COMMENTARY

OPPORTUNITY IN DELIVERY OF HEALTH CARE OVER MOBILE DEVICES IN DEVELOPING COUNTRIES

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Kenya Development Network and Consortium: **Implications of mHealth**

OPPORTUNITY IN DELIVERY OF HEALTH CARE OVER MOBILE DEVICES IN DEVELOPING COUNTRIES

Access to health is a human right [1, 2]. Part 1 of Article 25 of the Universal Declaration of Human Rights stipulated that everyone has "the right to a standard of living adequate for the health and well-being of himself and of his family" [3]. To ensure access to health by everyone requires a high level of creativity in developing processes with potential to reach places where motor vehicles and similar expensive technologies cannot reach [4]. Viable alternatives remain unclear without firm leadership in addressing inadequate access to health of the poorest populations [5].

Health information can be transmitted through portable or mobile devices to extend the reach of health services to remote locations because such devices have the capability to create, store, retrieve, and transmit health data in real time between users [6]. From technological standpoint, health information can be loaded on a portable device such as a cellular telephone (cell phone) fitted with software applications for managing patient data. The patient information so loaded then flows over wireless networks, from one portable device to another. mHealth is the name used to refer to the concept of delivery of healthcare services over mobile devices.

Portable devices enabling transportability of software applications that can manage patient information could increase the reach and power to deliver health care services to the remotest areas possible. Because of ease of portability, mHealth has the potential to reach people living in most rural conditions where paved roads are scarce or do not exist [7]. This power-to-reach creates major opportunities to deliver high quality health care services to millions of people who would otherwise never have access to care. This power also ushers in potential for wealth generation for local people living in developing countries and for international investors [8]. Reaching the underserved people in rural areas is a difficult challenge because of the paucity of healthcare providers in these countries [9]. These factors enhance the feasibility of mHealth as an ideal mechanism for delivery of healthcare services in remote locations in developing countries.

BACKGROUND OF THE OPPORTUNITY

The business potential of mHealth encompasses the 2.4 billion mobile subscribers [10, 11]. This number of mobile subscribers is projected to increase to three billion by the end of 2009, connecting one-half of the global population [12]. Much of this growth will come from new subscribers in countries such as India, China, Africa, and Latin America. The number of mobile subscribers dwarfs any other means of reach. For example, there are only 11 million hospital beds in all developing countries [13]. The number of mobile phones even dwarfs the 305 million computers in Africa that would serve as a platform for telemedicine services. The ubiquity of the mobile phone renders it a powerful device for extending healthcare to the most rural areas of the planet [14].

Despite this tremendous power-to- reach, the general problem is that we are not close to achieving the health-related targets of the Millennium Development Goals (MDGs) set for 2015 [15]. The fact that each year, millions of children die from preventable diseases is disheartening, but at the same time illustrates the magnitude of opportunity to do good with appropriate investment and use of mobile technology. Many children continue to die due to lack of access to routine immunization programs, education programs, and health campaigns. Hundreds of thousands of women die because of complications at childbirth. Millions succumb to infectious diseases. Maternal mortality has stagnated for two decades, child mortality is not declining fast enough, HIV/AIDS still infects people faster than the pace of distribution of antiretroviral treatment; health inequalities are widening within and across countries [16]. Insufficient resources, lack of adequately trained staff, and frequent shortages of critical vaccines and medicines characterize much of the health care system in the developing world [16].

Mobile phone technology could help to overcome these global health challenges in several ways. First, mobile devices could serve as a simplified clinical assistant that would allow clinicians make a diagnosis using an electronic algorithm loaded on the mobile devise. When a clinician inputs patient clinical history and physical examination data, such an algorithm could lead to a set of differential diagnosis, and suggest a plan of action. Second, the mobile devices could serve as a payment system that would accept payments for clinical services through an electronic funds transfer application loaded on a mobile device. Such a mechanism would enable patients to pay clinicians directly without the need to travel long distances to pay for clinical services.

