Chapter 7
Mobile Means Global

Introduction/Overview

As a phenomenon, mHealth is rapidly expanding globally in terms of the number and type of initiatives emerging, and is projected to become a multibillion dollar industry by 2017 (Levy 2012). According to a report prepared by Pricewaterhouse Coopers (PwC 2010), the powerhouse international consulting and service enterprise, annual mHealth industry revenues are projected to reach US$ 23 billion worldwide, with Europe, Asia, and North America achieving similar revenue volumes by that time. Figure 7.1 illustrates the five largest projected growth areas.

The pivotal enabling technology to advance mHealth globally is arguably the mobile telephone, which can be used to quickly and directly reach people wherever they are (Adler 2009). While it is not a necessarily intuitive fact, mobile phones are believed to be used throughout the developing world more than any other modern technology (Sutherland 2006). Moreover, the penetration of mobile phone networks in many low- and middle-income countries surpasses other social infrastructure such as paved roads and electricity (World Health Organization (WHO) 2011).

It is estimated that as much as 90% of the world's population has wireless coverage with approximately 65% of total cellular subscribers located in the developing nations (Hampton 2012). Data from the International Telecommunications Union (ITU 2012) reveal the following facts:

- Total mobile-cellular subscriptions worldwide reached almost 6 billion by year-end 2011, which corresponds to a global penetration of 86%.
- Most of the growth was driven by developing countries, which accounted for more than 80% of the 660 million new mobile-cellular subscriptions added in 2011.
- By year-end 2011, there were 105 countries with more mobile-cellular subscriptions than inhabitants, including African countries such as Botswana, Gabon, Namibia, Seychelles, and South Africa.

Because of these increasing user numbers, there are high expectations for mHealth globally. Market penetration and the increasing sophistication of these mobile networks, i.e., greater speeds of data transmission combined with cheaper and more

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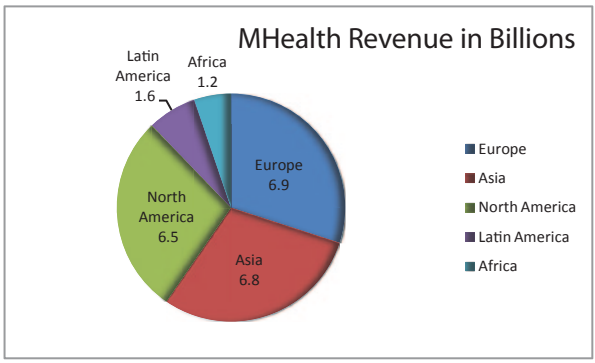

Fig. 7.1 Global mHealth revenue—2017 projections. (Source: Levy 2012 using PwC report data)

powerful handsets, are transforming the way health services and information are accessed, delivered, and managed (WHO 2011).

In addition to this cellular use explosion, the percentage of individuals using the Internet continues to grow worldwide and by year-end 2011, 2.3 billion people were online. Even with a doubling of Internet users in developing countries between 2007 and 2011, the total number of users grew only to 25% of the population. In comparison, 70% of the total households in developed countries had Internet access by year-end 2011 (ITU 2012).

Examples of mobile phone-based mHealth globally abound, including programs for information access, health monitoring, and alerts to potential disease outbreaks. Mobile phone technology is bringing greater health-care access to the masses in India through remote triage, medical advice, and health monitoring. Millions of poorer rural inhabitants in India are able to access health-care services from urban tertiary care centers that previously were not within their reach. In Mexico, Medicall Home has 5 million subscribers who can access medical advice via their phones (Levy 2012). In Cambodia, monitoring disease outbreaks is enhanced by using short message service (SMS) or text messaging for early detection or communication of abnormal events via mobile phones. Similarly in Bangladesh, mobile phones have been used to broadcast text messages to mobilize citizens for National Immunization Day. The messages especially encourage families to bring their children to get vaccinated (WHO 2011). Across the globe, mobile phones are used to reach out to those suffering with HIV/AIDs or those in search of information on disease prevention. Mobile phones are also offering pregnant women and mothers of newborns just-in-time information and access to care. Mobile phones—and the apps that run on them—have definitely gone global.

Clearly, the need for mHealth is growing, especially in developing countries that have high rates of communicable diseases, but are also now experiencing a steady growth of chronic diseases similar to those found in developed countries such as the USA. These diseases include hypertension, obesity, heart disease, and diabetes. The combination of communicable and chronic diseases is referred to as a "dual burden" (Boutayeb 2006). The dual burden presents unprecedented challenges for health delivery systems that are underdeveloped, as evidenced by limited infrastructure,

insufficient and inaccessible hospital resources, and shortages of health-care workers. However, proponents of mHealth suggest it has the potential to overcome many barriers to care and service delivery in order to meet the public health and clinical care needs of both types of diseases (Kahn et al. 2010).

Exploring the topic of global mHealth is complicated by a lack of standard terminology for identifying the economic and social status of countries. For example, when considering mHealth's global impact, it is important to recognize that countries are often categorized as developing/emerging or developed, and some sources use the term newly industrialized. Other classification systems use income as a differentiator, such as low income compared with high income. In some cases, such as with the World Trade Organization (WTO), member countries self-identify their status (WTO n.d.). We found no universally accepted criteria or definitions that distinguish a developing country from one that is developed or otherwise. Consequently, for this book we will use the various designations applied by researchers, analysts, and others investigating global mHealth in citing their findings.

The challenge for those attempting to quantify the impact of mHealth globally with regard to its effect on population health status is to separate fact from hype and speculation. Most of what is publicized about mHealth touts the successes of specific applications in a local setting. Yet, existing research reports that the quality of mHealth interventions and measurement of effect is poor. In fact, most mHealth research trials have been performed in the developed world with its impressive technology infrastructure and not in developing nations where the health needs are greatest and the technology is less robust.

However, we must acknowledge that technology is a means to an end, not the end point. One of the premier challenges of assessing global mHealth is that there is insufficient attention given to identifying and measuring global health outcomes generally. According to Bill Gates, founder and former CEO of Microsoft and also founder of the Bill & Melinda Gates Foundation, the largest transparently operated private foundation in the world, measurement is critically important—especially in light of global resource scarcity:

> Given how tight budgets are around the world, governments are rightfully demanding effectiveness in the programs they pay for. To address these demands, we need better measurement tools to determine which approaches work and which do not. (Gates 2013)

According to a recent white paper published by the Center for Technology Innovation of the Brookings Institution, more research is required to link mobile technology to health outcomes. The paper (West 2012) examined how mobile devices were transforming health care. Even though the research showed that there are considerable data demonstrating positive results for user satisfaction, reductions in wait time, improving attendance at medical appointments, and significant cost savings, the report also identified the need for more information demonstrating the connection to health outcomes, specifically outcomes such as declines in infant mortality, reductions in the spread of infectious diseases, and positive treatment of chronic illnesses.

In developing countries, mHealth innovations have not gone beyond pilot studies and have been funded primarily by private philanthropies and charitable donors. With the absence of formal evaluation processes, there is little documented evidence to encourage governments and businesses to invest in mHealth (Hampton 2012). Although mHealth innovation is coming from developing countries such as Africa and Asia, the funding is mostly provided by and through organizations and partners in the developed world (Curioso and Mechael 2010).

In emerging countries, mHealth trailblazers appear to be experiencing different levels of focus and engagement across the globe. Some countries are incubators of mHealth innovation and are engaged in a wide range of substantial mHealth activities and projects while other countries appear to be less focused and engaged. In 2011, 142 million mobile-cellular subscriptions were added in India, twice as many as in the whole of Africa, and more than in the Arab states, the Commonwealth of Independent States (CIS), and Europe together (ITU 2012). According to a 2012 New York-based Transparency Market Research Report, India is emerging as one of the incubators for launching mHealth innovations.

