mHealth

New horizons for health through mobile technologies

Based on the findings of the second global survey on eHealth

Global Observatory for eHealth series - Volume 3

World Health Organization

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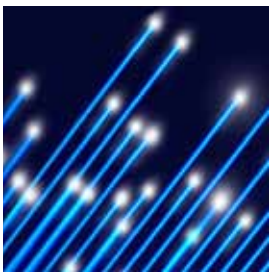


Acronyms and abbreviations

3G	Third generation mobile telecommunications
AIDS	Acquired immunodeficiency syndrome
DataCol	Data Collector
eHealth	Electronic health
EHR	Electronic health record
EMR	Electronic medical record
EMRS	Emergency medical response systems
H1N1	Influenza A (H1N1)
HIV	Human immunodeficiency virus
ICT	Information and communication technologies
IMCI	Integrated Management of Childhood Illness
ITU	International Telecommunications Union
mHealth	Mobile health
MDGs	Millennium Development Goals
MMS	Multimedia messaging service
GMA	Ghana Medical Association
GDP	Gross domestic product
GNI	Gross national income
GOe	Global Observatory for eHealth
GPRS	General packet radio service
GPS	Global positioning system
OECD	Organisation for Economic Co-Operation and Development
PDA	Personal digital assistant
RFID	Radio frequency identification
SIM	Subscriber identity module
SMS	Short message service
SQL	Structured Query Language
TB	Tuberculosis
UN	United Nations
WAP	Wireless application protocol
WHO	World Health Organization

Executive summary

The use of mobile and wireless technologies to support the achievement of health objectives (mHealth) has the potential to transform the face of health service delivery across the globe. A powerful combination of factors is driving this change. These include rapid advances in mobile technologies and applications, a rise in new opportunities for the integration of mobile health into existing eHealth services, and the continued growth in coverage of mobile cellular networks. According to the International Telecommunication Union (ITU), there are now over 5 billion wireless subscribers; over 70% of them reside in low- and middle-income countries. The GSM Association reports commercial wireless signals cover over 85% of the world's population, extending far beyond the reach of the electrical grid.

For the first time the World Health Organization's (WHO) Global Observatory for eHealth (GOe) has sought to determine the status of mHealth in Member States; its 2009 global survey contained a section specifically devoted to mHealth. Completed by 114 Member States, the survey documented for analysis four aspects of mHealth: adoption of initiatives, types of initiatives, status of evaluation, and barriers to implementation. Fourteen categories of mHealth services were surveyed: health call centres, emergency toll-free telephone services, managing emergencies and disasters, mobile telemedicine, appointment reminders, community mobilization and health promotion, treatment compliance, mobile patient records, information access, patient monitoring, health surveys and data collection, surveillance, health awareness raising, and decision support systems.

The survey shows there is a groundswell of activity. The majority of Member States (83%) reported offering at least one type of mHealth service. However, many countries offered four to six programmes. The four most frequently reported mHealth initiatives were: health call centres (59%), emergency toll-free telephone services (55%), managing emergencies and disasters (54%), and mobile telemedicine (49%). With the exception of health call centres, emergency toll-free telephone services, and managing emergencies and disasters, approximately two thirds of mHealth programmes are in the pilot or informal stage.

Consistent with eHealth trends in general, higher-income countries show more mHealth activity than do lower-income countries. Countries in the European Region are currently the most active and those in the African Region the least active. mHealth is most easily incorporated into processes and services which historically use voice communication through conventional telephone networks. This would explain why the majority of countries are already offering health call centres, toll-free numbers and emergency services using mobile communications. The least frequently seen is the use of mHealth in surveillance, raising public awareness, and decision support systems. These require enhanced capabilities and infrastructure to implement, and therefore may not be a health priority in Member States with financial constraints.

Competing health system priorities was consistently rated as the greatest barrier to mHealth adoption by responding countries. Health systems worldwide are under increasing pressure to perform under multiple health challenges, chronic staff shortages, and limited budgets, all of which makes choosing interventions difficult. In order to be considered among other priorities, mHealth programmes require evaluation. This is the foundation from which mHealth (and eHealth) can be measured: solid evidence on which policy-makers, administrators, and other actors can base their decisions.

Evaluation is part of a process that can determine cost-effectiveness, involves educating the public about the benefits of mHealth, and leads to government policy – all of which were reported as among the most important barriers to mHealth adoption by Member States. Despite the need for evaluation, the survey found that results-based evaluation of mHealth implementations is not routinely conducted. Only 12% of Member States reported evaluating mHealth services. A concerted effort needs to be made to promote the importance of evaluation and the sharing of results with all Member States.

Effective policy will become increasingly important as the field of mHealth matures. Data security is a particularly important issue to address within the area of policy. There are legitimate concerns about the security of citizen information by programmes using mobile health technologies. In particular, message transmission security and data storage security can put citizen information at risk if the necessary precautions are not taken. Policy-makers and programme managers need to be made aware of security issues in the mHealth domain so appropriate policies and strategies can be developed and implemented. Policies will also be vital to efforts in harmonizing eHealth and mHealth initiatives and directions in the short- and long-term.

The survey results highlight that the dominant form of mHealth today is characterized by small-scale pilot projects that address single issues in information sharing and access. There were only limited larger mHealth implementations (primarily supported by public-private partnerships). While it is anticipated that large-scale and complex programmes will become more common as mHealth matures, strategies

and policies that integrate eHealth and mHealth interoperability into health services would be wise. mHealth is no different from other areas of eHealth in its need to adopt globally accepted standards and interoperable technologies, ideally using open architecture. The use of standardized information and communication technologies would enhance efficiency and reduce cost. To accomplish this, countries will need to collaborate in developing global best practices so that data can move more effectively between systems and applications.

Moving towards a more strategic approach to planning, development, and evaluation of mHealth activities will greatly enhance the impact of mHealth. Increased guidance and information are needed to help align mHealth with broader health priorities in countries and integrate mHealth into overall efforts to strengthen health systems. To this end, WHO will undertake several actions.

- It will support the use of mHealth in Member States to maximize its impact. This will be achieved by providing information on mHealth best practices and the kinds of mHealth approaches best suited to specific public health scenarios. A series of databases need to be developed which include information on selected national and local initiatives, lessons learnt, evaluations and recommendations, best practices, and cost-effectiveness.
- In support of eHealth policy and strategy development, WHO and ITU are creating a National eHealth Roadmap Development Toolkit to support Member States with the development of their own comprehensive eHealth strategies. The Global Observatory for eHealth (GOe) and its partners will work to develop a framework for the evaluation of mHealth programmes, including meaningful and measurable indicators. A global database of selected evaluation research findings will be built for mHealth with a particular emphasis on developing country initiatives. Member States will have ready access to the database when planning projects and preparing project proposals.
- WHO in collaboration with the ITU will provide guidance to Member States on the content and scope of data privacy and security policy for mobile telecommunications in health.

Mobile health will advance through creating country-based eHealth strategies that incorporate it into the existing eHealth domain. Policies need to be complemented by standards, architectures, and solid partnerships to help pilot mHealth initiatives mature and realize their full potential – utilizing mobile and wireless technologies to improve health and well-being.

1 Overview



The unprecedented spread of mobile technologies as well as advancements in their innovative application to address health priorities has evolved into a new field of eHealth, known as mHealth. According to the International Telecommunication Union there are now close to 5 billion mobile phone subscriptions in the world, with over 85% of the world's population now covered by a commercial wireless signal (1). The penetration of mobile phone networks in many low- and middle-income countries surpasses other infrastructure such as paved roads and electricity, and dwarfs fixed Internet deployment. The growing sophistication of these networks – offering higher and higher speeds of data transmission alongside cheaper and more powerful handsets – are transforming the way health services and information are accessed, delivered, and managed. With increased accessibility comes the possibility of greater personalization and citizen-focused public health and medical care.

Governments are expressing interest in mHealth as a complementary strategy for strengthening health systems and achieving the health-related Millennium Development Goals (MDGs) in low and middle-income countries.[1] This interest has manifested into a series of mHealth deployments worldwide that are providing early evidence of the potential for mobile and wireless technologies. mHealth is being applied in maternal and child health, and programmes reducing the burden of the diseases linked with poverty, including HIV/AIDS, malaria, and tuberculosis (TB). mHealth applications are being tested in such diverse scenarios as 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, among others.

1 http://www.who.int/topics/millennium_development_goals/accountability_commission/en/.

The field's potential is recognized by the United Nations (UN) and World Health Organization (WHO). The former 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 22 September 2010. The latter included a module on mHealth in the 2009 Global eHealth survey.

An understanding of this new environment from the perspective of WHO Member States and analysis across World Bank income groups is a critical next step to advancing mHealth globally. This report aims to make policy-makers aware of the mHealth landscape and the main barriers to implement or scale mHealth projects. It combines the results and analysis of the data gathered from the mHealth survey and is complemented by five country case studies and a review of the current literature related to mHealth.

1.1 Defining mHealth

mHealth is a component of eHealth. To date, no standardized definition of mHealth has been established. For the purposes of the survey, the Global Observatory for eHealth (GOe) defined mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices.

mHealth involves the use and capitalization on a mobile phone's core utility of voice and short messaging service (SMS) as well as more complex functionalities and applications including general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), global positioning system (GPS), and Bluetooth technology.

1.2 Second global survey on eHealth

The second global survey on eHealth was conducted in late 2009 and was designed to build upon the knowledge base generated by the first survey conducted in 2005. A detailed description of the methodology and analysis is included in Appendix 1. One hundred and twelve Member States responded to the 2009 survey. Appendix 2 contains a list of the responding countries by WHO region and World Bank income group, and Appendix 3 shows the level of mobile phone subscriptions for them. While the first survey was general and primarily asked high-level questions at the national level, the 2009 survey was thematically designed and presented more detailed questions in a series of survey modules, including mHealth.

The goals of the mHealth module were to document mHealth activity in Member States as well as identify the barriers to its adoption. This included, specifically, identifying and documenting:

- the existence and maturity of mHealth activities within Member States;
- types of mHealth initiatives being conducted;
- status of monitoring and evaluation of mHealth initiatives; and
- barriers to implementation.

The thematic design of the survey has provided the GOe with a rich source of data that are being used to create a series of eight publications – *The Global Observatory for eHealth Series* – due for publication during 2010 and 2011.

1.3 Overview of findings

This report will show that:

- Rather than strategic implementation, the emergence of mHealth is occurring in many Member States through experimentation with technologies in many health settings. Policy-makers and administrators need to have the necessary knowledge to make the transition from pilot programmes to strategic large-scale deployments.
- Many countries reported up to six mHealth programmes per country.
- The survey ranked the adoption of the top mHealth initiatives ranging from Health call centres (number 1) to decision support systems (number 14); patterns of adoption were described according to World Bank income group and WHO region.
- Many of the top six barriers to mHealth implementation related to the need for further knowledge and information, such as assessing effectiveness and cost-effectiveness of mHealth applications. Other key barriers included conflicting health system priorities, the lack of supporting policy, and legal issues.
- Although the level of mHealth activity is growing in countries, evaluation of those activities by Member States is very low (12%). Evaluation will need to be incorporated into the project management life-cycle to ensure better quality results.
- Data security and citizen privacy are areas that require legal and policy attention to ensure that mHealth users' data are properly protected.
- Member States will progress further in implementing mHealth if they share global ICT standards and architecture. Cooperation in the development of best practices enterprise architecture will ensure that data can move more effectively between systems and applications.

2 Global results



The 2009 survey results and analysis are presented from a global, regional, and economic perspective, through the lens of the WHO regions and World Bank income groups.[2] Each mHealth initiative is presented independently. Evidence from the literature is presented along with the results to provide a more complete picture.

2.1 mHealth initiatives globally

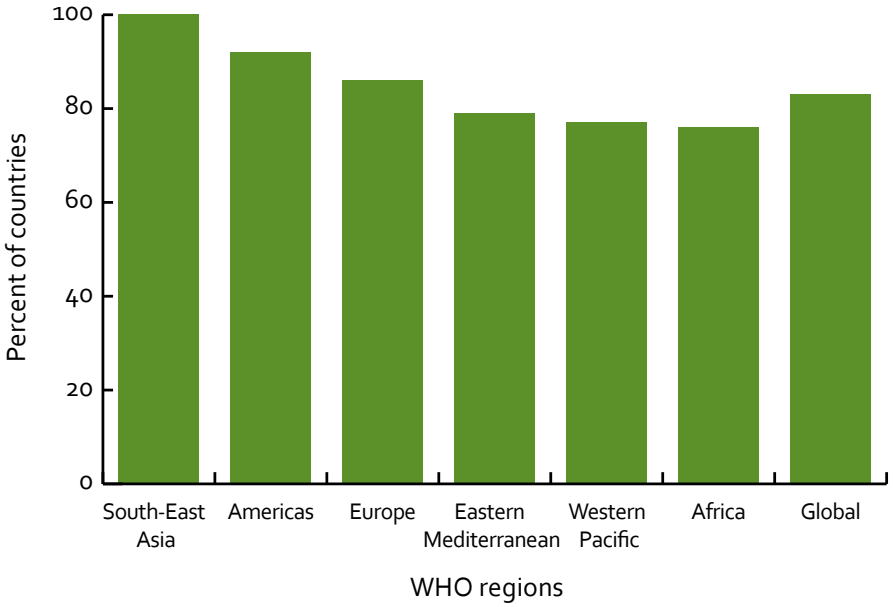
Key findings

- One hundred and twelve Member States completed the mHealth module of the survey. A vast majority (83%) reported at least one mHealth initiative in their country.
- Of this 83%, most Member States reported implementing four or more types of mHealth initiatives.
- Responding low-income countries (77%; n=22) reported at least one mHealth initiative compared to 87% (n=29) of high-income countries.

2 http://data.worldbank.org/about/country-classifications.

The survey found that most Member States use mHealth initiatives: 83% of the 112 participating Member States reported the presence of at least one mHealth initiative in country (See Figure 1). Of these, three quarters reported four or more types of mHealth initiatives. Only 19 responding countries did not report the presence of an mHealth initiative. It is important to note that a Member State reporting zero mHealth initiatives does not indicate that no mHealth initiatives are being conducted in the country. Local projects being executed by small organizations or nongovernmental organizations (NGOs) may not be widely known and the expert informants completing the survey may not have been aware of them. In addition, the survey was limited by the fact that respondents could only provide one example for each mHealth category. Thus, the number of initiatives reported depicts the breadth of mHealth activity in a country but does not represent the depth of activity within each category.

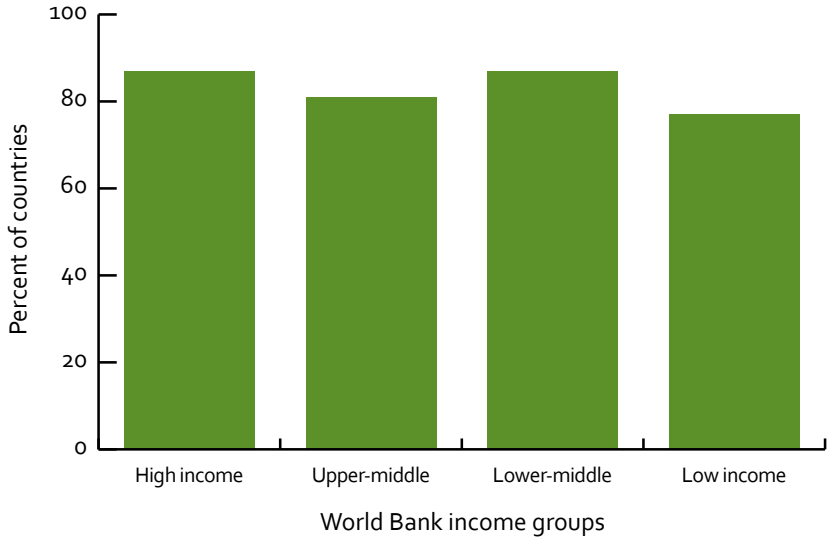
Figure 1. Member States reporting at least one mHealth initiative, by WHO region



At least 75% of participating Member States from each WHO region reported the presence of one mHealth initiative in the country (Figure 1). Countries in the African Region reported the fewest initiatives, while those in the South-East Asia Region reported the most.

Analysis of the survey results by World Bank income group is shown in Figure 2. The low-income group reported the fewest participating Member States with at least one mHealth initiative (77%); however, this was not significantly lower than that for the high-income group (87%). Based on the wide distribution of reported mHealth activity both geographically and economically, it appears that mHealth is an approach with global appeal.

Figure 2. Member States reporting at least one mHealth initiative, by World Bank income group



2.2 Categories of mHealth initiatives, globally

Key findings

- The most frequently reported types of mHealth initiatives globally were health call centres/ health care telephone help lines (59%), emergency toll-free telephone services (55%), emergencies (54%), and mobile telemedicine (49%).
- The least frequently reported initiatives were health surveys (26%), surveillance (26%), awareness raising (23%), and decision support systems (19%).

In order to help classify the use of mobile technology in a health care system, eight categories were created to reflect the most well-established mHealth interactions between the health system and the public and within the health system itself.

Countries were asked to report whether a certain type of mHealth initiative was taking place in their country, provide an example, and its stage of development according to the following definitions:

- Informal: not part of an organized health programme but involves the use of mobile technology to communicate for health-related reasons
- Pilot: testing and evaluating the use of mHealth in a given situation
- Established: an ongoing health-related programme using mHealth

Table 1 lists the types of mHealth initiatives covered in the survey.

Table 1. mHealth categories used in the 2009 survey

Communication between individuals and health services
- Health call centres/Health care telephone help line
- Emergency toll-free telephone services

Communication between health services and individuals
- Treatment compliance
- Appointment reminders
- Community mobilization
- Awareness raising over health issues

Consultation between health care professionals
- Mobile telemedicine

Intersectoral communication in emergencies
- Emergencies

Health monitoring and surveillance
- Mobile surveys (surveys by mobile phone)
- Surveillance
- Patient monitoring

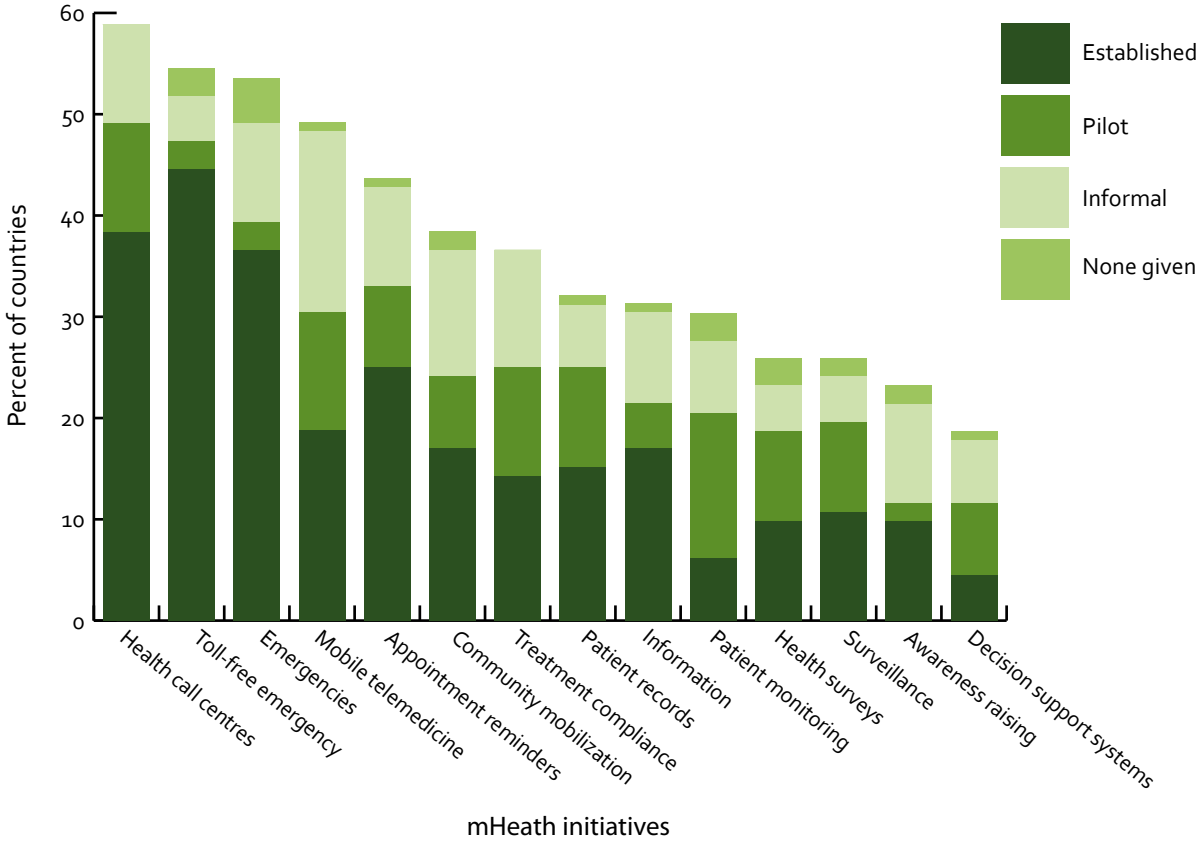
Access to information for health care professionals at point of care
- Information and decision support systems
- Patient records

Globally, the types of mHealth initiatives most frequently reported were health call centres/health-care telephone help lines (59%), emergency toll-free telephone services (55%), emergencies (54%), and mobile telemedicine (49%). These mHealth initiatives share the common characteristic of using the core voice functionality of a mobile device. Figure 3 shows the adoption of mHealth initiatives globally.

The least frequently reported mHealth initiatives were health surveys (26%), surveillance (26%), awareness raising (23%), and decision support systems (19%). These results differ from the reports in the literature, which supported the use of mobile devices for data collection and disease surveillance. However, most studies focused on observing the differences, effectiveness, and feasibility between traditional methods of data collection and disease surveillance (e.g. paper and pen) to mHealth solutions, with limited to no integration with government-supported health information systems. Thus, such projects may not be widely known among government officials and/or informants completing the survey.

