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INFORMATION AND COMMUNICATION TECHNOLOGIES FOR HEALTH SYSTEMS STRENGTHENING

DISCUSSION PAPER

JANUARY 2015

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Health, Nutrition and Population (HNP) Discussion Paper

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Health, Nutrition and Population (HNP) Discussion Paper

Information and Communication Technologies for Health Systems Strengthening: *Opportunities, Criteria for Success, and Innovation for Africa and Beyond*

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This report was prepared as a strategic input to the *Results Measurement and Monitoring Group* of the Bank's HNP Global Practice. One objective of the group is to support governments in strengthening information and communication technologies for health (e-health) to enhance the implementation of Universal Health Coverage (UHC) programs and projects in low and middle income countries.

Abstract: ICT for health—or eHealth—solutions hold great potential for generating systemic efficiencies by strengthening five critical pillars of a health system: human resources for health, supply chain management, health care financing, governance and service delivery, and infrastructure. This report describes the changing landscape of eHealth initiatives through these five pillars, with a geographic focus on Sub-Saharan Africa. This report further details seven criteria, or prerequisites, that must be considered and addressed in order to effectively establish and scale up ICT-based solutions in the health sector. These criteria include infrastructure, data and interoperability standards, local capacity, policy and regulatory environments, an appropriate business model, alignment of partnerships and priorities, and monitoring and evaluation. In order to bring specific examples of these criteria to light, this report concludes with 12 specific case studies of potentially scalable ICT-based health care solutions currently being implemented across the globe at community, national, and regional levels. This report is intended to be used by development practitioners, including task team leaders at the World Bank, to strengthen their understanding of the use of ICT to support health systems strengthening (HSS) efforts as well as to highlight critical prerequisites needed to optimize the benefits of ICT for health.

Keywords: ICT for Health, Health Systems Strengthening, eHealth, mHealth, Health Technology

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ACKNOWLEDGMENTS

The authors would like to thank Dominic Hazen (Lead Health Policy Specialist, GHNDR), Nedim Jaganac (Senior ICT specialist, GHNDR) and Samuel Mills (Senior Health Specialist, GHNDR) for reviewing the report, and Trina Haque (Practice Manager, GHNDR) for providing overall support to the development of the report. The authors are grateful to the World Bank for publishing this report as an HNP Discussion Paper.

EXECUTIVE SUMMARY

It is well known that information and communication technologies (ICT) have the potential to transform health services delivery by strengthening health systems in developing countries, especially for rural and underserved populations.

This report is intended for use by development practitioners, including task team leaders at the World Bank, to strengthen their understanding of the use of ICT to support health systems strengthening (HSS) efforts as well as to highlight critical prerequisites that are needed to optimize the benefits of ICT for health efforts. The bulk of examples in this report focus geographically on sub-Saharan Africa (SSA), though the discussions and lessons carry relevance across regions.

The report frames the discussion of ICT for health around five core pillars of a health system: human resources for health (HRH), supply chain management, health care financing, governance and service delivery, and infrastructure. As such, examples of ICT solutions highlighted throughout this report include the use of ICT to improve the professional capacity and performance of HRH; increase the reliability and predictability of the procurement, delivery, and stocking of health materials and supplies; prevent disease and promote public health by obtaining data from patients and health consumers; democratize access to and rating of health information and services by consumers; and reduce health care expenditures.

Despite the potentially transformative nature of ICT for health, or eHealth, in strengthening health systems, many projects in African countries remain at the pilot stage and are unable to be scaled up even when robust evaluations of these pilots show positive results. This difficulty in scaling up pilot projects is linked to a number of structural and institutional weaknesses that are often not sufficiently addressed in many ICT interventions, resulting in suboptimal benefits and operational inefficiencies. (Skoll World Forum, 2013)

In this context, the report details seven criteria, or prerequisites, that must be addressed in order to effectively establish and scale up ICT-based solutions in SSA health systems: infrastructure; data and interoperability standards; local capacity; policy and regulatory environments; an appropriate business model; alignment of partnerships and priorities; and monitoring and evaluation. Each criterion is discussed with reference to examples from particular developing countries that are currently grappling with these issues.

In addition, these criteria are explored in greater depth through a set of 12 specific case studies of potentially scalable ICT-based health care solutions currently being implemented across the globe at community, national, and regional levels. The common themes and indicators of success across these promising innovations include the need to strategically leverage existing (even if limited) infrastructure, to design for interoperability across health centers and systems, to strengthen rather than ignore local capacity, to consider the need for specific policies and regulations, to employ a sustainable business model, to develop thoughtful partnerships that align with national and local priorities, and to build in robust monitoring and evaluation systems.

LIST OF ABBREVIATIONS

ANC/PNC	Ante/Post-natal Care
CHW	Community Health Worker
EAC	East African Community
GPS	Global Positioning System
HEW	Health Extension Workers
HIS	Health Information System
HIT	Health Information Technology
HMIS	Health Management Information Systems
HNP	Health, Nutrition, and Population
HSA	Health System Administrator
HSS	Health Systems Strengthening
ICT	Information and Communication Technologies
ICT4D	Information and Communication Technologies for Development
ILS	Integrated Logistics Systems
IPR	Intellectual Property Rights
IT	Information Technology
IVR	Interactive Voice Response
M&E	Monitoring and Evaluation
MCH	Maternal and Child Health
MFS	Mobile Financial Services
MNCH	Maternal, Newborn, and Child Health
MNO	Mobile Network Operator
MOH	Ministry of Health
MOHSW	Ministry of Health and Social Welfare
NGO	Nongovernmental Organization
RAFT	Réseau en Afrique Francophone pour la Télémédecine
SMS	Short Message Service
SSA	Sub-Saharan Africa
TBA	Traditional Birth Attendant
TCO	Total Cost of Ownership
TTL	Task Team Leader
UNFPA	United Nations Population Fund
WHO	World Health Organization

PART I – INTRODUCTION AND CONTEXT

Information is a critical organizational ingredient in improving in the availability, quality, and financing of health care. Health care is increasingly an information-based service: an effective public health care system is one in which the right information gets to the right person at the right time in order to support evidence-based decision making. Systematically collected and appropriately analyzed data can provide information to guide improvement at all levels of the health care system and can hold providers and institutions accountable to the patients they aim to serve. Moving toward this goal in the SSA region would, in principle, enable more rapid, more widely scaled, and more significant improvements to health care access for many of the world's poorest and most vulnerable populations (Crean 2010).

Traditional approaches to improving basic health care delivery, therefore, are giving way to a paradigm shift toward the view that ICT can play a pivotal role in rapidly increasing access to data and information, and, in so doing, strengthen the Health, Nutrition, and Population (HNP) sector (Box 1 provides definitions and labels for common terminology). In particular, the availability of affordable Internet technologies in developing countries, combined with tremendous growth in the number of mobile phone subscriptions worldwide—spiking from 0.7 billion in 2000 to 6 billion by 2010, 77 percent of which are now in the developing world (World Bank 2012)—has led the development community to explore and develop innovative, and in some cases transformational, ICT solutions that attempt to overcome health systems challenges, particularly in low-resource settings (infoDev 2007; WHO 2011; Vital Wave Consulting 2009).

To date, however, many eHealth solutions, particularly in the SSA region, have faced logistical and resource constraints that restrict progress towards the results envisaged. Many interventions remain in formative stages and are applied only at the margins, rather than as central components of HSS. Many eHealth solutions are constrained by challenges such as poor ICT infrastructure and access, particularly in rural settings where these solutions could have the greatest impact. Specific, often local eHealth solutions can be efficient in meeting short-term information needs, but may not be scalable outside of their project area since they are unable to be integrated with other data systems, or adapted by other, similar programs elsewhere (Mair et al. 2012). As a result, ICT investments in SSA health systems have not been optimized to produce the broad, systemwide impacts or long-term sustainability that were predicted. Instead, many promising ICT solutions remain at the pilot stage.

Box 1: ICT for Health: Definition and Labels

The use of ICT in health care has engendered a number of related labels and definitions over the past 20 years as new technologies have emerged. They include information and communication technologies (ICT), information and communication technologies for development (ICT4D), telemedicine, electronic health (eHealth), and mobile health (mHealth). These are often used interchangeably, yet each implies its own perspective.

In addition to discussing ICT for health, this paper will also use the term *eHealth* as a generic label for all ICT-based health-related activities, including mobile phone–based health interventions (mHealth). As defined by the World Health Organization (WHO), "*eHealth* is the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research" (World Health Assembly 2005, 121). According to a broader explanation by Pagliari, "The term characterizes not only a technical development, but also a new way of working, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology" (Pagliari et al. 2005).

PART II – ICT FOR HEALTH SYSTEMS STRENGTHENING

The application of ICT can hold enormous potential benefits for the health sector. Within the health sector, ICT can act as "tools to increase information flows and the dissemination of evidence-based knowledge between provider and client, and serve to empower citizens" (infoDev 2006). This can result in critical efficiencies, discussed below. In addition, eHealth applications can provide manufacturers with new market opportunities at home and abroad, increase social inclusion, and reduce carbon emissions by removing the need for lengthy travel to unnecessary consultations. This can be a major benefit, particularly for people living in rural or island communities (EPC 2012).

Box 2: The Five Pillars of e-Health Solutions

1. Human resources for health: How can ICT enable health providers to deliver higher-quality care to a greater number of patients?

2. Supply chain management: How can ICT increase the quality of and access to essential commodities, including pharmaceuticals?

3. Health care financing: How can ICT remove financial barriers to care from the demand side and improve the efficiency of financing health systems from the supply side?

