Chapter 3

mHealth

Nicolas Friederici, Carol Hullin, and Masatake Yamamichi

Calling a doctor is a natural response to getting sick in most of the developed world, but that is not always an option in many developing countries. The spread of mobile phones in developing nations promises to change that, however, by enabling health professionals to speak directly with their patients, to arrange health care services such as appointments, and to monitor symptoms.

This chapter is concerned with what happens once basic communications are widely available. How can mobile devices be used to enhance health care? How can mobile devices improve the efficiency and effectiveness of health care interactions between patients and immediate health care providers (such as doctors and hospitals), as well as between patients, providers, and other institutions involved with health (such as health information portals, insurance companies, and government agencies)?

Early on, the term mHealth was narrowly defined to mean wireless telemedicine involving the use of mobile telecommunications and multimedia technologies and their integration with mobile health care delivery systems (Istepanian and Lacal 2003).[1] However, this definition does not do justice to the wide variety of stakeholders and types of uses that mHealth spans today. In this report, a broader definition is adopted: "mHealth encompasses any use of mobile technology to address health care challenges such as access, quality, affordability, matching of resources, and behavioral norms [through] the exchange of information" (Qiang et al. 2012). It is a dynamic field for innovative new services that move health care away from pure public service delivery toward seeing the patient as a consumer. Mobile health software and services have proved to be versatile tools for collecting data at the point of action, potentially resulting in more accountable management of information in health care delivery, increasingly going beyond telemedicine.[2] Table 3.1 summarizes some of the more important mHealth categories.

Why mHealth? Opportunities and challenges

How can mobile communications help to achieve public and private health sector objectives, and what policies can help facilitate mHealth deployments? On the supply side, mobile communications can help provide health care services more quickly and cheaply in many cases, mainly by focusing on primary, preventive, and self-empowered approaches to health care. From the demand perspective, mobile phones can make it easier and more convenient not only to find relevant information quickly but also to enter health data and engage in interactive services, such as symptom tracking and online communities of patients.

For mHealth to deliver, mHealth application developers should ideally consult with medical or health informaticians trained to understand the information flows involved in health care processes.[3] At the same time, to reach a wider market and to achieve sustainability, many

Table 3.1 Major categories of mHealth services and applications

mHealth category	Typical fields of application	Description/use cases	Examples (and sources)
Improving management and decision-making by health care professionals	• Treatment of medical conditions • Prescriptions • Targeted provision of information and marketing about health care products[a]	• Remote patient tracking • Updating and verification of digital medical records, accessible to health care providers and pharmacists • Delivery of health insurance and savings products	• Moca (Celi et al. 2009) • 104 Mobile (see box 3.3)
Real-time and location-based data gathering	• Health care delivery and logistics • Crisis mapping • Resource allocation	• Monitoring and surveillance of disease outbreaks for more timely reporting of symptoms and containment of epidemics • Crisis mapping after natural disasters • Reporting of urgent health needs • Real-time provision with information on available health facilities and resources • Supply chain management • Access to health emergency services and rapid response systems	• RapidSMS in Somalia (Vital Wave Consulting 2011) and Ethiopia (see box 3.2) • Trilogy/International Federation in Haiti (Qiang et al. 2012) • Desert Medicine Research Centre Interactive Voice Response System in India (Chalga et al. 2011)
Provision of health care to remote and difficult-to-serve locations	• Remote provision of health care services • Extending the reach of health care • Complementing traditional face-to-face health care services	• Medical advice, reminders counseling, monitoring, simple diagnoses • Focusing on areas where only limited physical infrastructure is available, such as remote and rural areas, including telenursing, teleradiology, telepsychiatry, and tele-education.	• Remote mobile health care for rural communities in Sri Lanka (Perera 2009) • Moca (Celi et al. 2009)

Fostering learning and knowledge exchange among health professionals	• Medical knowledge repositories • Virtual communities • Event and conference organization	• Retrieving best practices, international standards, and patient histories from other health care professionals • Local communities • Expert crowdsourcing for health information wikis • Virtual classrooms, webinars, and the like	• RAFT network in Burkina Faso, Côte d'Ivoire, Mali, and Senegal (Vital Wave Consulting 2011)[b] • Moca (Celi et al. 2009)
Promoting public health	• Delivery of health information • Awareness building and campaigning • (Mass-oriented) tele-education	• Games, quizzes, and other nontraditional mechanisms • Conventional mHealth prevention and education campaigns • Medication reminders	• Text to Change in Uganda (Vital Wave Consulting 2011)
Improving accountability	• Transparency for usage of funds • Feedback systems	• Public health fund flow tracking • Interactive portals for comments and complaints	• Kgonfalo (see table 3.2), Botswana—UPenn Partnership (2012) • Transparency International in Northern Uganda[c]
Self-management of patient health	• Enabling better self-help and limiting transactions • Lowering health care costs (shifting tasks to the patient) • Patient empowerment	• Patients obtain accurate information • Patients can better understand their diagnoses, for example, by checking medical records • Mainly focused on noncommunicable diseases and may deal with health indicators such as weight and blood pressure	• MEDAfrica (see box 3.1) • Calorie Counter (popular downloadable app)[d]

a. See Patil (2011) for suggestions on how to integrate traditional product marketing concepts, as well as social marketing, into mHealth for developing countries.