Further, it is important to note that the definition of 'awareness raising' used in the Second Global eHealth Survey included "downloading health information onto the mobile device". Since this would require web browsing and data storage capabilities – functionalities not necessarily readily available on mobile devices globally – this is likely to result in fewer reports of initiatives to raise the awareness of health issues and is often used for HIV/AIDS. Such initiatives are expected to increase in the near future, however, as mobile devices increasingly have Internet capabilities and enhanced data storage.

Figure 3. Adoption of mHealth initiatives and phases, globally



2.3 Adoption of mHealth initiatives by WHO region

Key findings

- The use of mobile phones in health call centres/health care telephone help lines was relatively high across all regions.
- Except for the African Region, the use of mobile phones in emergencies was also relatively high.
- Forty-eight per cent of responding Member States reported the use of mobile devices for emergency and disaster situations.

Due to the diversity within WHO regions it is often difficult to identify common trends between based on commonalities in countries and this applies to data gathered on mHealth adoption. However, the report attempts to identify regional findings where possible.

Figure 4 shows health call centres/health care telephone help lines are one of the two most common mHealth initiatives across all WHO regions; the other is emergency toll-free telephone services – with the exception of the African Region. The use of mobile devices for emergency and disaster situations was reported by over 48% of Member States across all regions except the African and Eastern Mediterranean Regions.

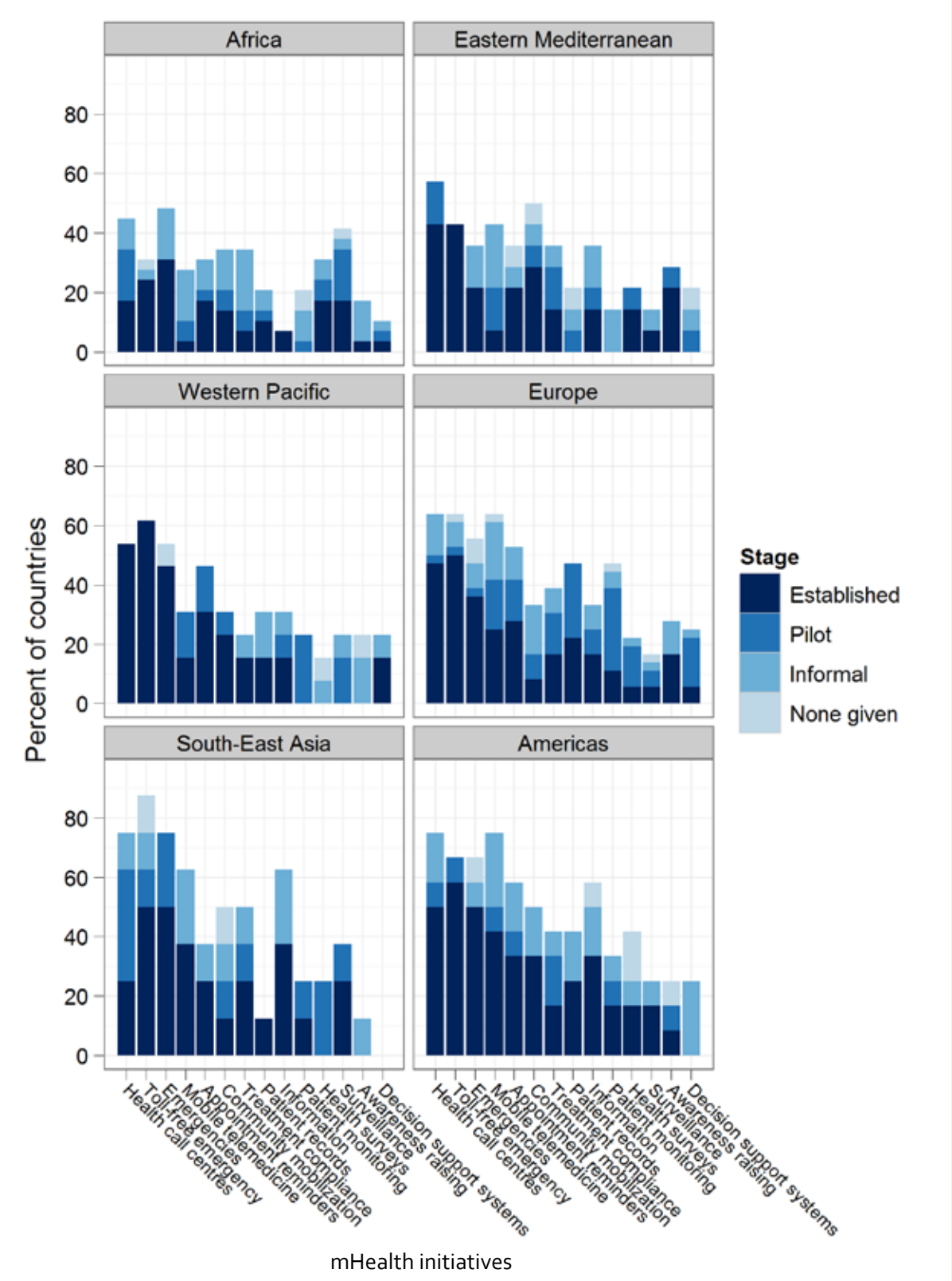
The low frequency of emergency toll-free telephone services reported in the African Region (28%) compared to other regions (42–75%) could be due to insufficient infrastructure to respond efficiently and effectively to emergency calls in some countries (e.g. lack of paved roads, dispatch systems connecting ambulances to hospitals).

Health call centres, globally the most frequently reported initiative, show consistently high levels of adoption across all regions except the African Region where it is just over 40% compared to all other regions which are approximately 60%. With the ongoing development of infrastructure and increasing level of acceptance of these services it is likely that they will expand in the African Region.

The use of mHealth for emergency situations is also frequently reported globally (approximately 50%). The Regions of the Americas and South-East Asia show higher than average adoption (around 70%) and the African and Eastern Mediterranean Regions are lower (approximately 40%).

Treatment compliance shows a global uptake of almost 40% and five regions show little variation above or below this figure. The Western Pacific Region is the exception, with an uptake of only 20%. This is most likely due to the fact that mobile technologies have not yet been accepted or integrated into this particular process.

Figure 4. Adoption of mHealth initiatives and their phases, by WHO region



2.4 Adoption of mHealth initiatives by World Bank income group

Key findings

- Countries in the high-income group reported a greater range of initiatives compared to those in the low-income group.
- Health call centres/Health care telephone help lines were among the most frequently reported types of initiatives across all income groups.
- Health surveys and surveillance initiatives were reported by a relatively high proportion of responding Member States in the low-income group. These initiatives were the least reported by countries in the high and upper-middle income group.
- Appointment reminder initiatives were frequently reported by high-income countries.

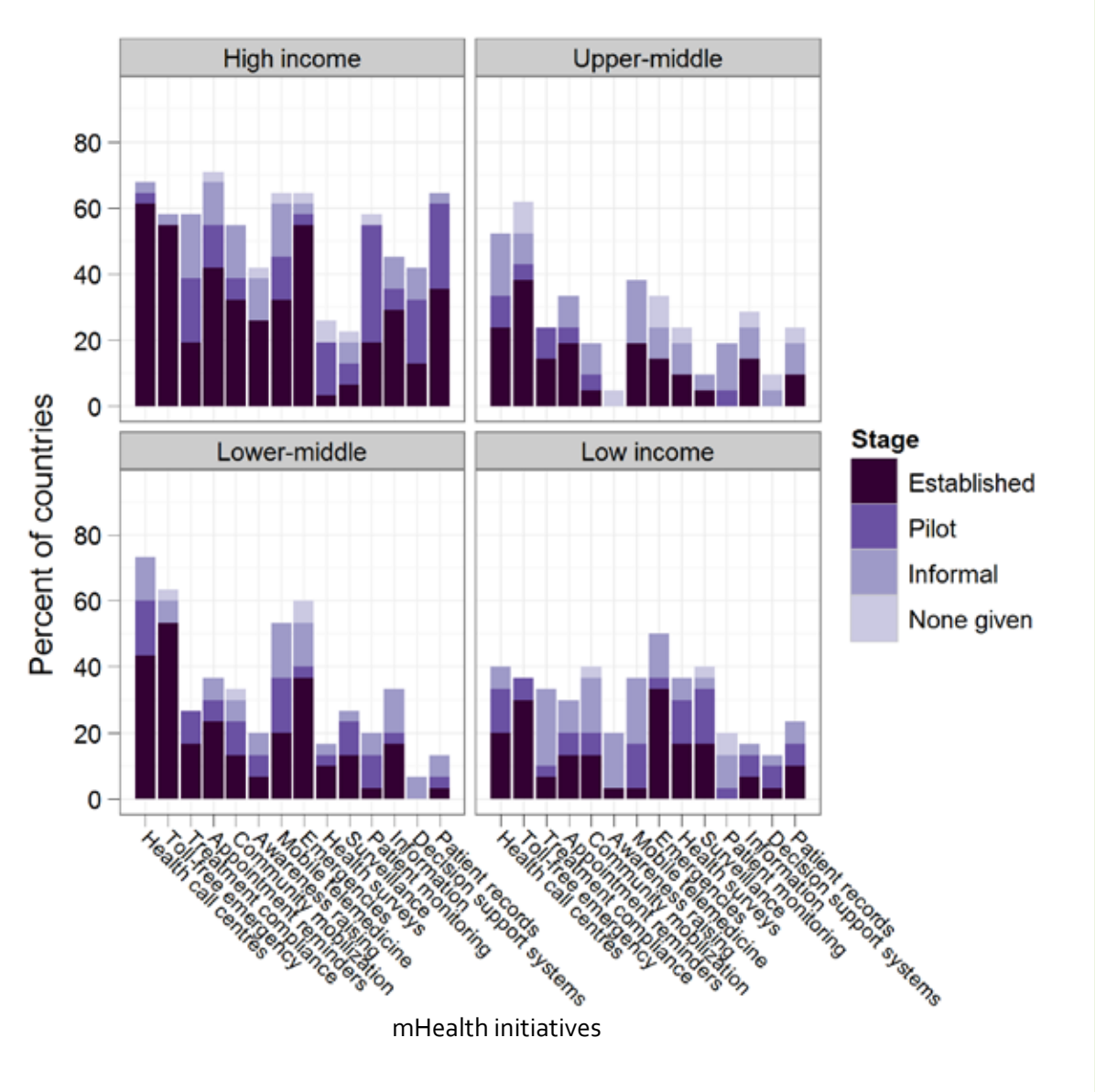
Figure 5 provides an overview of the adoption of mHealth initiatives by World Bank income group. Countries in the high-income group reported the highest proportion of mHealth initiatives, and were conducting more established initiatives. In contrast, the proportion of Member States in the low-income group reporting mHealth initiatives was 50% or less for all categories. Health call centres/health care telephone help lines were commonly reported by countries in all income groups, in addition to initiatives for mobile telemedicine and emergencies. These three types of mHealth initiatives in particular target the entire population of a country, and thus have the potential for scale and sustainability.

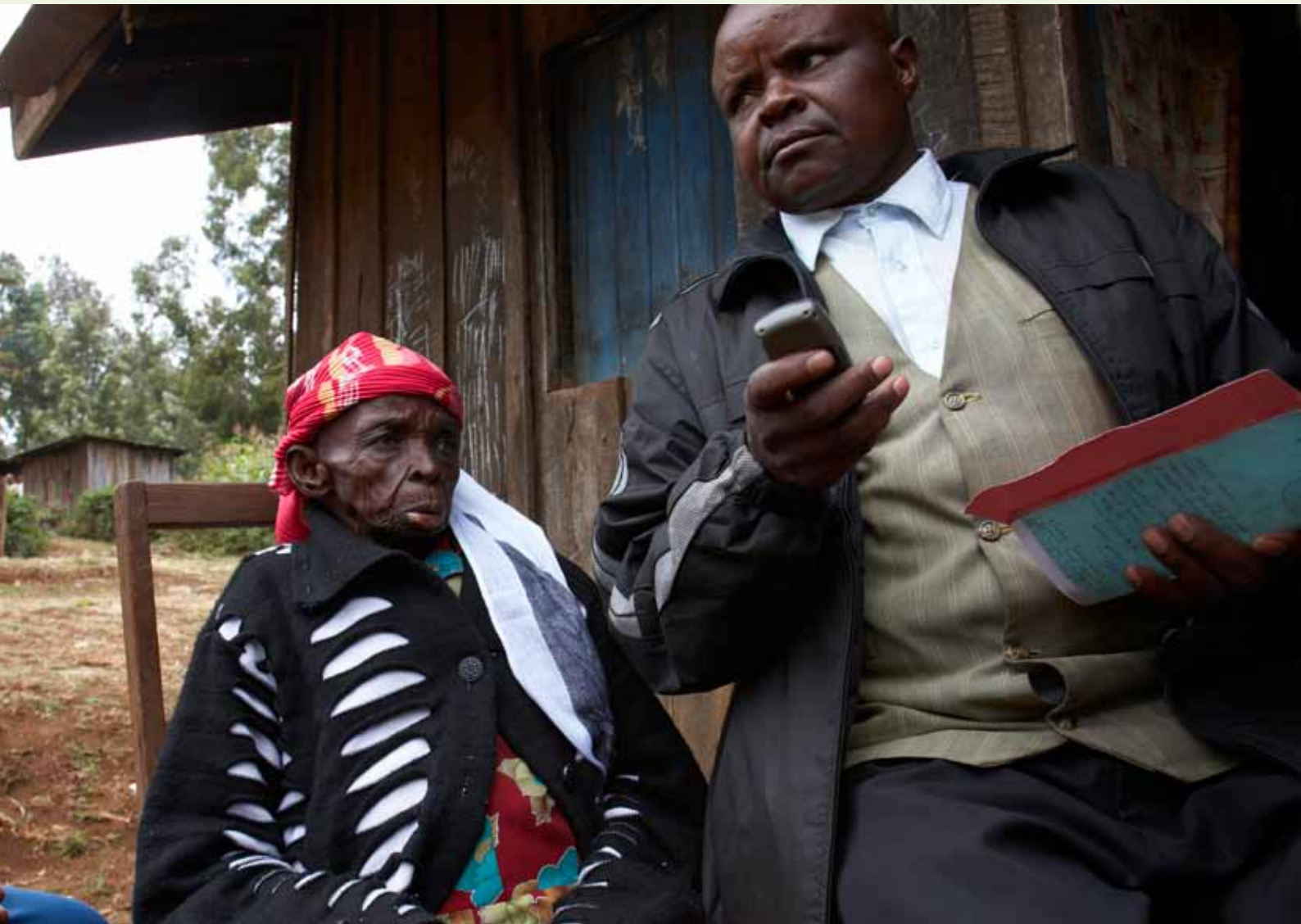
Health surveys and surveillance initiatives were among the most frequently reported by participating Member States in the low-income group. In contrast, the high and upper-middle income groups reported very few of them. The most probable explanation for this is that countries in the higher income groups have some existing surveillance capacity and so will not be limited to such initiatives.

The use of mobile devices to send appointment reminders is becoming more common among Member States in the high-income group as well; 71% reported the existence of these initiatives. With reports that non-attendance for hospital outpatient appointments cost countries such as the United Kingdom of Great Britain and Northern Ireland an estimated £790 million per year (2), the demand for solutions to overcome this challenge is high. mHealth could well provide a cost-effective and simple answer to this problem.

The use of mobile technologies for patient records shows a large contrast between countries in the high-income group and the others. For instance high-income countries reported just over 60% adoption compared to approximately 20% among countries in the other groups. This significant difference is likely related to the level of maturity of electronic medical/health records in high-income countries, where country income corresponds to technological advances.

Figure 5. Adoption of mHealth initiatives and their phases, by World Bank income group





3 Results and analysis by mHealth category



The survey results indicate a more mature view of mHealth than had been predicted. Member States reported many initiatives of several mHealth categories scaled to the national level. The literature, in comparison, was found to focus mostly on small-scale pilot studies, predominantly from higher-income countries. This section provides a detailed comparison between the survey results and literature by considering each of the mHealth initiatives queried in the survey.

3.1 Health call centres/Health care telephone help line

Health call centres/Health care telephone help lines are a service created to deliver health care advice triage services by trained health professionals on the telephone. This method of communication is established to manage national emergencies, and was routinely made available during the H1N1 influenza outbreak in 2009.

Key findings

- The European Region reported more general-purpose health call centres (64%) than other regions.
- The African (17%) and South-East Asia (38%) Regions reported a low level of pilot-stage activity for health call centre/health care telephone help line initiatives.
- Countries in the high-income group reported the highest number of established health call centres (61%).
- The African, Americas and Eastern Mediterranean Regions reported health call centres/health care telephone help lines that address specific health issues such as HIV/AIDS, H1N1, reproductive health/family planning, pandemics, and drug abuse.

3.1.1 Survey results

The survey results show that over 40% of participating Member States in each WHO region had established health call centre/health care telephone help lines, with the exception of the African and South-East Asia Regions. Pilot projects in these regions (17% and 38%, respectively), however, indicate that individual countries in these regions are increasingly investigating this type of mHealth activity.

Analysis of the qualitative responses from those countries that provided additional information (n=22) indicated that the European Region has more all-purpose health call centres than any other region. Member States such as Estonia, Finland, France, Germany, and Greece described health call centres and help lines that operated 24 hours per day seven days per week, staffed by health professionals to provide triage services and health information. These operations are either publicly or privately owned.

The United Kingdom reported that the National Health Service (NHS) in England and Scotland operates a no-cost 24-hour health call centre/health care telephone help line with nurses who triage patients. In contrast, private companies in Finland, Germany, and Greece operate paid health call centres/health care telephone help lines with established business models. An example of this is SOS Doctors, reported by Greece, which operates a fee-for-service 24-hour health help line and in-home medical service with a team of freelance, specialized medical professionals. Finland reported a similar model, indicating that many health call centres were linked to electronic medical records.

The African, Americas, and Eastern Mediterranean Regions frequently reported offering health call centres and help lines that addressed specific health issues. This included public health issues such as HIV/AIDS, drug abuse, addiction and suicide, family planning, smoking cessation, cholera, dengue and febrile syndromes and emergencies. Six Member States reported an established or informal health call centre to address the H1N1 influenza pandemic of 2009.

An initiative in Bangladesh deserves mention. It reported the presence of advanced health call centre implementations including both public and private sector models. First, the Ministry of Health & Family Welfare provided mobile phones to all district (64) and sub-district (421) hospitals. The mobile phone numbers are advertised on a central web site for the local community to promote free access. In each district and sub-district hospital, one doctor remains available 24 hours per day seven days per week to receive incoming calls from citizens and patients to provide medical advice. Second, in 2006, an entrepreneur launched a health call centre called HealthLine in partnership with a local telecommunications operator. The hotline is managed by licensed physicians and has been designed to be accessible directly from mobile phones by dialling "789". Since November 2006, the service has received more than 3.5 million calls (3). Other telecommunication operators, private hospitals, and non-profit-making organizations such as Our Village and BRAC have also launched health call centres (4).

With respect to World Bank categories, Member States in the low and lower-middle income groups reported the highest percentage of health call centre activity (68%), while participating Member States in the upper income group reported more established initiatives (61%). Overall, over 40% of participating Member States in each World Bank income group reported activity in this category, making it the most frequently reported mHealth initiative.

3.1.2 Relevant literature

In low and lower-middle income countries, there has been a growing interest in capitalizing on the ubiquity of mobile technology infrastructure to develop health call centres that can increase accessibility of health advice and information to patients and the public. This approach has been found to overcome widespread health system barriers such as health professional shortages, reliance on untrained and/or informal providers, cost of service and transportation, and lack of sources of reliable information. While the literature indicates that health call centres have been operating in Canada, the United Kingdom, and United States of America, for decades, a study conducted by Ivatury, Moore and Bloch documented examples from developing countries such as Bangladesh, India, Mexico, and Pakistan (5).

For example, in the Democratic Republic of the Congo Population Services International (PSI), in partnership with a telecommunications operator, launched an initiative called the Ligne Verte Toll-Free Hotline to complement its family planning initiatives in the region (6). It provides confidential family planning information, and refers patients to nearby clinics to access contraceptives and other commodities. Each call cost PSI US$ 0.36, and was exclusively for mobile device users of the partnered telecommunications operator. Calls were limited to two minutes. The programme was funded by revenue generated from sales of contraceptives and commodities at family planning clinics, and had a total of 20 036 calls in 2008. Men made 84% of these calls – a result unanticipated by the family planning programme (6).

Similarly, Mexico's MedicallHome service offers its one million subscribers access to professional health advice for a fixed fee of US$ 5 per month, which is billed directly to the consumer's mobile phone invoice, and is far below the market price for a physician consultation. The health call centres studied were found to share three common characteristics (5):

- health call centres in developing countries are more often for-profit operations than non-profit-making;
- customers are directly charged for services; and
- many companies partner with mobile network operators, or other telecom firms with extensive networks, brand recognition, established distribution and retail channels, as well as billing and revenue collection systems.

These characteristics constitute a model often used by the programmes taken from the survey results (e.g. Ligne Verte). While this model offers many advantages, it also has its limitations. These can include the lack of affordability of services for the poorest segments of the population, inconsistent availability in regions where mobile coverage is poor, limited access for women who less often own or have access to a mobile phone, and lack of integration of health call centre systems with other sources of information.

3.2 Emergency toll-free telephone services

Emergency toll-free telephone services are often used for quick access to health professionals or staff trained to provide direction during a medical emergency. Access to telephony services is required to engage with a health call centre and/or emergency toll-free number (e.g. 911 in the United States).