India, considered an emerging nation, has severe doctor shortages (0.6 doctors per 1000 people) and access to care is a major challenge. In this environment, telemedicine is thriving. The Apollo Telemedicine Network has more than 70 telemedicine centers serving rural areas, where most of the population resides. Plus, the government also has announced plans to create national telemedicine networks that include disease surveillance and oncology. On the other hand, the UK, a developed nation, has shown uneven progress in mHealth activity, including terminating a 10-year attempt to create a nationwide electronic health record program and reducing budgets for telemedicine efforts. Some experts suggest that there is a leapfrog phenomenon occurring in which developing countries can expedite adoption of mHealth because they face less entrenched opposition and barriers such as legacy health systems. This could help explain why studies have shown less engagement in mHealth activities among developed nations such as the UK: Approximately 48% of British respondents did not engage in any mHealth-related activity compared with 12% of Indian respondents (Levy 2012). The bottom line is that emerging countries are, and will continue to be, sources of considerable innovation that can be shared with developed nations (Levy 2012; NHS Press Release 2011).

Measurement Challenges

Annually, Bill Gates writes a letter on behalf of the Bill & Melinda Gates Foundation. In these annual letters, Gates documents the foundation's accomplishments and challenges, especially in regard to the health and education. In his 2013 Annual Letter, Gates focused on the impact of measurement and how mobile technology is facilitating more accurate measurement.

> In Nigeria, I've seen how the digital revolution allows us to improve the use of measurement in the campaign to eradicate polio. Thanks to cell phones, satellites, and cheap sensors, we can gather and organize data with increasing speed and accuracy. (Gates 2013)

But, after the data are collected and organized, they must be analyzed. Outcomes must be evaluated. As yet, no standard methods and definitions of evaluation exist to do so. There is no way to uniformly measure health outcomes for mHealth interventions. This statement is intuitively reasonable for global mHealth. The sheer size of the global mHealth market makes measurement a challenge, especially combined with the number of countries that are not communicating with one another because of political constraints, wars, and other hostilities. Also, there is no entity in charge of collecting data or authorized to conduct assessments. Accordingly, much of the data are derived from private sector research, including consultancy firms.

The estimates of mHealth initiatives and revenue also vary considerably because of lack of standard reporting and forecasting methods. Market research and consultancy firms produce varying estimates about the global mHealth market because they rely on their unique forecasting tools. An excellent example is various estimates of the financial impact of mHealth:

- Transparency Market Research (Albany, New York) reported that the global mHealth market will reach US$ 10.2 billion by 2018, up from US$ 1.3 billion in 2012, with North America representing the largest share of mHealth market revenue, followed by Europe and the Asia Pacific region (Mobile Health Market 2013; Slabodkin 2013a).
- Markets and Markets Research reported a forecast that the global mHealth market would reach US$ 20.7 billion by 2018, up from current estimate of US$ 6.6 billion (Slabodkin 2013b).
- SNS Research projected global mHealth revenue to reach US$ 9 billion by the end of 2014 (Slabodkin 2013c).

Measurement is crucial to move forward with global mHealth. But as Bill Gates observed, it is not easy to do and even more difficult to do well. It requires accuracy in measuring, but it also requires an open environment where problems can be raised and discussed to figure out what is working and what is not. Setting targets for immunization and other interventions can motivate government health workers, but it can also encourage overreporting to avoid problems with supervisors (Gates 2013).

The challenges to measuring global mHealth progress can be seen in the following *Case of Africa.* Africa reflects the heterogeneity of demographics, health needs, resources, and geography that make it difficult to assess mHealth globally. However, as the case demonstrates, changing economics as well as important patterns of mobile phone sharing among poor women in rural areas are emerging. These developments are expected to influence the diffusion and projected progress of mHealth in the second most populous continent in the world, with numbers exceeded only by Asia.

The Case of Africa

Fifty-five countries/states are internationally recognized and members of either the African Union or the UN or both (Becker 2012). By 2009, the population of Africa had exceeded 1 billion for the first time, thereby making Africa the second most populous continent, behind Asia (World Population Review 2013). Africa's population has rapidly increased over the past 40 years, and consequently, it is a relatively young population. In some African states, half or more of the population is under 25 years of age. A growing number of countries in Africa are moving into "middle-income" status countries. Currently, 22 states (with a combined population of 400 million people) have officially achieved middle-income status. Key demographics driving the future for Africa will be urbanization, an expanding labor force, and the rise of the African middle-class consumer. In 1980, just 28 % of Africans lived in cities. Today, 40 % of the Africa's one-billion-plus people live in cities (Africa Overview 2013, Population of Africa 2013).

Africa has reported rapid adoption of mobile phone technologies with over 400 million mobile phone subscribers. However, a 2009 study of phone ownership and usage across Kenya revealed the existence of distinct regional, gender, and socioeconomic variations among rural communities and the poor. Furthermore, ownership of mobile phones was reported as low in rural communities and among the poor. In particular, poor rural women are the least likely to own phones. Consequently, evolving patterns of phone-sharing, which appear to be extremely common in rural areas, may have significant future implications for mHealth diffusion in Africa (Wesolowski et al. 2012).

The Status of Global mHealth: What is Known and Unknown?

Research in the global mHealth field is expanding and includes some of the most prestigious and well-known global nongovernmental organizations (NGOs), including the WHO, the Center for Technology Innovation at Brookings, and the mHealth Alliance (mHA) that works to generate public and private partnerships in support of mHealth innovation. Private sector research by PwC, who commissioned the Economic Intelligence Unit (EIU) to conduct two comprehensive global surveys, also offers a comprehensive examination of the challenges and opportunities, especially for entrepreneurs and companies seeking significant and increasing roles in mHealth. In addition, universities and other academic enterprises continue to investigate and report their findings. These research efforts reveal some striking differences between mHealth in emerging and developed countries as well as formidable barriers and opportunities for achieving the promise of mHealth globally.

The differences are significant between developed and developing nations when it comes to adopting mHealth initiatives (West 2012). In addition, variation exists

within the category of developing nations, as not all developing nations are similar in terms of their capacity, motivations, or incentives for adopting mHealth. Some developing nations such as India are experiencing rising income levels and a trend toward growth of more urbanized populations. Others are not, including some example countries in sub-Saharan Africa.

Take as an example maternal and infant mortality, which is a serious global problem. The UN has targeted reducing these deaths in their Millennium Development Goals. Mobile phone interventions appear to be a viable tactic in achieving UN objectives. However, a study by Lund et al. (2012) shows that the special needs of rural women are not being addressed when considering the implementation of mHealth solutions in the developing world. Their study in sub-Saharan Africa showed that mobile phones may contribute to saving the lives of newborns and mothers, because the phones offer increasing communication linkages with primary care providers and enable more opportunities for skilled assistance during difficult labor and delivery. Yet, the mobile intervention strategies failed to reach rural women who are the poorest and most vulnerable to obstetric emergencies.

The results of the study by Lund et al. (2012), along with prior research (Koblinsky et al 2006; Kowalewski et al. 2000; Cole-Lewis and Kershaw 2010), suggest formidable access barriers exist. Specifically, geographical distances, poverty, quality of care, and sociocultural factors have the potential to impact implementation of mobile phone interventions. Furthermore, in rural populations, limited access to mobile phones, electricity to charge them, and inability to read text messages because of illiteracy presents challenges that are not easily resolved.

The study by the WHO (2011) is a major effort and represents their first attempt to determine the status of mHealth among its member countries. Completed by 114 countries, the survey documented four aspects of mHealth: adoption of initiatives, types of initiatives, status of evaluation, and barriers to implementation. A total of 14 categories of mHealth services were surveyed. Table 7.1 illustrates the most-reported categories and initiatives.

The four most frequently reported mHealth initiatives were health call centers (59%), emergency toll-free telephone services (55%), managing emergencies and disasters (54%), and mobile telemedicine (49%). Approximately two thirds of mHealth programs are in the pilot or informal stages of implementation, except for the health call centers, emergency toll-free telephone services, and managing emergencies and disasters.