4. Governance and service delivery: How can ICT improve governance and service delivery efforts?

5. Infrastructure: How can ICT improve soft infrastructure needs?

The potential to increase efficiencies that impact health workers, patients, and medical organizations is promising. Among many other benefits, eHealth solutions can ensure that: ***Healthcare providers*** have access to information when and where it is needed, have more time for patient care, are less likely to make errors, use personalized medicine to identify best patient treatment, and are better able to predict treatment outcome. ***Patients*** have more choice and can be empowered to take control of their health care needs, do not need to provide the same information many times over, can avoid unnecessary multiple examinations, enjoy faster access to providers by using electronic booking systems, and have access to their own data. ***Health centers and hospitals*** enjoy better coordination of health care resources, optimized system performance and coordination, improved safety, and better disease surveillance and management (infoDev 2006).

eHealth applications can be strategically applied to five core areas of health systems strengthening (HSS) (see Box 2): (1) human resources for health (HRH), (2) supply chain management, (3) health care financing, (4) governance and service delivery, and (5) infrastructure. Each of these system's pillars is underpinned by a variety of activities and developed and implemented by relevant technical expertise (for example, HRH experts, pharmaceutical experts, and so on). Many of these activities in turn can be supported, improved, and extended by the judicious use of ICT, which brings the above-discussed benefits for physicians, patients, and medical organizations, and thus the health system as a whole.

To date, and as highlighted in Table 1, the majority of eHealth applications implemented in the SSA region have been directed toward the HRH and the governance and service delivery pillars. Nevertheless, there are still important opportunities for eHealth in the other three pillars: public financing and health insurance, supply chain management, and infrastructure. The following section provides a brief overview of the use of eHealth applications areas across all five HSS pillars. Rather than an exhaustive listing of applications within each area, illustrative examples are provided; some of these are elaborated in the case study discussion in Part IV of this report.

TABLE 1: SELECT EHEALTH APPLICATIONS ACROSS THE FIVE HSS PILLARS

eHealth Application Types	HRH	Supply chain management	Health care financing	Governance & service delivery	Infrastructure
Connecting providers to providers	X			X	
Data collection				X	X
HR management & supervision	X				
Health promotion				X	
Health worker training	X			X	
Payments and reimbursements		X	X		
Disease surveillance				X	
Referrals & emergency transport				X	
Diagnosis & treatment support	X			X	
Logistics & inventory management		X		X	
Remote monitoring				X	

HUMAN RESOURCES FOR HEALTH

Africa and developing countries throughout the world are experiencing an HRH crisis: a situation in which health workers are few in number, inequitably distributed, and do not perform well.

In response to this crisis, ICT tools have been developed and used to improve the performance of health workers by linking providers with each other for advice, using e-learning platforms to deliver training even in faculty-scarce areas, enhancing health management information systems (HMIS) for health-worker monitoring and accountability, and applying tools for diagnosis and treatment support. These systems can also assist in task shifting, by providing lower level staff with clinical decision support tools needed to expand the range of interventions they can treat and providing medical oversight as needed.

Examples of these tools include Switchboard's MDNet program—a free, closed calling network available only to registered physicians, connecting doctors' mobile phones in Ghana—which removes the cost and connectivity barriers to doctors seeking advice or assistance from their peers. Recent ICT solutions developed by Amref Health Africa—the largest African-led healthcare organization on the continent, which provides health training and health services—have facilitated the piloting of e-learning software and infrastructure to deliver theoretical modules of the midwifery curricula to rural areas, increasing the skills and competencies of health workers despite a lack of on-the-ground faculty.

Other ICT solutions provide clinical and diagnostic support to providers by making medical knowledge, care schedules, and patient data more readily accessible. Electronic health records (EHR) provide one way to better serve patients by having patient medical history data available. Specifically, an electronic health record system such as OpenMRS (now being used in 23 low-income countries) conveniently runs off any computer operating system, can function on laptops, requires no expert programming to tailor the system, and provides users with tools for data analysis and reporting within a single, integrated system. Dimagi's CommCare system similarly supports HRH by providing free and open source case management software that runs on inexpensive mobile phones. Workers can complete and submit patient registration forms on the phone, review checklists and danger signs, and be reminded of key health knowledge via educational prompts.

SUPPLY CHAIN MANAGEMENT

Weak supply chain systems across low-income countries often result in remote health posts being understocked or out of stock of essential commodities, including pharmaceuticals. Furthermore, the WHO estimates between 10 percent and 30 percent of drugs that do make it to shelves in the developing world are probably counterfeit, putting millions of lives at unnecessary risk of death and disease if those medicines make it into the system unnoticed.

ICT tools can play a role in monitoring stock levels as well as monitoring the legitimacy of pharmaceuticals. eHealth can be used to support anti-counterfeiting measures, to manage supply chain (inventory, stockouts), to support cold chain management, and to enable back-end financial transactions. Although the application of possible solutions is at an early stage of development, current ongoing efforts include StopStockouts, which allows field-level health workers to text (via short message service, or SMS) accounts of stockouts on their mobile phones to a central database. These accounts are then converted, via Global Positioning System (GPS) data, to a geographic visualization of the problem in order to alert administrators and supervisors of the issue. Additionally, the organization mPedigree employs Sproxil, a technology that can track counterfeit drugs in developing nations through barcodes and unique identification mechanisms.

HEALTH CARE FINANCING

Financial barriers to both receiving and providing quality care are a core bottleneck in the provision of health services in many countries. There have already been significant efforts to integrate ICT into health financing in many African nations, namely financial management systems like enterprise resource planning (ERP) software, and systems to support the operation of national health insurance plans like Ghana's Claims Management System, supported by the World Bank's Health Insurance Project. However when it comes to the capacity for individual patients to manage their health finances, it is problematic that the number of people globally who have no bank account but are in possession of a mobile phone is estimated at 1.7 billion.

For these individuals, efficient health care financing mechanisms can help to improve health outcomes by increasing their ability to pay for services, and by streamlining health systems management and eliminating waste in procurement and payment systems. The proliferation of mobile money (or mMoney) through systems such as M-PESA in Kenya, for example, have allowed even low-income people to manage small payments from their mobile phones without requiring a bank account.

Access to traditional health insurance or savings accounts remains limited in developing countries. Currently, the pairing of mobile technologies and offline mobile money agents has created the field of

mobile finance services (MFS), which enables mobile operators to act as banks, taking the place of ATMs or bank branches. But such tools are not yet widespread. Of the 630 mobile network operators in the world, only 124 mobile network operators have implemented mMoney systems. Companies such as Changamka MicroHealth Ltd (an integrated health finance company in Kenya), however, have succeeded in making prepaid smart cards available to the public. These cards allow users to obtain specific kinds of health care at designated health facilities, and can be topped up by the mMoney system M-PESA or physical terminals.

Opportunities for the worlds of personal finance and health to overlap to strengthen the health system are numerous, since both systems require components such as user IDs, identity authentication, and security measures. For example, integrating mobile money systems into healthcare management could result in efficiencies for both supply and demand sides. Hospitals could more easily manage innovative provider payment systems, such as the increasingly popular pay-for-performance schemes, and could more easily collect health insurance premiums and payments from patients, such as through voucher schemes for specific types of care. (USAID, 2013) The integration of health and financial systems promises a quicker, more cost-effective, and more efficient delivery of health services in developing countries.

GOVERNANCE AND SERVICE DELIVERY

Health systems across the developing world are hampered by weak service delivery and governance structures. Traditional paper-based reporting systems, for example, can hamper service delivery efforts by distracting the time and attention of health workers from service delivery to data entry. Relatedly, inadequate time and effort dedicated to this process can result in inaccurate and incomplete data. Upstream, the absence of timely, readily accessible and accurate data can lead to reduced evidence-based decision making, thereby negatively impacting governance efforts.

ICT can play an important role in improving healthcare governance primarily by improved data collection efforts. These efforts, which in themselves also improve service delivery efforts, include ICT-based mechanisms for referrals, tele-consultation, remote disease surveillance and health promotion initiatives. Mobile phone–based data collection tools, for example, can save health workers time as well as data entry and transportation costs associated with paper-based systems**.** In 2011, a World Bank–supported project in Guatemala, for example, reported a 71 percent decrease in data collection costs when using the Episurveyor program on a mobile phone compared to paper-based data entry. The nongovernmental organization (NGO) Partners in Health employed a personal digital assistant for tuberculosis results collection; its processing time of 6.2 days was significantly lower than baseline and control days, and reduced errors from 10.1 percent to 2.8 percent. When designed appropriately, free and customizable software such as Episurveyor, OpenXData, and Open Data Kit can enable remote data collection that is faster, more accurate, and less costly than existing paper systems. Even more importantly, the higher-level benefit of such systems is that by improving the quality of diagnosis, clinical follow-up, and referrals, health systems can improve the quality of health data as well. When data is more easily collected, in user friendly ways that evidence immediate benefit to the provider collecting the information, the data becomes important to the person generating it, and the quality of the data collection process improves, with more end-user buy-in.

Incorporating the ability to track and record GPS locations adds to the surveillance capabilities of ICT tools. This is particularly helpful in emergency disaster relief scenarios. RapidSMS, InSTEDD's GeoChat, and Ushahidi are all technologies that have been used to assist governments with rapid response to emergencies from famine to flooding and earthquakes.

The governance of health systems also involves promotion of public health to encourage healthier behaviors that avoid future treatment costs. Many efforts have been launched to creatively use mobile

phones to engage citizens in their own personal health promotion. This includes the Praekelt Foundation's Project Masiluleke, a program that offers free information about HIV testing locations via customer mobile phones. Praekelt sent more than 690 million text messages and provided HIV testing information in six local languages; this resulted in 1.5 million calls to a local AIDS helpline.