Key findings

- The South-East Asia Region reported the highest percentage of emergency toll-free telephone services (88%).
- The African Region reported the least activity in this category (31%).
- Countries from the lower-middle income (63%) and high-income (58%) groups reported the highest level of service.

3.2.1 Survey results

Emergency toll-free telephone services were reported by over half of all responding Member States, with the exception of those in the African and Eastern Mediterranean Regions. Analysis of the qualitative responses from the survey showed that citizens did use emergency toll-free numbers for transportation dispatch support during an emergency. All implementations reported relied on the voice functionality of a mobile or fixed line phone, with the exception of Portugal, which documented a multi-channel toll-free emergency call centre service supporting voice, e-mail, web, and fax.

The African Region reported the lowest percentage of activity (31%) in this category. A few participating countries in the African Region did report, however, disease-specific emergency toll-free telephone services. For example, Benin established a service specifically for HIV/AIDS patients; Zimbabwe reported launching a telephone line for citizens to report cholera cases; Madagascar had a service to support victims of domestic violence; and Togo gave an account of an emergency toll-free telephone service set up for citizens to obtain information on H1N1 and TB.

Similar reports were seen in Member States from other regions. For instance, the Styrian regional Ministry of Health in Austria set up an emergency toll-free telephone service to support women, girls, teachers, and parents struggling with eating disorders. The Philippines reported a programme implemented by the National Management and Poison Control Center at the Philippines General Hospital at the University of the Philippines that provides an emergency toll-free telephone service for poison-related queries.

Across the World Bank income groups, activity of emergency toll-free telephone services ranged from 37% in the low-income group to approximately 60% for the other three income groups. Participating Member States in the high-income and lower-middle income groups both reported the highest percentage of established initiatives (around 55%).

3.2.2 Relevant literature

Yang and colleagues found infrastructure costs required to establish an emergency toll-free telephone service in low and lower-middle income countries to be prohibitive (7). Costs incurred may include the set up and service package of the toll-free number, as well as personnel and data management costs. In some countries where emergency toll-free telephone services are established adoption has been found to be weak. For example, a qualitative study of health-related uses of mobile phones in Egypt found that, despite the presence of a national emergency toll-free telephone service, participants preferred to call local private transportation services during a medical emergency. This was explained by the fact that emergency calls were being routed to a call centre in Cairo and resulting in a slow response time (8). In contrast, private sector organizations in India have established emergency toll-free telephone services for transportation dispatch during an emergency. For example, Dial 1298 for Ambulance was the first responder during the Mumbai attacks in 2008, which subsequently led the company to engage with the public sector through state government contracts (9).

3.3 Treatment compliance

Treatment compliance is described as the sending reminder messages, by voice or SMS, to patients with the aim of achieving treatment compliance, disease eradiation, and overcoming challenges such as drug resistance. It has been applied to support patients with conditions such as diabetes, HIV/AIDS, and TB.

Key findings

- Approximately one third of responding Member States across all WHO regions reported conducting treatment compliance initiatives.
- Almost 60% of countries in the high-income group have treatment compliance initiatives, compared to approximately 30% in other income groups.
- A large number of treatment compliance initiatives in Member States in the high- and low-income groups are in the informal stage.

3.3.1 Survey results

Approximately 35% of Member States across WHO regions reported conducting treatment compliance initiatives, with the South-East Asia Region highest (50%) and the Western Pacific Region lowest (23%). New Zealand reported smoking cessation programme Txt2Quit as an example that has undergone a clinical trial, achieved scale in the country, and has been replicated by other countries (10). Txt2Quit has been designed to send support text messages to consumers attempting to quit smoking. On average the service attracts 317 new clients per month, and was recently adopted in Canada by a local telecommunications operator (11).

In the European Region, reported treatment compliance initiatives targeted chronic illnesses such as diabetes, asthma, obesity, chronic obstructive pulmonary disease (COPD), and chronic heart disease. In the Czech Republic, a programme to remind women to take their contraceptive pills via SMS has

been initiated. Treatment compliance initiatives reported from the European Region were often locally operated or based out of a single hospital. For instance, Greece reported a system deployed in a private hospital; Germany and Switzerland highlighted local corporate solutions.

Participating Member States in the African Region reported the highest percentage of informal programmes (21%) but the lowest percentage of established treatment compliance programmes (7%). Informal programmes reported include general medication reminders being instituted by health service providers in Ghana and Ethiopia, and an HIV/AIDS treatment compliance programme in the Congo.

A preference for using SMS for treatment compliance programmes was observed across the globe. The enormous popularity of SMS as a method of communicating by mobile phone is not surprising. It is inexpensive or without cost, is a succinct way of sending a message without the need to talk, and offers a record of messages sent and received. This aligns with the findings from the literature review. In contrast, Bhutan, Colombia, the Congo, and Sierra-Leone reported treatment compliance programmes using voice functionality rather than SMS.

Close to 60% of participating countries in the high-income group reported treatment compliance initiatives, compared to approximately 30% for the other income groups. These results are consistent with the literature review, which found a concentration of studies from high-income countries such as Canada, the United Kingdom, and United States with treatment compliance programmes using SMS, mobile phone applications, web browsing and e-mail for chronic diseases such as diabetes, asthma, and obesity (12–20). Both the high- and the low-income groups had a large proportion of Member States reporting informal initiatives (around 20%).

3.3.2 Relevant literature

Treatment compliance programmes in the literature were found to vary across country income groups. Studies from high-income countries tended to focus on chronic or noncommunicable diseases, whereas studies from low and lower-middle income countries focused on drug adherence for HIV/AIDS, malaria, and TB (21–23). Recently, plans to conduct more rigorous studies by employing a randomized control study design have been reported by Lester et al. (24) and Curioso et al. (25). These studies are investigating the impact of treatment compliance initiatives for chronic disease patients in Kenya and Peru.

3.4 Appointment reminders

Appointment reminders are voice or SMS messages sent to patients to schedule or attend an appointment. After receiving qualitative reports from the survey responses, the GOe expanded this definition to include immunization reminders, treatment results, and post-appointment follow-up calls. In low and lower-middle income countries, where access to fixed-line telephony is minimal and in high-income countries where fixed line telephony is being replaced with mobile phones, the mobile phone is rapidly becoming the primary means of receiving appointment reminders.

Key findings

- Countries in the high-income group reported the largest proportion of appointment reminder initiatives (71%). The majority of these initiatives were established (42%) using various functionalities including voice, SMS, and the Internet.
- The Americas (58%) and European (53%) Regions have the highest percentage of Member States with appointment reminder initiatives.
- SMS was the most common mobile phone feature used for appointment reminder initiatives.

3.4.1 Survey results

The Americas and European Regions had the highest percentage of Member States reporting appointment reminder initiatives (58% and 53%, respectively). Responding Member States in the African (31%), Eastern Mediterranean (36%), and South-East Asia (38%) Regions reported the lowest percentage of appointment reminder initiatives.

Over 70% of participating Member States in the high-income group reported established appointment reminder initiatives with a preference for using SMS to send appointment reminders, complemented by voice and e-mail reminders and online scheduling options. Most implementations reported were offered by health service providers and hospitals. These findings are in contrast to the other groups, where less than 40% of Member States reported appointment reminder initiatives. Zimbabwe was one exception, reporting established mHealth follow-up programmes for HIV/AIDS, TB, cholera, and influenza home-care patients in rural areas. In the Eastern Mediterranean Region, Egypt, Lebanon, and the Syrian Arab Republic reported established appointment reminder programmes.

3.4.2 Relevant literature

Studies show that missed appointments have a financial and operational cost, especially in health systems with strained capacity (26). However, results on the effectiveness of appointment reminders from studies in China, Brazil, and the United Kingdom were mixed (27–30). Fairhurst and Sheikh's randomized controlled trial in Scotland yielded insignificant results on the evaluation of using SMS reminders to improve non-attendance rates (31). In contrast, a study in Sao Paulo, Brazil that sent 7890 SMS reminder messages through the clinic manager and clinic web software system to patients at four medical clinics found that non-attendance rates were lower among patients who received SMS messages (28). For appointment reminder systems to be effectively implemented, mobile phone penetration with SMS capability must be widespread.

3.5 Community mobilization & health promotion

Mobile phones provide a new communication channel for health promotion and community mobilization. Community mobilization is defined as the use of text messaging for health promotion or to alert target groups of health campaigns. This can be used, for example, to increase participation in immunization campaigns or to promote voluntary counselling and HIV screening.

Key findings

- The Americas, Eastern Mediterranean, and South-East Asia Regions reported the highest adoption for community mobilization and health promotion.
- High-income countries had the highest percentage of community mobilization initiatives (55%), of which 32% were established initiatives.
- Community mobilization and health promotion initiatives addressed general health information or specific public health issues such as H1N1, HIV/AIDS, immunization and vaccination, reproductive health, chronic illness, and blood donation.
- SMS was the primary method of communication used in the initiatives.

3.5.1 Survey results

Overall, the level of activity for community mobilization and health promotion initiatives was moderate, with the Americas, Eastern Mediterranean, and South-East Asia Regions reporting the highest rate of adoption in this category (50%). Countries from the high-income group reported the most community mobilization initiatives (55%), of which 32% were established initiatives. In contrast, activity in this category among participating Member States in the upper-middle income group was low (19%).

Colombia reported a programme being implemented by the Department of Health that sends SMS messages to pregnant women to encourage prenatal care, HIV/AIDS testing, and vaccination. The United States reported an SMS-based initiative to promote HIV/AIDS testing as well. By sending their zip code to the SMS shortcode[3] KNOWIT, users receive a text message with the address to the nearest HIV/AIDS testing centre. Programmes to remind parents to have their children vaccinated are running in Albania, Bangladesh, the Congo, Ethiopia, the Syrian Arab Republic, and Yemen.

Although the Western Pacific Region had a relatively low level of adoption in this area (31%), New Zealand reported an established programme called Get the Msg! Launched in August 2006 as a pilot project in collaboration with a local telecommunications provider, Get the Msg! has now become an established information service. The service offers free health and safety information about common legal and illegal drugs and direct referrals to web sites and help lines by texting the name of a substance to the shortcode DRUG.

3 A shortcode is a special telephone number, often shorter than conventional numbers, used to address SMS or MMS (multimedia messaging service) from a mobile phone

3.5.2 Relevant literature

Health promotion studies addressing public health challenges such as nutrition, smoking cessation, HIV/AIDS, maternal health, sexually transmitted infections, and disease outbreaks such as H1N1, have been well documented in the literature. A collaborative project executed in South Africa called Project Masiluleke sent out 1 million SMS messages per day to subscribers of a local telecommunications operator and project partner to encourage HIV/AIDS testing (32). While these types of interventions have proven effective in disseminating information, there are few studies that provide evidence of the impact of such programmes on behaviour change.

Many studies were described as donor-funded and short-term. In contrast mDhil is a health promotion organization launched in India with a for-profit business model. For 1 rupee a day, consumers receive to their mobile phone three health messages created by registered nurses and physicians on topics such as weight management, sexual health, and H1N1. At the end of 2009, mDhil had 150 000 paid subscribers, and closed a 'series A financing round' with a venture capital firm. mDhil sent out 1 million public health SMS messages by the end of 2010 (33).

Barriers to using mobile technology for health promotion campaigns have been identified in the literature and include the following: SMS length restrictions (maximum of 160 characters), language barriers, illiteracy, and lack of technical support in rural areas. Security and privacy issues are especially critical in low and lower-middle income countries, where mobile phones are often shared among family and community members, leading to potential challenges with protecting confidential health information, particularly in the case of conditions like HIV/AIDS, which remain highly stigmatized (34).

3.6 Raising awareness

Raising public awareness was queried in the survey; it includes the use of health information products, games, or quiz programmes to educate people on health topics such as HIV/AIDS. These programmes are often available for download onto the mobile phone or as a series of text messages that tell a story with embedded health messages.

Key findings

- Awareness raising initiatives showed relatively low levels of uptake across WHO regions, though the Eastern Mediterranean (28%), European (28%) and Americas (25%) Regions reported using this initiative the most.
- High-income countries had the highest proportion of countries with awareness raising initiatives (42%).
- Main health topics for these initiatives were women's health, drug and alcohol abuse, smoking cessation, and HIV/AIDS.

3.6.1 Survey results

The global activity level for these types of initiatives was one of the lowest compared to other mHealth categories queried. The Eastern Mediterranean (28%), European (28%), and Americas (25%) Regions had the highest proportion of Member States reporting this type of mHealth initiative. Only 15 countries reported specific examples of mHealth programmes to raise awareness of health topics, many of which used online interfaces. Bangladesh was one of these. The programme is detailed below.

Examples reported in the survey had diverse health objectives, including raising awareness regarding women's health, drug and alcohol abuse, smoking cessation, and HIV/AIDS. For example, the Czech Republic documented a mobile application that supports monitoring a person's alcohol behaviour to prevent drunk driving. Users provide personal information such as sex, age, weight, time when they started drinking, and type of beverage. The application, which works with SMS, wireless application protocol (WAP) and web browsers on a mobile phone, provides the time when the user will be sober again, in addition to the associated risks.

High-income countries had the highest percentage of countries with awareness raising initiatives (42%); in comparison, adoption in other income groups was 20% or below.

3.6.2 Relevant literature

Health information via mobile phones is especially useful for diseases such as HIV/AIDS and other sexually transmitted infections, which are highly stigmatized. However, few mobile phone-based health awareness projects have been documented in the literature, with most examples coming from high-income countries rather than low and middle-income countries. For instance, the non-profit-making organization Text to Change set up SMS quizzes in Uganda in partnership with telecommunications operators to educate consumers about HIV/AIDS and other health-related issues.[4] In response to rising gonorrhoea rates among African American youth in San Francisco, Internet Sexuality Information Services (ISIS), in partnership with the San Francisco Department of Public Health, developed SEXINFO, a sexual health SMS service. The pilot programme found usage of the service to be greater than expected with evaluation assessments showing promising results (35).

An example of a programme from Bangladesh, in the low-income group, highlights how SMS messages are used to educate the population on various health topics (case study 1).

4 http://www.texttochange.org.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Raising health awareness in Bangladesh via SMS campaigns

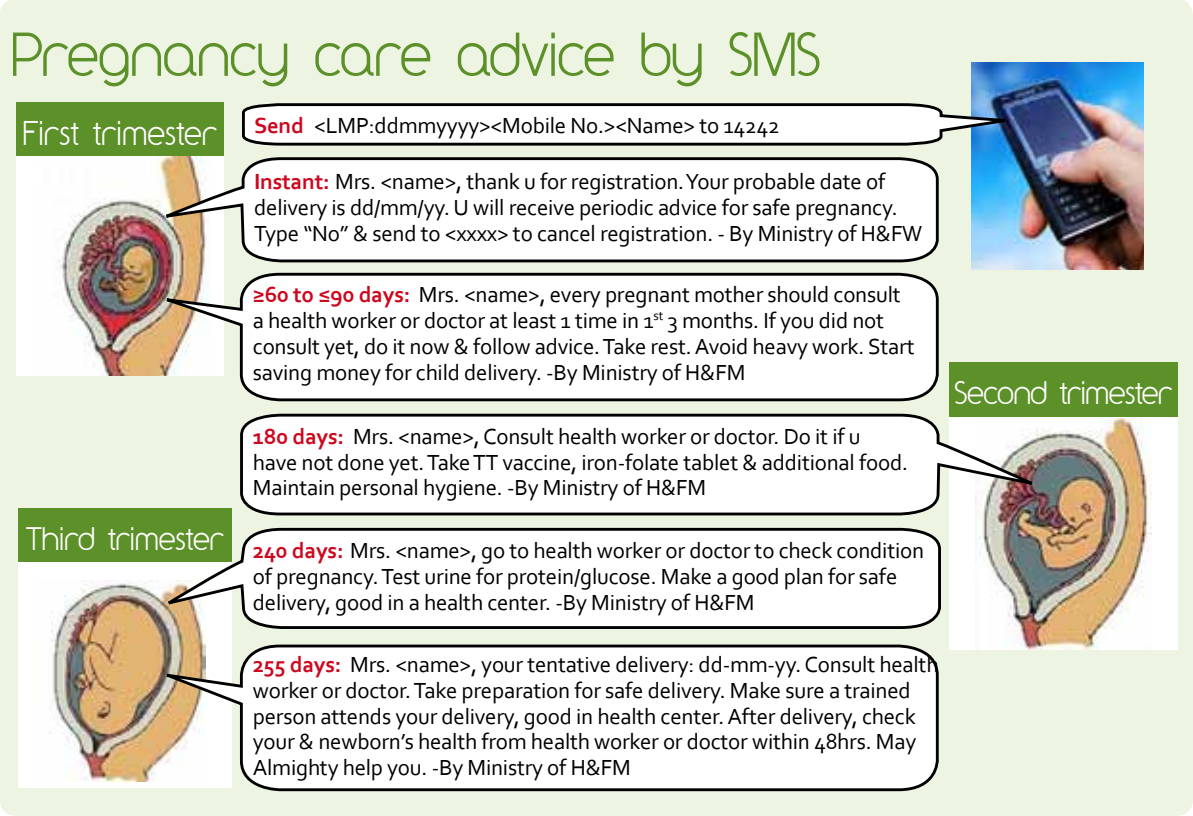
Project overview

The Ministry of Health and Family Welfare of Bangladesh has taken advantage of the rapidly increasing number of mobile telephone subscribers in the country to improve the health of its citizens and overcome existing communication barriers. In 2007, the Ministry started a project to increase awareness of its health campaigns by broadcasting SMS text messages to all mobile telephone numbers in the country, irrespective of their service providers, initially to mobilize citizens for National Immunization Day. Messages encouraging parents to bring their children to get vaccinated, along with the event's date were sent via SMS. Heartened by the positive response of the population, the Ministry now uses the SMS service for its National Immunization Day campaign, as well as other large-scale nationwide health campaigns, such as its Vitamin A Week, National Breastfeeding Week, and National Safe Motherhood Day.

To implement Bangladesh's eHealth plan and help fulfil the goal of expanding the use of ICT in health service delivery as expressed in the Digital Bangladesh Vision 2021 plan, the Ministry has introduced two additional services that use SMS for health promotion. The first one, launched in 2009, aims to increase awareness and improve coordination among health staff members during emergency health situations, providing them with information on their role after a natural disaster or a communicable disease epidemic. The second service, initiated by the Ministry and the public mobile operator in March 2010, allows mobile telephone users to subscribe, at a reduced rate, to an SMS service that broadcasts text messages on diverse health topics. Health workers in communities throughout the country can advise

patients on useful topics they can access through their mobile telephones. For instance, pregnant women in remote villages can register their mobile numbers to receive useful prenatal advice that is appropriate to their gestation stage, as illustrated in Figure 6.

Figure 6. Example of a mobile phone-based SMS pregnancy advice system for mothers



Source: Ministry of Health and Family Welfare of Bangladesh.

In the coming years, and after evaluating the impact of these projects, the Ministry plans to further consolidate its SMS services by improving their quality and adding new dimensions to them. To this end, the Ministry is exploring the possibility of obtaining external assistance for technical training and for hiring additional skilled personnel.

Technology

Bangladesh's mobile telephony network currently covers 98% of the Ministry's target population, making this technology an ideal tool for the distribution of text information relating to health awareness campaigns. A key factor that has facilitated the use of SMS for health promotion in Bangladesh is its telecommunications regulatory framework. Under current regulation, the Bangladesh Telecommunication Regulatory Commission (BTRC) can instruct mobile telephone operators to broadcast text messages provided by the Ministry and other government agencies at no cost to the mobile telephone users or the Ministry. One technological limitation is that the mobile phones capable of sending and receiving text messages in Bangla – the official language spoken by more than 98% of the population as their first language – are not available to the entire population. Therefore, the SMS messages sent by the Ministry are broadcast in English only, requiring translation for those users who only speak Bangla.

A local health care worker shows a pregnant woman in Dhaka how to get timely pregnancy advice through her mobile phone.
Courtesy of the Ministry of Health and Family Welfare of Bangladesh.

The Ministry is responsible for content of the text messages for mass SMS health campaigns and coordinates with the BTRC for their broadcast. The SMS messages for health staff members and for the SMS subscription service are prepared by the Department of Management Information Systems, which coordinates directly with participating mobile operators. One of the mobile operators has developed, at no cost, the software used by the Ministry for the SMS subscription service. The service of bulk messages for health staff members uses a corporate SMS Service Package hired from a mobile operator.

Benefits

The use of mobile telephones to reach and inform families about health events has been well received in Bangladesh. While no formal evaluation of the impact of the SMS health messages has yet been conducted, the Ministry has witnessed wide acceptance of the immunization and Vitamin A campaigns. Mass broadcasts of SMS health messages ensure that an estimated 55 million mobile telephone users will receive reminders and information regarding health campaigns. Similarly, the implementation of the SMS service directed to nearly 100 000 health staff members has helped the Ministry reduce time lags in the communication of urgent health information to health care practitioners. This service has also streamlined the workload at the Ministry's headquarters, reducing paperwork and the use of fixed line telephony. Even the recently launched Health SMS subscription service is already informing a few hundred subscribers about key health topics. The Ministry expects that once this service gets more widely promoted, the number of subscribers will rapidly increase.

Costs

The main advantages of using SMS messages for health campaigns are their low cost and broad reach. In the case of Bangladesh, the nationwide SMS health campaigns are conducted at no cost for both the mobile telephone users and the Ministry due to the country's telecom regulatory framework that mandates operators to provide the service free of charge. Therefore, the Ministry only has to bear the cost of the bulk SMS service for its health staff members, paying the mobile operators less than one cent of a Bangladeshi Taka (BDT) per SMS message. Finally, the cost of the Health SMS subscription service is borne by the mobile telephone users who subscribe to it, but the operators only charge half of the regular rate (1 cent BDT) per SMS message.