b. RAFT (Réseau en Afrique Francophone pour la Télémédecine) http://www.who.int/workforcealliance/members_partners/member_list/hugraft/en/index.html.

c. http://www.ict4democracy.org/about/partnerproject-briefs/ti/.

d. The "Calorie Counter: Diet and Activities" was one of the 10 most popular Apple iPhone/iPad apps in 2011; see http://mobihealthnews.com/15229/top-10-iphone-medical-apps-for-2011/7/.

mHealth applications need to offer standardized services that can be delivered and accessed by nonexperts. Finally, mHealth should be integrated with larger eHealth programs and aligned with the delivery of offline health care services (box 3.1). So far, short message service (SMS) texting has probably been the most prominent mode of delivery (see table 3.1 and box 3.2), perhaps, according to some research, because texting is already an integral part of mobile usage culture (Gombachika and Monawe 2011). Increasingly, however, mHealth services are also offered as

Box 3.1 Kenya: A breeding ground for mHealth applications

Box figure 3.1.1 MedAfrica app

Kenya has emerged as a leading player in mobile for development, largely because of the success of the mPesa mobile payment ecosystem, based on local application developers, projects mounted by local nongovernmental organizations (NGOs), favorable governmental policies, foreign investment, and stable economic conditions. This active ecosystem has benefited the health sector, with many mHealth applications being piloted in Kenya.

Unfortunately, the proliferation of pilot programs, with diverse goals and stakeholders, has fragmented the Kenyan mHealth landscape: standardized platforms that are well-integrated with the local health care system are lacking; few projects have been endowed with long-term funding; and systematic evaluation and impact studies are scarce.

Only recently have more streamlined coordination and division of responsibilities started to emerge. Increasingly, the government is taking over mHealth implementation and ensuring that it complements national policy, while NGOs undertake research, monitoring, and evaluation. Kenya certainly offers an insightful repertoire of mHealth applications.

A recent notable effort is MEDAfrica.org, a company launched in November 2011 that is currently being incubated in the *info*Dev mobile applications lab in Nairobi (see chapter 5). The application integrates symptom checkers, first-aid information, doctor and hospital directories, and alert services into a single, customizable mobile information platform (see screenshot in this box). MEDAfrica won the East African application contest Pivot 25.

MEDAfrica is also pioneering a viable business model, which has attracted worldwide media and investor attention. Other Kenyan mHealth applications are based on remote monitoring or supply chain management through simple SMS technology. Examples include systems for HIV medication reminders, children's health monitoring, early-infant HIV diagnosis, and medicine validation through scratch codes.

Sources: Adapted from Qiang et al. 2012 and www.medafrica.org.

Box 3.2 Ethiopia: SMS helps in monitoring UNICEF's food supply chain

Box figure 3.2.1 RapidSMS in Ethiopia

Ethiopia faces significant challenges to effective performance in its health sector. The country is struggling to reduce maternal and child mortality, preventable communicable diseases, and malnutrition. While some policy initiatives have achieved notable success, Ethiopia is likely to meet only one of the six health-related targets under the Millennium Development Goals (MDGs) by 2015. Health care coordination, monitoring, and supply chain management are largely deficient. Funding is limited and well-trained health staff scarce.

In 2008 Ethiopia was hit by severe droughts, leading UNICEF to administer a large-scale food distribution program. Because of the country's poor telecommunication infrastructure and low technical literacy, however, inventory management at local distribution centers was arduous: teams of monitors had to travel back and forth to the centers to deliver hand-written reports of inventory. Inventory analysis could be started only after the data had been delivered, which often took several weeks. In response, UNICEF worked with RapidSMS, which helped cut delays in data transmission related to paper-based collection. Transmission times were reduced from about two months to approximately two minutes. Additionally, data quality discrepancies decreased from 14.2 percent to 2.8 percent while generating significant cost savings. In developing RapidSMS, UNICEF has shown that mHealth applications can represent a feasible low-tech response to challenging conditions such as those in Ethiopia.

RapidSMS was designed to be a simple supply chain management tool, which automatically integrates inventory information sent by SMS into a central database in real time. SMS technology is easily accessible and robust, and minimal training is needed to use the application. RapidSMS allows for stock taking, new admissions, precise location of distribution centers, and analysis of the quantities of food distributed and consumed. This analysis was sped up by immediate visualizations in graphs and maps, accessible by offices in all locations. Monitors still have to travel to distribution centers, but from there they can immediately send stock information to the server. Saving days in travel literally saves lives: UNICEF can respond to shortages and deliver new food resources more promptly, rapidly, and efficiently.