Third, the mobile device could serve as a platform for collecting epidemiological data using electronic forms. Such data could be good for benchmarking clinical services, disease surveillance, treatment effectiveness, or any other purposes that the user could find useful. The data so collected could be available for use by government officials, non-governmental organizations, and even private businesses for strategic decisions. The goal of health delivery in rural areas of developing countries includes monitoring chronic diseases such as diabetes, hypertension, cardiovascular diseases, cancers, and infection with human immunodeficiency virus. Chronic disease monitoring delays or slows the progression of disease related complications, reducing the financial burden of disease related care and treatment, and improves the quality of life for the patient and his or her family.

Fourth, the short messaging service (SMS) with a communications protocol that allows interchange of short text messages between mobile devices could be a useful tool for communication among health workers, and between health workers and patients. Health workers in remote locations could use the SMS for education and training through long-distance learning programs. Workers could use the SMS to stay abreast of health alerts, and to communicate directly with patients. Effective

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interactions with patients via telephone, telehealth, instant messaging, and monitoring devices help providers manage chronic disease from a distance. Providers can adjust patients' medications according to algorithms, coordinate referrals of patients to the community healthcare setting or district hospital, and deliver disease based education programs via the mobile phone technology set up between patient and provider. Patients can receive care in their homes while not having the burden of traveling to the provider location. As an added benefit, patients with chronic diseases could be monitored more closely than if they had a monthly appointment with a provider in the office. This close monitoring would reduce the need for hospitalizations and emergency room visits, ultimately reducing the overall healthcare costs.

mHEALTH AND COMMUNITY HEALTH CENTERS

Community health centers (CHCs) in rural Africa provide primary health services to the rural people. Limited access to clinical services due to long distance of travel and shortages may contribute to suboptimal outcomes of care among the CHC patients [17]. Since transportation costs are prohibitive, use of mobile phone devices can increase access to health services for patients receiving care in CHCs. Mobile technology could keep as many patients as possible in the village, and in the community health centers, and to the district hospital if the diagnosis or care is not possible at the community health center.

Community Benefits

Chronic diseases affect communities. Communities are facing issues of a growing population of people with chronic diseases, few or nonexistent clinical providers, and more complex management concerns of people with chronic diseases. Health care workers are overworked and are not accessible by patients. Reaching the underserved population is difficult so many patients die undiagnosed, or lose their power for diagnosis.

Communities can benefit by reducing costs of management of disease through mHealth. For example, diabetic concerns could be handled at home with a consultation via mobile phone applications. Health care workers can review patient data remotely with the patient. More frequent mHealth visits can help patients reach their health goals. Patients also have a place to call if an acute illness arises. Patients and families enhance their self-efficacy and improve decision-making and healthcare status, therefore, reducing community costs of care and misuse of patient and health worker's time.

BARRIERS TO IMPLEMENTATION

Poor infrastructure complicates development and management of health delivery systems in African countries. The advent of mHealth minimizes the need for expensive physical infrastructure. The idea is to strengthen health systems using innovative mobile technology. Mobile technology cannot solve the entire problem of

global health, but represents a significant step forward. Remaining challenges include the complexity of health systems, which requires coordination of water and sanitation, civil service reform, and health financing policies. The interdependence of the disparate systems with a broad range of cross-sector issues demands greater creativity. Because of this system interdependence, the emergence of a robust mHealth system mandates abroad range of local and national partners.

The use of mHealth applications requires health literacy skills. Patients cared for via mHealth must be able to understand and interpret basic health information in ways that enhance health. Patients must understand their medication, nutrition, and treatment regime to manage their disease. mHealth applications can enhance this knowledge, but patients with low health literacy are less likely to use technology for information health information.

Cultural diversity and language in developing countries are limitations of mHealth applications. Various cultural values, belief systems, and customs affect how patients are willing to care for their health. Customizing mHealth applications to meet the needs of this diversity is one solution.

Access to mHealth technology is another drawback. Mobile phone consumes chargeable minutes; extra minutes needed for medical consultation may not be affordable to many people living in developing countries. Mobile operators generate significantly less revenue from customers in emerging markets than they do from customers in more developed regions [12]. For example, major carriers in the U.S. can expect to bring in about $50 in revenue per subscriber per month. Brazil's 80 million people have a family income of less than $400 per month. In this population, telephone companies expect between $3.50 to $7 in revenue per user per month [12].