The operational costs of the Ministry for providing these services have been minimal, as the regular staff members do the work as part of their duties. The Ministry also plans to utilize its numerous field workers, operating at the community level, to promote the subscription service at almost no operational cost. The Ministry's budget and the political support of the Digital Bangladesh Vision 2021 also help ensure the long-term sustainability of the health SMS project.

Lessons learnt

The success achieved so far by the Ministry's Health SMS services is largely the result of the commitment of the Bangladeshi Ministry to make good use of the growing mobile telephone network and the enabling regulatory and strategic environment – as expressed in the BTRC's rules, the Digital Bangladesh Vision 2021, and its own eHealth plan – to increase the level of health awareness among the population. The effective implementation of the services has also been driven by the sustained cooperation and coordination of activities between the Ministry, the telecommunications regulator, and the mobile operators that contribute to this project as part of their corporate responsibility efforts.

The development and improvement of the SMS health services, however, have been affected by a shortage of skilled technical personnel at the Ministry to promote innovation. Attracting and retaining technically trained personnel requires an adequate salary structure and continuous training to update the IT capacity of the staff. Having sufficient personnel with IT skills would help the Ministry incorporate voice and multimedia SMS capabilities into the current health awareness services.

From the users' perspective, the English language messages and cost of the Health SMS subscription service still represent barriers to access for some portions of the population. The text messages can only be sent in English, which can require the intervention of a third person to translate the text messages into Bangla. Similarly, competing health priorities limit the financial ability of the Ministry to subsidize the distribution costs of the subscription service. Lower cost rates for SMS services and the possibility of using the local language would make this service an even more effective tool for health care promotion in Bangladesh.

3.7 Mobile telemedicine

Mobile telemedicine was defined in the survey as the communication or consultation between health professionals about patients using the voice, text, data, imaging, or video functions of a mobile device. But it can be applied to other situations; the management of chronic diseases of patients living at home is one example. In developing countries, as well as underserved areas of developed countries, human resource shortages in the health sector pose a major barrier to a patient's access to treatment and/or specialized care. Mobile technologies present an opportunity to circumvent this challenge by connecting patients, community health workers and physicians in urban and rural areas to improve quality of care at the point of care and reduce unnecessary referrals.

Key findings

- The Americas (75%), European (64%) and South-East Asia (62%) Regions reported high rates of adoption of mobile telemedicine initiatives, though a large proportion of these initiatives were informal or in the pilot phase.
- Countries in the high-income group reported the highest percentage of mobile initiatives (64%) followed by lower-middle income countries (53%).
- Mobile telemedicine initiatives included consultations between health-care providers and transmission of a patient's health-related data using mobile devices.

3.7.1 Survey results

A high level of mobile telemedicine activity was reported among participating Member States in the Americas (75%), European (64%) and South-East Asia (62%) Regions. Qualitative analysis of reported initiatives found a range of mobile telemedicine examples reported from these regions such as voice and SMS communication between health professionals to more advanced applications such as wireless electrocardiogram transmission of a patient during travel to a health clinic by ambulance. Belize reported policy guidelines for telephone consultations that regulate mobile telemedicine. Member States in the European Region such as Austria, Belgium, Finland, and Germany reported mobile telemedicine initiatives for the management of chronic diseases with applications in elderly health and home care, and indicated great interest in adapting them to ageing populations.

A large proportion of initiatives reported were informal or in the pilot phase across regions and income groups. Developing countries in the African and Eastern Mediterranean Regions reported informal initiatives involving communications between health professionals using voice and SMS for second opinions, for consultation between physicians in urban and rural areas, and between generalists and specialists. Ghana reported a programme where a local mobile phone operator provided physicians with mobile services to communicate with each other free of charge. Pakistan reported a project supported by the Aga Khan foundation to increase collaboration between community-based health centres in the northern areas of Pakistan and urban centres. This includes tele-consultation and continuing medical education, in addition to experimentation with low-bandwidth technologies that can be replicated in other areas of central Asia. Cameroon reported a mobile telemedicine programme in the pilot stage for

managing patients with hypertension. More advanced mobile telemedicine initiatives require significant established infrastructure, fast telecommunication networks (i.e. general packet radio services (GPRS), 3G, 4G), and advanced technology, which are all factors that can pose challenges to growth and adoption for low and lower-middle income countries.

The high-income group had the largest percentage of participating Member States reporting mobile telemedicine initiatives (64%). The lower-middle income group had the next highest rate of adoption at 53%, a large proportion of which were informal and pilot initiatives (34%).

3.7.2 Relevant literature

Feasibility studies were often found in the literature from parts of Asia, including China and its province, Taiwan. For example, Hsieh et al. studied the feasibility of using a mobile phone camera for tele-consultation and diagnosis of soft tissue injuries in Taiwan, China. They found an 85% accuracy rate in the diagnosis, and noted that the system would benefit if accompanied with on-line or telephony communication (36). Limitations to mobile telemedicine systems include mobile phone screen size, image quality and network connection to transmit data (36).

Case study 2 contains the details from a programme in Ghana, where telemedicine is being used to overcome high referral costs and geographical barriers between doctors, leading to improved health outcomes for patients.

Mobile communications between doctors in Ghana improve medical practice

Project overview

With an estimated two thousand physicians serving a population of nearly 24 million inhabitants, doctors in Ghana need to have a reliable communication system for conducting consultations and referring patients. With support from New York University and in collaboration with a mobile telephony provider in Ghana, and Switchboard[5] (a US-based non-profit-making organization) the Ghana Medical Association (GMA) launched the Mobile Doctors Network (MDNet)/Medicareline programme (MDNet here forward) in Ghana in 2008. It provides free mobile-to-mobile voice and text services to all the physicians in Ghana currently registered with the Association. More recently, a one-way bulk SMS service was also enabled, allowing GMA to send information to doctors about national emergencies and meetings, as well as to contact doctors within a particular specialty.

MDNet is the first service of its kind implemented in Africa and aims to promote the transfer of knowledge between physicians in Ghana using mobile phones – the means of communication most doctors in rural and urban areas of the country already use in their daily practice. The initial concept was to develop an online communication tool for physicians; yet, the lack of access to computers and the low penetration of Internet services, particularly in rural areas of the country, made it evident that cellular telephony was a more efficient and culturally responsive means to provide the service.

5 Switchboard was previously known as Africa Aid and changed its name in early 2011 (http://www.africaaid.org/).

MDNet also facilitates emergency response communications between doctors on a cellular network. This service provides doctors rapid, unlimited access to peer advice over the phone, letting practitioners use their mobile phone continuously during emergency situations, without concerns about the number of minutes still available on the phone's account.

Sodzi Sodzi-Tettey, General Secretary of GMA, on the left, and Brian Levine, NYU and Chief Medical Officer of Switchboard, led the deployment of MDNet in Ghana.
Photo: Brian Levine, 2009. Courtesy of Switchboard.

By facilitating access to free mobile telephone service, MDNet has removed an important cost barrier for clinical consultations among doctors, advancing the provision of medical advice and the referral of patients needing specialized medical attention across Ghana. To ease the referral process GMA and Switchboard will soon launch the first Ghana doctor directory, using information collected through GMA. The directory will include a physician's MDNet telephone number, hospital, and region where s/he practises, organized by both last name and medical specialty.

Using information collected for the directory, Switchboard and GMA are planning, in collaboration with the Ministry of Health, the Ghana Health Service, and the Ghana Medical and Dental Council, the development of a dynamic software database of physicians that will integrate data collected by the five organizations in a central data repository. The Ministry is also discussing with its service provider the feasibility of extending the MDNet services to the Ministry, free of charge, as part of the mobile operator's social responsibility programme.

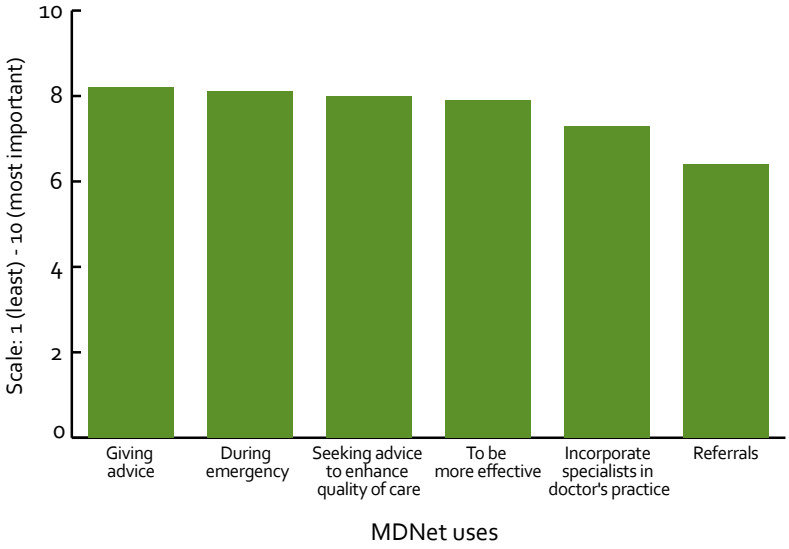
Technology

To gain access to MDNet, GMA-registered physicians were provided with over 1600 free subscriber identity module (SIM) cards, linked to telephone numbers within the mobile network. The SIM cards work with any brand of mobile phone and allow doctors to make voice calls free of charge, as long as they are contacting other colleagues within the MDNet programme. The GMA and provider are still discussing the best way to operationalize the free text messaging service originally agreed by the three partners.

Benefits

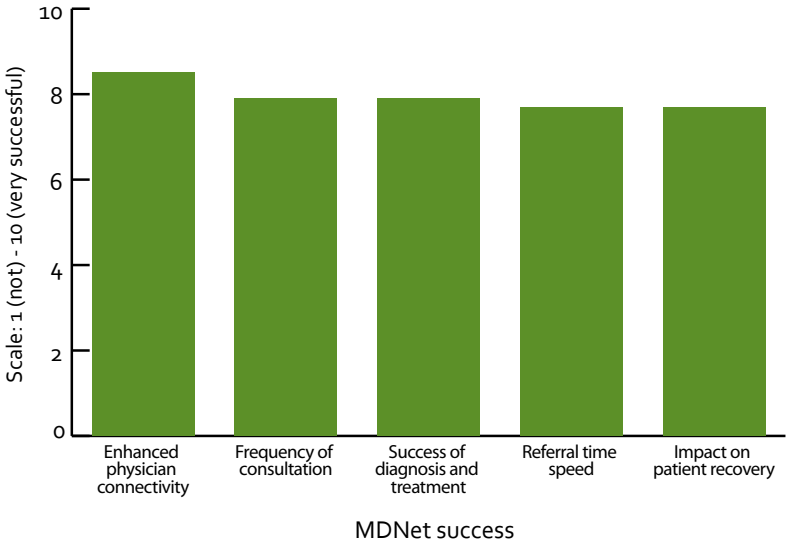
According to a 2009 survey of MDNet users conducted by Switchboard, doctors consider that MDNet has improved communication about patient management among physicians throughout Ghana's health delivery system (see Figures 7 and 8). Similarly, district and rural medical practitioners report that they are increasingly reaching out to more experienced colleagues for advice on the management of complex medical cases and use MDNet to solicit information regarding specialists, bed availability, and clinic times, facilitating the referral of patients to higher levels of care.

Figure 7. Top MDNet uses in Ghana



Source: Africa Aid, 2009 MDNet Ghana survey. N=77 doctors

Figure 8. MDNet success indicators



Source: Africa Aid, 2009 MDNet Ghana survey. N=77 doctors

Switchboard's 2009 survey of GMA physicians indicates some of the benefits health care services in Ghana have obtained from the implementation of MDNet.

Based on the success of this programme in Ghana, Switchboard extended the service to Liberia in 2009, in cooperation with the Liberian Ministry of Health, the Dental Association, MTN mobile provider, and the Liberian Medical and Dental Council, and is currently discussing with the Ministry of Health its possible implementation in Kenya.

Costs

The start-up costs of launching MDNet in Ghana were minimal. MDNet was conceived as a scalable programme based on a business model that provides incentives for the participation of telecom providers. One service provider, for example, donated the SIM cards for all the MDNet members, gaining access to a group of active telephone users that could generate profits from personal calls made with the network cards to numbers outside the MDNET programme. GMA, on its part, has absorbed the costs of distributing the SIM cards among its members, and maintains ongoing contact with the service provider to facilitate the activation of new MDNet users. Switchboard has contributed technical skills and designed services and tools like the Ghana Doctor Directory. The directory will be distributed to all doctors registered with GMA for an estimated cost of US$ 6000, which will be partially offset through advertisement sponsorships sourced by GMA. Finally, the development of more advanced tools, including a database, which is expected to cost around US$ 40 000, will require additional fundraising efforts to be successfully implemented and expand the MDNet programme. The business model is still in its early stages of development. The costs need to be better understood as well as the ramifications of the direct marketing that will be received by the professionals using the service.

Lessons learnt

An essential factor in MDNet's success has been partnering with health institutions in the country that are committed to the programme to act as local champions and lead the project on the ground. The GMA, for example, has facilitated MDNet's deployment in Ghana and actively addressed some of the problems faced during its implementation. Similarly, the provision of economic incentives to the telecommunication partners is fundamental to ensure their participation and promote the long-term sustainability of the programme. Finally, initiatives like MDNet should go through a process of institutionalization, documenting the management, logistics, training and evaluation processes involved in running the programme. This institutionalization would facilitate the transfer of knowledge to local partners in the country (that could step in and run the programme, if necessary) as well as to other countries. The ultimate challenge will be to create the right revenue and support model that will make the project sustainable in the long-term. With the support of other national health institutions and mobile operators, MDNet has the potential to become a scalable pan-African initiative.

3.8 Public health emergencies

A public health emergency response in the context of mHealth is defined as the use of mobile devices to respond to and manage emergency and disaster situations such as natural disasters, disease outbreaks, and conflict.

Key findings

- The use of mobile devices for emergency communications was one of the most frequently reported initiatives across all WHO regions. The African, South-East Asia, and Americas Regions, have the highest levels of adoption at 48%, 75%, and 67% respectively.
- High-income (64%) and low-income (50%) groups reported high uptake.
- Many responding Member States used multiple communication channels including two-way radios as a back up to manage emergency situations due to the unreliability of mobile networks during emergencies.

3.8.1 Survey results

The use of mobile devices for emergencies was one of the most commonly reported mHealth initiatives across WHO regions. It was the most highly adopted mHealth initiative in the African Region (48%). The Regions of South-East Asia (75%) and the Americas (67%) also reported high levels of activity.

Globally, the reported uses of mobile devices during a national emergency, natural disaster, disease pandemic or conflict varied between internal coordination, citizen communication, alert systems, transportation dispatch, and reporting. While voice telephony and SMS functionality on mobile phones were the most commonly reported methods of communication, countries such as Belgium, Belize, Bhutan, Colombia, Malta, and Viet Nam reported the use of two-way radios as well.

Additional examples of informal initiatives using mobile technology to alert citizens during an emergency were reported by Eritrea, Ethiopia, and Guinea-Bissau. Sri Lanka documented an initiative that used voice telephony to coordinate health care services and delivery for internally displaced populations in the northern part of the island.

Countries in the high-income group most frequently reported using mobile technologies during an emergency, with 55% of these reporting an established programme. In contrast only 30% of countries in the lower-middle income group described their initiatives as established.

3.8.2 Relevant literature

The literature suggests that implementing comprehensive emergency medical response systems (EMRS) is often given low priority in low and lower-middle income countries, despite being a low-cost and viable solution. This may be the result of preferring to implement more technologically advanced systems found in high-income countries compared to simple solutions (37). Whatever the reason, it has been found that systems are generally established *after* a country experiences a disaster.

Documentation of mHealth initiatives during an emergency in low and lower-middle income countries was found to focus on the impact of using mHealth to respond to disasters such as the Indian Ocean tsunami in South-East Asia, versus the potential economic impact (38). In 2010, during the Haiti Earthquake, organizations Ushahidi, FrontlineSMS and SamaSource partnered to create a citizen reporting mapping system via mobile phones. Citizens were asked to send an SMS to a standardized shortcode to communicate needs or report a missing person. Volunteers coordinated by SamaSource then translated the SMS messages from Haitian to English. Translated SMS messages were then uploaded and plotted on a map of Haiti using the Ushahidi platform. This system was initially used by aid agencies for rescue operations and later to identify needs and provide services (39).

Descriptive studies of emergency response systems were found, but few documented sufficient evidence of impact (39–43). Overall, the use of mobile phones in emergency contexts has been shown to improve access to transportation and emergency coordination outside of a formal EMRS, however, very little is known about the impact of such systems on case fatality rates, complications related to delayed access to health services, and health outcomes.

3.9 Health surveys and surveillance

Health surveys, in the context of mHealth, are defined as the use of mobile devices for health-related data collection and reporting. Similarly, surveillance is defined as the use of mobile devices to input and transmit data that will be used to track diseases for surveillance programmes. Given the overlap between the two types of mHealth initiatives, they have been presented together.

Key findings

- The use of mobile devices for health surveys was low across all WHO regions, with the exception of the Region of the Americas (42%).
- Responding countries in the low-income group reported the highest activity of health survey initiatives (37%).
- mHealth surveillance activity is more prevalent in countries in the low-income (40%) and lower-middle income groups (27%) than those in the higher-income groups.
- The African and South-East Asia Regions had the highest percentages for surveillance initiatives (41% and 38%, respectively).

3.9.1 Survey results

The survey found that the use of mobile devices for health surveys was low across all WHO regions. The Americas (42%) and the African Regions (31%) reported the highest proportion of Member States with this mHealth initiative. Few Member States provided detailed examples of using mobile technology to collect health data. Pesinet, a non-profit-making organization cited by Mali, is an exception; it started a small pilot project to collect child health data.[6]

Other examples reported include a pilot project in Bangladesh led by the International Centre for Diarrhoeal Disease Research (ICDDR) and the National Institute of Preventive and Social Medicine (NIPSOM) that is using PDAs to collect survey data. In Poland, PDAs are being used to collect data for the Global Adult Tobacco Survey to assess the current status of tobacco use among adults. In Colombia, PDAs were reported as being used to execute the national health survey, with results being uploaded to a central server for continuous access. Further, the citizen's electronic health registry that is currently being developed in Bangladesh is expected to use a mobile phone interface to collect individual and household data.

When aggregated by WHO region, the highest activity for surveillance initiatives was found to be in the African (41%) and South-East Asia (38%). These regions provided examples illustrating the use of mobile phones to collect general epidemiological data to prepare for potential disease outbreaks. For instance, Thailand reported that the Mukdahan Provincial Health Department is piloting a programme with community health workers using mobile phone data collection software developed by InSTEDD (Innovative Support to Emergencies Diseases and Disasters) to record incidents of communicable diseases in communities. Similarly, Cambodia reported that InSTEDD is also working with the Cambodian Communicable Disease Control to pilot an early warning disease surveillance initiative that utilizes

6 http://www.pesinet.org/wp/.

SMS, e-mail, and Geochat.[7] Currently, 12 diseases and syndromes are under surveillance using SMS technology to send data from district levels to provincial levels, and from provincial levels to the national level. Automatic analysis of trends has been integrated into the programme to detect abnormal events and prepare for potential disease outbreaks. The country anticipates the implementation will save time, freeing the capacity of its monitoring and evaluation staff for other things (44).

The Eastern Mediterranean (14%) and European (17%) Regions reported the lowest activity in the use of mobile technologies for surveillance. Explanations for this could be that countries in these regions are more likely to have established methods of disease surveillance, and may not feel the need to transition surveillance initiatives using mobile technologies at this stage. For example, the European Union has established The European Surveillance System (TESSy), which is described as a "highly flexible metadata-driven system for collection, validation, cleaning, analysis and dissemination of data" (45), but is not dependent on mobile technologies for its implementation. An example that does use mobile technologies comes from Pakistan, in the Eastern Mediterranean Region; a coalition of partners – Indus Hospital Research Center, a mobile phone provider in Pakistan, and MIT Media Lab – enables a pneumonia surveillance programme in Karachi.

When mHealth surveillance activities are aggregated by World Bank income group the results show that there are more initiatives taking place in countries in the low-income (40%) and lower-middle income groups (27%) than those in high- and upper-middle income groups.

3.9.2 Relevant literature

Increasingly sophisticated health information systems (enabled through mobile and computer-based data collection, aggregation, and reporting) are expanding the capacity for real-time monitoring and prospective surveillance, removing the need for paper health surveys altogether to monitor health outcomes and tracking utilization of health services (46). Advances in mobile technology have resulted in support for data collection solutions, such as administering health surveys or monitoring diseases. To date, most studies have compared traditional pen and paper methods of disease surveillance with mobile technologies. Benefits of the latter included improved accuracy, reductions in time and cost, and improved data quality (47). A study conducted by Patnaik, Brunskill, and Thies compared which mobile device functionality (i.e. voice, SMS, electronic form) produced the least errors during data collection. The study found that the voice method had the lowest error rate, followed by electronic forms and SMS (48). More comparative research is required to better understand the most effective methods for data collection using mobile devices and the health benefits they generate.

Two programmes show the benefit to health outcomes that mHealth can provide. The one in Senegal highlights how mHealth expedites data collection. The other, in Cambodia, tracks disease outbreaks in real-time (case studies 3 and 4).

7 See for more information: http://instedd.org/technologies/geochat/

Senegal's use of EpiSurveyor for maternal health data collection*

Project overview

High-quality and up-to-date health data are essential for identifying health needs, informing decision-makers, and eliciting actions to improve health outcomes. This is particularly the case in developing countries, which often face the compound challenges of heavy disease burden and weak health infrastructure.

In Senegal, the Ministry of Health teamed up with WHO to improve health data collection through the use of mobile technology. Twenty community health workers in ten districts were equipped with handheld devices (PDAs) loaded with EpiSurveyor[8], and trained in its use. During a six-month pilot project in 2008 the health workers made monthly field visits to 90 health posts collecting information using EpiSurveyor – basic supervisory data in real-time using an 82-question survey. The data collected were sent electronically to the district level for analysis, and subsequently transferred to the Ministry of Health for synthesis with reports from other districts. Health officials used the processed data to reallocate their budgets in order to respond to the shortages and specific needs the data revealed.