INFRASTRUCTURE

The health system in which human resources, commodities, health financing, and governance and service delivery systems interact requires appropriate infrastructure. ICT tools can help develop infrastructure, but "soft" and "hard" forms. Soft infrastructure includes data collection and HMIS, payment and reimbursement systems, and logistics and management systems. Hard infrastructure that could be improved by ICT initiatives includes asset management and maintenance systems, including biomedical equipment maintenance, which maintain the useful life of facilities and equipment. Traditionally, health systems in developing nations lack the resources to maintain facilities and equipment, and this comes at major costs to the system.

ICT-based solutions for infrastructure that have been successful in systems outside the developing world include systems like software that schedules and manages preventative and emergency maintenance of large equipment and high-volume facilities. Solutions also exist at the individual level, not only within systems, such as mobile phone–based tools that eliminate poor roads as a reason for not seeking care. Mobile phone voice response menus, for example, can be used to provide real-time disease management information to patients with chronic illnesses, or to spread information quickly during epidemics, thus ensuring that patients have access to life-saving care even when infrastructure like roads are not available. Mobile solutions (mHealth) are not as dependent on consistent power supplies as computer-based solutions, which are problematic in rural settings where reliable electrical connections are rare. In an evaluation of the WelTel program in Kenya, 62 percent of HIV positive patients who received text message reminders about their medication adhered to their regimen, compared to 50 percent in the control group. Additionally, suppressed viral loads were reported for 57 percent of the text message recipients, compared to only 48 percent in the control group.

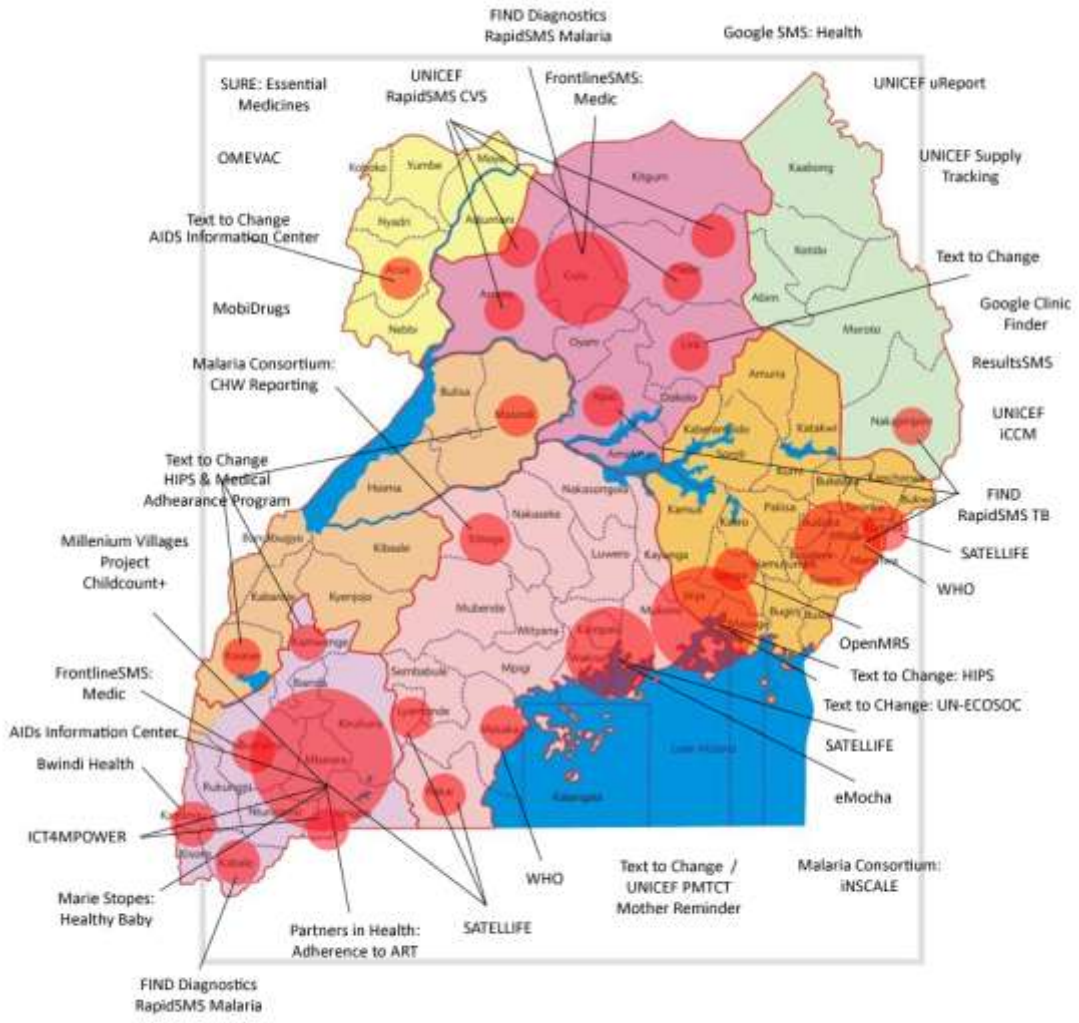
PART III – ESTABLISHING AND SCALING ICT-BASED SOLUTIONS

While international donors and health agencies have increased investment in ICT to support HSS in recent years, investment and policy approaches to eHealth initiatives often result in a proliferation of pilot efforts rather than efforts to scale projects (infoDev 2006). Systems and applications are often developed and implemented ad hoc, to meet the immediate requirements of specific activities, with a limited focus on scalability. As a result, solutions that are successful in one locale are often unable to be integrated with other data systems or adopted by other, similar programs. Figure 1 shows an example of donor-driven "pilotitis" in Uganda by 2010; this includes over 50 eHealth projects from almost as many donors. Uganda's Ministry of Health has temporarily placed a moratorium on mHealth projects until the finalization of a national eHealth policy and strategy. This tremendous duplication of effort results not only in a waste of resources, but also in more complicated health systems. Rather than improve information flows among stakeholders, a series of nonintegrated health systems create disjointed "information islands" that become barriers to effective communication. Furthermore, the useful lifespan of many projects is often determined by the availability of limited donor funding, and thus many cease to operate once initial development funding ends.

Piloting, while useful for demonstrating the feasibility of new approaches, tends to encourage small-scale thinking, even when a pilot has demonstrated new and better ways of providing services. The challenge of sustainably growing effective ICT-based solutions from pilot to scale has been the focus of several recent studies (Lemaire 2011; Management Sciences for Health 2007). These studies, as well as resources like the WHO/ITU's 2012 National eHealth Strategy Toolkit, all reach similar conclusions on the seven elements that are necessary for developing scalable eHealth solutions:

1. Adequate physical infrastructure
2. Data and interoperability standards
3. Sufficient local capacity
4. Supportive policy and regulatory environment, including an integrated national eHealth strategy
5. Appropriate business model
6. Thoughtful partnerships aligned with national and local priorities
7. Effective monitoring and evaluation (M&E)

Figure 1: Uganda eHealth "Pilotitis"



Source: Sean Blaschke, Technology for Development Specialist at UNICEF Uganda, 2010.

Note: Red dots represent mHealth projects; the larger the dot, the more mHealth project activity.

The first four elements (infrastructure, standards, capacity, and policy) are closely tied to *scalability,* while the remaining three elements (business model, alignment of partnerships with priorities, and M&E) impact the potential *sustainability* of an initiative. Although each element can be described independently, it is important to realize that these elements represent different perspectives within the health care ecosystem, and they interact synergistically. The following sections discuss each in greater detail.

ADEQUATE PHYSICAL INFRASTRUCTURE

A fundamental requirement for implementation and scaling of eHealth systems is the availability of adequate technological infrastructure. Physical infrastructure across the Africa region, though still lagging

behind much of the rest of the world, has continued to improve rapidly, particularly in the area of telecommunications and mobile telephony.

Consequently, mHealth tools have become some of the most popular eHealth innovations to date. While fixed-line telephone service remains sparse and service is often poor, mobile telephony has become increasingly accessible and the costs of mobile use and ownership are falling. Currently, the mobile penetration rate in the Africa region is 54 percent. It is expected that this will increase steadily over time to approximately 75 percent, or around 700 million connections by 2016 (GSMA 2012).

Another feature that makes mHealth more attractive than other eHealth solutions is that mobile solutions are not as dependent on consistent power supply as computer-based solutions, which are problematic in rural settings where reliable electricity connections are rare. Furthermore, as solar power chargers slowly become more available in African markets, modest mobile handsets remain less power-intensive than complex computer systems.

Like mobile telephony, Internet access is also increasing across the continent. However, there is still a tremendous gap between most African countries and the rest of the world. At the end of 2011, Internet penetration across Africa was about 13.5 percent, compared with a world average of about 36 percent, with wide variations across countries. Kenya, for example, had a penetration rate of over 25 percent while in Tanzania only 2.5 percent of the population had access to the Internet**.** Notably, 80 percent of African Internet users log online via mobile phones, not desktop or laptop computers or tablets (Miniwatts Marketing Group 2011). However, although current Internet access remains low, particularly in rural areas, this scenario is likely to change rapidly over the next few years. Many African countries are upgrading their internal digital infrastructure, and international Internet connectivity is rapidly moving from satellites to high bandwidth undersea cables.

DATA AND INTEROPERABILITY STANDARDS

The function of a health information system (HIS), within which there are various components that require thoughtful design to function interoperably, is to collect relevant data and transform those data into actionable information for health care providers, system administrators, and health policy makers. In general, the organization that has commissioned the HIS and its various components will define and develop its functional requirements based on needs for analytical outputs and, in effect, data and information to support evidence-based decision making.