Mobile phone manufactures are careful when developing equipment, to avoid cost overruns that would be too pricey for local consumers in developing countries. For example, Nokia's work in Africa in partnership with Entrepreneurial Programming and Research on Mobiles (EPROM), has proven demonstrated potential for real profits from low-cost phones in designed and programmed, and assembled in laboratories in Universities in Africa. [11]. Nokia is the largest maker of handsets in the world, and EPROM is a part of part of the Program for Developmental Entrepreneurship at Massachusetts Institute of Technology, Cambridge MA.

Lack of education is another barrier to effective use of mHealth applications. Education is related to a person's risk of developing a disease. Less educated patients frequently make unhealthy lifestyle choices and are less likely to utilize mHealth applications. Patients with less education are also less likely to turn to mHealth applications for information on healthier lifestyle choices, disease management, and remote consultation with a provider.

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Financial Ramifications of mHealth

One benefit of mHealth is that it reduces face-to-face service utilization. By targeting interventions for the individuals served, mHealth may be cost-effective for a larger proportion of diabetics. Even with all the financial constraints, the sheer volume of subscribers in poor and underdeveloped regions of the world has allowed carriers to make money on services, even if these cost just a few dollars a month. For example, 59% of these 2.4 billion people live in developing countries, making cell-phones the first telecommunications technology in history to have more users there than in the developed world [11]. Mobile phone shipments grew 19 percent to 810 million units in 2005 and are expected to rise by 15 percent to 930 million units in 2006. Cellphone usage in Africa is growing almost twice as fast as any other region and jumped from 63 million users two years ago to 152 million today. mHealth services have a profound effect in communities. Ten mobile phones per 100 people advance the GDP by 0.6 percent a year [11].

As penetration increases in developing areas, some carriers are creating services with specific importance to the people who live there. This includes introduction of services such as mobile banking, which enables people who do not have bank accounts to use cell phones to transfer money. Operators in the Philippines and in Africa have already begun experimenting with such a business model.

Ethical and Legal Implications

Privacy, security, and confidentiality are issues concerning patients and providers of mHealth applications. The 1996 Health Information Portability and Accountability Act (HIPAA), which protects personal health information, has providers concerned about violations when using electronic communication. Whether real or perceived, this concern is an obstacle preventing providers from using mHealth applications in large numbers.

Implications to Patient/Provider Relationship

mHealth applications have the potential to enhance the provider/patient relationship. Communication using electronic mediums can improve continuity of care, quality of care, and efficiency. Electronic communication can be used for prescription refill requests, test results, and non-urgent medical information or advice. Using electronic communication frees the provider's time. Patients can receive care without the boundaries of the regular clinic hours. Control of a disease can be achieved by closer monitoring of activities of patients and families over mobile devises.

OPPORTUNITY FOR INNOVATION

Resource-poor settings will drive innovation, by demanding less expensive, and easier to use ingenious product designs that require fewer infrastructure [4, 18, 19]. Hart [18] observed that it is easier to disrupt the technological status quo in the absence of entrenched commercial interests. Disruption of technological status quo is

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hard to achieve in a centralized system organized around existing products [4]. The high-cost, high-tech centralized medical facility model commonly found in developed countries is of limited use in poorer countries. Where these facilities exist in developing countries, they serve the affluent, urban population and are not accessible to the majority of rural inhabitants. Most primary health care services at the periphery, in many instances are less than basic equipment, health-care workers have little training, power and water supplies are tenuous, and capacity is limited for maintaining complex equipment and handling fragile reagents.