* Based on an evaluation by Dalberg Development Advisors

8 Free data collection software developed by DataDyne.org. The project and development of the software were sponsored by the United Nations Foundation and the Vodafone Foundation Technology Partnership

Technology

EpiSurveyor is a web- and mobile phone-based tool that makes it simple to collect public health and other data on mobile phones. Usable on common mobile phones available in every country, as well as PDAs and a variety of smartphones, EpiSurveyor is a simple, no-cost tool that requires only basic word processing and cell phone skills to use. Survey forms can be downloaded and modified, data entered and synchronized. Recent releases of EpiSurveyor include automated analysis in charts and graphs and reporting by e-mail and upload of data via SMS.

Benefits

Faster data processing time was achieved within the six months of the programme in Senegal. Gaps in the health system were revealed more quickly. For example, data collected by EpiSurveyor across multiple districts showed a shortage of a basic birthing tool called a partogram. The partogram is a graphical tool used by midwives to monitor the process of labour and ensure safe delivery. The effective, inexpensive and simple system helps community health workers and midwives identify deviations from the expected trajectory of labour that might require additional interventions.

In areas where maternal mortality is a prevailing challenge, the partogram has been shown to improve the chance of survival for both mother and child. However, despite the recognized benefits of the tool, the EpiSurveyor-collected data in Senegal revealed that only 55% of the districts surveyed were systematically monitoring labour using the partogram.

Based on these data, Senegal's Ministry of Health increased the distribution of partograms and asked field officers to encourage midwives to use the tool during every delivery. During follow-up surveys, health workers using EpiSurveyor verified use of the partograms, and, when necessary, noted that training was required to ensure the tool's effective use. Subsequent data collection using EpiSurveyor revealed that, between March and August 2008, use of partograms to assist labour increased on average by 28% among all ten regions involved in the project, compared to a 1% increase in the use of partograms in areas outside the EpiSurveyor pilot study.

A midwife in Senegal's Pikine district holds a partogram, a fundamental tool enabling healthy deliveries.
Source: UN Foundation/Dalberg

Based on this success, the Ministry of Health and WHO designed an expansion plan to equip more health workers with EpiSurveyor running on mobile devices to increase the collection of up-to-date health information from health facilities around the country. In addition to expanding the use of EpiSurveyor to other regions, Senegalese officials also considered its use in disease surveillance, where timely data and analysis are critical to effective decision-making.

Costs

The Senegal pilot was part of a larger mobile health programme funded by the UN Foundation and Vodafone Foundation Technology Partnership. Since 2006, the foundations have invested over US$ 1 million to support the development of mobile health data collection and analysis tools like EpiSurveyor, and over US$ 1 million in funding to WHO to support mHealth programmes across sub-Saharan Africa.

Lessons learnt

An evaluation of the pilot programme based on interviews with WHO, the Ministry of Health, and district health personnel in Senegal identified strong progress in the test phase, including:

- more frequent supervision in the pilot areas (visits every 1–2 months) versus non-pilot areas (every 3–6 months);
- faster data collection and analysis (one district reported that data requiring up to two weeks to collect on paper was being collected in one hour); and
- data made available for decision-makers could be used to reallocate funds to address current needs.

The evaluation also indicated that the Senegal health system was well-equipped to support the expansion of EpiSurveyor; health districts were empowered to use the data collected; ownership by, and political support from, Senegal's Ministry of Health was strong; and the pilot programme was well planned and executed.

Still, challenges to programme expansion were identified. Successful pilot expansion included the need for significant training to roll out the programme to all 65 health districts; incentives to ensure supervision continues after pilot funding concludes; thorough integration with national-level programmes; and additional hardware needed for scale-up.


WE CHARGE
MOBILES
@ 15/ ONLY

Cam e-WARN: monitoring disease outbreaks in Cambodia via SMS

Project overview

The outbreak of SARS in Cambodia in 2003 made apparent the limitations of the country's existing surveillance system – an event-based telephone hotline used by the population to report specific cases of disease – to promptly respond to major outbreaks. To address this gap, the Ministry of Health of Cambodia, in collaboration with WHO, conducted a needs assessment and revised its disease surveillance programme to introduce a more advanced system for the early detection of abnormal events or outbreaks, using indicators. The system, called Cam e-WARN, intends to expedite the ongoing systematic collection, analysis, and interpretation of data on a predetermined set of diseases and syndromes affecting the population, with the purpose of ensuring prompt action in case of an outbreak (Table 2).

Table 2. Cam E-WARN disease monitoring in Cambodia

Suspected Acute Flaccid Paralysis (Polio paralysis)	Acute jaundice (malaria, hepatitis A, B and C)
Acute lower respiratory infection	Acute watery diarrhoea/cholera
Dengue	Diphtheria
Dysentery	Meningoencephalitis
Suspected measles	Neonatal tetanus
Rabies	Cluster of unknown etiology

Cam E-WARN monitors the outbreak of 12 major diseases in Cambodia.

Cam e-WARN has a staff of 1200 employees distributed throughout the country, who participate in the collection and analysis of data on twelve monitored diseases, including hepatitis and acute watery diarrhoea. The surveillance system collects and aggregates data at different levels of the health structure. Local health centres and hospitals report information on the number of cases and deaths related to these diseases to a Cam e-WARN district office using SMS, phone calls, and even in person. Surveillance officers in the 78 districts then sum up the local data using software downloaded onto their mobile phones and send the information via SMS to the provincial office. Staff at the province level enter the district information into Cam e-WARN's database and analyse it for trends at the health centre, district, and province levels. Finally, to obtain national trends, the 24 provincial offices send their database information via SMS to the national office, where it is analysed for trends and incidence of diseases by province, creating also matrices and tables of the monitored diseases at the provincial level.

When the number of cases on any of the monitored diseases exceeds a predetermined threshold, it triggers a signal in the corresponding computer database, indicating the specific province and district where the abnormal event has occurred. Once the staff members at the provincial and district offices confirm that the abnormal event is not the result of a mistaken data entry or statistical error, a rapid response team is sent to the site of the event to investigate and take action.

Improving the health of its population is top priority for Cambodia's Ministry of Health.
Photo: Jim Holmes. Courtesy of WHO/WPRO image bank.

Technology

Cellular technology provides a fast, simple, and affordable platform for operating Cam e-WARN, particularly in rural district areas in Cambodia where Internet services are still unavailable. Surveillance officers use the technology to communicate and transmit data via SMS on the monitored diseases from the district and provincial offices to the national office. The mobile phones employ SIM cards owned by private mobile network operators with national or regional coverage.

Benefits

The implementation of Cam e-WARN for the rapid detection of early stage disease outbreaks has improved the Ministry's ability to control the spread of diseases and protect the health of Cambodia's 14 million inhabitants. Cam e-WARN has increased the accuracy of disease outbreak reports in the country, particularly when compared to the ad-hoc telephone hotline surveillance system, which still receives a higher number of unconfirmed reports and prank calls from the public. Since Cam e-WARN became fully operational in 2008, it has helped detect multiple outbreaks, including incidents of acute watery diarrhoea at the district level. The SMS system was used also to monitor influenza-like illnesses during the recent H1N1 global pandemic.

Surveillance officers appreciate the simplicity and cost-effectiveness of the reporting method, which has eased the implementation of the e-WARN system in Cambodia. Similarly, government officials and policy-makers welcome the rapid availability of data from the system when outbreaks occur.

The Cambodian government will continue updating Cam e-WARN to improve, among other aspects, its capability to assess risk when abnormalities are detected and to verify and check for data error. If funding becomes available, the Ministry of Health also intends to provide software to its district surveillance officers that would allow them to use their mobile phones to report primary disease data via SMS directly to the computer database at the national office. By bypassing current intermediate steps, the Ministry expects to expedite Cam e-WARN's analysis and response rates.

Moreover, Cambodia is collaborating with its neighbouring countries to use the e-WARN system throughout the region. Laos is already operating a similar system and other countries like Indonesia, Papua New Guinea, and Viet Nam are preparing to implement versions as well. The e-WARN tool could also be used for cross-border collaboration, supporting the exchange of information about outbreaks.

Costs

Remote health post in Cambodia.
Courtesy of Ministry of Health of Cambodia.

Since its inception in 2003, the operation of Cam e-WARN has required an investment of approximately US$ 100 000 financed with funds from WHO, the Asian Development Bank and other donors, and complemented with regular public budget resources. The external donors supported the development of the automatic data analysis software and the purchase of equipment, including computers, mobile phones, and SIM cards; meanwhile, government funds have been used to cover the mobile phone's monthly fee, as well as for maintenance and surveillance training. The Ministry of Health also gives its surveillance staff a monthly stipend of US$ 5.0 for phone usage to encourage the reporting of abnormal events.

As part of its social responsibility activities, the private mobile phone operator with the best national coverage has partnered with the government to provide Cam e-WARN phone users a discounted fee (less than US$ .50 per month) for the SMS service. Other mobile operators offer free SMS, but their networks do not provide coverage for the full country, limiting their usefulness for the surveillance system. This could be overcome if more operators could be brought into the programme.

Lessons learnt

Since most of the funds supporting Cam e-WARN come from external sources, a major concern is the long-term sustainability of the system. To address this issue, the Ministry is planning to develop a long-term funding strategy and an ICT policy to support the continuity of the system.

Cam e-WARN faces technical barriers as well, due to the lack of IT staff at the district and provincial level. To facilitate data analysis at the district level and improve the quality of event data entry, the Ministry of Health is planning to install more computers in its district offices and provide low-cost mobile phones to local health centres to ease the reporting process at the field level. The Ministry is also training its staff to secure the integrity of the database and protect it from viruses.

Beyond the availability of technical tools, a fully sustainable surveillance system requires leadership, ownership, and knowledgeable staff to be able to provide continuous monitoring and data follow-up. This is most likely to happen if there are incentives to integrate the work into the health information system. Achieving these goals also requires securing access to long-term funding.

3.10 Patient monitoring

In the context of mHealth, patient monitoring is defined as using technology to manage, monitor, and treat a patient's illness from a distance (e.g. diabetes and cardiac patients). Remote sensors installed in households or imaging devices linked to mobile phones are often used to facilitate data transmission to the health service provider. This can reduce the need for visits to a health centre for check-ups.

Key findings

- Patient monitoring initiatives were most prevalent in the European Region (47%), followed by the Region of the Americas (33%).
- Member States from the Eastern Mediterranean (14%), African (20%), and Western Pacific (23%) Regions reported the lowest activity of patient monitoring initiatives; none reported established programmes.
- Countries in the high-income group reported the highest levels of activity in this area (58%).

3.10.1 Survey results

Patient monitoring initiatives were most frequently reported in the European (47%) and Americas Regions (33%).

The survey indicated that private companies are beginning to develop solutions for chronic disease patients. For instance, Switzerland reported a local company that is using telebiometry for the management of patients with chronic diseases such as diabetes, heart insufficiency, and hypertonia. Vital signs such as blood pressure, weight, blood sugar, and electrocardiography (ECG) are measured using wearable biosensors and transmitted over the mobile wireless network to a central server. Several other countries in the European Region are also piloting similar patient monitoring systems, including Austria, Bulgaria, and Estonia. Only a few specific implementations were reported in the Americas region. For example, Canada described the Congestive Heart Failure Home Telehealth Project being implemented in the province of Nova Scotia to increase access to clinical care for communities in rural areas.

Member States from the Eastern Mediterranean (14%), African (20%), and Western Pacific (23%) Regions reported the lowest activity of patient monitoring initiatives. Pilot programmes reported by New Zealand, the Philippines, and Singapore in the Western Pacific Region all included the use of remote sensors and devices that track vital signs and transmit data through the mobile network to a secure online database. Singapore also reported that some hospitals were using radio frequency identification (RFID) technology to track patients within a hospital. The most common application of this technology is to supply patients with wristbands containing RFID tags. The tags can be used as one component of a hospital information system that can monitor among other things: patient identification, admission, transfer, discharge, drug administration, specimen collection, and physical location of the patient.

In the South-East Asia Region, Bangladesh described a private company that has established an integrated programme that uses mobile technology, Bluetooth-enabled glucometers, telephone help lines, and an online portal to manage diabetic patients. With the success of this programme there are plans to expand services to support hypertensive, cardiac, and asthma patients.

When reviewed by World Bank income group, Member States from the high-income group reported the highest percentage of patient monitoring activity (58%). In comparison, the level of adoption for other income groups was approximately 20%. Overall, the survey found patient monitoring as one of the least established mHealth initiatives. However, a significant amount of pilot activity was reported across all income groups, indicating the strong potential for growth of programming to monitor patients remotely.

One of the more recent drivers within the European Union is that of personal health systems (49). These systems promote personalized care through wearable, portable, or implantable systems with the objective of early diagnosis and remote disease management. It is an efficient method of managing chronic diseases and often allows patients to remain at home – both of which can significantly cut health care costs.

3.10.2 Relevant literature

Mobile patient monitoring requires diagnostic sensor technology, which is not yet available at the low costs that would make it accessible in developing countries. Since health data are transmitted via the telecommunication network, patients are required to have access to a mobile phone and/or wireless device, to which diagnostic sensors can easily connect (50). In regions where mobile patient monitoring initiatives have been implemented, delays in care may be resolved. The literature primarily reported patient monitoring studies for elderly individuals in high-income countries throughout the European and South-East Asia Regions (51–53). Caregivers are increasingly able to monitor the real-time status of vital signs of patients remotely, using a mobile phone, PDA, and/or computer.

3.11 Information initiatives

mHealth information initiatives are defined as services that provide access to health science publications or databases at point of care using mobile devices.

Key findings

- The South-East Asia (62%) and Americas (58%) Regions had the highest proportion of Member States with information initiatives.
- The African Region (7%) had the lowest rate of adoption.
- Countries in the high-income group reported the most activity (42%); those in the low-income group reported the least (17%).
- Most initiatives used PDAs, smartphones, mobile web sites, and web browsing to access health information.
- Bandwidth and handsets are not a prerequisite for access as data can be downloaded onto PDAs.

3.11.1 Survey results

The South-East Asia (62%) and Americas (58%) Regions show the highest level of mobile information initiatives. Specific examples were provided by Bangladesh, Bhutan, India, and Thailand in their survey responses which included the use of PDAs, smartphones, mobile websites,[9] and web browsing to access health information. While relatively new to developing countries, these services are established in developed countries, where medical professionals are often equipped with advanced mobile devices.

3.11.2 Relevant literature

Few studies were retrieved from the literature with evidence reporting access to information using mobile technologies. There was an identified need, however, for services that allow mobile access to health information and education (54, 55). Case study 5 highlights a recent programme in Canada that provides health information to registered nurses working with Aboriginal communities in remote locations.

9 This refers to web sites designed for use on the small screens of hand held devices. For more information see: http://www.pcmag.com/encyclopedia_term/0,2542,t=mobile+Web+site&i=60020,00.asp.

Personal digital assistant technology enhances nursing care in Aboriginal communities of Saskatchewan, Canada

Project overview

Nurses play an essential role in health service delivery both at nursing stations and through home care nursing. This is particularly true in remote and less populated regions of Canada. First, where medical support is scarce and primary care nurses need to perform diagnostic and prescribing functions (outside their usual scope of practice) and second, in the case of home-care services where increasingly acute and complex nursing care is required in the home. Under these circumstances, registered nurses need quick access to effective tools and health information resources to support their practice. To help address these challenges, Health Canada is collaborating with on-reserve Aboriginal (First Nations) communities in the province of Saskatchewan. The aim is to provide nurses serving these communities access to tools and detailed health information at the point of care through handheld computer technology, specifically, PDAs.

Registered nurse referring to relevant health information on her PDA.
Photo: Nadine Morris, 2010. Courtesy of File Hills Qu'Appelle Tribal Council, First Nations, Saskatchewan, Canada.

Health Canada is currently supporting two PDA-related projects in Saskatchewan. In May 2007, Health Canada launched the Personal Digital Assistant and Nursing Software Evaluation Project, which

aims to evaluate the technology's potential for improving the quality of health care in the province.[10] Health Canada provided PDAs, loaded with nursing software, to a group of home and community care nurses working with First Nations communities. Thirty nurses volunteered to join the project and received technical training. The PDAs they received were loaded with reference materials, including a manual on diseases and disorders, a handbook on laboratory and diagnostic tests, and a drug guide – all frequently used in nursing practice.

To help evaluate their experiences, nurses were asked to complete a questionnaire at the beginning of the project, as well as weekly logs detailing the frequency and purpose of their PDA usage at intervals throughout the evaluation period. Early findings show the nurses frequently used the devices to support care planning, respond to questions about diseases and to educate clients and their families. Reference materials, such as the drug handbook, are typically used to prepare for home visits and to support medication reconciliation for client safety.

While the project was originally intended to last only six months, Health Canada has extended it to meet requests of more home-care nurses in the province. Although the evaluation will be a factor for the future, the positive results of this project have already led to plans to introduce a telehealth project to improve wound and diabetes care. This will feature mobile audio/video camera devices used by nurses and will link clients living with chronic diseases to medical and specialized health professionals in urban areas.

The second project supported by Health Canada, PDAs for Primary Care Nurses in Northern Saskatchewan First Nations, was proposed and launched in 2009 by the Northern Inter-Tribal Health Authority (NITHA), a partnership of four tribal councils/bands[11] representing over 30 communities in Northern Saskatchewan. This four-year project (2009–2013) aims to use PDAs to support primary care nursing practice and better meet the needs of clients at NITHA's 13 nursing stations.[12]

NITHA nursing stations function 24 hours per day seven days per week and are distributed over the northern Saskatchewan region, which covers an area of 11 000 Km2. Some nurses have to be flown into nursing stations located in remote zones, which are not accessible by road. Registered nurses working at the nursing stations provide various services, ranging from emergency trauma to care for chronic illnesses and immunization.

NITHA's objective is for the nurses participating in this project to use the PDAs not only for education and reference, but also for clinical decision-making. The PDAs will provide access to primary care material on such subjects as medication, clinical guidelines and assessment, as well as ready access to digital information on drug side-effects and interactions, pharmacy references, drug calculators and other tools, including immunization charts.

10 First Nations and Inuit Health Branch. Personal Digital Assistant (PDA) and Nursing Software Evaluation Project: Home and Community Care Nurses in First Nations Communities in Saskatchewan. June to December 2007. "Homecare nurses embrace technology". FNIH Saskatchewan, p.8.

11 The Peter Ballantyne Cree Nation, Lac La Ronge Indian Band, Prince Albert Grand Council, and the Meadow Lake Tribal Council are partners of NITHA and their communities comprise almost half of the on-reserve First Nations population in Saskatchewan.

12 Northern Inter-Tribal Health Authority. *Nursing innovation investments.* Project Proposal 2008-2013. [Unpublished document].

The use of PDAs in the delivery of home-care programs in Sasketchewan, Canada.
Photo: Mary Skolney, registered nurse, Home-care programme, 2010. Courtesy of Touchwood Agency Tribal Council, First Nations, Saskatchewan, Canada.

Technology

PDAs are considered an efficient, low-cost tool that can improve information access for nurses, reduce medication errors, ease nursing workload, and facilitate patient education through a practical visual aid.[13] The selection of the PDA models used for the Saskatchewan projects was based on various criteria, including affordability, ease of use, display size, storage capacity, and battery life. Similarly, decisions on the nursing PDA software took into account the quality and source of information provided including ease of use, compatibility with diverse PDA devices, and the availability of a simple process for automatic updates. Data safety was also an important consideration and nurses were required to take a course on personal data protection.

Benefits

Both PDA-related projects are in-line with the overall national effort to promote the use of technology in health care to enhance the quality of services provided, particularly in communities in rural and remote areas. The adoption of PDA technology also fits with Canada's eHealth agenda, where expanded use of ICT is expected to result in improvements in health care system accessibility, quality, and efficiency for all Canadians.[14] The PDA evaluation project has the potential to improve the quality of home health care services provided to approximately 2500 clients in at least 40 First Nations communities in Saskatchewan by increasing access to current health information right in the client's home. Meanwhile, an estimated twenty thousand First Nations community members may benefit from the NITHA project.

The introduction of PDAs in daily nursing practice in Saskatchewan is expected to help familiarize both clients and nurses with the use of ICT at point of care, gradually increasing their sense of comfort with these technologies. In this sense, the projects are stepping stones towards the adoption of new telehealth activities and electronic health records in the province. Furthermore, use of technologies is becoming even more necessary, given persistent nursing shortages and the need for greater efficiency.

13 See for example Smith-Stoner M. (2003). 10 uses for PDAs in home care. *Home Healthcare Nurse: The Journal for the Home Care and Hospice Professional,* 2003, 21(12):797–800; and, George LE. & Davidson LJ. PDA in nursing education: prepared for today, poised for tomorrow. *Online Journal of Nursing Informatics*, 2005, 9(2).

14 According to Health Canada's eHealth site, "Health Canada's priorities and efforts have focused on addressing policy issues and challenges in mainstreaming eHealth services within Canada's health care system and in measuring progress in the deployment and investment of these services." See: http://www.hc-sc.gc.ca/hcs-sss/ehealth-esante/index-eng.php.

Costs

Health Canada is financing these two nursing projects. The PDA evaluation project required an investment of 400 to 500 Canadian dollars per PDA device, including software. This project total cost over three years, including the upcoming evaluation, is under $25 000. The costs for future PDA replacements and regular updates of clinical and medical reference software are built into the operating costs for home-care services.

The initial investment for the NITHA project was $166 000. The cost for the entire project, including the addition of a pharmacy electronic management system, is estimated to be about $300 000, over the four years of the pilot project.

