Unite For Sight Overview

mHealth Technology in Global Health

mHealth is the use of mobile telecommunications and wireless multimedia to integrate and develop successful health care delivery systems.(1) It combines two distinct factors present within the context of developing nations: the inherent need for improved health care delivery and the increasing penetration of mobile phones to the most rural areas.(2) Mobile networks cover more than 90% of the world’s population, and the proportion of mobile phone users already outweighs those without one.(3) While Internet services require ground infrastructure, connection junctures, and heavy equipment, mobile telecommunications provide an additional benefit of wireless and hands-free technology that can be maximized in developing health care systems.

There are a variety of ways in which mHealth can potentially be used to provide health care services.(4) Effective implementation, however, adds a new level of complexity, as simple phone dissemination to patients and/or health care personnel will not improve health outcomes alone. Some key areas of focus include:

1. **Improving patient compliance**

There is potential to improve adherence by direct reminders to patients via voice calling or SMS. Likewise, wireless technology utilizing phone networks can be used. A 2007 pilot study in South Africa demonstrated that patient compliance can jump to over 90%, in areas previously recording 22-60% compliance, when using a mobile device known as SIMpill.(5) SIMpill is a medication container that interacts with an assigned mobile phone to remind the patient when he or she has not taken the next dosage. Repeated or missed dosages are brought to the attention of health care workers, who then follow-up with the patient and arrange for an in-person visit.

For diseases with highly complex treatment systems such as HIV/AIDS and TB, having a point-of-contact with a key provider allows the patient increased autonomy and reliability. This is one distinct area where clinical evidence has demonstrated the impacts of mHealth technology on disease outcomes, partly due to the capacity to link demonstrated behavioral change in compliance to improved outcomes.

Developing countries are facing an increasing “double burden” of traditional communicable diseases and chronic (or so-called “lifestyle”) diseases. This epidemiologic transition can be seen as a direct result of the economic development over the last fifty years, in which diseases associated with Western lifestyle (diabetes, hypertension, cancer) have spread to developing nations through an increase in the availability of high-fat foods, tobacco, and alcohol.(6) Non-communicable diseases require long-term care strategies. In the context of poorly-developed health systems and poverty, such long-term strategies may be particularly difficult to provide or advocate for, as many of the behaviors are associated with greater wealth and social status within communities.(7) Chronic diseases require lifestyle interventions and self-care, which has notoriously low compliance even in the most developed nations.

It is in this field that mHealth could potentially provide the greatest impact. The components of mHealth technology would grant patients the long-term support needed during treatment, without jeopardizing patient autonomy. By beginning to develop mHealth solutions to these non-communicable diseases now, technology can be maximized as a preventive measure that would reduce the burden of advanced illness.

1. **Disseminating health information among the community**

Information may be distributed through text message services, voice calling, or e-mail as a method of delivering care. It has been recognized that primary prevention is key to the reduction of disability and disease, and mHealth technology provides an effective channel to fulfill this objective. As mobile phones become one of the first technologies to reverse the digital divide, care must be taken to ensure that information being received is accurate and interpreted correctly; otherwise, there exists a risk of acting upon misleading or false information.(8)

Communication may be provider-to-provider (i.e. between health care services), provider-to-patient or patient-to-patient. Messaging can connect people to the appropriate services and also act as a search engine to seek care, potentially increasing choice and marketability among health care providers.

1. **Remote diagnosis and support for on-the-ground health care workers (“Telemedicine”)**

Medical imaging is just one field of care that can be provided to areas lacking sufficient health personnel, as specialists can access diagnostic images and case histories from remote locations (i.e. distant health care facilities).(9) Advice and assistance can also be shared in complex medical situations, with the ability to seek emergency help if necessary. By creating a medium for exchanging health information at a distance, telemedicine has been able to help circumvent some issues of acute labor shortages in developing countries. Although innovations in telemedicine have been increasingly adopted by health systems of developed countries, initiatives remain overwhelmingly in pilot or informal settings among developing countries. The MDNet Ghana program (see below) is one of the more successful examples, showcasing how simple mobile technologies may be used to fill physical gaps in health care delivery.