Consistent with other eHealth trends, higher-income countries tend to report more mHealth activity than do lower-income countries. Countries in Europe were identified as the most actively engaged in mHealth activities. Meanwhile, countries in the African region demonstrated the lowest level of engagement. The most commonly seen service involves voice communication through phones, which would probably explain the prevalence of health call centers and emergency telephone services. The least frequently seen applications are the use of mHealth in surveillance, raising public awareness, and decision support systems. These require enhanced capabilities and infrastructure to implement, and consequently may not be a health

Table 7.1 Leading categories of mHealth in WHO 2011 survey. (Source: World Health Organization 2011)

Categories	Examples of health initiatives
Communication between individuals and health services	Health call centers
	Emergency toll-free telephone services
Communication between health services and individuals	Appointment reminders
	Treatment compliance
	Raising health awareness
	Community mobilization and health promotion
Consultation between health care professionals	Mobile telemedicine
Intersectoral communications in emergencies	Managing emergencies and disasters
Health monitoring and surveillance	Patient monitoring
	Surveillance
	Mobile health surveys and data collection
Access to health information for health professionals at point of care	Mobile patient records
	Information access
	Decision support systems

priority in countries with financial constraints. Many countries reported up to six mHealth programs in use (WHO 2011).

A UN Blog identified the availability of two reports from the mHA offering additional evidence to support mHealth efforts (Sugrue 2013). The first report, *mHealth and MNCH: State of the Evidence, mHealth Alliance,* presents findings of a needs assessment and a gaps analysis using mHealth for maternal, newborn, and child health (MNCH) as a case study, with the goal of ultimately encouraging further evidence-based research. One of the key findings of this research was that mHealth and MNCH research tends to be focused more often on maternal health interventions, such as reminders for appointments, than on newborn and child health interventions. The literature review also showed more studies using health outcome indicators as primary or secondary measurement units as well as using more rigorous methodologies (Philbrick 2013).

The second report of the mHA is *Baseline Evaluation of the mHealth Ecosystem* (2012), which provides information about the current level of adoption, implementation, funding, and impact of mHealth in low- and middle-income countries. It also measures the impact of the mHA on promoting mHealth in the global health ecosystem. The report had several significant findings at the impact level:

- Sub-Saharan Africa has the highest number of identified mHealth projects compared with Asia and Latin America regions.

- Nearly 50% of projects were focused on UN Millennium Development Goal #6: Combat HIV/AIDS, malaria, and other communicable diseases.
- Limited funding is available for mHealth initiatives. Only 22% of the leading 50 global health donors were funding mHealth activities.

Findings at the outcome level were important as well:

- A review of studies and published journal articles revealed a dearth in the quantity and rigor of evidence for mHealth.
- Adoption of technology standards was very low.
- The alliance has been successful in providing support to facilitate technical working groups.
- 100% of the Every Woman Every Child Innovation Working Group catalytic grantees surveyed had made a plan for sustainable financing of their project when their grant funding ends.

Emerging mHealth: Paths for Growth (Levy 2012) is a PwC report based in large part on extensive survey research by the EIU. The purpose of the report was to examine the current and potential state of mHealth, including challenges and opportunities. This work is especially noteworthy because it looks at mHealth from a variety of perspectives, including payers, providers, and patients. Key findings include the following:

- Patients and physicians living in emerging markets are much more likely to use mHealth than those in developed countries.
- Eight out of ten doctors practicing in emerging markets recommend mHealth services.
- Fifty-nine percent of patients surveyed already use some form of mHealth.
- Remote monitoring, a component of telemedicine, is expected to comprise about two thirds of this global market as doctors and patients use these devices to manage chronic illnesses.

The finding that patients in emerging markets are much more likely to use mHealth applications or services than those in developed countries is particularly intriguing. Patients in emerging markets reported higher awareness of and expectations for mHealth, on average, when compared with patients in developed countries. Patients in emerging markets are more aware of mHealth (61 vs. 37%). They are also reportedly more optimistic about the contributions of mHealth for their overall health care as noted in patient expectations for improvements in affordability (reduced costs), quality, and access (convenience). Table 7.2 describes the comparisons and key findings among them.

Furthermore, emerging market patients are already using mHealth, as 59% said that they are using at least one mHealth application or service. This number of users is compared with 35% of patients in developed countries. In many instances, mHealth is the only method to deliver health-care services. mHealth in the developing world may not be an alternative or luxury as it is in developed countries that have well-established health systems.

Table 7.2 Comparison of patient expectations in developed and emerging markets. (Source: Derived from Economic Intelligence Unit 2012 as reported in Levy 2012)

Patient expectations	Key differences among markets
% of patients who are familiar with the terms "mobile health" or "mHealth"	Patients in emerging markets are more aware of mHealth compared with patients in developed markets
61 % emerging markets	
37 % developed markets	
% of patients who report that in the next 3 years mHealth will change how they seek information on health issues	Patients in emerging markets have higher expectations of mHealth with regard to obtaining health information
64 % emerging markets	
53 % developed markets	
% of patients who report that in the next 3 years mHealth will change how they manage their chronic conditions	Patients in emerging markets have higher expectations of mHealth with regard to managing chronic conditions
54 % emerging markets	
42 % developed markets	
% of patients who expect that mHealth applications/services will substantially cut their overall health-care costs in the next 3 years	Patients in emerging markets believe that mHealth will substantially reduce health-care costs
53 % emerging markets	
40 % developed markets	
% of patients who expect that mHealth applications/services will make health care substantially more convenient in the next 3 years	Patients in emerging markets believe that mHealth will make their health care more convenient
57 % emerging markets	
48 % developed markets	
% of patients who expect that mHealth applications/services will improve the quality of their health care in the next 3 years.	Patients in emerging markets believe that mHealth will improve the quality of their health care
54 % emerging markets	
42 % developed markets	

Levy's findings (2012) also revealed that more emerging-market physicians offer mHealth services than colleagues in developed countries, and more payers cover the cost of mHealth services. Specifically, 43 % of telephone-based consultations and 37 % of text-based consultations were identified as covered by emerging markets payers compared with 29 and 23 % of consultations, respectively, covered by developed country payers. This finding is especially meaningful because it reinforces claims that reimbursement is a major impediment to mHealth implementation in the USA.

Meanwhile, mHealth research has drawn increasing scrutiny and news attention because of the lack of solid evidence and rigor in studies. UN Blog postings referenced the works of Free et al. (2010), Tatalovic (2013), and others documenting gaps in the literature and evidence challenges (Sugrue 2013).

Evaluation has been identified by researchers and analysts as an underdeveloped component of mHealth. Because mHealth is a relatively new field of study, it is expected that increased scrutiny and calls for improvements in this area will lead to more useful assessments of mobile health technology's impact. However, evaluation is challenging in a real-world setting, especially as smartphone applications and technology are updated and evolve on a continuous basis. It can be anticipated that some aspects of mHealth intervention may be outdated by the time of implementation; such is the nature of the rapidly changing market (Whittaker et al. 2012), all of which begs the question—are we becoming too hung up on using conventional assessment mechanisms for unconventional technologies?

The September 2013 launch of an online reference database to help overcome gaps in the literature and offer researchers a tool for locating evidence-based literature was announced by The Center for Communication Programs at Johns Hopkins University's (JHU) Bloomberg School of Public Health. The Case of Knowledge for Health (K4Health) provides more details on the project efforts.

The Case of Knowledge for Health (K4Health)

The Center for Communication Programs at JHU Bloomberg School of Public Health launched an online reference database in September 2013. The project, Knowledge for Health (K4Health), was federally funded by US Agency for International Development (USAID). The database was specifically designed to help researchers overcome gaps in the literature with evidence-based knowledge. The database can quickly locate relevant literature demonstrating the feasibility, usability, and efficacy of mobile technologies in health care. The database is designed to serve as a global resource for the worldwide mobile health-care community. Project goals included efforts to catalog, categorize, and grade all of the known peer-reviewed literature on mHealth in high-, middle-, and low-income countries. In addition, USAID recently awarded the JHU Center for Communication Programs a 5-year, US$ 40 million grant to improve knowledge and information sharing in global health programs, particularly for family planning and reproductive health (Versel 2013).

The Real World of Global mHealth: Beta Testing Environment

There seems to be little testing beyond the pilot or introductory stages of mHealth implementation. The predominant form of mHealth today is characterized by small-scale pilot projects that address single issues such as information sharing and access.