Lessons learnt

The two projects have overcome different barriers, yet they share some common issues. For example, the lack of dedicated funding for project coordination meant the Health Canada and NITHA staff involved had to temporarily delay both projects, to focus on more critical health priorities, such as the H1N1 epidemic in 2009. Both projects highlight the fact that promoting the adoption of new technology requires a dedicated leader and available technical staff to encourage participation, support technology usage, and educate practitioners.

Health Canada also contributed to the PDA Evaluation project by supporting the initial research on, and investment in, the PDAs and software. While health leaders from the First Nations communities participated in the decision-making process, the collaboration meant they did not have to search on their own to determine the best products to start their projects.

The projects clearly demonstrate that PDAs can support nursing practice in rural, isolated communities by facilitating access to better tools and information at the point of care. The Canadian PDA projects anticipate that with effective resources in the hands of health professionals to support care provision where people live and work, residents of rural communities will receive better care. Since the benefits of PDA usage in health care are not dependent on the level of Internet access, similar projects could be conducted in other countries.

3.12 Decision support systems

Decision support systems are defined as software algorithms that advise health providers on clinical diagnoses of patients based on the interaction of patient data and medical information, such as prescribed drugs. Mobile devices are used to input patient data and receive targeted health information.

Key findings

- There is low global uptake of mobile decision support systems within WHO regions; no region reported adoption of over 25%.
- Countries in the high-income group reported the highest percentage of uptake (42%).
- Pilot and informal initiatives were more common than established initiatives; these included drug databases, treatment and interaction protocols, and systems for prescribing and ordering medication.

3.12.1 Survey results

Globally the uptake of mobile decision support systems was low, with the highest level of activity being reported by the European and Americas Regions (25% for both). Types of applications reported by Member States in the European Region included deployment of pilot decision support systems such as drug databases, treatment and interaction protocols, and systems for prescribing and ordering medication. For example, Estonia reported a pilot project being implemented by a private company to establish an Internet connection within ambulances to enable access to patient information and decision support tools. Further, a private company in Switzerland detailed a partnership with the Novartis Foundation for Sustainable Development and WHO to develop a decision support program as part of the Integrated Management of Childhood Illness (IMCI) strategy. For use by health professionals in low and middle-income countries, the program was initially computer-based and is now being extended to mobile phones (56). Clinicians at the National Healthcare Group in Singapore use PDAs to access decision support systems to check for drug allergies, interactions, and costs. In the United States, a popular mobile phone application can be used to verify prognosis and check for medication interactions in real-time.

Member States from the World Bank's high-income group reported the highest level of activity (42%), in comparison to other groups. Overall, pilot and informal initiatives were more common than established initiatives.

3.12.2 Relevant literature

The number of studies documenting the implementation of decision support systems was low across all regions, indicating that this may still be an emerging field within mHealth. A noteworthy initiative has been launched jointly by D-Tree International[15] and the Harvard School of Public Health. The programme develops clinical algorithms for HIV/AIDS, diabetes, reproductive health, and child health – including IMCI – that support nurses and community health workers in the diagnosis and treatment of patients at government facilities or through home-based care initiatives. A control pilot study conducted in South Africa to treat HIV/AIDS patients validated the software (57). Future plans include integration of algorithms into electronic health records to combine point-of-care support and data collection.

3.13 Patient records

The use of mobile devices to support the treatment of patients (including collecting and displaying patient records) is becoming more prevalent. This aspect of mHealth enables access to electronic medical records (EMRs) at point-of-care through mobile technologies.

Key findings

- The level of adoption of mobile patient records was moderate across all WHO regions and World Bank income groups.
- The European (47%) and Americas (42%) Regions reported the highest levels of activity.
- Countries in the high-income group had the highest level of uptake, with 65% of countries reporting a patient record initiative.

3.13.1 Survey results

The survey enquired about patient record initiatives that specifically use mobile devices to create and/or access EMRs and/or electronic health records (EHRs) of patients at the point of care. Although EMR and EHR are not strictly the same, for the purposes of this survey they were used interchangeably (58).

The level of adoption of this initiative was moderate across WHO regions and World Bank income groups. The European (47%) and Americas (42%) Regions reported the highest levels of activity. In the European Region, reported implementations included access to EMR at point of care, either in a primary health care clinic, hospital, or in the home during a visit by a nurse or midwife. Germany and Switzerland reported specific examples of personal health record programmes, which are generally aimed at patient use rather than provider use. MyChart, reported by Canada, is an example of an implementation that combines an EMR with other mHealth applications such as appointment and medication reminders.

Countries in the high-income group had the highest level of uptake for this category (65%). This indicates that programmes enabling access to EMRs at point-of-care are primarily being implemented in developed countries, possibly due to the availability of services such as mobile Internet.

15 http://www.d-tree.org/.

3.13.2 Relevant literature

No literature was found that supported the use and development of EMR software exclusively for mobile devices. Most EMR systems were designed for use on a personal computer. It should be noted, however, that advanced mobile technology is making it possible to access EMRs directly and input data. Since use of mobile devices significantly exceeds personal computers in developing countries, EMR software for mobile phones has the potential to increase the quality of patient care in these settings. However, barriers to adopting EMRs on Internet and mobile platforms include clinician resistance, and increased concerns regarding the security, confidentiality, and privacy of patient health data (59). Martins and Jones assert that while mobile technology can make access to patient data and health information easier, the speed of adoption will depend on integration into existing information and communication technology systems (60). An effective EMR programme must be a part of the overall health system. For this reason it is essential that mHealth solutions are interoperable with eHealth solutions.

4 Barriers to mHealth implementation

One of the aims of the 2009 survey was to identify the most important barriers to mHealth implementation and the scaling of projects. Member States were asked to select the four most important barriers that applied to their country situation from a list of nine options. Additional barriers could also be listed.

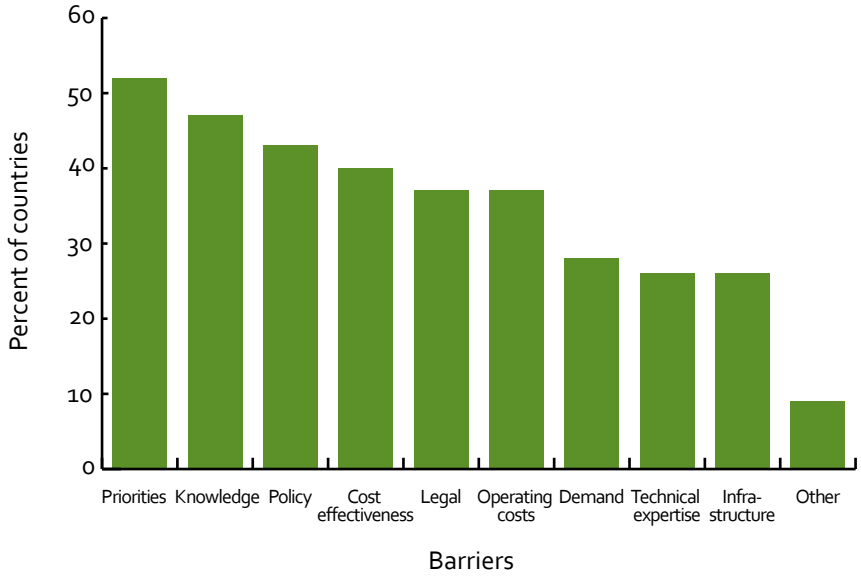
Key findings

- Approximately half of responding Member States (53%) reported competing health system priorities as their top barrier.
- Globally, infrastructure was cited as the least important barrier (26%).
- Similar trends were found in countries in the high, upper-middle, and lower-middle income groups; they all reported competing priorities, cost-effectiveness and lack of knowledge as their most important barriers.

The results, which were supported by the literature, explain the differences in the adoption of mHealth initiatives found between regions and income groups. Understanding the barriers to mHealth adoption and its effective utilization in country contexts is vital so that resources – financial, human, and technical – can be allocated (or re-allocated) to optimally put these initiatives into practice to better the health of populations.

Figure 9 illustrates the cited barriers to mHealth implementation globally. The highest is conflicting health system priorities (52%) and the lowest is underdeveloped infrastructure (26%). All identified barriers, however, should be reviewed when considering the many factors that can impede mHealth adoption.

Figure 9. Barriers to mHealth implementation, globally



Most health systems are severely overburdened. This means they are constantly challenged by the need to make difficult decisions about competing priorities. Since mHealth currently lacks a strong evidence-base to verify its impact on health outcomes and health systems, it is understandable that about half of the responding Member States reported competing priorities as their main barrier. Conflicting priorities generally indicates that funding is allocated to other programmes ahead of mHealth, or can reflect a lack of general interest or understanding of the field.

The lack of knowledge concerning the possible applications of mHealth and public health outcomes was the next highest rated barrier (47%). This highlights the need for evaluation studies of mHealth applications across a range of settings and target groups. Once evaluated, the results will need to be disseminated by WHO or other partner international agencies.

The third most important barrier identified was that of country or regional eHealth policy not recognizing mHealth as an approach to health-related issues. This finding is not surprising given that mHealth is still in a relatively early stage of adoption and development. Recent studies indicate that health information security, patient confidentiality, standardized metrics, and interoperable systems were identified as pertinent policy challenges to overcome before the consideration of mHealth as a strategic initiative can occur (61). Addressing such points within a health policy that includes electronic and mobile health will promote and validate mHealth, systematizing it.

This is a multi-step process, of course, which includes public awareness campaigns (highlighting the need and potential solution/benefit), research and development (innovation), trials and their evaluation to prove effectiveness, and guidelines for use (part of policy). The policy-making process rarely keeps up with technological development or public's demand; this is especially true of the field of mHealth – where technology evolves so quickly and there are multiple sectors involved (e.g. health, communications, and technology).

Cost-effectiveness of mHealth solutions was the final of the top four barriers cited. Most responding countries at the time of the survey did not know the cost-effectiveness of available mHealth solutions. This is not surprising; few data exist on the evaluation of mHealth programmes. It should be noted that cost-effectiveness is just one element of the health system that requires resources alongside operating costs, infrastructure, knowledge, and technical expertise.

Most mHealth solutions to date are independent, local initiatives. Such solutions are unlikely to be the most cost-effective; indeed the opposite is true. Integrated, interoperable systems are more likely to be the cheapest to deploy and operate, as well as having the most significant impact. That is, integrated regional (and even global) solutions are likely to provide the most benefits – there are as yet no data for this. Technology industry leaders could lead this effort, perhaps, motivated by corporate social responsibility as well as profit – robust market share can be gained in one area from subsidized usage in another.[16] Once such programmes began evaluation would follow, either conducted by industry itself, or other organizations.

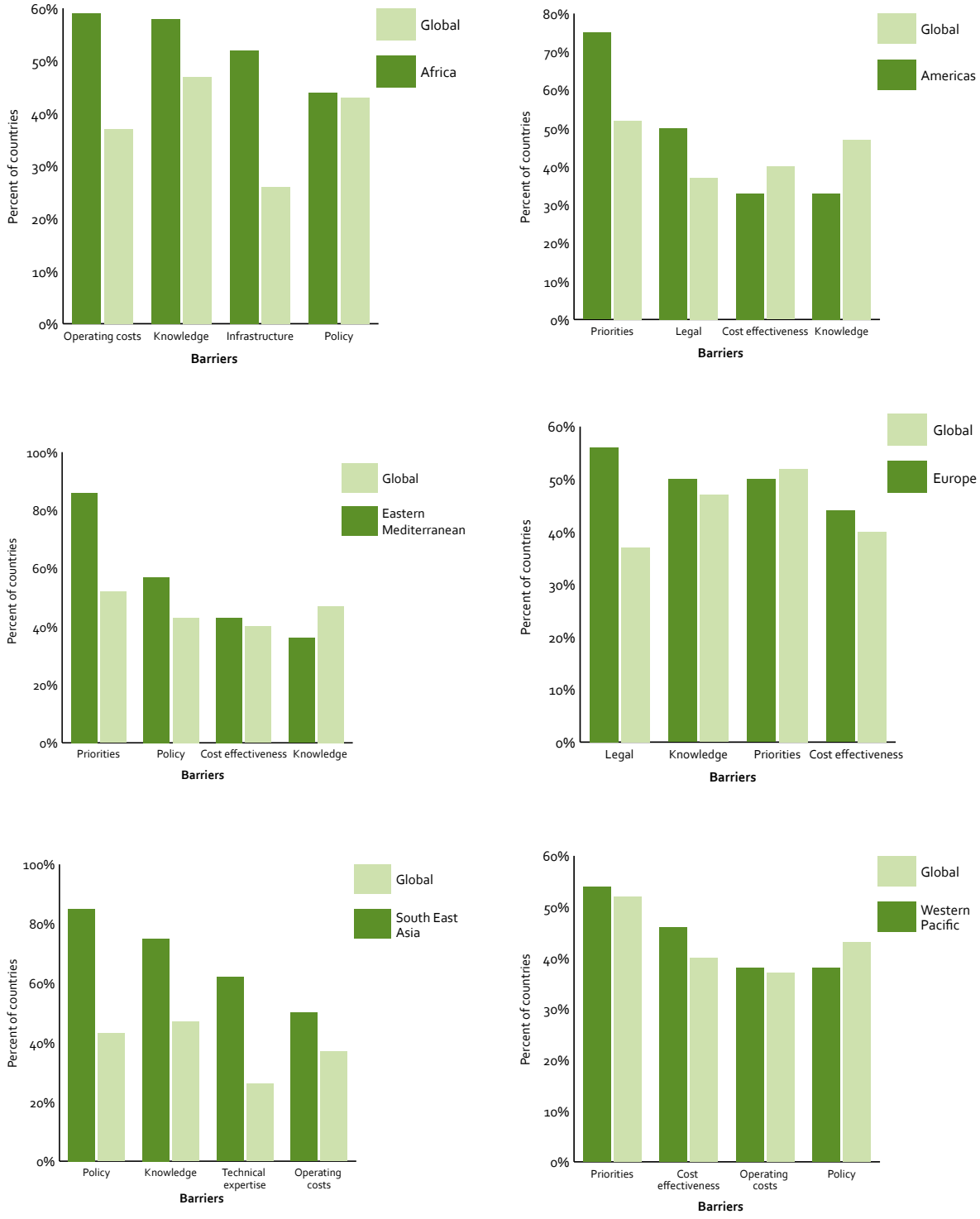
As there have not been large-scale deployments of integrated systems, however, it is not yet possible to present the business case. Still, as the field matures the costs of implementation and expectations will change, and the environment will become more conducive to evaluation of efforts. All stakeholders can promote or support sound evaluation and cost-effectiveness studies of mHealth initiatives, particularly donors, academia, governments, and industry.

16 The case study from Ghana in this report is a good example.

4.1 Barriers by WHO region

Figure 10 shows the main barriers to mHealth by WHO region. Conflicting health system priorities were still identified as the main barrier by the Americas, Eastern Mediterranean, and Western Pacific Regions. The main barriers for the remaining regions were: operating costs perceived as high for the African Region; legal issues for the European Region; and policy concerns for the South-East Asia Region.

Figure 10. Top four barriers to mHealth implementation, by WHO region



The African Region identified the lack of infrastructure as one of its top barriers. It is evident that although much work has been done in the region enormous challenges still exist. One indicator of infrastructure is the level of cellular network coverage. The growth of mHealth is dependent on widespread network coverage and access to mobile devices. Network coverage is expanding dramatically across the globe, driven in particular by strong consumer demand as well as policies to stimulate growth in telecommunications infrastructure and expand network capacity. Urban areas have been covered first, but services are expanding rapidly into rural areas – which potentially stand to benefit the most from mHealth solutions. The upward trend of coverage and subscriber numbers highlight this is a dynamic market but with still much room to grow.

The Americas, Western Pacific, and Eastern Mediterranean Regions reported conflicting health systems priorities as their main barrier to mHealth implementation. While elements of mHealth can be implemented on their own, many of the applications and systems now being introduced will be far more effective if implemented as a natural extension of eHealth. A stronger understanding of mHealth applications within the context of eHealth will be essential to align the benefits of mobile technologies within broader health and eHealth priorities.

The lack of knowledge concerning the possible applications of mHealth was a key barrier reported across all WHO regions except the Western Pacific Region. The results exemplify the ongoing need to keep stakeholders informed of trends and developments in the field, and communicate mHealth research findings and evaluations within the broader context of eHealth. Given the embryonic stage of the market, and the absence of model, integrated deployments that can be researched and emulated, this lack of knowledge is not surprising. In contrast to these results, technical expertise was only reported as a barrier by the South East Asia Region, indicating that locally qualified personnel appear to be available in Member States in other regions.

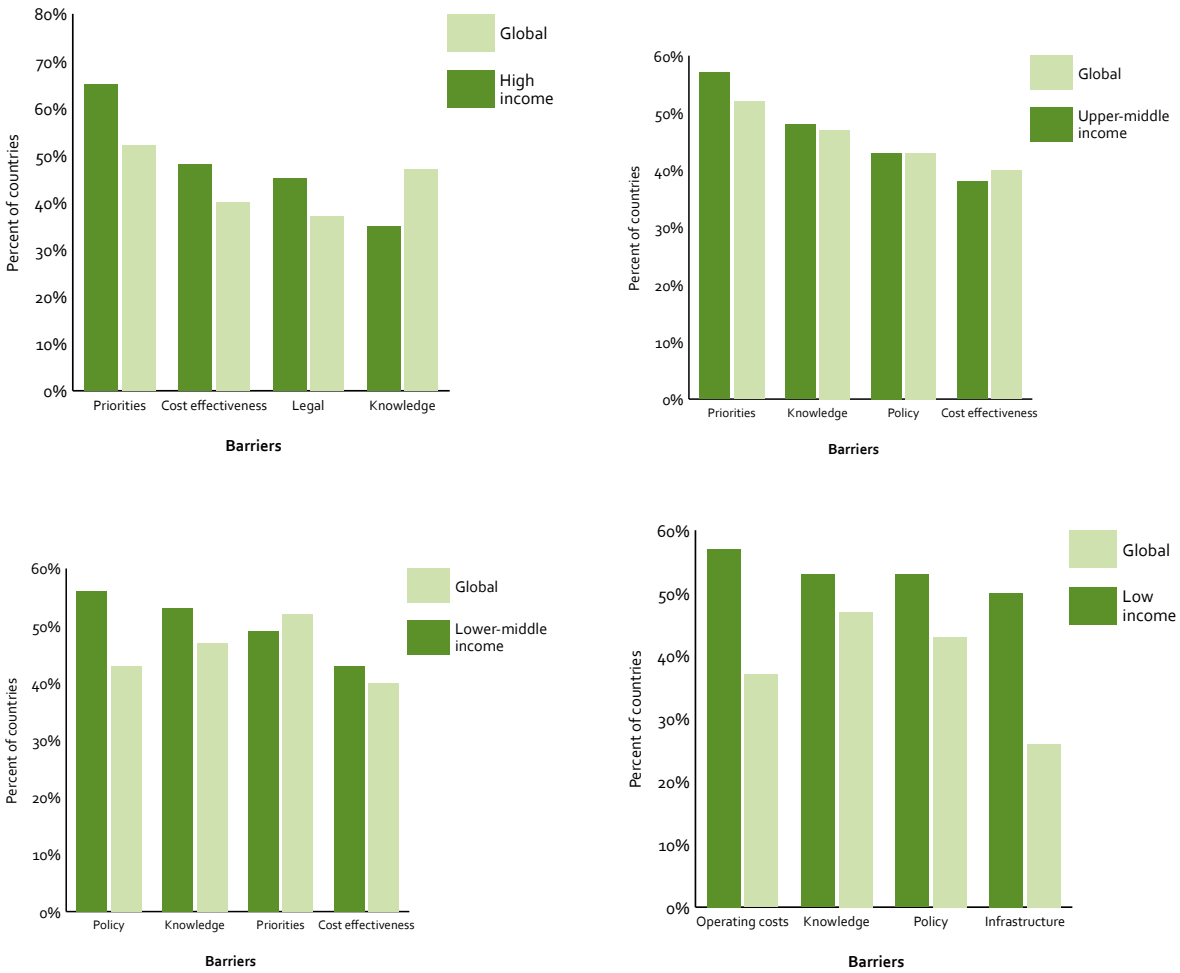
The European (56%) and Americas (50%) Regions reported the absence of legal guidelines on privacy and confidentiality in the mHealth domain as the two most important barriers to mHealth implementation. Many countries in these regions already have highly regulated health information and patient confidentiality laws. Legal frameworks that govern the integrity of health data transfer and storage, in addition to identifying access control and medical liability are critical to enabling eHealth (and therefore mHealth) in countries in these regions. Importantly, countries in the process of developing eHealth policies and legislation should include mHealth within the framework of their policies, as the field is an extension of eHealth, and shares almost exactly the same policy and legal considerations and technical solutions.

The unknown cost-effectiveness of mHealth initiatives was reported as one of the top four barriers by almost all WHO regions, particularly the Western Pacific, European, Eastern Mediterranean, and the Americas Regions. mHealth cannot be considered in a vacuum; this will make it difficult to evaluate its cost-effectiveness. It needs to be studied in the overall context of eHealth or a larger deployment to recognize the full value and potential for cost-savings. Cost–benefit studies have been identified as one of the largest gaps in mHealth research, and are acknowledged as critical to providing evidence for national governments to summon the policies required to enable mHealth scale-up and sustainability (61). As previously noted, most mHealth pilot programmes to date have been technical proofs of concept or single problem solutions. Neither of these approaches lend themselves to cost–benefit analysis, or to efficient large-scale deployment.

4.2 Barriers by World Bank income group

Figure 11 shows the top four barriers to mHealth implementation aggregated by World Bank income groups. The lack of supporting policy was found to be an important barrier for responding countries in all the income groups, except for those in the high-income group.

