., 2005). It is crucial to have access to reliable and relevant content that reflects conditions in low- and middle-income countries at the right time (Mechael & Sloninsky, 2008). Finally, we need to move away from pilot programs and case studies to more formal applications and more thorough studies that can establish the foundation for national programs and policies (Shields, Chetley et al., 2005).

The use of mobile communication technologies for health, or mHealth, is a newly evolving sub-field within eHealth and mServices. The future of mHealth will depend on the establishment of a critical knowledge and evidence base that will enable health administrators and policymakers to make better informed decisions about how to invest limited health resources in technology. To make this happen, projects will need to be implemented at a large enough scale to generate results, using research protocols that can demonstrate where, how, and why mHealth works best.

The starting point for considering the potential impact of ICT should be a broad-based assessment of organic mHealth practices and health-related needs. At the global scale, it can begin with broad-based health priorities such as the Millennium Development Goals, Roll-back Malaria,[4] Stop-TB,[5] and improving human resources for health, among others. These efforts highlight concrete aims and objectives, with specific targets that countries have adopted within their national health strategies. At the moment, there is significant momentum and convergence to create an enabling environment for mHealth with high-profile partnerships and media coverage. There is even a growing spirit of "co-opetition" for telecommunications companies, as an industry colleague mused: even those who traditionally are economic rivals can together support a fairer operating environment for social entrepreneurs, NGOs, and government social services. The opportunities for leveraging the potential of technology form an endless list of possibilities both to create efficiencies within health systems in poor countries and to positively influence health outcomes, while also creating new revenue streams for telecommunications hardware, software, and voice and data service providers.

At the close of 2008, as an outgrowth of the first ever, week-long consultation on mHealth, hosted by the Rockefeller Foundation and convened by the UN Foundation and Vodafone Group Foundation, discussions and actions have focused on creating a neutral coordinating and advocacy body to take on this mHealth call to action. It is my sincere hope that the current wellspring of interest in mHealth will advance the current state of anecdotal potential, translating it into tangible improvements in health for years to come.

Endnotes

1. http://www.internetworldstats.com/stats.htm.
2. http://www.voxiva.com/rwanda.asp.
3. http://www.grameenphone.com/index.php?id=106.
4. http://www.rbm.who.int/.
5. http://www.stoptb.org/.

References

Agar, J. (2003). *Constant Touch: A Global History of the Mobile Phone*. Cambridge, England: Icon Books Ltd.

Crampton, T. (March 5, 2007). "Wireless Technology Speeds Health Services in Rwanda." *New York Times.* http://www.nytimes.com/2007/03/05/technology/05wireless.html

Fuscaldo, D. (December 15, 2004). "Soon, Cellphones Will Monitor the Vital Signs of the Chronically Ill." *The Wall Street Journal On-line*. http://www.wirelesslifesciences.org/pdfs/WSJ1_12152004_Cellphones.pdf

GSM Association (2005). *The Role of Mobiles in Disasters and Emergencies*. London: GSM Association.

Harrison, G., S. Zaghloul, et al. (1993). "Breastfeeding and Weaning in a Poor Urban Neighborhood in Cairo, Egypt: Maternal Belief and Perceptions." *Social Science and Medicine* 38(8): 1063-1069.

IRIN PlusNews (2008). "Uganda: Using mobile phones to fight HIV." http://www.plusnews.org/Report.aspx?ReportId=80176

Istepanian, R. (2004). "Introduction to the Special Section on M-Health: Beyond Seamless Mobility and Global Wireless Health-care Connectivity." *IEEE Transactions on Information Technology in Biomedicine* 8(4): 405-413.

Istepanian, R. and J. Lacal (2003). "Emerging Mobile Communication Technologies for Health: Some Imperative notes on m-Health." Paper presented at the 25th International Conference of the IEEE Engineering in Medicine and Biology Society, Cancun, Mexico.

Kaplan, W. A. (2006). "Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries?" *Globalization and Health* 2(9): 1-14.

Lacal, J. (2003). "Cell Phones and telemedicine." Paper presented at the Fifth International Workshop on Enterprise Networking and Computing in the Healthcare Industry, Santa Monica, California.

Ling, R. (2004). *The mobile connection: The cell phone's impact on society*. London: Morgan Kaufmann.

Mechael, P. (2006). *Exploring Health-related Uses of Mobile Phones: An Egyptian Case Study*. PhD Thesis completed at London School of Hygiene and Tropical Medicine.

Mechael, P. and D. Sloninsky (2008). "Towards the Development of an mHealth Strategy: A Literature Review." Working paper. New York: Earth Institute at Columbia University.

Micevska, M. (2005). "Telecommunications, Public Health, and Demand for Health-Related Information and Infrastructure." *Information Technology and International Development* 2(3): 57-72.

SatelLife (2005). *Handhelds for Health: SatelLife's Experiences in Africa and Asia*. Watertown, MA: SatelLife.

Shankar, A., L. Bartlett, et al. (2008). "Delivery on MDG 5 by active management with data." *The Lancet* 371(April 12, 2008).

Shields, T., A. Chetley, et al. (2005). ICT in the health sector: Summary of the online consultation.

InfoDev Working Paper. www.infodev.org/en/Document.84.aspx

The Economist (September 15, 2005). "The doctor in your pocket."

The Economist (March 24, 2006). "A text a day."

UNICEF (2008a). *Progress for Children: A World Fit for Children Statistical Review.* New York: UNICEF.

UNICEF (2008b). *Progress Report for Children: A Report Card on Maternal Mortality*. New York: UNICEF.

United Nations (2000). "United Nations Millennium Declaration" (General Assembly Resolution 55/2). New York: United Nations.

Verclas, K. and P. Mechael (2008). *A Mobile Voice: The Use of Mobile Phones in Citizen Media.* New York: MobileActive.org. <http://mobileactive.org/mobile-voice-use-mobile-phones-citizen-media>.

Vodafone (2006). *The role of mobile phones in increasing accessibility and efficiency in healthcare.* London: Vodafone.

Wireless Healthcare (2005). *101 Things to do with a Mobile Phone in Healthcare*. <http://www.wirelesshealthcare.co.uk/wh/report_101.html>.

World Health Organization (1946). *The Constitution of the World Health Organization.* Geneva: WHO.

World Health Organization (1978). *Declaration of Alma-Ata. International Conference on Primary Health Care, Alma-Ata, USSR*. Geneva: WHO.

World Health Organization (2005). *eHealth Tools and Services: Needs of Member States*. Geneva: WHO.

World Health Organization (2006). *The World Health Report 2006: Working Together for Health*. Geneva: WHO.