Large-scale, more complex mHealth implementations, mostly supported by public–private partnership, are reported to be limited. Even though it is anticipated that larger programs will become more common as the field of mHealth matures, strategies and policies that integrate eHealth and mHealth interoperability into health service delivery are needed (WHO 2011; Hampton 2012). Moreover, few of the mHealth applications and services have been tested scientifically or validated with respect to their long-term impact. Randomized control trials and traditional methods of scientific evaluation take too long and the technology might become obsolete before the end of the trial. Equally important is whether mHealth applications can be scaled up (Hampton 2012).

A study by Gurman et al. (2012) identified the lack of long-term evaluation and suggested that it could be the result of an emerging field that has yet to address this aspect of research or because of inadequate funding for program evaluation. In addition, the mHealth focus has been on interventions for chronic conditions, which is consistent with the rising incidence of chronic diseases. However, there is also a need to explore mHealth applications for acute care as well. Mobile phones enable real-time, continuous, interactive communication from just about anywhere, all of which would be useful in meeting the needs of patients with acute conditions such as chest pain or moderate-to-severe trauma. In addition, often smartphone apps that are tested are not available to the public; instead, they are created just for testing purposes (Fiordelli et al. 2013). Using real-world smartphone apps in testing should be encouraged.

Despite the demonstrated potential of mobile phone technology to improve health service delivery, there is little guidance about scaled implementation. Success in a pilot study does not necessarily mean the technology can be adapted for more wide-scale use. Limited implementation capacity can be the result of a variety of factors, including securing privacy of information, ensuring interoperability, integration with other systems, or lack of sustainable funding (Leon et al. 2012).

Global mHealth: Challenges and Recommendations

There is no “one size fits all” solution for implementing mHealth globally, in part because challenges are different in different parts of the world. Even though mobile phone penetration is skyrocketing, there are still countries where geography, lack of electricity (to recharge phone batteries), poverty, and functional illiteracy mitigate the benefits of the potential of mHealth. In some countries, there are problems of funding, competing interests, sustainability, legal issues, and lack of a supporting political and technical infrastructure. Perhaps the greatest challenge of global mHealth is diffusing mobile health technologies across such varying political, economic, technical, and social environments.

Economic, organizational, and technology disparities across nations represent a significant impediment to developing mHealth. According to research by Patricia Mechael and colleagues at the Columbia University Center for Global Health and

Economic Development (2010), countries that have made progress in developing mHealth should transmit their best practices to other countries to enable them to move forward and overcome such obstacles (West 2012).

In addition, implementation of mHealth is complicated because many organizations have unclear goals and focus when they originally decide to use mobile applications. They may initially concentrate on mobile data collection, but rapidly switch to using mobile devices to support the workflow once the data are collected. Meanwhile, the mobile technologies used for data collections may not be appropriate for follow-up work (Derenzi et al. 2011).

Some of the challenges appear to be shared worldwide. For example, "competing health system priorities" was consistently rated as the number one barrier to mHealth adoption by countries participating in the WHO survey (2011). The survey also found that the need for further knowledge and information specifically assessing impact and cost-effectiveness of mHealth applications ranked at the top of the list. The WHO survey also discovered that health systems worldwide are under increasing pressure to perform with multiple health challenges, chronic workforce shortages, and limited budgets. In order to be considered among other priorities, mHealth programs require evaluation; that is, evidence showing the effort will yield desired long-term effects and be worth the expense. Decision makers require reliable evidence, but the study showed that results-based evaluation of mHealth initiatives is not routinely conducted, with only 12% of countries responding that they conducted evaluations.

Documenting Effectiveness

mHealth assessments tend to focus on feasibility studies rather than on measuring impact, including long-term outcomes, as well as cost-effectiveness. This approach produces limited information, thereby making it difficult to determine whether the investment is worth the effort and funding, especially long term.

Positive examples of the benefits of mHealth interventions exist, but there is little reliable information regarding clinical or economic performance, both of which are important for the future of mHealth. Furthermore, in order for mHealth to remain competitive with other types of interventions, it must be measurable in terms of cost per disability-adjusted life year (DALY) averted, which is becoming an accepted measure of health intervention performance (Jamison 2006).

A framework for economic evaluation of mHealth should include the following five foci, according to Kahn et al. (2010):

- Description of the mHealth intervention
- Computed costs of the intervention
- Expected clinical outcomes, i.e., changes in health status, mortality, etc.
- Potential drawbacks and adverse effects of using this intervention versus another or none
- Awareness of practical/real-world issues such as sustainability of the product, costs, and outcomes

An example of sustainability challenges can be seen with regard to the mHealth project, Cam e-Warn, in Cambodia. Following an outbreak of severe acute respiratory syndrome (SARS) in Cambodia in 2003, Cam e-Warn, a text messaging system, was implemented to detect and monitor disease outbreaks. Thus far, Cam e-Warn has increased the accuracy of reporting and improved the ability to control the spread of diseases compared with earlier telephone hotline surveillance systems. The project initially cost US$ 100,000 and was financed with funds from the WHO, the Asian Development Bank, and other donors, and supplemented with Cambodian budget resources. Because most of the funding for this mHealth effort is supplied by external sources, there is concern about long-term sustainability, and the government is aware of the need to develop long-term funding strategies (WHO 2011).

Security/Privacy Concerns Mobile applications may introduce or affect security and privacy concerns, with the greater risks occurring during transmission and storage of data. And, patient data may be made available on multiple handsets and phone software platforms making it difficult to protect access beyond basic passwords. Linking different mHealth tools and then connecting them to existing databases can be challenging as well. mHealth programs often operate with different data systems developed at different times or perhaps from different funding sources, which can mean separate platforms run by different sources, such as the government or private sector or a grant-funding agency. While open standards have been proposed to address such problems, they are still a work in progress (Derenzi et al. 2011).

Scaling Up Researchers in South Africa (Leon et al. 2012) found that a developmental approach was preferred over large-scale implementation in their examination of mHealth in community-based services in South Africa. Even though South Africa represents a positive environment for mHealth implementation, scaling up of programs creates challenges to organizational capacities and culture that can compromise possibilities for sustaining larger, more mainstream mHealth service delivery.

Lack of Global Standards The need for mHealth to adopt globally accepted standards and interoperable technologies, ideally using open architecture, is widely recognized. The use of standardized information and communication technologies would enhance efficiency and reduce cost. This will necessitate collaboration across countries for developing global best practices so that data can move more effectively between systems and applications (WHO 2011).

Major barriers identified by the WHO (2011) analysis include:

- Lack of knowledge about mHealth applications and public health outcomes
- High operating costs for mobile communications
- Undeveloped infrastructure, such as unreliable mobile networks
- Lack of supportive policies at the country or regional level

System fragmentation is often a problem for developed nations. The medical infrastructure is enormous, conservative, and resistant to change. In the USA, fragmentation is often identified as a major cause of access, cost, and quality problems.

However, in the UK, a highly centralized, top-down approach failed in establishing a nationwide health information network with subsequent calls for more localized health IT approaches (NHS Press Release 2011; Rowe 2011).

Reliable electricity is a major barrier to mHealth adoption in developing countries. If there is no way to charge a cellphone, mHealth will not work. The private sector has recognized the need to find sustainable sources of power for their overseas markets such as Africa. For example, Motorola has been involved in testing wind- and solar-powered base stations in Namibia, which could bring down the cost of connecting remote areas to cellular networks (Corbett 2008). If alternate energy sources are found to work, an important barrier will be marginalized for the developing world. However, reliable electricity and battery life are less pertinent considerations for developed nations.

Battery life is also an impediment for community health-care workers in low-income countries. These workers are out in the field, usually covering large geographic areas, and poor connectivity as well as difficulty keeping batteries charged impinges on their ability to see patients and/or conduct surveys. In addition, these workers often face theft or loss of their mobile phone and have to devise ways to work around such events (Derenzi et al. 2011).