HISs that run efficiently and support effective decision making are built upon well-defined requirements. However, scalability issues can arise if the requirements are *too* restrictive. Creating a HIS that produces detailed data on a small pilot project can be inexpensive and implemented quickly. However, once a project aims to scale, this approach can become expensive and operationally complex. Inevitably, the informational needs of end users change over time within a single institution; needs vary across organizational units within a single organization as well, meaning that highly restricted systems must be amended frequently to accommodate changing needs. Furthermore, when attempts are made to extend a restricted system beyond an original user community, issues such as problems with security, reliability, and maintainability are often exposed. These issues are magnified as a system grows, and are often not resolvable without a complete redevelopment effort.

A more cost-effective and less complex approach to building HIS “rules” and requirements is one that values linked systems and interoperability, and in low-resource settings these goals can often be best achieved through the use of open standards. *Open standards* are a set of customizable information system standards publicly available for free or at a nominal charge, and developed and maintained

through collaborative and consensus-driven processes. Key elements of open standards include (ITU 2005):

- ***Collaborative development***: A transparent, consensus-driven process that is open to all interested parties, and is not dominated by any single interest group.
- ***Due process***: A community of developers who are considerate of and responsive to comments by interested parties.
- ***Intellectual property rights***: IPRs that are licensed to all applicants on a worldwide, nondiscriminatory basis.
- ***Quality and level of detail***: Mass participation of global talent that enables the development of a variety of competing implementations of interoperable products and services.
- ***Publicly available***: Development processes that are easily available for implementation and use, at free or reasonable prices.
- ***Ongoing support***: Systems that are maintained and supported over a long period of time.

In addition to general adherence to Open Standards by country governments, international donors can also play a cooperative role by committing to the "Principles for Digital Development," a modified version of the 2009 Greentree Consensus that "represents a concerted effort by donors to capture the most important lessons learned by the development community in the implementation of information and communications technology for development projects." (ICT4D Principles, 2014). The current version of the principles features the use of Open Standards as one of nine core principles, and was developed together by major development partners such as The World Bank.

SUFFICIENT LOCAL CAPACITY

Insufficient local capacity to implement and maintain eHealth solutions can be a significant bottleneck to their scalability and sustainability. eHealth solutions in low-income countries are commonly developed and implemented under contract by donor-funded NGOs, allowing systems to be developed and implemented quickly at little or no cost to local organizations. However, without sufficient software development and implementation expertise at the local level, and without ex-ante attention to scalability, projects are rarely scalable or sustainable after temporary, foreign "experts" complete an initial launch. Furthermore, technically qualified human capacity is not needed only in the development phase of an initiative, but also in its system implementation and maintenance. Investment in human capacity, therefore, must be prioritized across all phases of a system life-cycle.

Currently, there are many examples of innovation and technology incubators across Sub-Saharan Africa that can provide skilled local information technology (IT) talent. High-profile centers include The Innovation Hub in South Africa: Africa's first internationally accredited Science and Technology Park and home of the Open Innovation Solution Exchange, providing 47 tech businesses with Wi-Fi, professional mentorship, and a community of peer innovators. Other centers include Kenya's iHub in Nairobi, with nearly 13,000 members; IceAddis in Ethiopia, with more than 500 active members; Botswana's Innovation Hub; Zambia's BongoHive; Uganda's Outbox Hub; the iLab in Liberia; and the online network AfriLabs, which successfully implemented Apps4Africa and comprises 14 hubs and labs across Africa. When donors work collaboratively with these centers and their IT talent, local capacity can be fully utilized and projects can be made more sustainable.

Investing in local IT talent is also beneficial to the scalability of projects because innovators in low-resource settings, often by necessity, employ open source software options rather than paying for private software. Open source software use means that:

- Software is freely distributable;
- Source code is included in the distribution, or the process of obtaining it is well publicized;
- Derived works and modifications are allowed; and
- Licensing is neither product-specific nor restrictive of other software, and is technology-neutral. [1]

The open source development model is collaborative, as users are co-developers and maintainers of the system. The strengths of this collaborative approach include lower total cost of ownership, better functionality and security, and localization of the solution. The participatory, community-based open source model also fits naturally with cooperative development approaches that emphasize local ownership, knowledge sharing, public-private partnerships, and communities of practice. Resources specific for health system managers—such as the California HealthCare Foundation's 2006 report, "Open Source Software: A Primer for Healthcare Leaders"—detail the steps necessary for implementing successful open source systems.

Not every aspect of open source systems is without its challenges; a flexible, low-cost system could come with higher risks and liabilities of self-deployment; however well-orchestrated open source systems can avoid these potential pitfalls with rigorous pre-implementation, iterative testing and training for system users, to identify and fix any system weaknesses and to familiarize all users with the system to increase a sense of ownership. Coming full circle, the very cooperative nature of open source makes it is easy to create additional opportunities for building local IT capacity to support sustainability (van Reijswoud and de Jager 2008).

SUPPORTIVE POLICY AND REGULATORY ENVIRONMENTS

In the past, telecommunications have not been a major focus of national health policies. If included at all, telecommunications were seen as basic support infrastructure that allowed facilities to communicate via phone and, more recently, e-mail. But with the increasing ubiquity of telecommunications infrastructure and new communications norms, a more explicit acknowledgment of ICT within health policies, particularly regarding mHealth programs, is necessary (Dzenowagis 2005). Until such arrangements are fully coordinated, in an environment of pilotitis, most eHealth projects will remain limited in size and externally funded, and they will operate *outside* of existing policy and regulatory structures.

In order to appropriately inform the eHealth strategy, including the scaling of pilots to national or regional levels, country governments must develop policy frameworks to coordinate the large number of stakeholders engaged in eHealth interventions—including ministries of health, finance, gender, social planning/development, education, and telecommunications. Furthermore, these pilots must fit into a coordinated growth strategy, as in the Ghanaian Ministry of Health's National e-Health Strategy.[2] This strategy outlines implementation plans for governance of the eHealth systems, stakeholder involvement,

1 See The Open Source Definition at Open Source Initiative; last accessed October 10, 2014. http://www.opensource.org/docs/definition.php

2 For details about Ghana's e-Health Strategy, see http://www.isfteh.org/files/media/ghana_national_ehealth_strategy.pdf .

and coordinating mechanisms, thereby ensuring that all relevant government offices work efficiently together to support the system. Section 7.0 on Implementation Arrangements of the strategy states:

> A number of the action areas serve as pilot stages. Mechanisms will be put in place to review such projects and use the lessons for scaling up where necessary. Such projects will therefore have sufficient scope for evaluation and the design of scale up programmes as part of the plan. (Ghana E-Health Strategy)

According to the WHO's Global Observatory for eHealth, only thirteen countries in Sub-Saharan Africa have formally established eHealth as part of their national health strategies (WHO, 2015)**.** Several more have developed mHealth committees, task forces, and working groups within their ministries of health to begin the work of integrating mobile technology into health policies and regulations. However, various stakeholders in the public and private sectors are not always aware of newly developed policies and strategies. Many national operational plans feature increased cooperation with mobile network operators (MNOs), the private sector bodies responsible for managing mobile telephony networks and key partners in the development of national-level mHealth practices and policies. Appendix A provides additional information about national eHealth planning across Sub-Saharan Africa.

Furthermore, at a transnational level, policy and regulatory issues become even more critical to the scalability of eHealth projects. Restrictive transnational telecommunications regulations, for example, can hinder the implementation of ICT-based health system solutions, by impeding important opportunities to take advantage of economies of scale. In this regard, it is crucial for countries to work together and, when relevant, together with MNOs across national borders, to build harmonized eHealth policies.

APPROPRIATE BUSINESS MODEL

In order to deliver an eHealth product or service in a sustainable way, ministries of health and donor agencies, together with the MNOs responsible for managing mobile networks, must have a coherent view of the elements that constitute an ICT service's business model. The core components of any business model are highly relevant to the development and implementation of eHealth systems in low-resource settings, and include:

- ***Resources required***: What inputs are needed to supply the service or product?
- ***Value proposition***: How will clients benefit from the product? What is the product's ability to improve efficiency, quality, and transparency of services?
- ***Market definition***: Who are the beneficiaries and payers, and what is their willingness and ability to pay?
- ***Distribution channel***: How will services and products be delivered to customers?
- ***Organizational format***: What roles, including both staff and partners, are required to provide the product or service, and who will fill each role?
- ***Long-term viability*****:** How will costs be covered or profit generated?

The business model should clearly identify how the initiative will remain financially sustainable beyond initial pilot funding and how it will continue to add value as the user base expands. Without a thorough consideration of all financial costs associated with eHealth programs, scale and sustainability are unlikely. This requires a realistic consideration of the full cost of a service—the *total* cost of ownership (TCO)—including hardware, software, servers, workstations, installation costs, warranties and licenses, operational expenses, system maintenance, training costs, and replacements over a system's useful

lifespan. However, often only initial technology-related costs are considered in calculations; these represent only about 10–30 percent of the overall TCO, with 50–70 percent of costs attributable to costs such as personnel training, system maintenance, and administration (MacCormack 2003).

Components of TCO, such as personnel costs, can become particularly costly to ignore, particularly in uncoordinated eHealth systems with poor business models. For example, if data collectors within an eHealth system are not the same people reading and analyzing those data on a daily basis, they may perceive their work as an added burden with little value, and may commit more errors in data collection than if they had some incentive to report the highest quality possible. eHealth solutions that do not have a clear chain of value-add for all system users may be "sustainable" in the sense that they continue to operate for a period of time, but the quality of data and information they produce may be quite suspect and of little programmatic or actual value.