The RapidSMS system is a success story, but several issues arose, including a lack of standards for coding distribution centers, poor allocation of responsibilities, and slow resolution of technical issues. This experience underlines the need for ICT systems to be integrated into existing health care systems as well as the need for capacity building to use ICT effectively.

Source: Adapted from Vital Wave Consulting 2011.

voice-based systems (Chalga et al. 2011) or as specific applications that can be downloaded to a mobile device, as the MEDAfrica example in box 3.1 illustrates.

Optimism about the potential of mHealth is growing; indeed, its potential to be a cost-effective solution for health care in developing countries has led to a growing influx of funds, mainly from public sector and civil society donors (Vital Wave Consulting 2011). In turn, the funding is scattered and mHealth implementations are too often standalone pilot programs. Further, mHealth can help consumers and communities in the developing world keep themselves informed and take more control of their health choices.[4] The opportunities that mobile phones offer for health monitoring could mean that people will start thinking of their phones as personal digital assistants (PDAs) to take care of their health. In parallel, entry barriers for the supply of applications are often lower for mHealth than for other eHealth services or conventional delivery of health care, because small start-ups and local developers can develop mobile software with relatively few resources and can address a much wider potential user base. The shift from eHealth to mHealth can also create an opportunity for a shift from top-down to bottom-up approaches, from government to consumer initiatives, and from centralized to decentralized spending, if mHealth initiatives are effectively implemented.

However, the health sector remains both complex and challenging. The most relevant challenges to the greater uptake of mHealth include:

- *Insufficient financial resources.* Obstacles to comprehensive mHealth solutions are often financial, especially in the developing world. In particular, if no payment structures have been established, it is unclear who should cover the costs for mHealth in private health care (consumers, governments, insurance companies?). This is critical, since the largest part of the cost is often related not to the development of the mHealth application but to the integration of mHealth services with other health care infrastructure.
- *Lack of sustainable business models.* The roll-out of mHealth and other eHealth products and services needs sustainable business models and revenues. Besides a lack of public and private investments in developing such products and services, low-income countries often lack human resources and purchasing power on the demand side. Thus, business models cannot simply be adapted from the developed world but must be designed to match the scarcity of resources both on the demand and supply side.
- *Privacy and security concerns.* Typically, mHealth faces significant privacy and security concerns, with limitations on access to patient data that can complicate interactions between different systems such as primary care, emergency care, and insurance.
- *Limited evidence.* Reliable assessments on the impact of mHealth services are scarce, making it difficult to justify adoption and implementation.
- *Difficult coordination of stakeholders.* Orchestrating diverse private, public, and development sector interests for mHealth can be challenging. Clear roles have yet to be defined, and role models are lacking. The different stakeholders have different goals and strategies that often overlap and conflict, leading to frictions and inefficiencies.
- *Interoperability issues.* Piecemeal implementation of mHealth products and services has led to a lack of interoperability between applications that run on different devices and platforms.

The potential of mHealth

Despite the growing popularity of mHealth, in both usage and commercial terms, there is a disappointing lack of comprehensive studies evaluating its impact. Overall, mHealth is often associated with lower costs and improvements in the quality of health care, but also with a focus on the prevention of diseases and promotion of healthy lifestyles. In line with this assertion, a recent study estimates that mHealth reduces data collection costs by approximately 24 percent, costs of elderly care by 25 percent, and maternal and perinatal mortality by 30 percent (Telenor Group 2012). The same study finds that mHealth can improve compliance with tuberculosis treatment by 30–70 percent.

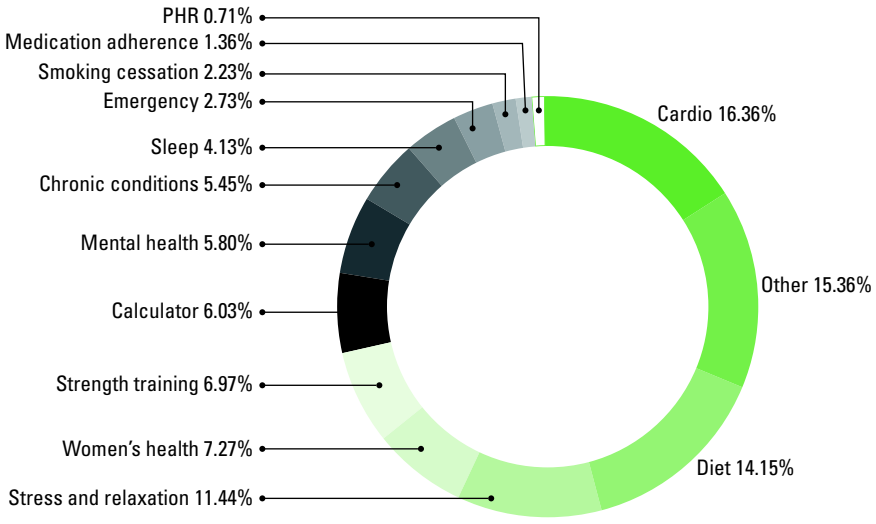
Given consumers' higher purchasing power and their shown willingness to pay for mHealth applications and devices (IBM Institute for Business Value 2010; MobiHealthNews 2009), huge business opportunities have been identified, mainly in the developed world. Of note, in 2011 the third convention of the mHealth Summit attracted more than 3,600 visitors, up from fewer than 800 in 2009