1. **Health records: web-based data entry and disease surveillance**

mHealth allows improved notification and tracking of disease spread. Initiatives like Medic Mobile that have implemented programs such as Patient View (see below) have been frontrunners in this developing technology. Yet, for the most effective application, community data should be integrated with national databases and used to develop appropriate patient record systems. Unlike many of the other aspects of mHealth, this particular area has been most broadly initiated in the African region.(10)

1. **Emergency Response**

Citizen reporting during emergency situations can become a reliable source of timely information, while offering comfort to individuals in need. Most developing countries do not have an organized emergency number, and therefore rely on private contractors, such as “Dial 1298 for Ambulance,” a private company based in India that services both wealthy and poor consumers with a scaled system of payment.(11)

Another prime application of m-Health technology to emergency response occurred in the aftermath of the 2010 Haitian Earthquake. Ushahidi, FrontlineSMS, and SamaSource collaborated to create a logistics map using SMS alerts for missing people or immediate humanitarian needs.(12)

The benefits of m-Health are numerous. The application of mobile technology in health care builds on existing supply chains in telecommunication systems, brings access to remote areas that may lack physical infrastructure and health care providers, and promotes the propagation of health information. There is evidence that contact by SMS can increase patient compliance for treatment regimens combatting diseases such as TB and HIV, both of which require strict adherence for successful outcomes.(13) Meta-analysis in literature has demonstrated a link between mHealth and attainment of the Millennium Development Goals, particularly those in areas of child mortality, maternal health, and HIV/AIDS.(14)

Current Situation

Impact assessment remains at a pilot stage, particularly in low-income countries. Rigorous evaluation is necessary before any wide-scale interventions are put into place, with peer-reviewed clinical trials, natural experiments, and study into the DALY (disability-adjusted life year) cost of these interventions. To ensure sustainability, technologies in the field of mHealth need to be adopted and refined by global organizations such as the World Health Organization (WHO), who can take responsibility for management of the sector.(15) Yet, involvement by these larger, blanket organizations may not come into play until the appropriate analysis is available, resulting in an under-utilization of mHealth technology. Integration is the key, primarily between governments and the private sector and within the NGOs themselves, as currently there is significant overlap between differing organizations.

mHealth remains most widely available in high-income countries, with many of the projects being delivered in the low-income block still at pilot or informal stages. 83% of WHO member states have reported using an mHealth service, however, competing system requirements were highlighted as a major barrier to further implementation.(16)

Despite the competition with smart phones, Personal Digital Assistants (PDAs) are still being recognized as a beneficial mode of m-Health technology.(17) There exists a need for further study on the variety of pilot projects that have been carried out over the last few years. The impact of such projects are often difficult to determine, and their scale often not yet large enough to provide meaningful results, without taking the broader picture into account.

It has emerged from various trial applications of mHealth devices that there is a real need for integration among technology.(18) Health care workers have documented preferences for a system in which multiple functions can be carried out using the same technology (see Project Mwana case study below).(19) Unfortunately, many trials thus far have focused only on the implementation of technologies with isolated functionalities due to financial restraints. The potential to integrate many functions into one device or system would increase ease of access and also greatly improve the cost-effectiveness of the network as a whole.(20) A large deployment of mHealth solutions is the next step in scaling up this technology.

Many applications thus far still rely on an Internet-based management system, instead of a system based on telecommunications that does not require constant modem connection.(21) For mHealth technologies to be effective in the long-term, particularly in areas of low internet availability, they need to run independently of broadband infrastructure. Otherwise, restricted broadband connection becomes the limiting factor in effective use.