Furthermore, it is important for business models to articulate how an initiative will benefit each partner within their own context, role, and responsibilities. eHealth initiatives involve many stakeholders—public-private, government-community, and organization-individual—each of which wants to benefit from the outcomes of the initiative. Although "social investment for the common good" is becoming a common business model in eHealth initiatives, scale cannot be achieved if funding relies on short-term grant opportunities or corporate social responsibility "gifts." Given the competition for common resources, other non eHealth models may be more profitable for stakeholders to support in the long run (Lemaire 2011).

A strong example of sustainable financing is evident in an SMS-based service launched in India in 2009, called *mDhil*, which provided consumers between the ages of 17 and 25 with otherwise "taboo" health information on sexual health and women's health. mDhil shares content through applications on mobile phones and desktops, and generates revenue by enabling pharmaceutical companies and other private sector partners to sponsor content, and by charging telecom service providers for their SMS service. As highlighted by Google's Eric Schmidt in a 2013 article in *The Times of India:*

> They reach 30,000 users a day. They have attracted 5.6 million viewers of their YouTube videos. No one told mDhil to do this. Each of those views represents an economic benefit: a trip saved; a health check self-administered; a reminder on how to administer a drug safely. They did it because something that wasn't possible in India before suddenly became possible and they took the opportunity.

Finally, it is important to highlight that a successful eHealth program capitalizes on market demand through creative supply mechanisms that are made possible only as ICT infrastructure and tools become more ubiquitous.

PARTNERSHIPS ALIGNED WITH PRIORITIES

As a project scales, the number of stakeholders involved in the project tends to grow. A greater number of stakeholders means a greater need for the proposed eHealth solution to be aligned with their priorities. Whereas, during the pilot phase, the benefits of an eHealth initiative are closely linked to the goals and priorities of the pilot sites and involved organizations, as the project expands, new external stakeholders—including national agencies and local communities—will need an eHealth solution that is aligned with their prioritized objectives and plans.

One example of a health system coordinating multiple stakeholders around shared reform goals is the Republic of Tanzania's M&E Strengthening Initiative (MESI), a component of the 2009-2015 Health Sector Strategic Plan, which includes the development of an ICT strategy for the health system. In this

example and others, there is an explicit positioning of partnerships as value propositions, which foster local ownership and investment in the program even when funded by global donors.

Aligning donors and stakeholders as ICT projects scale is not a simple task; expanding a project from one geographic and cultural local to others across a country inevitably introduced challenges of building systems that are acceptable to and followed by a diverse set of constituents. However, building an eHealth system through the lens of both national and local priorities can lead to more committed partnerships and thus improve uptake and support (Miniwatts Marketing Group 2011). Crafting a partnership that is more than a symbolic connection requires a diverse body of stakeholders in content development so that, rather than repackaging content from other locales with different sociocultural norms and health behaviors, content is relevant, accessible, and appropriate for the levels of health literacy of the target population.

The concept of stakeholders also goes beyond the implementation designers and the end users. As initiatives scale, other funders who work in shared geographies also become involved. Collaborating to leverage existing efforts and lessons learned from past projects, rather than running parallel solutions and duplicating efforts, will result in the best possible program impact, including scale-up. Furthermore, it is important that ICT project funders and coordinators engage with relevant ICT sector partners such as MNOs and technology companies. Not only can private sector partners provide technical know-how, resources, and networks that will support scale-up, but they also are aware of emerging technologies and processes that may have a significant impact on scale-up designs. In addition, recent advances in citizen engagement, often made possible through mobile phones, also have the potential to support expansion and sustainability of eHealth initiatives.

MONITORING AND EVALUATION

It remains critical for organizations and governments to monitor and evaluate eHealth solutions rigorously. The potential benefits of open eHealth solutions are real and offer potentially transformative solutions for HISs in low-income countries. However, without M&E practices in place across the eHealth field, both donor partners and governments have a diminished capacity to make informed decisions about eHealth investments, and thus have less confidence that these investments will lead to desired changes in health outcomes.

Measuring the benefits of any particular eHealth solution, however, involves a complex mix of interacting variables, and few eHealth systems are rigorously evaluated. Those which do produce evidence of benefits may have published results in peer-reviewed literature, and still more evidence resides online within blog posts or practitioner discussions on topic-specific listservs and cannot be found in journals. Further, data that *are* available tend to focus on process improvements, rather than systemic impact on health outcomes (Piette et al. 2012), and the strength and reliability of data that are not peer reviewed do not always stir enough confidence to warrant investments in scaled systems.

Several online communities are now attempting to change this status quo by creating mechanisms for more rigorously collecting and comparing eHealth evidence. One such example is the website mHealth Evidence (http://www.mhealthevidence.org/) from the Knowledge 4 Health Initiative of USAID and Johns Hopkins. mHealth Evidence exists as a searchable database of both peer-reviewed and gray literature on mHealth activities globally, classified according to a harmonized taxonomy. Similarly, the NetHope Cloud Services Community Portal presents a series of searchable, topic-specific webinars, IT strategies, and case studies for low-resourced NGOs and nonprofits interested in integrating ICT solutions into social

services including health.[3] Other sites, such as the Institute for Technology and Social Change,[4] offer users university-style courses that detail existing evidence of technology creating positive impacts across sectors and systems—including the popular course mHealth: Mobile Phones for Public Health.[5]

Although such initiatives are helpful, much more needs to be done to strengthen and standardize rigorous M&E of eHealth solutions. M&E systems provide the core feedback loop that informs scale-up processes. Ongoing M&E provides opportunities for corrective measures to be taken when necessary, and for sharing best practices once proven. Transparent examination can also increase the willingness of stakeholders to invest in systems by providing a way to determine the cost efficiency and return on investment of a scaled system. As time passes and systems scale, complexity and resource-intensiveness also increase, so work that may have been cost-effective for a single implementation may not be when scaled to multiple implementations.

[3] http://solutionscenter.nethope.org/

[4] http://techchange.org/

5 http://techchange.org/online-courses/mhealth-mobile-phones-for-public-health/

PART IV – EHEALTH INITIATIVES OF NOTE: 12 CASE STUDIES

As previously indicated, an underlying purpose of this paper is to identify strategic opportunities for expanding the use of ICT in health service delivery.

This section provides an overview of 12 eHealth initiatives that show promising potential for sustainable scale beyond their current implementation. The case studies were identified following an Internet review considering the various criteria for success. They concentrate primarily but not solely on Africa region innovations (a focus of this study). Accordingly, the common themes and indicators of success across these promising innovations include efforts to strategically leverage existing (even if limited) infrastructure, design for interoperability across health centers and systems, strengthen rather than ignore local capacity, consider the need for certain policies and regulations, employ a sustainable business model, develop thoughtful partnerships that align with national and local priorities, and build in robust M&E systems.

As is illustrative of the general trend, however, only very few of the cases are accompanied by a rigorous impact evaluation, suggesting the need for some level of caution. Generally, eHealth pilots and interventions should be considered as candidates for actual support provided that they are accompanied by in-depth information; published, rigorous evaluations; and positive impact and results data that are available for review. In an environment where resources are scarce, the impact of eHealth solutions on efficiency, health outputs, or outcomes should also be accompanied by assessments of the cost-effectiveness of the intervention. With the exception of a notable few (mainly Frontline SMS, and RAFT), most interventions to date have been assessed by qualitative case studies or report descriptions.

The case studies presented here are grouped along a geographical axis (regional, national, community), which reflects their defined potential market, as well as around four associated health systems pillars: (1) HRH, (2) supply chain management, (3) health care financing, and (4) governance and service delivery (see Table 2). A case study on the fifth pillar, infrastructure, is not discussed on its own because it involves ICT tools that cut across each of the previous pillars (for example, websites, data collection systems, etc.). Each initiative is described in greater detail in Appendix B (regional), C (national), and D (community), summarizing its relevant business model and scalability.

Table 2: 12 eHealth Case Studies with Potential for Scale-Up

HSS Pillar	Regional	National	Community
Human resources for health	RAFT	FrontlineSMS	MOTECH
Supply chain management	mPedigree	ILS Gateway; cStock	mTrac
Health care financing			Changamka
Service delivery and governance	m4RH	KimMNCHip; mDhil	Trac FM

REGIONAL INITIATIVES

Three promising eHealth initiatives that reflect a regional market and hold potential for being scaled up to a transnational implementation level are: m4RH, mPedigree, and RAFT (Table 3). Each of these regionally focused eHealth initiatives is centered on activities that benefit from economies of scale or deal with health issues that transcend national borders. Since health care is a highly regulated sector and health care systems closely reflect national sociopolitical contexts, successful eHealth initiatives need to be able to overcome, if not bridge, social and political divides. The three selected case studies demonstrate this flexibility. A detailed description of each initiative is found in Appendix B.

Table 3: Selected Regional eHealth Initiatives

Initiative	HSS pillar	Technologies	Strategic opportunity
m4RH	Governance and service delivery	SMS-based health communications program	• Addresses regional problem of lack of basic information about contraceptive methods and family planning via text messages • Government run; information is WHO approved and structured according to national family planning guidelines • SMS messages are simple, cost-effective: protocol is available across all makes and models of mobile phones
mPedigree	Supply chain management	SMS access to proprietary database	• Addresses major regional problem (counterfeit medicines) • Uses public-private partnership (government, pharma, telecoms) • Strengthens regional cooperation on policy and standards (EAC) • Reaches individual consumers with cost-effective technology
RAFT	HRH	Internet-based audio conferencing, synchronous and asynchronous tele-consultation	• Has 10 years of successful scaling in Francophone Africa (15+ countries) • Creates strong South-South collaborations for human resource development • Leverages existing regional organizations (e.g., EAC, African Virtual University)

Note: EAC = East African Community.