(mHealth Alliance 2011), and the mHealth market went up from $718 million in 2011 to an estimated $1.3 billion in 2012 in the United States alone (Telecoms Tech 2012). In particular, mHealth applications aimed at individuals are growing in popularity. The number of health-related applications in Apple's App Store grew from just over 4,000 in February 2010 to more than 15,000 by September 2011; roughly 60 percent of these were aimed directly at consumers, with the most popular applications relating to cardio workouts and diet (figure 3.1). The most popular health-related search in 2011 was for information on chlamydia, a sexually transmitted disease, suggesting that the privacy offered by mobile access to health information is important to users. Also the use of "wellness apps" is seen to be growing: an estimated 30 percent of smartphone users are likely to use them by 2015 (Telenor Group 2012). Currently, applications focusing on individuals are mainly geared to developed countries, where purchasing power and education are higher.

Yet, mHealth arguably offers even greater potential in the developing world, where mobile phones serve not only as communication tools but also as key means for accessing health information, obtaining medical insurance, and making payments. As long as macroeconomic conditions are at least somewhat favorable, a lack of existing structures can translate into a greater scope for mHealth solutions; it is expected that major emerging economies, finding themselves in rapid transition to new health care structures, will see the strongest uptake of mHealth in the years to come (Freng et al. 2011). Because of the diversity of mHealth applications and the limited potential of mHealth commercialization, however, the larger economic or development impact of mHealth is difficult to assess, and there is a lack of systematic data for the developing world that would justify higher-level investments (Qiang et al. 2012).

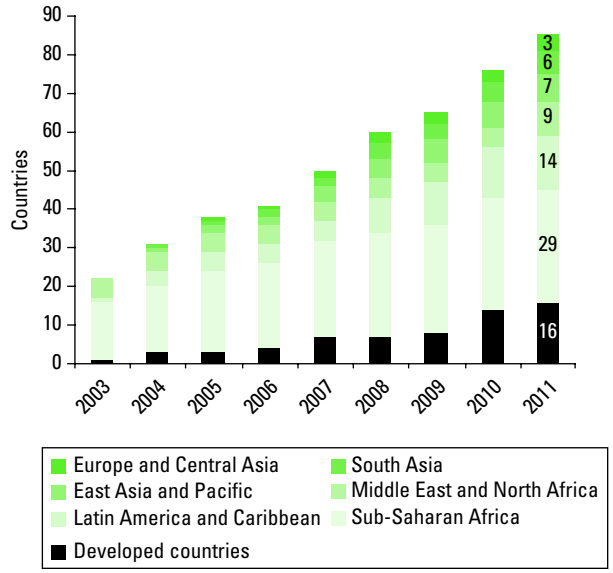
Nonetheless, more than 500 mHealth projects have been deployed around the world (Telenor Group 2012). According to the World Health Organization's Global Observatory for eHealth (GOe), some 83 percent of 112 surveyed countries had at least one mHealth program in operation, with the majority reporting at least four types of application (WHO 2011). The same survey showed that the mHealth adoption gap between low- and high-income countries is fairly small: 77 percent of the former and 87 percent of the latter reported they had implemented at least one mHealth program. In absolute terms, Africa is still the region with the most countries with mHealth deployments, while the developed world and other developing regions have seen stronger adoption growth in recent years (figure 3.2).

Figure 3.1 Relative popularity of consumer health applications in Apple's App Store, 2011



Source: MobiHealthNews 2011.
Note: PHR = personal health records.

Figure 3.2 Number of countries with at least one mHealth deployment, by World Bank region



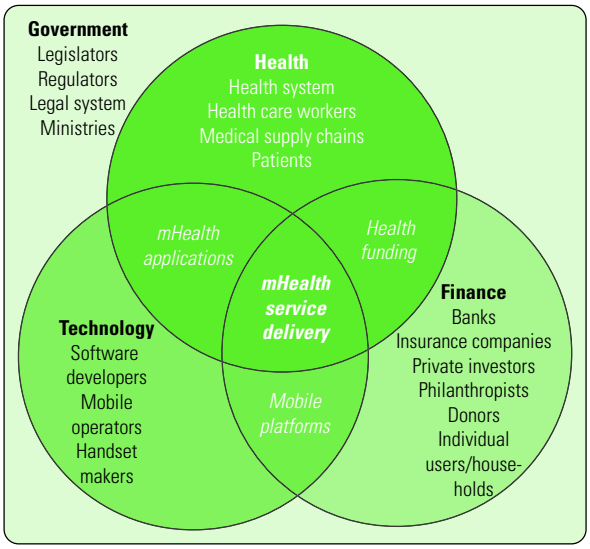
Source: Adapted from GSMA mHealth Tracker 2012.