Privacy

Significant issues have been raised relating to the possible breaches of privacy that can result with the use of mobile technologies. mHealth can serve as an effective mechanism for providing information remotely about concerns of sexually transmitted infections, HIV/ AIDs, family planning, and domestic violence – topics perceived to be sensitive among society. Despite the application of this information to improving individual and population health, the dissemination of information over an unfamiliar network can create problems in patient sense of confidentiality.

A 2007 Nokia survey of emerging markets noted that 50% of respondents in India were open to the idea of sharing, whereas the practice of phone renting was otherwise commonplace in areas of the world.(22) In either case, the passing of phones between hands adds an extra challenge to the delivery of health-related information by mobile technology.  To address this challenge, various iterations of technological programs have used codes within SMS messages to disguise sensitive phrases such as HIV/AIDS or drugs.(23) Using codes only recognizable to the patients has provided one solution to navigating mobile technology.

Additional Benefits

There is the viewpoint that significant investment in m-Health may benefit the development of local software and telecommunication industries. This is because the proper function of such technology will require platforms tailored to local capacities and needs. Yet, there are constraints in the design. It is not sufficient to merely distribute cellphones; successful programs must include a support platform that integrates their usage into the community. For instance, back-up mechanisms should be in place to handle problems in loss of electricity or breakage.  mHealth has been a frontier in closing the gap in access to healthcare, eliminating the logistical challenges that have plagued patients from the “last-mile” access to care. Despite the advances provided by such technology, there is worry that clinical practice could lose the element of human interaction.(24)

mHealth in the Context of Technology

mHealth is unique in that it is both a technology and a means by which other technologies can be distributed or supported. As with programs such as Medic Mobile and Child Count+, there is ample opportunity for integrated and effective design of mHealth software systems that are relevant in the low-income context. Often, these remain as open source designs, allowing local innovators to manipulate software to fit within local requirements.(25) One challenge to this framework is that the lack of a common design or technology makes it difficult for potential users to scale up or down cohesively.

Case Study: Cell-Life Aftercare in South Africa

Described as “one of the most experienced initiatives combining mobile phone technologies and AIDS management,” Cell-Life is a data collection and support network for patients suffering from HIV/AIDS in Cape Town, South Africa. Health care workers visit patients in their homes to collect data, which then are imported to a central server to be managed appropriately. Reminders and instructions are sent back to patients through community health care workers, or directly to personal phones themselves.(26)

Case Study: Medic Mobile

Medic Mobile is a non-profit organization that develops new and existing tools to coordinate health systems in developing areas. Particular tools include FrontlineSMS, an open-source software program to send mass text messages to any mobile phones operating with an available signal. OpenMRS Messaging Module similarly develops modules to send patient messages about medication, field data, and reminders. Patient View establishes a simple electronic medical record system useful for small-staffed clinics, and CelloPhone has been revolutionary in its ability to perform diagnostic tests on the back of a camera phone using LUCAS imaging to “take cellular-level images of blood or other liquids without complex lens systems or microscope hardware.”(27) These and other novel technologies have leveraged existing communication technologies to advance health systems and interaction between clinical and field staff.

Trial studies held at St. Gabriel’s Hospital in Namitete, Malawi, suggested that fuel savings alone far outweighed the cost of implementing and maintaining the technology, while estimates of worker-hours saved from the mobile text messaging system totaled around 2000 hours for a 6 month period.(28) Time saved from increased efficiency in technology also allowed physicians to increase their enrollment of tuberculosis patients, a great benefit for an area where the need for treatment consistently surpasses available resources. Although the actual outcomes on patient health are difficult to evaluate from this information, the efficiency of the system is vastly improved. With such significant labor shortages in many developing nations, productivity of health resources is integral essential. Thus far, FrontlineSMS technology is being used by twenty different projects in ten countries, engaging an estimated 1,500 community health workers in rural areas.(29)

Case Study: Child Count+

A two-way mobile-based platform developed by the Millennium Villages Project, Child Count+ is used as a technology for health reporting, feedback, and alert system to gain field-level data. With the objective to improve child survival and maternal health, Child Count+ has developed formats to follow-up on births, deaths, health status of pregnant women and newborns, children under 5, and adult management of tuberculosis, malaria, and non-communicable diseases.(30) It works as an integrated system, linking individual patient records with broader, population data for use in policy decisions.(31) At the user-level, iterations of the system have applied consultations with community health workers to best suit local needs and empower individuals to use a system that would benefit community health and reporting.