Global mHealth Opportunities

The potential inherent in mHealth is recognized by the UN and the WHO. The UN included mHealth as a key innovation to achieve the goals outlined in the new Global Strategy for Women's and Children's Health launched in New York on September 22, 2010. The WHO has conducted focused research on the topic of mHealth worldwide. Growing attention and interest has culminated in a series of mHealth deployments that are providing early evidence of the potential for mHealth globally. mHealth is being used and tested in several key areas, including:

- Maternal and child health
- Programs reducing the burden of diseases linked with poverty, including HIV/AIDS, malaria, and tuberculosis
- Improving timely access to emergency and general health services and information
- Managing patient care
- Reducing drug shortages at health clinics
- Enhancing clinical diagnosis and treatment adherence (WHO 2011)

An example of opportunities for innovations is the development and implementation of telementoring, developed at the University of Pittsburgh Medical Center (UPMC) and its Center for Crania Base Surgery. Telementoring uses virtual technologies to train and educate physicians worldwide. The Case of Telementoring provides more details.

The Case of Telementoring

The standard model of surgeons traveling around the world to perform complex surgeries or teach others how to do them is an extremely limited model, especially in view of today's resource shortages. The impact of treating one person at a time is neither efficient nor cost-effective. Telementoring, combining telemedicine with surgical education, however, can broaden the impact and reduce the costs. The UPMC and its Center for Cranial Base Surgery offers telementoring for international physicians who have completed their onsite courses. They do so because after they return home, physicians may encounter difficulty implementing new and highly complicated surgical procedures. Using virtual technology, a surgical team of specialists continues training by providing live support and mentoring for their colleagues from other countries. Telementoring began at UPMC in 2005 and since that time over 500 surgeons from 30 countries have trained in cranial base procedures. Telementored surgeries were introduced in 2011 and have been done twice thus far. Everything is done over the Internet, using existing connections and standard telemedicine capabilities with different types of cameras (Hagland 2012).

mHealth can offer solutions at different organizational levels in developing countries, large geographic areas, local communities, and individual patients and providers. For example, social networking, including text messaging, can be helpful in averting and mitigating disasters in large geographical areas. These mHealth tools can also be used in large-scale health promotion campaigns that encourage people to get tested for HIV/AIDS or eat healthier. At the community level, social networking can connect people to available services in the community. At the individual level, text messaging and phone reminders can improve appointment attendance and medication adherence (Kahn et al. 2010).

Partnerships and Collaborations

The majority of mHealth interventions considered successful in both low- and middle-income countries are based in NGOs and are not part of the mainstream of the country's public health (Mechael et al. 2010). Therefore, the need for partnerships and other collaborative efforts among private and public sectors is underscored.

The mHA has as its mission to serve as a global catalyst for advancing the use of mobile technologies to improve health care globally, especially in developing countries. Membership is free and open to institutions across all sectors that are actively engaged or interested in mHealth. As of October 31, 2012, the Alliance reported 1387 member organizations. Nearly 40% of members are based in Asia, Africa, or Latin America. Most members (44%) are from the private sector with

39% representing nonprofit organizations. Representation also includes academic, foundation, and government institutions.

The National Institutes of Health (NIH) in partnership with the mHA conducts a variety of summer institutes that connect technology leaders, behavioral science researchers, federal health officials, providers, and others to discuss research, advance collaboration, and facilitate partnerships. The mHA also hosts Health UnBound (HUB), a global online community for resource sharing and collaborative solution generation. The mHA is hosted by the UN foundation and funded by the UN, Rockefeller, and Vodafone foundations.

In many countries, private and public sector organizations are collaborating to encourage healthy behaviors, help people monitor their care, provide disease surveillance, improve diagnostic care and treatment, and train health-care workers to support mHealth service delivery (Curioso and Mechael 2010). As a result, mHealth tools are being created to meet the specific needs and resources of local communities, including remote and isolated ones.

Health eVillages, a nonprofit organization based in Marlborough, Massachusetts, is a collaborative effort to bring mHealth tools and services to primary care providers in remote and underserved areas globally, including Haiti, Uganda, Kenya, China, and some of the more remote islands in the Pacific. Launched about 2 years ago by Physicians Interactive and the Robert F. Kennedy Center for Justice & Human Rights, Health eVillages furnishes iPods, iPads, and other mobile devices equipped with health-care information and clinical decision support tools (Wicklund 2013).

mHealth efforts do not have to be complicated. They can be simple in design and implementation, such as the Mobile Alliance for Maternal Action, a public–private partnership inaugurated in 2011. This alliance furnishes health information through mobile phone services such as text messages and voice mail alerts for new and expectant mothers in Bangladesh, India, and South Africa, countries with high maternal and infant mortality (Hampton 2012). Many of the new mHealth innovations are originating from Africa, Asia, and Latin America.

Key Drivers of mHealth

Drivers are different in different countries. However, even though the mHealth market has witnessed widespread growth in emerging economies, the highest per capita expenditure on mHealth applications is expected to continue from developed countries such as the USA and Canada that experience increases in chronic diseases and higher disposable incomes (Slabodkin 2012). Among the most often cited mHealth applications are:

- Widespread availability of mobile phones. The low levels of literacy required to use them is an added benefit.
- Familiarity with texting. Short message service (SMS or texting) has been used by doctors for patient communication since the 1980s.

- Scarcity of health-care resources. mHealth offers a means for extending medical care to underserved geographic areas or disadvantaged populations.
- Growing need for medical care, especially with the rising incidence of chronic diseases.

Availability Mobile technology is often the only way to reach people in emerging countries such as Africa—where the cellphone is the only way to access health care for the majority of those living there. This is also true for much of Asia. Bangladesh is a country with less than one doctor per 4000 people. But by establishing Healthlink, a telephone service that allows people to talk with a doctor at any time, day or night, medical care is available to those who otherwise would not have it (Levy 2012).

Overwhelming Need Overwhelming need for basic medical care might help explain the rapid adoption of mHealth in emerging countries where health-care challenges are more practical and immediate. For example, physicians worldwide tend to concentrate in urban areas. In the USA, such distribution has led to access problems, especially for those living in rural and remote areas. However, the impact is especially dramatic in countries such as India, China, and South Africa, where physicians are scarce and much of the population resides in rural areas (Levy 2012).

Need Versus Want In emerging markets, mHealth is perceived as driven more by need than by want, that is, getting medical care for a sick child when there are no available doctors or health-care workers. In developed countries, mHealth is often viewed as a luxury or fad such as downloading a diet or fitness app.

Value A study published by the World Resources Institute entitled *The Next 4 Billion: Market Size and Business Strategy at the Base of the Pyramid* revealed that the poor and very poor families in developing countries spend a substantial portion of their income on telecommunications, specifically on cellphones and airtime, usually in the form of prepaid cards. Furthermore, as a family's income increases—from US$ 1 per day to US$ 4, for example—their spending on telecommunications increases faster than spending in any other category, including health, education, and housing. Such spending patterns demonstrate that the perceived value of mobile communication supersedes basic needs for even the very poor (Corbett 2008). A study of mobile phone usage and ownership in Kenya (Wesolowski et al. 2012) found that the poor in this country spent a disproportionate amount of their income on phone airtime, providing additional documentation of the significance of mobile phones in their lives, too.

mHealth Drivers of Cost, Quality, and Access

The EIU surveys commissioned by PwC (Levy 2012) reported that 54% of patients in emerging markets identified cost of health care as a driver for increased use of mHealth compared with 34% of patients in developed nations. In emerging

Table 7.3 Comparison of cost, access, and quality drivers for mHealth usage. (Source: Derived from Economic Intelligence Unit 2012 Survey Data reported in Levy 2012)

Motivator	India (emerging country)	UK (developed country)	Comment
Cost	Indians cover ~75% of their medical expenses out of their own pocket	UK's National Health Service (NHS) provides free care at point of need, thereby removing any economic burden of care	Medical care is beyond the financial reach of many in India. In the UK, the care is mostly free
Access to care	0.6 doctors per 1000 people, with most doctors, including specialists, located in urban areas where less than 30% of India's population (1.2 billion) reside. Rural residents receive much of their care from certified social health activists versus trained medical personnel	2.15 doctors per 1000; Long waiting lists and inconvenience inhibit access to care	Because doctors tend to locate in urban areas, their services will be inaccessible to the majority of Indians (1.2 billion) In the UK, patients wait for months to get access to specialists and high-tech services such as CT scans and MRIs
Quality	Ability to obtain information otherwise unavailable was rated as important by 40% of India's respondents	Greater control over their own health was rated as important by 43% of UK respondents	Both of these items suggest adoption of mHealth technologies that will enable quality efforts

markets, such as India, health care is indeed expensive, with Indians themselves covering about 75% their medical care expense. In developed countries, such as the UK, health care is free at the point of care, and therefore not a financial burden. Indian respondents prioritized reasons for using mHealth as follows:

- Fifty-eight percent cited cost reduction as the number one reason for using mHealth.
- Fifty-five percent cited convenience of access.
- Forty percent cited the ability to obtain information otherwise unobtainable.