The mHealth ecosystem

The emergence of mHealth initiatives in many parts of the world can make it difficult to assess their impact in a coherent manner. Increasingly, mHealth stakeholders are realizing the need to arrive at a more holistic understanding of the subject not only to base implementation on best practices but also to factor in local circumstances. Moreover, the large number of different stakeholder groups requires that their different roles and responsibilities be clarified as well. Because mHealth always exists within and interacts with a country's larger health care system, it will be affected by public policy, private sector influence, diverse patient needs, and the interests of several other participants.

A useful framework for the mHealth ecosystem is provided in a World Bank report on mobiles in health (Qiang et al. 2012), which positions mHealth at the nexus of health, technology, and financial services, with government influencing all three of these spheres (figure 3.3). This positioning is in line with a common argument that mobile financial services can enhance the impact of mHealth initiatives (mHealth Alliance and WEF 2011).

Figure 3.3 mHealth ecosystem



Source: Qiang et al. 2012.

Business models for mHealth

Basing mHealth services on a sustainable business model is vital for implementing mHealth. The first decision that an mHealth organization has to make is what financing model to adopt. Broadly, the options are nonprofit, for-profit, or hybrid.

- Nonprofit organizations may rely less on investments from the private sector and more on large blocks of funding from ministries, multilaterals, and other major donors. Often, a nonprofit mHealth organization's goal is not revenue maximization, but maximum development impact and improvement of patients' health outcomes.
- In contrast, for-profit organizations focus on developing services and products that generate revenues to be distributed to investors and owners, although they may also include a philanthropic element, for example, in probing the opportunities in new markets.
- Whereas health care almost always implies strong public sector involvement, there is certainly potential in mHealth for for-profit projects as well, suggesting that hybrid models may be an appropriate option. For instance, a subscription to mDhil's medical information service in India, costs 1 rupee ($0.02) a day, which is in line with the purchasing power of its target consumers—young Indians between 18 and 25 (Qiang et al. 2012).

For both nonprofits and for-profits, clear value propositions for the still emerging mHealth industry have yet to be established. Value chains in mHealth can be complicated even for simple applications (Vital Wave Consulting 2009), so capturing and monetizing value for only one among many stakeholders in the chain can be difficult (Freng et al. 2011). Because demand for mobile applications for health care delivery is high, however, consumers might be willing to pay for mHealth, for instance, if the service can help them avoid disease and the high opportunity costs of suffering from a medical condition. Cumulative losses in global economic output from noncommunicable diseases are expected to amount to $47 trillion, or 5 percent of GDP, by 2030, so governments also have an interest in promoting better access to health information (Chand 2012).

For now, however, the main challenge for the mHealth industry in low-income countries has been to continue to deliver services once initial funding of pilot projects ends and to scale up or replicate effective models in large-scale implementations. This challenge results in part from a lack of long-term feasible business models. In developed countries, many mobile apps are offered free of charge, with revenues derived from advertising. Fee-for-services is a secondary model (for example, some health apps in Apple's App Store cost up to $79). To obtain sustainable investment in this emerging industry, the private sector needs to demonstrate effective and robust mobile apps that address both local and national health needs, especially for low- and middle-income countries, where average per-user revenues are lower. In cases where incentives for the private sector are not strong enough (that is, where the market prospects are too uncertain, or consumers lack purchasing power), the public sector will have to fill the gap, for example, by directly subsidizing mHealth services, limiting administrative cost for licensing, or engaging in public-private partnerships.

The business models for mHealth must follow the actual health care needs of individuals and the public to be sustainable. As health is considered a public good, the business models should also be aligned with public policy interventions. Investment in mobile applications for public health issues such as noncommunicable diseases should help reduce the costs of health care services and guarantee a healthier population and workforce for developing economies.

Principles for implementing mHealth applications

Clearly, the field of mHealth is just beginning to demonstrate its full potential. So far, there have been many pilot projects and scattered initiatives, with dramatically varying levels of success (table 3.2). This section briefly outlines some of the principles that hold across contexts from these early mHealth initiatives.[5]

Avoid a one-size-fits-all approach

Mobile health applications must be designed to respond to people's needs and suited to their local context. A common pitfall is that, once an application is working well technically and is seen to have high potential, there is an immediate enthusiasm to implement it everywhere regardless of context. Conducting readiness assessments with users can help avoid such overextension. Close involvement of health practitioners in the design and development of mobile app content can also ensure accuracy for public health programs. A good example of successful adaptation to various contexts and sectors is RapidSMS—this system has been used for food supply chain management in Ethiopia (see box 3.2), as a citizen outreach system in Senegal (see table 3.2), and as an emergency response tool in Somalia (Vital Wave Consulting 2011). The success of RapidSMS has also sparked the development of other mHealth tools, such as ChildCount+ (Vital Wave Consulting 2011).