NATIONAL INITIATIVES

Promising national-level eHealth initiatives with potential for scale up include Frontline SMS, ILS Gateway, cStock, KimMNCHip, and mDhil (Table 4). The national-level marketplace of eHealth solutions is the best established of the three geographic axes, both because tools are often developed as part of more easily coordinated HSS efforts and because donor funding is more frequently available at this level. Given the large number of potential ICT primed for scale, this review sought out the most unique examples of integrating multiple ICT platforms into coherent programs that address a broad health need. For example, consider the emerging relationship between the OpenMRS clinical record system,[6] the Health Information Systems Program's District Health Information System (DHIS2),[7] and the iHRIS suite

6 http://openmrs.org/

7 http://www.hisp.org/

of human resource for health management applications.[8] Each of these open source initiatives is a leader in its focus area and each could be extended to include functionality found in the others. But instead, the respective communities of practice have decided to collaborate and develop a set of common interoperability standards, paving the way toward a core national HIS that could be implemented across many settings. A detailed description of each initiative is listed in Appendix C.

Table 4: Selected National eHealth Initiatives

Initiative	HSS pillar	Technologies	Strategic opportunity
Frontline SMS	HRH	Frontline SMS, plus local customization of the platform	• System is run through national telecom infrastructure, making regional initiative nationally scalable • SMS-based technology is a familiar format and easily accessible for rural community health workers
KimMNCHip	Governance and service delivery	eBanking, SMS/ interactive voice response (IVR) smartphone	• Private sector initiates public-private partnerships • Cross-sector collaboration is led by telecoms • Focuses on dynamics of successful partnerships and technology integration
mDhil	Governance and service delivery	Text messaging, mobile web browsing, and interactive digital content	• Creates access to accurate, reliable information about personal and public health and wellness so that everyday citizens can make healthy decisions and contribute to positive public health outcomes
ILS Gateway	Supply chain management	CommTrack (Dimagi)	• Increases visibility of logistics data, improves product availability • Provides a low-cost, sustainable system in which health workers use personal phones to send data via SMS to toll-free number
cStock	Supply chain management	CommTrack (Dimagi)	• Improves data visibility of key health commodities to improve supply chain management. • Allows decision makers at high levels of health systems to utilize accurate and timely data to prevent stockouts

COMMUNITY INITIATIVES

At the community level, some notable eHealth initiatives are MTrac, MOTECH, Changamka, and Trac FM (Table 5). eHealth initiatives designed to serve at the community level tend to fall into two broad categories: those that support community- level health care providers and those that focus on empowering the individual health care consumer, thereby enhancing citizen engagement in health. eHealth solutions that support health workers—whether these are physicians, community health workers, or village birth attendants—are most often intended, theoretically, to support a nation's overall health care delivery system, and have therefore been included as national-level initiatives in this paper. eHealth programs focused on the individual also serve to reconfigure health systems, but rather than doing so by

8 http://www.ihris.org/

strengthening existing institutions, they redirect power to the patient as an active participant in achieving health outcomes. The following case studies highlight ICT that empower individual patients to take a more active role in their own health and to influence decisions of the health system from a community perspective. A detailed description of each initiative is listed in Appendix D.

Table 5: Selected Community eHealth Initiatives

Initiative	HSS pillar	Technologies	Strategic opportunity
MOTECH	HRH	SMS, IVR, mobile JAVA	• It is tailored to individual's health context • Open source system is well integrated with other systems (OpenMRS, CommCare) • Evaluation effort is strong and transparent • It is part of Kenyan MCH eHealth integration project (KimMNCHip)
Changamka	Health care financing	Smartcard, eBanking	• Strong private, multisector partnership with public sector participation building • Health care finance focus aims at low-income individuals • Has potential to expand to a broader regional effort based on technology partner (Safaricom and M-PESA) • Part of Kenyan MCH eHealth integration project (KimMNCHip)
Trac FM and U-Report	Governance and service delivery	Radio, SMS, Internet	• Builds on the success and ubiquity of community-based radio with the technology to create "two-way" communication • Engages community members directly in health system governance/accountability issues • Combined, the two applications could support a public "routine reporting system" on health issues and could form the basis for a citizen-engagement effort in health (and other sectors) in Africa
mTrac	Governance and service delivery	Rapid SMS	• Provides a disease-specific application of an mHealth tool (malaria) • User-friendly: system is utilized consistently, even without financial incentives or additional supervision • Low cost: facilities use phones that staff already own, minimizing costs

PART V – CONCLUSION

ICT offer the potential to transform the delivery of health services. This can be particularly transformative in developing countries, especially among rural and underserved populations. Specifically, by increasing the availability and flow of important information, eHealth solutions hold great potential for generating efficiencies among human resources, patients, and medical organizations and for helping to strengthen critical pillars of a health system: HRH, supply chain management (including pharmaceuticals), health care financing, governance and service delivery, and infrastructure. Yet, to date, the potential of ICT remains largely unrealized; attention is being placed largely on the technologies rather than on their integration into existing capacities and systems. In addition, small-scale, local solutions dominate the eHealth landscape. Increased emphasis on the use of standards-based applications and open source development models, however, is slowly beginning to shift this focus.

In an effort to highlight this changing landscape, and with an emphasis primarily on Africa, this report has outlined seven important elements that help determine the success—in terms of scalability—of eHealth initiatives and has highlighted 12 innovative cases that take these criteria for success into account during both the development and implementation phases. Indeed, when contemplating further investment to scale up eHealth, the following critical issues should be considered:

- To what degree do the health sector structure and the national regulatory framework support new approaches?
- Have national goals and action plans been clearly defined?
- Are there mechanisms for coordinating action in a way that links public, private, and social efforts?
- What progress has been made in expanding affordable ICT access?
- Are data-related standards and a regulatory and legal framework in place?
- Are there mechanisms in place for developing the capacity of program managers, health workers, and community members to make effective use of ICT?
- What options exist to ensure continuity and sustainability of eHealth projects and programs in terms of finance channels and public-private partnerships?

Although effective implementation of ICT solutions, particularly on a national or regional scale, does require significant capital and human resources, these investments should not be viewed as diverting funds from other health care needs. Faced with competing priorities, and despite the potential benefits that ICT have to offer, government agencies and donors responsible for health care systems are often faced with limited resources for implementing technology-based solutions. In this environment, a critical consideration should be the multiplier effect that ICT tools have on scarce resources by improving access to essential services, increasing the efficiency and quality of these services, and reducing both waste and duplication of services (Lemaire 2011).

APPENDIX A: SUMMARY OF AFRICAN COUNTRY PROGRESS ON EHEALTH POLICY FROM NOVEMBER 2012 TO NOVEMBER 2013

The following list summarizes eHealth policy progress in 16 African countries. It is taken from the report *Scaling Up Mobile Technology: Applications for Accelerating Progress on Ending Preventable Maternal and Child Death* that resulted from the USAID mHealth Meeting in Addis Ababa, Ethiopia, on November 10, 2013. The report was written by Lungi Okoko, in close collaboration with Ishrat Husain, Margaret D'Adamo, and Kaitlyn Patierno, and is available at: http://www.africanstrategies4health.org/uploads/1/3/5/3/13538666/mhealth_addis_usaid_meeting_report__-_final_12dec2013.pdf .

ANGOLA*

- Discussions on policy and systems for mobile technology and health programming are ongoing
- mHealth projects include:
    - The national-level SMS Mulher (SMS Woman) initiative—a system sending maternal and child health information to women via SMS
    - The National Malaria Control Program mobile data collection initiative

BENIN**

- mHealth piloted during the past three years by three community-based projects:
    - BASICS iCCM Project (MSH) in five districts in 2011–12: Malaria and IMCI
    - CARE/Benin in 2011–present: maternal health, essential obstetric and newborn care, and referrals
    - URC/CHS (PRISE-C) Child Survival Project, 2011–present: family planning and MCH
- Benin's MOH has demonstrated a high level of commitment toward mHealth

BURKINA FASO

- The Dar action plan on mHealth was shared with senior MOH officials
- A stakeholders meeting on mHealth was held in 10 districts. The main focus of discussions was on mobile data collection
- Began encouraging government agencies, UNFPA, and other donors to push for investment in mobile data collection

DEMOCRATIC REPUBLIC OF CONGO

- Fiber optic cable deployed in July 2013
- Debriefed MOH after the Dar meeting
- Constituted a National Health Informatics and Technology Working Group under MOH leadership
- The MOH gave approval for a large-scale health information technology (HIT) project
- Developed partnerships with MNOs
- HIT policies under early stage of development

ETHIOPIA*

- In 2013, the MOH aligned with partners to deploy mHealth in more districts
- In 2012, the MOH started proof-of-concept pilot implementation of an initial platform in 4 districts
- After creating a national mHealth strategy in 2010 and developing sets of interoperability standards in 2011, Ethiopia now has 10 mHealth projects
- Ethiopia's MOH now plans to empower each Health Extension Worker with mobile technology for:
    - Data exchange for health events
    - Referrals to facilities
    - Consultations with physicians and nurses
    - Supply chain management
    - Training and education

GUINEA

- Mobile technology is used for clinical referral, coordination, data collection, and logistics management and information systems (LMIS).
- New partners now use SMS for data transmissions in more than 15 districts. These include USAID partners and Engender Health
- Organized a national-level workshop to discuss the harmonization of mHealth solutions
- Established a multi-stakeholder mHealth working group, which includes donors, MOH, and MNO Orange
- Advocated to the Ministry of Communication and the MNO regulatory agency to help resolve key challenges