Meanwhile, respondents from the UK ranked cost reduction farther down on their list; however, convenience of access, which was second on the Indian listing, was at the top of the UK list:

- Forty-nine percent cited convenience of access.
- Forty-three percent cited the desire to take greater control over their health care.
- Twenty-five percent cited cost reduction (Levy 2012).

Table 7.3 further describes and differentiates the mHealth drivers between India, an emerging nation, and the UK, a developed nation.

Success Meets Global mHealth

DataDyne.org initiated a project known as *Coded in Country* that promotes using local software developers to create programming solutions that address local information technology challenges. *Coded in Country* was developed in conjunction with D-Tree International, a nonprofit organization, and Dimagi, a health-care technology company. The company encourages funding sources or operators to allocate more than 50% of their program monies toward local coders. The idea is that using locals will (1) develop more effective solutions because they are closer to the problems and (2) build information and communication technology capacity that will not disappear, as happens when outside software developers leave (Curioso and Mechael 2010). Other researchers agree with the need for developing local technical capacity in order to implement mHealth as well as promoting local microenterprise that will generate more economic opportunities (Kahn et al. 2010) and perhaps lead to sustainable mHealth interventions.

The OpenROSA consortium is a group of developers working to create open-source, nonproprietary, standards-based tools for mobile data collection that meets a common need. Open source development increases opportunities to work on larger-scale development efforts that include different countries and systems. Members include small companies, giants such as Google, and universities, including the University of Washington and the University of Bergen. The group has active developers working in a variety of developing countries such as India, Bangladesh, Kenya, Pakistan, Tanzania, and Uganda. OpenROSA successes include devising ways to capture or record data transferred via mobile devices (mobile data capture). Current initiatives of OpenROSA include JavaROSA, an open-source platform for mobile data collection. Uses are wide ranged and include disease surveillance and collecting data for electronic medical records. Projects that use the JavaROSA platform can be run on most Java-enabled phones. Even though these phones can usually be found in low-income areas, Java compatibility is not universal or inexpensive (Curioso and Mechael 2010).

Extending Rural Access Access to specialty medical care for rural residents is especially challenging in developing and low-income countries. Digital technology and mobile applications are viewed as helping people in rural areas overcome geographical barriers to care. In China, mobile devices often allow for remote consultations with specialists in urban areas. In India, videoconferencing enables some rural residents to access care. A mobile health app called Health Buddy has been used in Singapore to provide access to health information from specialists. In Bangladesh, where 90% of births in rural areas occur outside of hospitals or clinics, a mobile notification system is used to alert health clinics of the need for midwife services (West 2012).

Counterfeit drugs kill at least 100,000 people a year, mostly in the poor world. The UN estimates that about half of the antimalarial drugs sold in Africa, which are valued at close to US$ 438 million a year are fakes. Expensive radio frequency identification (RFID) technology and database software are being used to detect fakes, but mobile phones offer a less expensive alternative for developing countries

to screen drugs. For example, a Ghanaian start-up firm mPedigree has developed a way to use mobile phones to authenticate drugs. Participating drug companies emboss a special code onto packages, which customers find by scratching off a coating. By sending a free text with that code, customers can find out instantly if the drugs are fakes (Poison Pills 2010). A US-based company is beta testing an app that visually compares a patient's pills against a database of images to aid clinicians in managing a patient's total pharmaceutical profile. The app is particularly useful in interviewing elderly patients who cannot self-report their drug regimens.

The expanded functionality of cell phones offers a solution to another problem identified in a polio immunization program funded by the Bill & Melinda Gates Foundation. Program administrators found that some teams were simply not going to the geographical regions they were assigned. To resolve this issue, the program is piloting the use of phones equipped with a Global Positioning System (GPS) application for the vaccinators to carry. Tracks are downloaded from the phone to a laptop at the end of the day so managers can see the route the vaccinators followed and compare it to the route they were assigned. This helps ensure that geographical areas that were missed can be reassigned to vaccinators, ensuring that children are not left unprotected from polio (Gates 2013).

Because developing countries have fewer infrastructure barriers to innovation, they are often the incubators of innovation. As such, developed countries can learn from them. For example, Text4Baby, which is a free service that sends information to pregnant mothers, drew on the design of Mexico's VidaNet service (for patients with HIV/AIDS) and Kenya's MobileforGood Health Tips (Levy 2012). The potential for technology transfers from emerging countries to advance the deployment of mHealth is one of the most advantageous entrepreneurial assets in the industry.

mHealth phone tools also help train, supervise, and monitor community health workers in low-income countries. Supervising large numbers of workers who are distributed over large geographic areas is one of the most costly and difficult components of multinational companies. Mobile data collection can reduce costs, save time, and assure accuracy of data compared with traditional paper methods. Despite the considerable number of ICT projects for community health workers, little published research exists describing what works and what does not. Table 7.4 explains some of the possible benefits of these tools. If a community health program is not working well, adding mHealth to the mix is unlikely to resolve fundamental underlying programs as these tools cannot remedy more serious problems of politics, infrastructure, or funding (Derenzi et al. 2011). However, mHealth tools can support and/or strengthen a program, such as enhancing remote guidance and supervision of health workers.

Conclusions and the Future of Global mHealth

We began this chapter by asking what is known about the impact of mHealth globally and its future. As it happens, we know a great deal about how mHealth is changing the nature and extent of health service delivery worldwide. For example, text messaging turns out to be a particularly cost-effective way to connect with people

Table 7.4 Benefits of mobile phone applications by health system function. (Source: Derived from Derenzi et al. 2011)

Health system function	Description and example	Benefits
Facilitate communication with health-care workers	Transmit images to physicians for remote diagnosis. Pilot telemedicine projects in Botswana in dermatology, radiology, cervical cancer, and oral medicine	Enables patients in remote and rural areas access to specialists; improves quality of medical care
Data collection	Global positioning systems (GPS) technology in a mobile phone can track health workers and identify location of patient homes in the absence of accurate maps	Improves accuracy, efficiency, and costs of data collection Enhances surveillance activities
Training and access to information for health-care workers	Continuous training for health-care workers in community health centers in remote areas of Uganda. Sharing new clinical information and procedures via satellite in Uganda, AED-SATELLIFE	Make training/retraining more efficient, less expensive, more effective
Supervision of health workers	Mobile phone applications can enable real-time monitoring of health-care workers remotely. Remote guidance can also include automatic message reminders and/or motivation from supervisors	Offers supervisors the ability to stay in contact with field workers and quickly react to changes and provide corrections or positive feedback
Promoting population health, healthy behaviors	Chronic disease management tools have been deployed for health prevention and promotion. Text messaging to improve compliance with treatment regimens, including weekly and customized messages, games that can be downloaded to phones for incentivizing and encouraging healthy behaviors	Relatively easy and inexpensive way to reach large populations, especially those who live in rural and remote areas
Providing job aids and decision support	Mobile applications designed to help clinicians adhere to clinical guidelines and procedures by guiding clinicians through a series of protocols by offering one question at a time, with a question automatically determined by the answer to the preceding question	Improved adherence to clinical guidelines can improve treatments and reduce mortality rates

privately and across great distances. Public health workers in South Africa now send text messages to tuberculosis patients with reminders to take their medication. In Kenya, people can use SMS to ask anonymous questions about culturally taboo

subjects such as AIDS, breast cancer, and sexually transmitted diseases, receiving prompt answers from health experts for no charge (Corbett 2008).