Maintain flexibility

Policy-makers must be careful not to overregulate mHealth nor to prescribe, from the top down, how applications are to be implemented. Because mHealth technology is cheap to implement and change, it can be a tool for achieving efficiencies and improved flexibility in the health system. Mobile health can also be combined with other mobile services to enhance its impact. The industry may also evolve freely, including in ways that the health sector may not anticipate. For example, mHealth and mMoney can be integrated in a variety of useful ways. A patient might receive a prescription through an mHealth application and pay for it using an mMoney transfer or bank account, all using the same mobile phone. Health care workers who spend most of their time in the field and transfer information to health systems through mobile phones could receive their wages in the same way.

Table 3.2 Selected examples of mHealth projects and lessons learned

Country	Application	Services provided	Scale/location	Key success factors and lessons learned
Botswana Botswana-UPenn Partnership (2012)	**Kgonafalo:** A remote diagnosis facility using camera-equipped mobile handsets and tablets to send photos of patients for treatment advice.	Initially focused on oral health, it now covers radiology, cervical cancer, and dermatology. Photos sent from rural areas are used to determine whether to transport patients for treatment in Gaborone.	Initially piloted in 6 locations, it is now ready to be scaled up to 25 locations, before going nationwide, with funding from the government. The pilot program assessed 230 cases over a 6-month	The initial implementation, using technology from a Bangladeshi company, was not robust, and was replaced by an application developed locally by PING (Positive Innovation for the Next Generation). In addition, handsets were replaced with Android Tablet PCs preloaded with medical databases and treatment guidelines.
Kenya Changamka (2012)	**Changamka MicroHealth:** A smart card that enables payments to be made for medical services via mPesa, linking health care providers with medical insurance companies.	Smart cards are available (from supermarkets and the like) to outpatients and pregnant mothers. Patients can buy health care packages that include consultation, lab test, and drugs, for example, or top up credit with amounts as low as K Sh 100 ($1.20).	Launched in 2008, it now covers 18 service distributors and 29 health care facilitators across Kenya but is mainly concentrated in Nairobi. Available to all citizens.	This health application is designed to be user friendly and to respond to selected high-demand services. Improved interoperability has created value, especially in linking many different service providers and insurance companies.
Peru WawaRed (2012)	**WaWaRed:** A mobile application providing timely messages for pregnant women.	SMS messages and basic health information delivered at different stages during pregnancy. It also includes a symptom checker, which can be accessed and used via SMS.	Launched in 2010, WaWaRed is available in Ventanilla Distrito, a vulnerable community of Lima, and serves the Callao community of 5,000 people. It is now being scaled up nationally.	Involvement of pregnant mothers has been facilitated by a high adoption rate of mobile phones. This case has also highlighted that fathers need to be involved in maternal health education for effective communication with health care providers.
Chile Centro de Informatica en Salud (2012)	**Centro de Informatica en Salud:** Provision of health care to the elderly at home, in a project called Cuidado Domiciliario.	Providing health information to and from mobile devices, such as phones and tablets, Devices store electronic health records to facilitate care at home.	Launched in 2011 to serve 3,000 elderly people in the Pedro Aguire Cedra district, it is now being scaled up nationally.	An assessment of digital literacy among the elderly was carried out before the project launch. Awareness raising and training is essential to engage effectively with health care services when using mobiles for health care at home.
Senegal RapidSMS (2012)	**RapidSMS:** Implementation in Senegal through the Jokko initiative, with UNICEF and Tostan, an NGO.	Citizen engagement with health care providers through an SMS aggregation service, allowing short texts to be distributed to a large network of users.	Launched in mid-2009, the Jokko initiative now serves 800 communities in 8 African countries.	Significant costs have been saved by using SMS aggregation to broadcast text messages to multiple recipients for the price of a single message. The messaging process may take up to 8 hours depending on the technology used, so it may not be effective for emergency alerts.
South Africa Cell-Life (2012)	**Cell-Life Aftercare:** an SMS alert service for patients following HIV retroviral therapy.	Patients receive SMS alerts when medication is due, along with other health tips. Mobile phones are also used for data capture by nurses following patients.	Begun in 2001 as a research project at the University of Cape Town, this initiative became a company in 2005. It is currently working in partnership with over 50 organizations.	In South Africa, the prevalence of HIV and AIDS in adults is close to 20 percent. Cell-Life has developed a philosophy of "Dispense, Communicate, Capture."

Sources: Assembled from diverse sources (see References).

Take standards and interoperability into account

Although apps should be adapted to local context, designing a separate and incompatible application for every stakeholder group or every locale frequently leads to large inefficiencies. Applications often benefit from economies of scale and reach—the power of singular mHealth services can be multiplied by their ability to work together, operate on common platforms, and share information. Making interoperability a prerequisite for new mHealth applications could help reduce inefficiency or duplication. Accordingly, a lack of standards is seen as preventing the scaling up of applications and, thus, to be a key obstacle to achieving cost savings through mHealth (Telenor Group 2012). The perspective should go beyond the health sector: seamless integration with other mobile platforms, such as mobile money, can enhance the value of mHealth applications even more.