KENYA

- Established a broader mHealth Committee with 3 working groups (research, linking supply and demand, and stakeholder mapping); members of the mHealth Committee are from both the private sector and work under leadership and coordination of the MOH
- Kenya's mHealth Task Force is very active and meets quarterly
- eHealth is now a department within the MOH
- Conducted a stakeholder mapping to identify what all partners are doing in mHealth
- Discussion is ongoing between MOH and the Communication Commission of Kenya (CCK) on affordable tariffs for mHealth applications

MADAGASCAR

- Madagascar is home to about 10 mHealth projects, including the Village Phone Project (VPP). The VPP project conducted mapping simulation overlays supply points GPS coordinates with existing Airtel coverage, which revealed:
    - 460 sites are suitable or VPP "able"
    - 186 sites are <15 kilometers from a tower and require on-the-ground testing
- VVP trained 35 supply points in 2 districts on credit management and mobile phone technology
- VPP included development of a web-based dashboard application for supply chain tracking

MALAWI

- eHealth mapping exercise was successfully conducted, leading to scaling-up strategies for some initiatives
- New initiatives launched and scale-up is underway through partnerships:
    - New SMS service launched for family planning
    - cStock initiative being scaled up
    - Mobile mentoring with Health Surveillance Assistants (trained health workers) initiative being scaled up
- Quarterly mHealth Sub-Committee meetings and the ICT Innovation Fair (now an annual event) have become a platform for the establishment of stakeholder working relationships
- Advocacy toward removal of interconnectivity charges is underway
- A national eHealth strategy is under development; zero draft is being finalized
- ICT for Development Policy is drafted; it seeks to provide an environment where ICT can thrive to enable improved delivery of health care services

NIGER**

- HMIS is paper-based from district to region, and web-based from region to national level
- MOH is experiencing delays in Family Planning data transmission
- A project is piloting the integration of a mobile platform with health information system DHIS
- Another project is piloting the use of mobile technology sending reproductive health information and alerts to women

NIGERIA

- Constituted a Country Working Group on mHealth
- Developed framework and implementation guidelines
- Continued advocacy with mobile network operators
- Collated and documented existing mHealth programs

RWANDA*

- The Government of Rwanda works closely with MNOs. The Technical Working Group for Health includes members from MNO companies. MNOs are thus a part of the conversation from the beginning of the process.
- Before establishing operations in Rwanda, MNOs have to sign an agreement with the government to ensure they will engage in social development
- Rwanda's MOH has been rolling out three different but complementary mHealth technologies:
    - m4RH: this sends interactive, accurate reproductive health information to young people
    - mUbuzima: this is used by all CHWs to collect and report MDG indicators at the community level
    - RapidSMS: this is used only by maternal CHWs to track each pregnant woman's first 1,000 days from pregnancy to delivery and post-partum

SENEGAL**

- A few pilot mHealth projects are underway, including one by IntraHealth that uses open-source, interoperable technology to provide:
    - Voice-based capacity building to health care providers
    - Mobile Logistics Management Information System

TANZANIA

- Forged partnerships with private sector to create reasonable win-win solutions and move away from expecting cost-free solutions
- Launched eHealth strategy in October 2013
- Began the development of guidance and standard operating procedures for mHealth solutions
- MOHSW in discussion with MNOs to reduce SMS rates and general mHealth costs
- Mapping of all mHealth initiatives in Tanzania
- Hosted the first Hackathon Challenge on Family Planning, combined elements of sustainability (October 2013)

TOGO

- Agreement from the MOH to make contact with DataWinners for a pilot project
- Contact with DataWinners and the development of a test form for the collection of logistics data
- Discussion with donors on the funding for a pilot project in one region of the country

UGANDA

- Uganda's MOH has put a moratorium on mHealth project development and implementation until the national eHealth policy, strategy, and roadmap are developed. The current status is that the MOH only provisionally has approved a few mobile systems to move forward
- Drafting criteria for approving new mHealth platforms. Criteria include: strategic fits with national agenda, interoperability, timeline, cost, local capacity, and sustainability
- MOH uses the WHO eHealth Toolkit to ensure mHealth is implemented through a health systems lens

***** These countries did not specify whether the progress reported occurred since a prior meeting in Dar es Salaam in November 2012 or not.

******These countries did not report at the meeting in Dar es Salaam in November 2012.

Table A.1: Summary of Country Progress

Country progress	Angola	Benin	Burkina Faso	Congo, Dem. Rep.	Ethiopia	Guinea	Kenya	Madagascar	Malawi	Niger	Nigeria	Rwanda	Senegal	Tanzania	Togo	Uganda
1. Establishment/strengthening of national mHealth coordination/governance mechanism				✓		✓	✓		✓		✓	✓				
2. Development of eHealth strategy/policy or framework				✓	✓				✓		✓	✓		✓		✓
3. Mapping of mobile technology and stakeholders							✓	✓	✓					✓		
4. Agreement/discussions with the mobile operators							✓		✓		✓	✓		✓		
5. Advocacy for scaling up	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6. Expansion of pilots or programs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: In November 2012, 170 representatives participated in the "Using Mobile Technology to Improve Family Planning and Health Programs" meeting in Dar es Salaam. Countries in blue reported these updates since the Dar meeting; countries in black did not specify whether the progress reported was since the Dar meeting or not.

APPENDIX B: REGIONAL CASE STUDIES

B.1: MOBILE FOR REPRODUCTIVE HEALTH

Organization	FHI 360's PROGRESS (Program Research for Strengthening Services)
Technologies	Text for Change: An organization that designs and deploys customized, interactive, opt-in SMS-based health communication programs that provide "customers" with valuable health information
Focus area	Service delivery and governance
Phase	Scaling
Locations	Kenya, Tanzania, Rwanda
Partners	USAID, Ministries of Health (Kenya, Tanzania, Rwanda)
Duration	2008–present
Problem addressed	Unmet need for family planning services coupled with a severe shortage of health human resources limits opportunities to receive information and ask questions about sexual and reproductive health.
Strategic plan	The m4RH SMS system provides mobile customers with basic information about contraceptive methods and nearby family planning services via a series of concise text messages. Reproductive health information is WHO-approved and structured according to national family planning guidelines.
Costs	• **Programming software:** m4RH services operating in Kenya and Tanzania, provided by Text for Change, utilize open-source coding • **Sending SMS:** fees for end users (questions submitted via SMS and informational text messages received) fully subsidized by funders. In the pilot, bulk SMS rates were agreed upon with mobile phone providers; these ranged from US$0.03 to US$0.06 per SMS. SMS costs vary by country, user volume, and scale of promotion. • **Short Code Subscription**: A short code (a 3–5 digit telephone number) can either be annually "leased" from a local communications commission (the m4RH pilot spent US$1,500–$2,000 on the annual lease), or be obtained through a technology partner or local aggregator. • **Promotional Material:** m4RH in Kenya and Tanzania printed 100 posters, 200 flyers, and 1,200 palm cards for US$2,500 per country.
Results	An evaluation of the m4RH pilot program found that a full range of contraceptive methods can be feasibly delivered and accessed by women and men of reproductive age via mobile phone, and that data from some participants suggest the potential for positive behavioral impact.
Mode of assessment	• FHI360 published an interview-based qualitative evaluation: http://www.fhi360.org/sites/default/files/media/documents/formative_results_m4rh.pdf • FHI360 published a research brief: *Assessing the Feasibility of Providing Family Planning Information via Mobile Phones in Kenya and Tanzania:* http://www.fhi360.org/sites/default/files/media/documents/m4rh-research-brief.pdf

Sustainability and scale considerations	• FHI 360 designed m4RH specifically to provide information via text message because the SMS protocol is available across all makes and models of mobile phones. Taking advantage of this universal aspect of mobile phone functionality ensures that the potential reach of the m4RH service is maximized.
	• The m4RH pilot team recommends working with a mobile telephony provider so that the follow key issues can be handled efficiently:
	  ○ the need for a technological platform to support m4RH,
	  ○ the complexity of interactions offered by the m4RH system,
	  ○ the goal of providing m4RH free of charge for the users using a zero-rated short code, and
	  ○ the anticipated volume of system traffic.**]**
	• In Tanzania, m4RH was found to scale significantly after it became part of the "Jiamini" national family planning campaign, promoted through print and visual advertising. Prior to Jiamini it engaged 3,000 unique users over three months; during the campaign it drew 50,000 unique users over three months.

B.2: mPEDIGREE

For the first time in recorded commercial history, those with the greatest stake in pharmaceutical safety—patients and consumers—are being brought directly into the heart of the anti-counterfeiting agenda, thanks to the transformative impact of mobile phones in the developing world.
—Bright Simmons, Founder of mPedigree Network

Organization	mPedigree Network (founded 2008)
Technologies	Sproxil, an SMS-accessed proprietary database and data verification service
Focus area	Supply chain management
Phase	Scaling
Locations	Nigeria, Ghana, Kenya
Partners	HP, mobile network operators, pharmaceutical companies, government agencies
Duration	2010–present
Problem addressed	The WHO estimates that up to 25 percent of medicines in developing country markets are counterfeit or substandard. However, reforming supply chain management can be costly and complex, requiring supply chain security, enforcement, prosecution, public education, and technology.
Strategic plan	mPedigree embosses medicine packages with a unique alphanumeric code. Consumers scratch off a panel to reveal the code, which they then send by text message to a toll-free number and receive a message confirming that the product is authentic or warning that it may be counterfeit. The "one-time use" design of the codes prevents forgeries of legitimate medicines entering the supply chain.
Costs	• **Supplies:** Scratch-off label for each medication package (currently supported by participating pharmaceutical companies). • **Network costs:** SMS messages from and to the consumer (mobile network operators offer both the toll-free lines and SMS at a volume discount).
Results	The first pharmaceutical companies to use the system, May & Baker and KAMA Group, debuted in December 2010 in Nigeria and Ghana. A pilot in Kenya began in 2011 with the aim to scale. mPedigree plans to make the service available for other medications and in more countries in the near future.
Mode of assessment	No impact evaluations of the tool's efficacy are available online, however there is evidence that it is a tool countries are increasingly adopting: • http://211.144.68.84:9998/91keshi/Public/File/38/345-7884/pdf/bmj.e7836.full.pdf • http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3959911/

	• http://mpedigree.net/mpedigreenet/images/docs/Computerworld_mPedigree_Case-study_2012.pdf • http://mpedigree.net/mpedigreenet/images/docs/McKinsey_mHealth_Study_Cites_mPedigree.pdf
Sustainability and scale considerations	• Participating pharmaceutical companies fund the service, eliminating costs to the user and increasing accessibility to the initiative. The lost sales of legitimate drugs is a key motivator for pharmaceutical company participation, and governments can address both lost tax revenues as well as increased public health costs. • All mobile network operators in Ghana and Nigeria are signatories to the scheme. Local mobile operators gain increased usage of and demand for telecommunications services, and most importantly, the consumer is engaged. • The East African Community (EAC) agrees upon the significance of potential benefits, and political will for logistic management of pharmaceuticals exists at a regional level. However, current differences in regulatory structures and pharmaceuticals management between different nations complicates regionally scaled impact.