Overall, mobile data traffic is expected to increase 18 times over between 2011 and 2016, when it is projected that there will be 10 billion mobile devices in use around the world (Cisco Virtual Networking Index 2012; West 2012). However, mobile phone ownership and usage is not uniform across populations. Heterogeneities of ownership may distort estimates of population dynamics and social networks, especially in countries such as Africa where few people in rural areas have phones and phone-sharing practices are extensive. In the meantime, penetration of mobile phones is expected to increase and subsequently reduce, if not eliminate, many of the problems associated with predicting the growth and impact of mHealth (Wesolowski et al. 2012).

In terms of mHealth's transformative potential, we learned that among developing countries there are extraordinary opportunities to strengthen existing weak or underdeveloped health systems and to take on serious health challenges ranging from chronic to infectious diseases. Cell phones and the Internet are rapidly penetrating the world and allowing remote and underserved communities to gain access to health information and services—often in real time (Curioso and Mechael 2010). Thus, access to care when and where you want it is becoming a reality for much of the world.

In developing countries, because the need for health care is overwhelming, money is scarce, and the infrastructure is less developed and entrenched, mHealth likely has a cleaner path to adoption of mobile technology. In developing countries, cellphones are perceived to be a lifeline to health care for many who live there and have had limited to no access to health care previously. Cellphones appear to extend the reach of health-care providers to underserved, disadvantaged, and vulnerable populations wherever they may be (Whittaker et al. 2012). Meanwhile, in the developed world, cellphones are more often seen as intriguing gadgets for entertainment and personal convenience, with thousands lining up to buy the latest upgrade of an iPhone.

Most of what is communicated about mHealth touts the successes; yet, existing research reports that the quality of mHealth interventions is poor. In fact, most of the mHealth trials have been performed in the developed world and not in the developing nations where the need is greatest. While mHealth is often publicized as having the potential to improve health care in developing countries, there is little supporting hard evidence to validate the hype. Furthermore, much of the testing has not gone beyond the pilot or introductory stages. In the future, there is a need for formative research and documenting outcomes, including lasting effects, of mHealth interventions (Curioso and Mechael 2010).

Because the field of mHealth research is new, there is a need to adequately investigate and corroborate findings to assure that findings are reliable and valid (Gurman et al. 2012). Beyond this, the lack of studies attempting to measure cost-effectiveness or health outcomes (Free et al. 2010; Tatalovic 2013) is a serious concern. Without this type of research, there is no way to know what works and what does not, particularly with regard to large-scale deployment. There is little to no evidence

to show governments, foundations, entrepreneurs, and businesses that mHealth is worthy of investment. Consequently, stronger evidence is necessary to distinguish reality from hype and to encourage investor and entrepreneur participation.

Measuring the impact of mHealth is challenging in a large part because of a lack of standardization in many important dimensions. There are no standards for evaluating mHealth and no universally accepted definition of terms such as mHealth, telemedicine, or telehealth. Thus, the numbers often do not add up nor do they paint a conclusive mHealth landscape. However, the field of mHealth is young, and researchers have called for more scrutiny and use of rigorous methodologies. The online reference database launched by JHU Bloomberg school of Public Health and the K4Health project should help improve the quality of mHealth research globally.

An important question is whether mHealth can be scaled and sustained for the foreseeable future. To be scalable and sustainable, mHealth requires more cost analysis research and further development and analysis of business models. Because of the significant role evaluation and assessment plays in demonstrating cost-effectiveness, the WHO and its partners are working to develop a framework to assist in evaluating mHealth programs, especially with regard to including meaningful and measurable indicators of robust outcomes. A global database of selected evaluation research findings will be built for mHealth with a particular emphasis on mHealth initiatives in developing countries. And, member states will gain access to the database to assist in planning projects and preparing project proposals (WHO 2011).

Because mobile phones and other mobile technologies require less investment and infrastructure than other health system transformative efforts, scaling up and widespread deployment of mHealth appears very achievable in developing countries. However, patient financial support has not yet been determined. Survey research shows that patients overall express a reluctance to pay out of pocket for mHealth. More patients in emerging markets reported that they were willing to pay for mHealth compared with patients in developed countries. However, some reluctance to pay for mHealth was evident even in developing countries (Levy 2012).

The possible future for mHealth is that it will continue to foster increased access to care in emerging countries while transforming the developed nations' large and costly health systems into affordable, prevention-based, and patient-focused delivery systems. Physicians and payers alike believe that widespread adoption of mHealth is inevitable. Furthermore, physicians predict the impact of mHealth on patient relationships will be as significant as the Internet has been in creating opportunities for individuals to engage in actions to influence their own health and well-being. Research has shown that patients have high hopes for the future of mHealth, including improvements in convenience, quality, and affordability. In the meantime, experts appear to remain more cautious about the future of mHealth—awaiting the intersection of health care and business models (Levy 2012). Thus, the development of business models remains a challenge for the future of mHealth globally.

Global mHealth is addressing many of the challenges of health-care access, cost, and quality issues worldwide, but impediments do exist. Developing countries often do not face the health-care infrastructure and bureaucracies that ultimately impede the diffusion of mHealth. Without these legacy systems, innovation has fewer

barriers to overcome. But many developing nations have formidable problems such as illiteracy and poverty. Even though the price of cellphones continues to decrease, they still remain unaffordable to someone earning less than US$ 5 per day. In addition, voicemail and video transmissions may ultimately address many of the needs of those who cannot read or text. Challenges to mHealth adoption will persist and require continuing attention.

mHealth services and applications will continue to be developed and used everywhere, regardless of country of origin, the patient, provider, or payer's location. But implementation will depend largely on what motivates the end users, the patients, and providers, and in many cases, the payers who can encourage adoption of mHealth with financial incentives for use. Technology is not the complicated piece of the global mHealth puzzle. How technology is used is what matters most and demands focus and attention (Derenzi et al. 2011). Barriers exist, but they are not insurmountable in most cases. Businesses are investing in development of solar, wind, and other technologies to resolve challenges of battery life and electricity in developing countries (Corbett 2008). And, governments are seeking partnerships to help build their global mHealth infrastructure.

References

Adler, R. (2009). The landscape of texting 4 health. In B. J. Fogg & R. Adler (Eds.), *Texting 4 health a simple, powerful way to improve lives* (pp. 9–19). Stanford: Stanford University.

Africa Overview. (2013). World bank. http://www.worldbank.org/en/region/afr/overview. Accessed 09 Sept 2013.

Baseline Evaluation of the mHealth Ecosystem. (December 2012). Baseline evaluation of the mhealth ecosystem and the performance of the mHealth alliance. *mHealth Alliance*. http://www.mhealthalliance.org/images/content/baseline_evaulation_report2013.pdf. Accessed 09 Sept 2013.

Becker, R. (19 November 2012). How many countries in Africa? How hard can the question be? *Africa Check*. http://www.africacheck.org/reports/how-many-countries-in-africa-how-hard-can-the-question-be/. Accessed 14 Sept 2013.

Boutayeb, A. (2006). The double burden of communicable and non-communicable diseases in developing countries. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 100*(3), 191–199.

Cisco Visual Networking Index. (14 February 2012). *Global mobile data traffic forecast update, 2011–2016* (pp. 1–3). San Jose: Cisco Visual Networking Index.

Cole-Lewis, H., & Kershaw, T. (2010). Text messaging as a tool for behavior change in disease prevention and management. *Epidemiologic Reviews, 32,* 56–69.

Corbett, S. (13 April 2008). Can the cellphone help end global poverty? *The New York Times Magazine*. http://www.nytimes.com/2008/04/13/magazine/13anthropology-t.html?pagewanted=all&_r=0. Accessed 23 Aug 2013.

Curioso, W. H., & Mechael, P. N. (2010). Enhancing 'M-health' with south-to-south collaborations. *Health Affairs, 29*(2), 264–267. doi:10.377/hlthaff.2009.1057. Accessed 23 Aug 2013.

Derenzi, B., Borriello, G., Jackson, J., Parikh, T. S., Virk, P., Lesh, N., & Kumar, V. S. (2011). Mobile phone tools for field-based health care workers in low-income countries. *Mount Sinai Journal of Medicine, 78*(3), 406–418. doi:10.1002/msj.20256. Accessed 09 Sept 2013.