A push for more universal platforms can come from the top (for instance, as part of a national eHealth strategy that encompasses mHealth) or from the bottom (especially at the point of care through mobile phones). The greatest value will be realized when both strategies are used and complement each other. International standards for hardware and software platforms can ensure interoperability among mHealth applications and other mobile tools, while also enabling the development of locally relevant applications. International bodies such as the mHealth Alliance, the Health Metrics Network, and the Continua Health Alliance are helping to forge cooperation in the development of globally recognized standards and metrics. For example, to achieve seamless exchange of data elements, HL7 and ISO standards have been widely used for electronic health records. Standards and interoperability must be addressed early on—consolidating many fragmented or incompatible services is hard, as cases like Kenya (see box 3.1) or Ethiopia (see box 3.2) have shown.

Evaluate existing information systems

Multiple health information systems exist and data are gathered with or without mobile applications. Reliable assessments of these systems are useful to identify where mHealth is needed and how it can best be implemented. Evaluation of delivery flows of health services should also be taken into consideration. Mobile apps may prove complementary to existing solutions, especially for remote data collection and telemedicine—for example, in the cases of the Health Management and Research Institute in India (box 3.3), the EpiHandy program in Uganda, the IHISM system in Botswana, and the Dokoza system in South Africa (Vital Wave Consulting 2011). Accordingly, it is estimated that mHealth can double the number of rural patients reached by a physician (Telenor Group 2012).

Poor evaluation of current information systems before entering the digital arena may result in fragmented or inappropriate health care applications. For example, it is vital for mHealth applications to be interoperational with eGovernment applications in other sectors. A success story in this context is Rwanda, which has implemented an overarching eHealth initiative combining patient record tracking, transmissible disease monitoring, and supply chain management, as well as mHealth telemedicine apps for health professionals in remote areas (Vital Wave Consulting 2011).

Track key success indicators for monitoring and evaluation

The need for evaluation does not end once an mHealth application has been implemented. To move from pilot projects to full-scale implementation, evidence is needed on the impact of mHealth applications, along with identification of operational efficiencies and detailed estimates of cost savings. In short, monitoring and evaluation (including tracking project-specific success indicators) are necessary right from the beginning of an mHealth implementation. However, only 7 percent of low-and lower-middle income countries report that they evaluate their mHealth initiatives (WHO 2011), and only a few systematic analyses of nongovernmental projects exist. A rare exception is WelTel (Lester et al. 2010), an SMS-based tool for tracking compliance with antiretroviral therapy. Peer-reviewed evidence confirmed its positive influence on health outcomes beyond the initial stages, which, in turn, led to the continuation of funding for the project and its increased sustainability.

Ensure quality and content of health information

The content and quality of health information must be tailored to end users and decision-makers. Lack of trust is a major resistance factor against the use of mobile applications in health care provision. Similarly, local languages and cultures often represent major barriers to adoption. One notable example of the relevance of trust in health information is the Indian mobile platform mDhil. While it received significant private sector investment and

Box 3.3 India: Health Management and Research Institute—104 Mobile

India's Health Management and Research Institute (HMRI) is a public-private partnership between the state government of Andhra Pradesh (which bears 95 percent of costs) and the Satyam Foundation (which bears 5 percent of costs) based in Hyderabad, Andhra Pradesh. HMRI launched "104 Mobile" in 2008[a] to improve local health services by replacing the traditional health care system with mHealth applications for disease surveillance, prevention counseling, telemedicine, and supply chain management.

104 Mobile sends medical units (MUs) to habitations more than three kilometers away from the nearest public health service provider to provide medical care to rural populations. Each MU circulates on a fixed date every month, ensuring continuity of care. Maternal and child health are prioritized, along with the diagnosis and management of chronic diseases such as diabetes, hypertension, asthma, and epilepsy. 104 Mobile deployed 475 MUs to 22 districts throughout Andhra Pradesh. Generally, treatments at clinics tend to be costly, and more than half of unmet requests for outpatient care could be treated by phone in rural areas—a potential that 104 Mobile can exploit through its hotline for medical consultations.

HMRI has delivered the following major benefits (partly thanks to the integration of mHealth applications):

- Expanded the service area covered by 25 percent
- Services may cost as little as one-tenth of those provided by the government
- Up to 55 percent of 600,000 unmet requests for outpatient treatment could be treated by phone
- 1.26 million pregnant women each received an average of three antenatal care check-ups
- 2.9 million people with chronic diseases were screened, tested, and provided with medication
- Over 10 million unique electronic health records were established, making this one of the largest public electronic health record databases worldwide

Source: Qiang et al. 2012.

a. 104 Mobile has been transitioned back to the government of Andhra Pradesh and the service is currently operated by the Ministry of Health under the government.

was able to attract a fairly large base of paying customers, one of its biggest challenges was to establish credibility and win the trust of its users, given the inaccuracy and lack of clarity of much of the health information it had to draw on (Qiang et al. 2012).