Local entrepreneurs contribute to an increase in cell phone utilization with their innovative use of mobile phone technology. Mobile phones are used in Africa for a wide variety of tasks, ranging from sending money to family members to buying a fish from the market. Kenyan businesspersons, farmers, and laborers, for example are finding new uses, and are coming up with original methods for solving local problems. For example, access to market information through mobile phones provides rural communities with information about centers of business in Nairobi and Mombasa (Alex Njoroge, personal communication, May 12, 2009). Anglers in Kisumu check fish prices in Nairobi on their phones before they can send the fish to the market. Contract workers provide their phone numbers to potential employers and go to attend to other matters in another location as they wait for jobs to arise (Alex Njoroge, communication). The Kenya Agricultural Commodity Exchange (KACE) presently furnishes growers with commodity information updates via text message. Farmers have daily access to produce prices from multiple markets. Many farmers have multiplied their earnings because they have access to information about potential buyers and prices before making the long and hard journey into urban centers to sell their produce.

The community payphone is another innovation unique to the developing world that helped bring mobile phone usage to the poorest areas of Africa [20]. Entrepreneurs who buy airtime from the network own and operate community payphones. They sell services to local people who do not own phones. The Communication Commission of Kenya, reported installation of more than 5,000 community phones by the end of 2004 [21]. The community phone model raised access to phone to 97% of Tanzanians, despite the lack of electrical infrastructure in the country. The community payphones serve remote areas best. They are easy to maintain, powered by car batteries or solar power. This rapid organic uptake of mobile phone technology in Africa is a testimony of thirst among the people in the continent to connect to the rest of the world, and is an excellent platform to deliver health services.

NEW VISION

The Kenya Development Network and Consortium (KDNC) is bringing together key stakeholders of health and human development to create a community of practice interested in mobile technologies to think about innovative ways of using mobile technology for healthcare delivery in Africa. KDNC proposes that we create

exceptional approaches that will bring mobile technologies to the agenda for global health and human development. The global health community must focus on creative applications for mobile technology to think about the role of mobile technologies. Effective use of health workforce on the mHealth may produce both improved health-system performance and improved health outcomes. Strategies for training are requisite to success. KDNC hopes to create strategies for continued investments in mHealth by creating carefully constructed public private partnerships.

Evaluation of these exciting developments will be at the spotlight during the KDNC Eighth Conference slated for March 22-26, 2010, in Orlando Florida [22]. The theme of the conference is global health, technology, and business. The purpose of the conference is to explore the use technology and entrepreneurship to improve health delivery in developing countries.

Partnerships for Health

In the past, partnerships for health provided a creative means for the industry to join the public in solving some of the world's most vexing problems such as development of new drugs for neglected diseases, specialized diagnostics, and delivery devices. The design of such public-private partnerships allowed the industry to remain true to its commercial purpose, while serving monumental public need.

These partnerships took many forms, involving highly creative approaches to management of intellectual property rights, negotiation of affordable access, and shared risk taking. The win-win partnerships created room for the public sector to support certain costs of product development, and helped to lower some of the business risk. The private sector manufactured products and availed them to low-resource markets through various mechanisms such as dedicated supply of products or preferential pricing on the product. Such partnerships allowed rapid expansion of services to the remote locations in developing countries.

Partnerships for mobile technology may extend the reach of health services to remote areas in developing countries. One example is Entrepreneurial Programming and Research on Mobiles (EPROM), a university program at Massachusetts Institute of Technology, for teaching mobile programming in sub-Saharan Africa. EPROM is largely funded by Nokia, and empowers African computer science students to develop mobile phone applications for their own communities. A coupled commercial venture called txteagle is designed to monetize the services and skills available in rural areas in Africa through the mobile phone. The skills monetized by txteagle include transcription and language translation skills available among the local populations.

EPROM partnership started at the University of Nairobi in Kenya, expanded out to Makerere University in Uganda, Graduate School of Telecommunications, and Information Technology [GSTIT] in Ethiopia, Kenyatta University in Kenya, and the Kigali Institute of Science and Technology in Rwanda. The program currently

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involves universities in 12 countries training thousands of students about mobile phone programming.

CONCLUSION

When healthcare is limited or non-existent or as accessibility to healthcare decreases the need for technology increases to fulfill an important disease control and patient care needs. Technology, used correctly, can bring together clinician and patient to better manage the healthcare needs of the patient. mHealth technology could decrease the cost of healthcare and provide the clinician and the patient more flexibility in managing health and reducing the global burden of disease.

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