Case Study: Mobile Doctors Network (MDNet)

An example of telemedicine in Ghana, MDNet enables free voice calls and SMS messaging among physicians registered under the Ghana Medical Association. The program issued 1600 free SIM cards, allowing individuals to contact other colleagues within the network. Interestingly the program emerged as an mHealth initiative following the failure of a previous eHealth pilot from lack of internet infrastructure in remote areas of the country.(32) Through MDNet, costs for medical consultations were removed, facilitating the referral process and creating communication links between previously isolated parts of the country.

An essential part of the pilot’s success was credited to the established links within institutions in Ghana.(33) For instance, the Ghana Medical Association facilitated efforts and created the base of users (providers), and telecommunications providers who were incentivized by the exchange allowed overhead costs to remain low. It is hoped that once the program is modified according to different localities, the model may become scalable across Africa.

Case Study: Project Mwana

Project Mwana was a UNICEF Innovation initiative, working with the Zambian Ministry of Health, Boston University, and the Clinton Health Initiative to implement a more effective method of reporting infant HIV-test results from distant labs to the local health facilities. Prior to the project, Zambia had begun a nationwide Early Infant Diagnosis (EID) program to test for HIV. Yet, a barrier to early treatment on antiretroviral (ARV) medication was the logistical challenge of relaying positive-test results back to the facility caring for the patient. Children started on ARV treatment before 12 weeks of age have a 75% lower mortality rate than those who are delayed.(34) As such, rapid transportation and communication of results are imperative.

In a pilot study now being scaled, RapidSMS technology was used to deliver results from reference labs back to the health facilities. It was discovered that the technology cut wait time by 57%, a notable reduction amidst rural clinics when comparing turnaround time before and after SMS introduction.(35) Thirty % more results were received by SMS than by traditional paper system. Although minimal data is able to link the delivery of results to the rate of treatment and effectiveness in preventing HIV/AIDS among patients, the project has made great strides in increasing rate and efficiency of health information systems. When evaluated for user-friendliness, the system had high rates of adoption and seemed to be well-liked by staff among the 31 pilot clinics. Areas of improvement include poor network coverage in some areas and the risk of system crashes. Yet, demand for such technology remains, with the desire to scale-up SMS technology for usage among other health care workers and strategies.

**Footnotes**

(1) Kahn, J.G, Yang, J., Kahn, J.S. “Mobile Health Needs and Opportunities in Developing Countries.”Health Affairs 29.2(2010): 254-261.

(2) Kinkade, S. and K. Verclas. “Wireless Technology for Social Change.” Washington, D.C and Berkshire, UK: UN Foundation–Vodafone Group Foundation Partnership. 2008.

(3) UNCTAD (United Nations Conference on Trade and Development). Information Economy Report 2007-2008. UN Publications (2008).

(4) Kinkade, S. and K. Verclas. “Wireless Technology for Social Change.” Washington, DC and Berkshire, UK: UN Foundation–Vodafone Group Foundation Partnership. 2008.

(5) Vital Wave Consulting. “mHealth for Development: The Opportunity of Mobile Technology for Healthcare in the Developing World.” Washington, D.C and Berkshire, UK: UN Foundation - Vodafone Foundation Partnership. 2009.

(6) Beaglehole, R. “Globalisation and the prevention and control of non-communicable disease: the neglected chronic diseases of adults.” *The Lancet* *362(2003):* 903-908.

(7) Kahn, J.G, Yang, J., Kahn, J.S. “Mobile Health Needs and Opportunities in Developing Countries.”Health Affairs 29.2(2010): 254-261.