Respect privacy and confidentiality

Although awareness of the issue of data privacy is often low in developing countries, the case can be made that mechanisms guaranteeing some level of privacy and confidentiality are a universal requirement for mHealth. Evidence from developed economies shows that privacy and confidentiality are important success factors in the management of public and personal data, especially in the case of infectious and transmissible diseases. For example, the privacy and confidentiality of personal data of patients is vital to prevent discrimination in the workplace. The dangers of poor privacy requirements are often visible only after the damage is done (for example, once security leaks are exploited by hackers), making this a natural field for government intervention and regulation (Qiang et al. 2012). However, privacy regulation should be limited according to context. For instance, health records on nonstigmatizing infectious diseases (such as dengue fever) should be shared quickly and widely, while a patient's interests in the confidentiality of personal data might triumph, for example, in cases of sexually transmitted diseases.

Enable public-private partnerships

Policy-makers contemplating mHealth should consider bringing private sector stakeholders to the table. If administered wisely, public investment and technology partnerships enriched with competitive incentives (through tenders and challenges, for example) can improve the quality of mHealth apps and services and improve choice. Often, public-private partnerships (PPPs) can benefit from a division of labor based on the respective competencies and resources of the stakeholders. For instance, private mobile operators and software developers might be better situated to provide the technological platform and develop the mHealth applications, while governments can provide a favorable regulatory environment and integration with the existing (public) health care system (Qiang et al. 2012). Governments might also use a PPP approach to spark innovation from a more agile private sector. This approach seems to be very effective; the largest and most scalable mHealth initiatives are mostly supported by PPPs (WHO 2011). One notable project is ChildCount+: the Kenyan government, the Millennium Villages Project, and UNICEF collaborated with Zain and Sony Ericsson as technology partners to develop a monitoring and tracking system with a focus on easily treatable diseases; the new system is expected to dramatically reduce child and maternal mortality (Qiang et al. 2012).

Offer training and take literacy into account

Mobile health services will have a greater impact on health outcomes where their users have high levels of literacy (and for health workers, training) in ICT and health. Proficiency with mobile devices and computers saves time and reduces errors. As a result, during mHealth implementation, the technical literacy of users needs to be factored in, and staff have to be trained to use the necessary technology. In addition, training in technical and organizational skills is often needed to launch, scale, and sustain mHealth interventions. For instance, major barriers to adoption of telemedicine in Uganda were lack of knowledge and skills on the part of health care staff (Isabalija et al. 2011). There are many ways to achieve improvements in these areas: dedicated training institutions, public information campaigns, programs in schools, and even software for mobile devices that trains people in their use and in treatment methods. All of these may ultimately require oversight to ensure that the information being conveyed corresponds to best practices and health system priorities.

Ensure the commitment of leaders

The mHealth industry is today at a pivotal moment in its rapid evolution. To realize the industry's full potential for improving health outcomes, long-term leadership is needed from government and from the health, technology, and financial sectors. Their leadership will help supply the industry with better inputs—both tangible (such as handset technology and financing) and intangible (such as market regulations, standardization of software, and rules for using bandwidth). It will also ensure that mHealth services correspond to health sector priorities. The impact of committed leadership can be magnified by a series of multipliers—improvements in reach, affordability, quality assurance, behavioral norms, and matching of resources—that can boost health outcomes. High-level leadership within government is especially crucial for forging inter-ministry partnerships.

Conclusions

As this chapter has argued, mHealth applications have the potential to transform health care systems in low-income economies: mHealth can generate cost savings and provide more effective health care delivery within relatively limited resources. Modern forms of health care are at a tipping point where consumers are taking on more responsibility for managing their own health choices, and mobile phones could contribute greatly to this shift of decision-making from state and health institutions to the individual. However, the most substantial challenge for mHealth is the establishment of viable and sustainable business models that can be replicated and scaled up. One step forward could be clearer delineation of roles within the health ecosystem between public and private health care providers. Accordingly, for "macro"-focused public health purposes, the World Health Organization (WHO 2005) recommends that mHealth be integrated into a country's broader eHealth strategy. Finally, a missing component is the effective monitoring and evaluation of mHealth, which could inform the design of more successful mHealth applications at this critical stage of their development.

Notes

1. One of the first uses of the term mHealth was in 2008 when the Rockefeller Foundation engaged global eHealth experts at Bellagio, Italy; see Mishra and Singh (2008).
2. For a comprehensive review on the provision of telemedicine in the developing world, see Wooton et al. (2009).
3. Medical informatics professionals are trained in medicine and computer sciences and information theory. See www.imia.org for more details.
4. The role of social intermediaries, including civil society organizations and community-based organizations, should not be overlooked. They can focus on health workers, building their capacity and training them in ICT skills. In addition, they can offer help directly to citizens in poor and isolated communities who do not possess adequate ICT skills, for instance by timely provision of necessary information to minimize information asymmetries, and sometimes by providing training on how to use mobile applications.
5. We also refer readers to a more detailed list of Calls to Action, divided by stakeholders, in Vital Wave Consulting (2009).

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