Figure 11. Top four barriers to mHealth implementation, by World Bank income group



When compared across income groups, the results show very similar patterns for the high, upper-middle, and lower-middle income groups, all of which reported conflicting health system priorities, unknown cost-effectiveness, and lack of knowledge within their top four barriers.

High-income countries already have access to many choices in eHealth and are looking for new approaches that add value and are cost-effective. Equally important is enhanced legislation. Some legislation related to eHealth has been introduced; strengthening privacy and security (of EMRs for example) are among the issues these countries would like to see in future legislation.

Upper-middle income countries have similar concerns as high-income countries: conflicting health systems priorities on where to allocate funds. These countries cite, however, the need for more information on the available mHealth options, which could be a reason mHealth policies are still not in place in many of these countries.

Lower-middle income countries have the following needs with respect to mHealth: policy, knowledge, and managing conflicting health priorities. Cost-effectiveness of solutions is not considered a barrier, as countries in this group have other critical health concerns to address before they can institute mHealth programmes.

Countries from the low-income group identified operating costs and lack of infrastructure as top barriers, illustrating that handset, voice, data, and text pricing for wireless services in the poorest countries is still relatively high and infrastructure is far from ubiquitous.

There are some striking similarities between the survey findings on mHealth and those identified in *Telemedicine – opportunities and developments in Member States* (62). Of particular note were the findings that countries from the low-income group were more likely to report as barriers to telemedicine development resource constraints such as operating costs and insufficient infrastructure; and those from the high-income group were more likely to report legal and competing priorities as barriers in the domain of telemedicine.

5 Evaluation of mHealth initiatives



5.1 Survey results

The survey enquired whether Member States had formally evaluated any of their mHealth initiatives, and if so, whether they had published the results.

Key findings

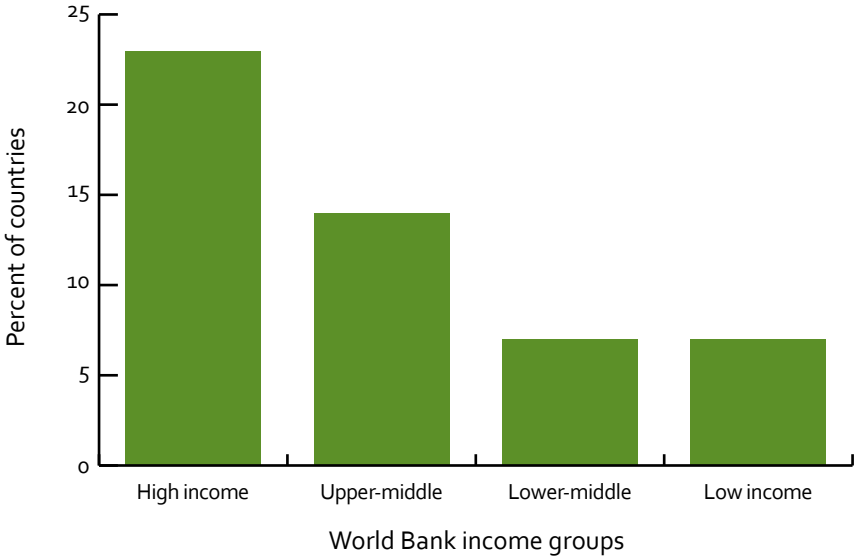
- Only 12% of countries reported having evaluated mHealth initiatives.
- Member States where mHealth initiatives are relatively mature are most likely to be conducting evaluations.

The percentage of countries reporting that they had formally evaluated mHealth initiatives was low (12%). Figures 12 and 13 show the distribution of evaluation activity by World Bank income group and WHO region, respectively.

Evaluation is a vital component to any policy or programme, including mHealth. Initiatives like those discussed in the in the case studies above highlight the potential mHealth has to facilitate health care. Evaluation of such programmes will ensure their development and success. Responses to the question of evaluation were most frequently reported by countries in the high- and upper-middle income groups (23% and 14%, respectively). This is likely to be a reflection of developed countries being more advanced in the field of mHealth and therefore having reached the stage where evaluation is built within the

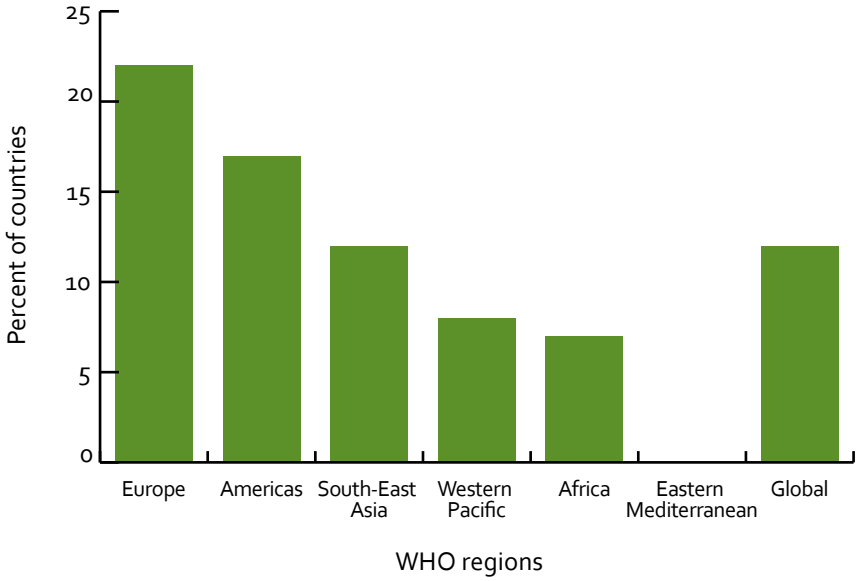
project management plan. Only 7% of responding developing countries reported conducting an mHealth evaluation. The evaluation of programmes, including cost–benefit analyses, will become an integral component of programme management as both eHealth and mHealth mature. In turn, it can be expected that evaluation will increase across all income groups

Figure 12. Evaluation of mHealth initiatives, by World Bank income group



Review by WHO region showed similar results as found for income groupings: developed countries from the European and the Americas Regions reported the highest percentage of mHealth evaluations (22% and 17%, respectively). The remaining regions display lower levels ranging from 12% to no activity in this area. The low levels of evaluation reported are a reflection that mHealth is still growing and the process of evaluation may still not be considered a priority at this stage.

Figure 13. Evaluation of mHealth initiatives, by WHO region



5.2 Relevant literature

Although the mHealth evidence-base is growing, there are major research gaps that must be addressed. The state of mHealth research in the context of developing countries has recently been published (61). It concluded that current research does not adequately evaluate mHealth interventions nor provide sufficient evidence on health impact. To ameliorate this it suggests moving from computer-based research investigating usability, to a health outcomes-based approach using randomized control studies and standardized replicable study designs. In order to conduct such studies, standardized indicators and metrics for monitoring and evaluating must be developed and agreed upon.

Preliminary work has been undertaken in a recent small-scale mHealth monitoring and evaluation survey conducted by WHO in collaboration with the Earth Institute, Columbia University. Researchers conducted a survey on metrics and evaluation of mHealth interventions in 2010 to understand the current status and needs of monitoring and evaluation in mHealth (63). The results suggest that there is a degree of ongoing monitoring and evaluation and research being conducted by mHealth implementers that could potentially inform the future of mHealth deployment through the sharing of best practices.

6 Conclusion



The world is experiencing an extraordinary phenomenon: the exponential growth of mobile communications not only in developed countries but also in the developing world, where such technology is bypassing conventional telephony systems and allowing people to communicate across vast geographical distances which until now were inaccessible. The ITU estimates that by the end of 2010 77% of the world's population had a subscription to a mobile phone, and over 85% were covered by a mobile phone network (1). With the rise of mobile broadband through 3G innovation, increasing numbers of people will have access to the Internet, particularly in low-income settings such as Africa, where inadequate infrastructure makes 'traditional' access to the Internet cost-prohibitive.

Alongside benefits to increased business and information access, innovative thinkers are seizing the opportunity to harness the power of mobile technologies for the benefit of public health. The field is called mHealth; it allows patients to be connected to services which include health information on demand, health record management, and the remote, real-time monitoring of chronic conditions such as diabetes, asthma, and hypertension to name but a few.

Mobile technologies have already changed, and will continue to change, the lives of millions around the world, though most particularly in high-income settings. Many are calling this change a revolution: almost 90% of the world's population could benefit from the opportunities mobile technologies represent, and at relatively low cost. Many sectors in low-income countries are already incorporating the use of mobile technologies into their business processes in increasingly sophisticated ways. Diverse applications in use in developing countries include online education, election monitoring, citizen journalism during political unrest, agricultural assistance to farmers, and mobile banking services. Yet the health sector has been slow in adopting mobile technologies into routine operations, which would benefit patients and providers alike.

To determine why this is so, WHO included a series of questions about mHealth in its 2009 global eHealth survey. It enquired about national trends in the adoption of mHealth in 14 specific areas ranging from the use of mobile technologies for health call centres and treatment compliance to mobile telemedicine and community mobilization for health promotion (Figure 3). Member States were also asked to assess the most significant barriers to mHealth adoption for their country situation, as well as the practice of evaluating existing programmes.

The results, reviewed by WHO region and World Bank income group, show the clear emergence of mHealth across the globe. mHealth activity, or experimentation, was reported by four of five responding Member States, many of which often reported up to six projects. The adoption of mHealth appears to follow a certain path – it is most easily incorporated into processes and services which traditionally use voice communication. This would explain why the majority of countries are already offering health call centres, toll-free numbers, and emergency services using mobile communications. When considering countries where the infrastructure is underdeveloped, however, the results show low uptake (e.g. the African Region). Decision support systems and disease surveillance were two areas in which uptake among Member States was low.

There is little published evidence on the effectiveness of mHealth interventions or their cost-effectiveness, particularly in low-income settings (which is the fourth-highest barrier cited by Member States; see Figure 9). Evaluation, the first step in providing these data, is not being undertaken for most mHealth programmes (only 12% of Member States have evaluated mHealth programmes). This is not entirely unexpected as mHealth is still relatively new and therefore unexplored but this practice needs to change.

An international framework for the evaluation of mHealth programmes, including meaningful and measurable indicators, would be an important step towards data collection. This would include a database of research findings on selected monitoring and evaluation studies in mHealth from across the globe, with a particular emphasis on gathering data at the country level.

Without such data, mHealth will not quickly become a part of government policy or be protected by legal guidelines on privacy (the third- and fifth-highest barrier cited, respectively), nor will policy-makers be aware of its possible applications (the second most-cited barrier). If these barriers were resolved, the case for expenditure on mHealth would most likely be bolstered, putting it into perspective among the competing costs that every health system must face (the number one cited barrier to implementation).

Data security is a particularly important issue to address within the area of policy. There are legitimate concerns about the security of citizen information by programmes using mobile health technologies. In particular, message transmission security and data storage security can put citizen information at risk if the necessary precautions are not taken. Security policies safeguard health identity information throughout the entire data life cycle – from the first input of patient data using the mobile device to follow-up through a post-surgery survey. Parameters such as password protection, network log on requirements, synchronization of files to the device, and backup and recovery and applications installed need to be evaluated and defined as part of the mobile security policy. It is also essential for devices to have antivirus and firewall capabilities to prevent data loss or infection. Policy-makers and programme managers need to be made aware of security issues in the mHealth domain so appropriate policies and strategies can be developed and implemented.

Member States indicated their commitment to maximizing the benefits of eHealth (including mHealth) in the 2005 resolution WHA58.28. They now need to be encouraged to develop comprehensive eHealth policies that promote the use of mHealth where appropriate. In order for this to occur, technological solutions need to be designed according to local realities and needs in such a way that they measurably contribute to achieving country health priorities and the MDGs. Health policy-makers and administrators need to be equipped with the knowledge required to shift emphasis from small pilot programmes to large-scale deployments. Standardized, interoperable systems are the goal, moving away from 'information silos'.

A common pattern for the introduction of ICT and mobile technologies in countries is their entrance to health markets in pockets, a plaster here or a bandage there, to fix a particular problem. In this scenario, individual investors with interest in a specific problem find sufficient improvement from use of mobile ICT to invest in a specific solution. The most common result is a profusion of non-interoperable islands of ICT. In fact, many developed countries are now trying to find solutions to this significant problem in their eHealth applications and spending vast sums of money in doing so. These countries provide a prime example of what to avoid for those countries currently addressing eHealth policy and infrastructure.

Countries will make far greater and faster progress and will save significant sums of money if they adopt global standards. For instance, standards developed in the banking sector for electronic payment processing have been highly successful due to their national and international adoption and cooperative approach. Another such example is the Global Harmonization Task Force,[17] where governments and industry collaborate to create standards for medical technologies. There is no reason why such public-private partnerships cannot be brought to bear on eHealth.

To this end, WHO and ITU will soon launch an information product called the National eHealth Roadmap Development Toolkit to support Member States in the development of comprehensive eHealth strategies and policies, of which mHealth is a part. Future action of the Observatory and its partners will involve compiling and disseminating information regarding mHealth initiatives, the lessons learnt, evaluations, best practices, and cost-effectiveness to support achieving country health priorities and the MDGs.

If implemented strategically and systematically, mHealth can revolutionize health outcomes, providing virtually anyone with a mobile phone with medical expertise and knowledge in real-time. This is a boon particularly to those marginalized or living in remote areas, who would otherwise not have access to this information or care. It is hoped that this report will highlight the possibilities inherent in mHealth and promote a dialogue among a broad range of actors including government, industry, academia, policy-makers, NGOs, and civil society partners that will help forge a more strategic and cohesive direction for this field and its great potential.

17 http://www.ghtf.org/.

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Appendix 1. Methodology of the second global survey on eHealth

Purpose

The World Health Organization's eHealth resolution WHA 58.28 was adopted in 2005 and focused on strengthening health systems in countries through the use of eHealth (1); building public-private partnerships in ICT development and deployment for health; supporting capacity building for the application of eHealth in Member States; and the development and adoption of standards. Success in these areas is predicated on a fifth strategic direction: monitoring, documenting and analysing trends and developments in eHealth and publishing the results to promote better understanding. In direct response to the eHealth resolution, the Global Observatory for eHealth (GOe) was established to monitor and analyse the evolution of eHealth in countries and to support national planning through the provision of strategic information.

The GOe's first objective was to undertake a global survey on eHealth to determine a series of benchmarks at national, regional and global levels in the adoption of the necessary foundation actions to support the growth of eHealth. The aim was to provide governments with data that could be used as benchmarks for their own development as well as a way to compare their own progress with that of other Member States. The survey is part of the mandate defined during the GOe's inception – to provide Member States with reliable information and guidance on best practices, policies and standards in eHealth.

The second global survey on eHealth was conducted in late 2009 and was designed to build upon the knowledge base generated by the first survey. While the first survey conducted in 2005 was more general and primarily asked high-level questions at the national level, the 2009 survey was thematically designed and presented more detailed questions. The thematic design of the survey has provided the GOe with a rich source of data that is being used to create a series of eight publications – The Global Observatory for eHealth Series – due for publication during 2010 and 2011.

Each publication in the series is primarily targeted to ministries of health, ministries of information technology, ministries of telecommunications, academics, researchers, eHealth professionals, nongovernmental organizations involved in eHealth, donors, and private sector partners.

Survey implementation

Based on the experience of the first global survey, the GOe benefited from many of the lessons learned in creating the second survey, disseminating the instrument in digital format, working with WHO regional offices and Member States to encourage survey completion, as well as processing the data and analysing the results. With the emergence of mHealth as a driver of eHealth in many low and middle-income countries, a specific module was included to capture country-specific activity in this area.

Survey instrument

The instrument focused on issues relating to processes and outcomes in key eHealth areas. Objectives for the survey were to identify and analyse trends in the:

- Uptake of eHealth foundation policies and strategies, building on the 2005 results
- Deployment of mHealth initiatives in countries
- Application of telemedicine solutions
- Adoption of eLearning for health professionals and students
- Collection, processing and transfer of patient information
- Development of legal and ethical frameworks for patient information in digital format
- Action concerning online child safety, Internet pharmacies, health information on the Internet, and spam
- Governance and organization of eHealth in countries.

Table A1 shows the seven themes of the survey.

Table A1. Survey themes

Theme	Action
mHealth	Identify the diverse ways mobile devices are being used for health around the world and the effectiveness of these approaches. Highlight the most important obstacles to implementing mHealth solutions. Consider whether mHealth can overcome the digital divide.
Telemedicine	Identify and review the most frequently used telemedicine approaches across the globe as well as emerging and innovative solutions. Propose necessary actions to be taken to encourage the global growth and acceptance of telemedicine, and particularly in developing countries.
Management of patient information	Describe the issues relating to the management of patient information at three levels – local health care facility, regional/district, national levels. Analyse the trends in transition from paper to digital records. Identify actions to be taken in countries to increase the uptake of digital patient records.
Legal and ethical frameworks for eHealth	Review the trends in the introduction of legislation to protect personally identifiable data and health-related data in digital format as well as the right to access and control one's own record. Identify and analyse the control of online pharmacies by Member States. Review government action to provide for child safety on the Internet.
eHealth policies – a systematic review	Identify the uptake of eHealth policies across the globe and analyse by WHO region as well as World Bank income groups to establish possible trends. Systematically review the content and structure of existing strategies highlighting strengths and weaknesses. Propose model approaches for the development of eHealth policies including scope and content.
eHealth foundation actions	Review trends in the uptake of foundation actions to support eHealth at the national level including: eGovernment, eHealth, ICT procurement, funding approaches, capacity building for eHealth, and multilingual communications.
eLearning	Analyse the extent of use and effectiveness of eLearning for the health sciences for students and health professionals.
eHealth country profiles	Presentation of all participating Member States eHealth data aggregated by country to act as ready reference of the state of eHealth development according to selected indicators.

Survey development

The survey instrument was developed by the GOe with broad consultation and input from eHealth, and in the case of this module, mHealth experts. Planning for the 2009 global survey started in 2008 with the review of the 2005/2006 survey results, instrument and feedback from participating countries. One of the constraints identified in the first survey was on the management of data and its availability for compilation and analysis. In order to facilitate data collection and management, Data Collector (DataCol) was used to make the survey instrument available online and therefore streamlining the collection and processing of data.

A set of questions was developed and circulated in the first quarter of 2009 for comments to selected partners in all regions through virtual teleconferences. The range of partners included those from government, WHO regional and country offices, collaborating centres and professional associations. Over 50 experts worldwide were involved in the process. Collaborative efforts extended to other WHO programmes as well as international organizations, such as the International Telecommunications Union (ITU) and Organisation for Economic Co-Operation and Development (OECD). An online forum to discuss the survey instrument and survey process was developed and hosted by the Institute for Triple Helix Innovation based at the University of Hawaii at Manoa in the United States of America.[18]

A draft questionnaire was developed and posted online for review by the partners and was pilot tested in March 2009 in five countries: Canada, Lebanon, Norway, Philippines, and Thailand. The final version of the survey instrument was enhanced based on the comments and observations received from the pilot testing. In order to encourage countries to respond, the survey questions, instructions and data entry procedures were translated into all WHO official languages plus Portuguese.

Data Collector

Data Collector, DataCol, is a web-based tool that simplifies online form creation for data collection and management and is designed, developed and supported by WHO. The collected data are stored in a SQL database maintained by WHO database administrators, and can be exported as a Microsoft Excel file for further analysis using other statistical software.

This is the first time that DataCol has been used as the primary method of implementing an online survey of over 40 pages of text and questions. Significant preparation and testing was required to ensure that the system was robust and able to accommodate the data entry process from around the world, as well as the volume of data entered and stored online.

The various language versions of the survey instrument and supporting documentation were entered into DataCol by language. In addition, individual country login names and passwords were assigned to ensure that only one entry was submitted per country rather than multiple entries. Country coordinators were responsible for completing the forms after obtaining agreement from the expert informant group.

Preparation to launch the survey

One of the most important tasks in executing an international survey is to build a network of partners at the regional level who can liaise directly with countries.

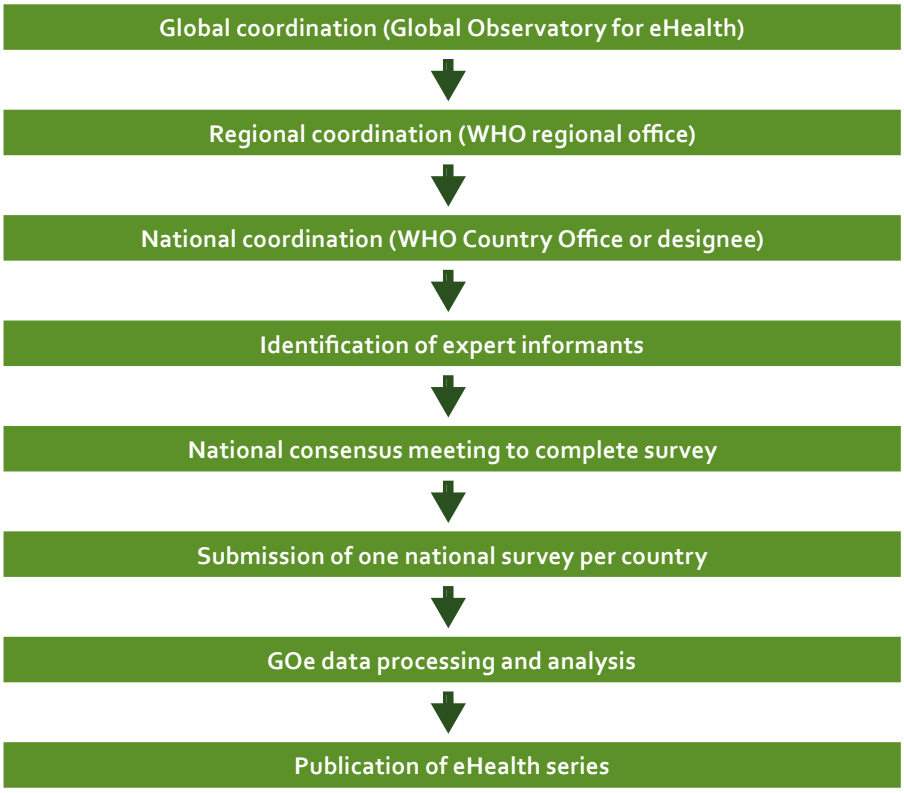
Due to differing priorities across WHO regions, not all regional offices have staff whose responsibilities included eHealth activities. For this reason many regional offices had to assign staff to assist in coordinating the survey process with countries in their respective region. Instructions for the survey procedures were circulated and were followed by a series of teleconferences.