Fiordelli, M., Diviani, N., & Schultz, P. J. (2013). Mapping mHealth research: A decade of evolution. *Journal of Medical Internet Research, 15*(5), e95. doi:102.2196/jmir.2430. Accessed 23 Aug 2013.

Free, C., Phillips, G., Felix, L., Galli, L., Patel, V., & Edwards, P. (2010). The effectiveness of M-health technologies for improving health and health services: A systematic review protocol. *BMC Research Notes, 3,* 250–256. doi:10.1186/1756-0500-3-250. Accessed 23 Aug 2013.

Gates, B. (2013). The 2013 annual letter from Bill Gates. http://annualletter.gatesfoundation.org/2013.aspx?cid=twt_BG_30Jan_twitpic#nav=intro. Accessed 27 Sept 2013.

Gurman, T. A., Rubin, S. E., & Roess, A. A. (2012). Effectiveness of mHealth behavior change communication interventions in developing countries: A systematic review of the literature. *Journal of Health Communication, 1*(17), 82–104. doi:10.1080/10810730.2011.649160.

Hagland, M. (2012). Telementoring at UPMC: The newest frontier in surgical training. *Healthcare Informatics*. http://www.healthcare-informatics.com. Accessed 27 Sept 2013.

Hampton, T. (2012). Recent advances in mobile technology benefit global health, research, and care. *JAMA (Journal of The American Medical Association), 307*(19), 2013–2014.

International Telecommunications Union Data Release. (2012). http://www.itu.int/ITU-D/ict/statistics/material/pdf/2011%20Statistical%20highlights_June_2012.pdf. Accessed 09 Sept 2013.

Jamison, D. T. (2006). Investing in health. Chapter 1. In D. T. Jamison, J. G. Breman, A. R. Measham, G. Alleyne, M. Claeson, D. Evans, et al. (Eds.), *Disease control priorities in developing countries* (2nd ed., pp. 3–34). New York: Oxford University Press and World Bank.

Kahn, J. G., Yang, J. S., & Kahn, J. S. (2010). 'Mobile' health needs and opportunities in developing countries. *Health Affairs, 29*(2), 254–261. doi:10.1377/hlthaff.2009.0965.

Koblinsky, M., Matthews, Z., Hussein, J., Mavalankar, D., Mridha, M. K., Anwar, I., et al. (2006). Going to scale with professional skilled care. *Lancet, 368,* 1377–1386.

Kowalewski, M., Jahn, A., & Kimatta, S. S. (2000). Why do at-risk mothers fail to reach referral level? Barriers beyond distance and cost. *African Journal of Reproductive Health, 4,* 100–109.

Leon, N., Schneider, H., & Daviaud, E. (2012). Applying a framework for assessing the health system challenges to scaling up mHealth in South Africa. *BMC Medical Informatics & Decision Making, 12*(1), 123–134. doi:10.1186/1472-6947-12-123.

Levy, D. (2012). Emerging mhealth: Paths for growth. http://www.pwc.com/mhealth. Accessed 23 Aug 2013.

Lund, S., Hemed, M., Nielsen, B., Said, A., Said, K., Makungu, M., & Rasch, V. (2012). Mobile phones as a health communication tool to improve skilled attendance at delivery in Zanzibar: A cluster-randomised controlled trial. *BJOG: An International Journal of Obstetrics & Gynaecology, 119*(10), 1256–1264. doi:10.1111/j.1471-0528.2012.03413.x.

Mechael, P., Batavia, H., Kaonga, N., Searle, S., Kwan, A., Goldberger, A., Fu, L., & Ossman, J. (2010). *Barriers and gaps affecting mHealth in low and middle income countries: Policy white paper*. New York: Columbia University Center for Global Health and Economic Development Earth Institute.

Mobile Health Market—New Industry Research Report Published by Transparency Market Research. (18 January 2013). http://www.prweb.com/releases/2013/1/prweb10320208.htm. Accessed 09 Sept 2013.

NHS Press Release. (22 September 2011). Dismantling the NIH programme for IT. Britain's Department of Health. https://www.gov.uk/government/news/dismantling-the-nhs-national-programme-for-it. Accessed 09 Sept 2013.

Philbrick, W. (2013). mHealth and MNCH: State of the evidence. *mHealth Alliance*. http://www.mhealthalliance.org/images/content/mhealthmnch_evidence_final.pdf. Accessed 27 Sept 2013.

Poison Pills: Counterfeit Drugs Used to Be a Problem for Poor Countries. Now They Threaten the Rich World, Too. (2 September 2010) The Economist. http://www.economist.com/node/16943895. Accessed 27 Sept 2013.

Population of Africa. (21 September 2013). World population review. http://worldpopulationreview.com/africa/. Accessed 14 Sept 2013.

PricewaterhouseCooper's Health Research Institute. (2010). Healthcare unwired: New business models delivering care anywhere. HRI consumer Survey 2010.

Rowe, J. (9 August 2011). UK offers US a chance to learn from failure. *Healthcare IT News*. http://www.healthcareitnews.com/blog/uk-offers-us-chance-learn-failure. Accessed 14 Sept 2013.

Slabodkin, G. (9 January 2013a). Global mHealth market to reach $ 10.2 billion by 2018. http://www.fiercemobilehealthcare.com/story/global-mhealth-market-reach-102-billion-2018/2013-01-09. Accessed 27 Sept 2013.

Slabodkin, G. (7 September 2013b). Global mHealth market to reach $ 20.7 billion by 2018. http://www.fiercemobilehealthcare.com/story/global-mhealth-market-reach-207b-2018/2013-09-07. Accessed 27 Sept 2013.

Slabodkin, G. (22 September 2013c). Reports provide Rosy mHealth forecast for remainder of decade. http://www.fiercemobilehealthcare.com/story/. Accessed 27 Sept 2013.

Sugrue, M. (6 February 2013). Where is the evidence? United Nations Foundation Blog. http://www.unfoundation.org/blog/where-is-the-evidence.html. Accessed 14 Sept 2013.

Sutherland, E. (2006). Counting mobile phones, SIM cards, and customers[Internet]. Parktown, South Africa: Learning Information Networking and Knowledge Centre, University of the Witwatersrand; [cited 2010 Jan 8]. http://link.wits.ac.za/papers/link-Mobile_numbers.pdf. Accessed 09 Sept 2013.

Tatalovic, M. (16 January 2013). Mobile phones may not solve health challenges in poor countries. *The Guardian*. http://www.guardian.co.uk/global-development/2013/jan/16/mobile-phones-health-challenges-poor-countries. Accessed 09 Sept 2013.

Versel, N. (25 September 2013). Johns Hopkins launches mHealth evidence reference site. http://mobihealthnews.com/25752/johns-hopkins-launches-mhealth-evidence-reference-site/. Accessed 01 Oct 2013.

Wesolowski, A., Eagle, N., Noor, A. M., Snow, R. W., & Buckee, C. O. (2012). Heterogeneous mobile phone ownership and usage patterns in Kenya. *PLoS ONE, 7*(4), 1–6. doi:10.1371/journal.pone.0035319.

West, D. M. (May 2012). How mobile devices are transforming healthcare. Center for Technology Innovation at Brookings. *Issues in Technology Innovation*, vol 18. http://www.brookings.edu/research/papers/2012/05/22-mobile-health-west. Accessed 09 Sept 2013.

Whittaker, R., Merry, S., Dorey, E., & Maddison, R. (2012). A development and evaluation process for mHealth interventions: Examples from New Zealand. *Journal of Health Communication, 17,* 11–21. doi:10.1080/10810730.2011.649103.

Wicklund, E. (30 July 2013). In projects near and far, health eVillages expands the reach of mHealth. *mHealth News*. http://www.mhealthnews.com/news/projects-near-and-far-health-evillages-expands-reach-mhealth. Accessed 23 Aug 2013.

World Health Organization. (2011). mHealth: New horizons for health through mobile technologies: Second global survey on eHealth. Global observatory for eHealth series, Volume 3. http://www.who.int/goe/publications/goe_mhealth_web.pdf. Accessed 19 Sept 2013.

World Trade Organization. (n.d.), Who are developing countries in the WTO?. http://www.wto.org/english/tratop_e/devel_e/d1who_e.htm. Accessed 19 Sept 2013.