(8) Mechael, et. al. “Barriers and Gaps Affecting mHealth in Low and Middle Income Countries: Policy White Paper.”  Center for Global Health and Economic Development. Earth Institute, Columbia University. mHealth Alliance, May 2010. Accessed 16 Dec 2011.

(9) Kahn, J.G, Yang, J., Kahn, J.S. “Mobile Health Needs and Opportunities in Developing Countries.”Health Affairs 29.2(2010): 254-261.

(10) World Health Organization. “mHealth: New horizons for health through mobile technology: second global survey on e-Health.”WHO Press: Geneva (2011).

(11) Mechael, et. al. “Barriers and Gaps Affecting mHealth in Low and Middle Income Countries: Policy White Paper.”  Center for Global Health and Economic Development. Earth Institute, Columbia University. mHealth Alliance, May 2010. Accessed 16 Dec 2011.

(12) World Health Organization. “mHealth: New horizons for health through mobile technology: second global survey on e-Health.”WHO Press: Geneva (2011).

(13) Vodafone Group. “The Role of Mobile Phones in Increasing Accessibility and Efficiency in Health Care.” Vodafone Group Policy Paper Series.Newbury, UK: Vodafone Group (2006).

(14) Tamrat, I., Kachnowski, S. “Special Delivery: An Analysis of mHealth in Maternal and Newborn Health Programs and Their Outcomes Around the World.” Healthcare Innovation and Technology Lab. New York (2011).

(15) World Health Organization. “mHealth: New horizons for health through mobile technology: second global survey on e-Health.”WHO Press: Geneva (2011).

(16) Ibid

(17) Mechael, et. al. “Barriers and Gaps Affecting mHealth in Low and Middle Income Countries: Policy White Paper.”  Center for Global Health and Economic Development. Earth Institute, Columbia University. mHealth Alliance, May 2010. Accessed 16 Dec 2011.

(18) Ibid.

(19) Project Mwana Blog. Accessed 15 Dec. 2011.

(20) World Health Organization. “mHealth: New horizons for health through mobile technology: second global survey on e-Health.”WHO Press: Geneva (2011).

(21) Mechael, et. al. “Barriers and Gaps Affecting mHealth in Low and Middle Income Countries: Policy White Paper.”  Center for Global Health and Economic Development. Earth Institute, Columbia University. mHealth Alliance, May 2010. Accessed 16 Dec 2011.

(22) Ibid.

(23) Ibid.

(24) Kahn, J.G, Yang, J., Kahn, J.S. “Mobile Health Needs and Opportunities in Developing Countries.”Health Affairs 29.2(2010): 254-261.

(25) Mechael, et. al. “Barriers and Gaps Affecting mHealth in Low and Middle Income Countries: Policy White Paper.”  Center for Global Health and Economic Development. Earth Institute, Columbia University. mHealth Alliance, May 2010. Accessed 16 Dec 2011.

(26) Cell Life. (2009). Accessed 7 Dec. 2011.

(27) MedicMobile. Accessed 14 Dec. 2011.

(28) Mahmud, N., Rodriquez, J., Nesbit, J.“A text message-based intervention to bridge the healthcare communication gap in the rural developing world.”Technology and Health Care18(2010): 137-144.

(29) MedicMobile. Accessed 14 Dec. 2011.

(30) ChildCount+. Accessed 23 Dec. 2011.

(31) Mechael, et. al. “Barriers and Gaps Affecting mHealth in Low and Middle Income Countries: Policy White Paper.”  Center for Global Health and Economic Development. Earth Institute, Columbia University. mHealth Alliance, May 2010. Accessed 16 Dec 2011.

(32) World Health Organization. “mHealth: New horizons for health through mobile technology: second global survey on e-Health.”WHO Press: Geneva (2011).

(33) Ibid.

(34) Kochi, E. Project Mwana (Abstract). Accessed 15 Dec. 2011.

(35) Project Mwana. Accessed 15 Dec. 2011.