One significant outcome during the survey implementation was the development of strong and productive working relationships with regional counterparts, without whom it would not have been possible to

18 http://www.triplehelixinstitute.org/.

successfully undertake such a task. The success of the survey implementation can also be attributed to the assistance of regional and national office colleagues who worked directly with national counterparts in completing the questionnaire.

Figure A1. GOe survey and report process



Survey

The survey was launched on 15 June 2009, and due to the high level of interest, did not close until 15 December 2009. Regional focal points worked to encourage Member States to participate. The purpose and rewards of participation have to be conveyed to national coordinators and then to survey expert informants. It is important to build momentum and to maintain enthusiasm.

At the national level, coordinators managed the task. Their responsibilities included finding experts in all of the areas addressed by the survey, and organizing and hosting a full-day meeting where the survey could be collectively completed by the entire group. The number of expert informants, per country, ranged from 5 to 15. The survey process helps build the GOe network of informants around the globe and now consists of over 800 eHealth experts.

Limitations

Member States were limited to one response per country; thus, the expert informants were required to come up with a single response for each question that was most representative of the country as a whole. Coming to a consensus could be difficult in cases where the situation varies widely within the country, or where there were significant differences in opinion. The survey does not attempt to measure localized eHealth activity at the sub-national level.

The survey responses were fundamentally based on self-reporting by the expert informant group for each participating Member State. Although survey administrators were given detailed instructions to maintain consistency, there was significant variation across Member States in the quality and level of detail in the responses, particularly to for the descriptive, open-ended questions. While survey responses were checked for consistency and accuracy, it was not possible to verify the responses for every question.

The scope of the survey was broad, and survey questions covered diverse areas of eHealth – from policy issues and legal frameworks to specific types of eHealth initiatives being conducted in-country. Every effort was made to select the best national experts to complete the instrument, however, it is not possible to determine whether the focus groups had the collective eHealth knowledge to tackle each question. While the survey was circulated with a set of detailed instructions and terminological definitions, there is no guarantee that these were used when responding.

Data processing

Upon receipt of the completed questionnaires, all textual responses were translated into English. Electronic submission through DataCol reduced the possibility of entry errors, however, survey responses were checked for consistency and errors, and countries were contacted for follow up to ensure accurate reporting of results. Data were exported from DataCol in Microsoft Excel format and the data analysis was performed using the R statistical programming language.[19]

Data were analysed by thematic section. For closed-ended questions, percentages were computed for each possible response to obtain the global level results. In addition, the data were aggregated and analysed by WHO region and World Bank income group to see trends by region and by income level. Preliminary analysis based on aggregation by ICT Development Index showed similar results as for World Bank income group (2). This is due to the high correlation between ICT Development Index and GDP per capita (Spearman ρ=0.93, p=10-16). Therefore, these results were not included in this report. Cross-question analysis was performed where two or more questions were thought to be related, and the results were probed in greater depth as warranted. External health and technology indicators such as mobile phone penetration were introduced into the analysis for comparison purposes where relevant.

Results from the current survey were compared to those from the previous survey wherever possible; however, as the subject matter covered by the 2009 survey was considerably broader, and the survey questions were worded somewhat differently, there was little scope for this sort of analysis. In addition, the percentages were often not directly comparable, particularly at the regional level, as the sets of responding countries were different, and the expert informants in each iteration of the survey were also different.

Table A2 shows the advantages and disadvantages of the groupings used in the survey.

19 See for more information http://www.r-project.org/.

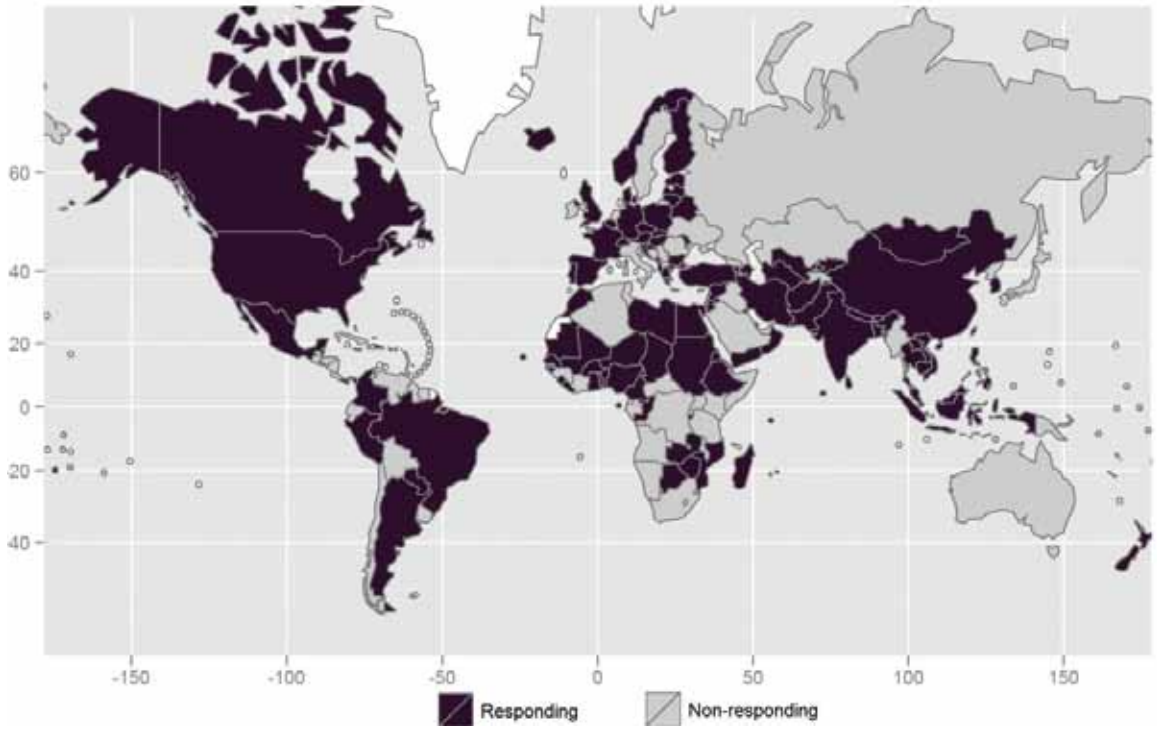
Table A2. Advantages and disadvantages of the country groupings

Country grouping	Advantages	Disadvantages
WHO region	WHO regional approach integrated into WHO strategic analysis and planning, and operational action.	Limited country commonality from an economic, health care, or ethnic perspective. Less useful for other agencies or institutions wishing to interpret or act on GOe data.
World Bank income group	Clear economic definition based on GNI per capita. Consistent application of criteria across all countries. Simple four-level scale.	Does not account for income disparity, ongoing armed conflicts, health of the population, or population age.

Response rate

The Mobile Health section of the survey, which this publication is based on, was completed by a total of 112 countries (58% of all WHO Member States). Figure A2 shows the responding Member States for the Mobile Health section of the survey. Tables A3 and A4 show the distribution of the 112 responding countries by WHO region and World Bank income group.

Figure A2. Responding Member States



Response rate by WHO region

Administratively, the WHO is made up of six geographical regions. However, the regions themselves are not homogenous. Their Member States are countries with differing characteristics of size, wealth and health care problems. Nevertheless, it is still important to present high-level analyses at the regional level, as this reflects the organizational structure and operational framework of the WHO.

A breakdown by WHO regional responses is presented in Table A3. It shows considerable variation ranging from 34% for the Americas to 73% for the South-East Asia Region. Numerous Member States, particularly those in the Region of the Americas, indicated that they would not be able to participate in the 2009 survey due to resources being diverted to prepare and respond to the H1N1 pandemic or due to other urgent public health issues such as conflict situations. The Western-Pacific Region has many small island Member States of which only a few responded to the survey, yielding a response rate of 48% for the region. The response rates for the Eastern Mediterranean, African and European Regions were over 60%. This was particularly encouraging for regions consisting of a large number of Member States such as the African and European Regions. Results from regions with low response rates should be interpreted with care as they may not be representative of the entire region.

Table A3. Response rate by WHO region

	WHO region					
	African	Americas	South-East Asia	European	Eastern Mediterranean	Western Pacific
Total number of countries	46	35	11	53	21	27
No. of responding countries	29	12	8	36	14	13
Response rate	63%	34%	73%	68%	67%	48%

For the South-East Asian Region, although the number of responding countries was the lowest, the response rate was the highest since the region consists of a total of 11 Member States. Self-selection of the sample often occurs in surveys of this nature, where responding countries are more likely to have a high level of interest and/or activity in eHealth. Table A4 shows that response rates in low and lower-middle income brackets were high. Past surveys have shown that countries in these groups generally have less eHealth activity in comparison to high and upper middle-income brackets. Thus, in some cases, Member States participating in the survey may reflect a commitment to moving forward with eHealth.

Response rate by World Bank income group

The World Bank classifies all economies with a population greater than 30 000 into four income groups based on gross national income (GNI) per capita.[20]

The classification is as follows: low income (US$ 975 or less), lower-middle income (US$ 976–3,855), upper-middle income (US$ 3856–11 905), and high income (US$ 11 906 or more) based on 2008 country data. These income groups are a convenient and practical basis for analysis, enabling a review of trends in the survey results based on income level. Classification by income does not correspond exactly to level of development; however, low and middle-income countries are sometimes referred to as 'developing' economies and high-income countries as 'developed', for convenience.

Table A4 shows the survey response rate by World Bank income group. Low-income countries had the highest response rate (70%), closely followed by high-income countries (63%). In terms of raw numbers, the distribution of responding countries was remarkably even, with 30 to 31 countries responding from the high-income, lower-middle income, and low-income groups, and a slightly lower number of countries from the upper-middle income group.

Table A4. Response rate by World Bank income group

	World Bank income group			
	High income	Upper-middle income	Lower-middle income	Low income
Total no. Countries	49	44	53	43
No. of responding countries	31	21	30	30
Response rate	63%	48%	57%	70%

20 http://data.worldbank.org/about/country-classifications

It is noteworthy that the low-income and high-income groups had the highest number of responding Member States, despite having very different mobile phone penetration rates. In 2008, it was reported that there were 28.5 mobile device subscriptions per 100 habitants in the low-income group, in comparison to 106 in the high-income group (3). This reinforces the notion that countries in both of these income brackets view the ubiquity of mobile devices as an opportunity to overcome public health challenges, provide support to strained healthcare systems or catalyse economic growth for improved livelihoods.

The information generated from the mHealth module of the survey is an invaluable resource for the development of a policy framework and strategy that aims to identify and strengthen priority mHealth initiatives and promote an enabling environment to overcome the challenges as expressed by Member States. Creating this framework will help countries align mHealth activities with health priorities including MDG targets and put into place the policies and standards needed to facilitate investment and activity in mHealth to achieve the scale and sustainability needed for its potential impact on health to be realized.

Literature review

As a complement to the analysis of the mHealth data, relevant studies and literature were drawn from a recent review of mHealth research conducted by the Earth Institute with support from the mHealth Alliance, entitled *Barriers and gaps affecting mHealth in low and middle income countries* (4). Selected findings from the review have been included in this report to contextualize and draw comparisons between the survey results and mHealth initiatives reported by Member States, and published literature.

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Appendix 2. Member States by WHO region and World Bank income group

Member States by WHO region

(Responding countries in dark green)

African	Eastern Mediterranean	European	Americas	South-East Asia	Western Pacific
Algeria	Afghanistan	Albania	Anguilla	Bangladesh	Australia
Angola	Bahrain	Andorra	Antigua and Barbuda	Bhutan	Brunei Darussalam
Benin	Djibouti	Armenia	Argentina	Democratic People's Republic of Korea	Cambodia
Botswana	Egypt	Austria	Aruba	India	China
Burkina Faso	Iraq	Azerbaijan	Bahamas	Indonesia	Cook Islands
Burundi	Iran, Islamic Republic of	Belarus	Barbados	Maldives	Fiji
Cameroon	Jordan	Belgium	Belize	Myanmar	Japan
Cape Verde	Kuwait	Bosnia and Herzegovina	Bermuda	Nepal	Kiribati
Central African Republic	Lebanon	Bulgaria	Bolivia	Sri Lanka	Korea, Republic of
Chad	Libyan Arab Jamahiriya	Croatia	Brazil	Thailand	Lao People's Democratic Republic
Comoros	Morocco	Cyprus	Canada	Timor-Leste	Malaysia
Congo	Oman	Czech Republic	Cayman Islands		Marshall Islands
Cote d'Ivoire	Pakistan	Denmark	Chile		Micronesia, Federated States of

African	Eastern Mediterranean	European	Americas	South-East Asia	Western Pacific
Democratic Republic of the Congo	Qatar	Estonia	Colombia		Mongolia
Equatorial Guinea	Saudi Arabia	Finland	Costa Rica		Nauru
Eritrea	Somalia	France	Cuba		New Zealand
Ethiopia	Sudan	Georgia	Dominica		Niue
Gabon	Syrian Arab Republic	Germany	Dominican Republic		Palau
Gambia	Tunisia	Greece	Ecuador		Papua New Guinea
Ghana	United Arab Emirates	Hungary	El Salvador		Philippines
Guinea	Yemen	Iceland	Grenada		Samoa
Guinea-Bissau		Ireland	Guadalupe		Singapore
Kenya		Israel	Guatemala		Solomon Islands
Lesotho		Italy	Guyana		Tonga
Liberia		Kazakhstan	Haiti		Tuvalu
Madagascar		Kyrgyzstan	Honduras		Vanuatu
Malawi		Latvia	Jamaica		Viet Nam
Mali		Lithuania	Martinique		
Mauritania		Luxembourg	Mexico		
Mauritius		Malta	Montserrat		
Mozambique		Moldova, Republic of	Netherlands Antilles		
Namibia		Monaco	Nicaragua		
Niger		Montenegro	Panama		
Nigeria		Netherlands	Paraguay		
Rwanda		Norway	Peru		
Sao Tome and Principe		Poland	Puerto Rico		
Senegal		Portugal	Saint Kitts and Nevis		
Seychelles		Romania	Saint Lucia		
Sierra Leone		Russian Federation	Saint Vincent and the Grenadines		

African	Eastern Mediterranean	European	Americas	South-East Asia	Western Pacific
South Africa		San Marino	Suriname		
Swaziland		Serbia	Trinidad and Tobago		
Togo		Slovakia	Turks and Caicos Islands		
Uganda		Slovenia	Uruguay		
Tanzania, United Republic of		Spain	USA		
Zambia		Sweden	Venezuela		
Zimbabwe		Switzerland			
		Tajikistan			
		The former Yugoslav Republic of Macedonia			
		Turkey			
		Turkmenistan			
		Ukraine			
		United Kingdom			
		Uzbekistan			

Member States by World Bank income group

(Responding countries in dark green)

High income	Upper-middle income	Lower-middle income	Low income
Andorra	Algeria	Albania	Afghanistan
Antigua and Barbuda	Argentina	Angola	Bangladesh
Aruba	Belarus	Armenia	Benin
Australia	Bosnia and Herzegovina	Azerbaijan	Burkina Faso
Austria	Botswana	Belize	Burundi
Bahamas	Brazil	Bhutan	Cambodia
Bahrain	Bulgaria	Bolivia	Central African Republic
Barbados	Chile	Cameroon	Chad
Belgium	Colombia	Cape Verde	Comoros
Bermuda	Costa Rica	China	Democratic Republic of the Congo
Brunei Darussalam	Cuba	Congo	Democratic People's Republic of Korea
Canada	Dominica	Cote d'Ivoire	Eritrea
Cayman Islands	Dominican Republic	Djibouti	Ethiopia
Croatia	Fiji	Ecuador	Gambia
Cyprus	Gabon	Egypt	Ghana
Czech Republic	Grenada	El Salvador	Guinea
Denmark	Jamaica	Georgia	Guinea-Bissau
Equatorial Guinea	Kazakhstan	Guatemala	Haiti
Estonia	Latvia	Guyana	Kenya
Finland	Lebanon	Honduras	Kyrgyzstan
France	Libyan Arab Jamahiriya	India	Lao People's Democratic Republic
Germany	Lithuania	Indonesia	Liberia
Greece	Malaysia	Iraq	Madagascar
Hungary	Mauritius	Iran, Islamic Republic of	Malawi
Iceland	Mexico	Jordan	Mali
Ireland	Montenegro	Kiribati	Mauritania

High income	Upper-middle income	Lower-middle income	Low income
Israel	Namibia	Lesotho	Mozambique
Italy	Palau	Maldives	Myanmar
Japan	Panama	Marshall Islands	Nepal
Korea, Republic of	Peru	Micronesia, Federated States of	Niger
Kuwait	Poland	Moldova, Republic of	Rwanda
Luxembourg	Romania	Mongolia	Senegal
Malta	Russian Federation	Morocco	Sierra Leone
Monaco	Saint Kitts and Nevis	Nicaragua	Somalia
Netherlands	Saint Lucia	Nigeria	Tajikistan
Netherlands Antilles	Saint Vincent and the Grenadines	Pakistan	Togo
New Zealand	Serbia	Papua New Guinea	Uganda
Norway	Seychelles	Paraguay	Tanzania, United Republic of
Oman	South Africa	Philippines	Uzbekistan
Portugal	Suriname	Samoa	Viet Nam
Puerto Rico	The former Yugoslav Republic of Macedonia	Sao Tome and Principe	Yemen
Qatar	Turkey	Solomon Islands	Zambia
San Marino	Uruguay	Sri Lanka	Zimbabwe
Saudi Arabia	Venezuela	Sudan	
Singapore		Swaziland	
Slovakia		Syrian Arab Republic	
Slovenia		Thailand	
Spain		Timor-Leste	
Sweden		Tonga	
Switzerland		Tunisia	
Trinidad and Tobago		Turkmenistan	
United Arab Emirates		Ukraine	
United Kingdom		Vanuatu	
USA			


2 ABC
DEF 3
5 JKL
MNO 6
8 TUV

Appendix 3. Global mobile phone subscriptions of responding Member States[a]

Country	Mobile cellular subscriptions (per 100 population)
Afghanistan	42.63
Albania	131.89
Argentina	128.84
Armenia	84.98
Austria	140.76
Azerbaijan	87.83
Bangladesh	31.07
Belarus	100.55
Belgium	116.65
Belize	52.74
Benin	56.33
Bhutan	46.9
Botswana	96.12
Brazil	89.79
Brunei Darussalam	106.66
Bulgaria	140.73
Burkina Faso	20.94
Burundi	10.10
Cambodia	37.78
Cameroon	37.89
Canada	68.75
Cape Verde	77.53
Chad	23.97

Country	Mobile cellular subscriptions (per 100 population)
China	55.51
Colombia	92.33
Comoros	14.79
Congo	58.94
Croatia	136.66
Cyprus	112.23
Czech Republic	137.51
Denmark	135.39
Dominican Republic	85.53
Egypt	66.69
El Salvador	122.77
Eritrea	2.78
Estonia	202.99
Ethiopia	4.89
Fiji	75.36
Finland	144.59
France	95.51
Gambia	84.04
Germany	127.79
Ghana	63.38
Greece	119.12
Guinea-Bissau	34.79
Hungary	118.01
Iceland	108.15
India	43.83
Indonesia	69.25
Iran (Islamic Republic of)	70.83
Israel	125.84
Jordan	95.22
Kuwait	...
Kyrgyzstan	81.85
Lao People's Democratic Republic	51.18
Latvia	99.72

Country	Mobile cellular subscriptions (per 100 population)
Lebanon	36.13
Lesotho	31.98
Liberia	21.29
Libyan Arab Jamahiriya	77.94
Lithuania	150.96
Madagascar	30.56
Malaysia	110.6
Maldives	147.94
Mali	28.76
Malta	103.27
Mauritania	66.32
Mauritius	84.36
Mexico	76.2
Mongolia	84.2
Montenegro	120.47
Morocco	79.11
Mozambique	26.08
Nepal	25.97
New Zealand	110.16
Niger	17.00
Nigeria	47.24
Norway	110.89
Oman	139.54
Pakistan	56.96
Panama	164.37
Paraguay	88.5
Peru	84.69
Philippines	80.98
Poland	117.02
Portugal	141.76
Qatar	175.4
Republic of Korea	99.2
Republic of Moldova	77.28

Country	Mobile cellular subscriptions (per 100 population)
Sao Tome and Principe	39.32
Saudi Arabia	174.43
Senegal	55.06
Seychelles	109.56
Sierra Leone	20.36
Singapore	140.43
Slovakia	101.7
Slovenia	103.98
Spain	113.56
Sri Lanka	69.65
Sudan	36.29
Swaziland	55.36
Switzerland	122.3
Syrian Arab Republic	44.27
Thailand	122.57
Togo	33.05
Tonga	50.98
Turkey	83.91
Turkmenistan	29.35
United Kingdom	130.55
USA	94.83
Uzbekistan	59.73
Viet Nam	100.56
Yemen	16.29
Zambia	34.07
Zimbabwe	23.88

a Data for 2009.

Source: *The world in 2010: ICT facts and figures*. Geneva, International Telecommunications Union, 2010 (http://www.itu.int/ITU-D/ict/material/FactsFigures2010.pdf, accessed 13 May 2011).

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