B.3: RESEAU EN AFRIQUE FRANCOPHONE POUR LA TELEMEDECINE (RAFT)

Organization	Geneva University Hospitals
Technologies	Internet-based audio conferencing; Synchronous/asynchronous tele-consultation
Focus area	HRH
Phase	Scaled up
Locations	Cameroon, Mali, Mauritania, Morocco, (since 2001); Algeria, Benin, Burkina Faso, Burundi, Chad, Côte d'Ivoire, Democratic Republic of Congo, Guinea, Madagascar, Niger, Republic of Congo, Senegal, and Tunisia (since 2004). Current pilots in Latin America.
Partners	WHO Center for eHealth and Telemedicine, Université Numérique Francophone Mondiale, Agence Universitaire de la Francophonie (UNESCO Chair for Distance Education), Université Senghor, in-country institutions, over 50 experts located in participating countries.
Duration	2001–present
Problem addressed	There is a critical shortage of competent HRH in the Africa region. Training and ongoing development of the health workforce is therefore an urgent priority.
Strategic plan	The RAFT network provides distance education, telemedicine tools, and IT-enabled diagnostic devices such as portable echography to isolated care professionals by establishing South-South collaborations between reference hospitals and regional/district hospitals. RAFT provides useful information to and a sense of community among participants located in remote areas. It is sensitive to technology constraints of its users while still aware of and responsive to changes in the technical environment that allow for service improvements.
Costs	• **HR Network and Institutional Support**: RAFT is organized and run by over 40 national coordinators throughout Africa and Geneva. The project is hosted at the division for eHealth and telemedicine at Geneva University Hospitals, and focal points in each participating country are responsible for national governance. Further, a local medical coordinator and a technical coordinator manage day-to-day operations, including communication with the care professionals, identification of training needs, and maintenance of various sites within the country. • **Satellite connections**: Given the high costs of satellite connections (about US$500/month), which are the only options in remote areas, sustainability can best be achieved at large, district-level hospitals serving populations of 50,000–200,000 because recurring connection costs can be included in operational budgets.

Results	RAFT has pioneered the webcasting of interactive courses to rural physicians, featuring topics proposed by partners of the network throughout Francophone Africa, which, as of this publication, is counted at roughly 500 providers. Weekly webcasts are free to access, and allow participants to interact directly with the teacher with a bandwidth of 30 kbits/second—the speed of an analog modem—which is available in remote hospitals and cybercafés. Further, 70 percent of RAFT courses are now produced and webcast by experts in Africa, and RAFT members regularly collaborate to develop educational on-line materials for their global colleagues.
Mode of assessment	• World Health Organization Bulletin 2012: http://www.scielosp.org/scielo.php?pid=S0042-96862012000500009&script=sci_arttext • Journal of Telemedicine and Telecare: http://jtt.sagepub.com/content/18/6/305.short
Sustainability and scale considerations	• In most countries the MOH or hospitals support RAFT within 2–3 years of initial deployment in a country. A clear exit strategy is agreed upon by Geneva University Hospitals and participating countries. • RAFT is spreading their model not only through Francophone Africa but through other global locales as well. Educational sessions have been produced in English since October 2008, available to hospitals in English-speaking Africa and the Middle East, and since 2011 RAFT has been implemented in Latin America in Spanish. • RAFT has also explored the possibility of sharing content with projects such as Project ECHO,[9] (rural New Mexico, United States; http://echo.unm.edu) which links over 1,000 doctors, nurses, nurse practitioners, physician assistants, and community health workers through tele-medicine clinics and trainings, and has facilitated over 10,000 case consultations through its learning networks. • To establish a network that both fosters South-South collaboration and leverages technical support and knowledge management from the north, the East Africa region will benefit from using a shared, common language (English) across Kenya, Uganda, and Tanzania. They will also need an organizing institution, a role that could be played by the African Virtual University in Kenya.

9 http://echo.unm.edu/

APPENDIX C: NATIONAL CASE STUDIES

C.1: FRONTLINESMS

Organization	The World Bank
Technologies	FrontlineSMS, plus local customization of the platform
Focus area	HRH
Phase	Pilot
Locations	Ethiopia
Partners	African Development Bank
Duration	2011–present
Problem addressed	To strengthen access to health care for the poor and provide MCH services in the absence of doctors/nurses, the government has trained and deployed over 40,000 HEWs in rural communities since 2003. However, HEWs are often isolated and their communication with supervisors and patients is often unpredictable, hampering their capacity to deliver quality care. Specifically, as articulated during World Bank–led interviews in fiscal 2012, HEWs stated they lacked capacity to prioritize urgent, unpredictable ante/post-natal care (ANC/PNC) needs, spread over a vast geographic area. HEWs noted monthly vaccination deliveries are based on population estimates and not new birth counts, so vaccine shortages and wastages commonly occurred, and they expressed frustration over making referrals to emergency care when there was no doctor present upon the patient's arrival. Lastly, mothers preferred traditional birth attendants (TBAs) over HEWs to preside over deliveries, despite TBAs lacking safe delivery supplies. HEWs carry supplies, but are often not informed of expected or occurring deliveries.
Strategic plan	Together with Addis Ababa University, in September 2012 the World Bank and the African Development Bank designed and implemented an innovative intervention equipping rurally based HEWs with a mobile phone application designed on the FrontlineSMS platform. The tool allows HEWs to register pregnant women and newborns. HEWs then receive automated SMS reminders for key appointments and track stock of essential medicines. The team is conducting a randomized evaluation of the intervention's impact on MCH indicators to inform a potential scale up, including baseline (August 2012) and mid-line (October 2013) data collection.
Costs	• **Hardware** (phones, chargers/batteries) • **Airtime** for HEWs • **Monthly subscription** to the national telecom for access to a single short-code used by all HEWs to avoid overloading of messages
Results	Initial data from this research showed early indications that improved communication flow had positive effects on health workers' ability to deliver services and improve health outcomes. Specifically, the report found with statistical significance that, in the treatment districts, between baseline and endline, more women had skilled assistance with their last delivery, more women delivered in a health center, and more women received ANC. This suggests that HEW awareness of key moments during ANC and delivery and capacity to respond in a timely way can help maximize the performance of health workers, and in a context where Internet coverage remains weak and HMIS systems continuously fail, mobile phones could be a cost-effective solution to maximize performance.
Mode of assessment	Rigorous impact evaluation by Addis Ababa University and the World Bank currently ongoing (following completion of the one-year midline data collection and analysis). This will be one of the first such rigorous impact evaluations accompanying a pilot.

Sustainability and scale considerations	• As a tool to improve rural health care delivery, this intervention is built to benefit the poor in Ethiopia where, in 2011, 83 percent of the population lived in rural areas (with a 2.3 percent increase in annual rural population growth), and over 30 percent of rural populations lived below the poverty line. • This solution functions through the national telecommunications company (ETC), uses existing mobile network coverage, operates on low-cost feature phones, and functions within constraints of hard-to-reach, un-electrified rural villages. Such features demonstrate the feasibility of scaling across poor communities. • Beyond the innovative nature of the mHealth application itself being built for scale in low-resource settings, the study also examines marginal effect of equipping village-level volunteers with simple, non-feature phones. • This is one of few interventions measuring impact of an mHealth tool on service delivery and health outcome indicators over time.

C.2: ILS GATEWAY

Organization	John Snow, Inc. (JSI)
Technologies	CommTrack
Focus area	Supply chain management
Phase	Scaling
Locations	Tanzania
Partners	JSI, USAID DELIVER Project, Tanzanian Ministry of Health and Social Welfare (MOHSW)
Duration	2010–present
Problem addressed	In the absence of quality logistics data, health system administrators cannot properly manage supply chains, and in many countries, restocking functions in a fractured manner across many parallel systems. Although the rise of integrated logistics systems (ILS) helps minimize chaos by creating a standard set of operating procedures, stockouts may still remain high if facility-level data are unavailable.
Strategic plan	ILS Gateway is a mobile health alert and reporting system designed to increase the visibility of logistics data and improve product availability. The system was developed with an eye toward sustainability, requiring health facility personnel to use personal cell phones to send logistics data via text message (SMS) to a toll-free number. These data are then transmitted to a website that analyzes and displays the information.
Costs	• **Hardware**
Results	ILS Gateway piloted in Mtwara, Tanzania, in November 2010, and tracked supply data for 20 key tracer commodities. A survey of 29 users revealed that 93 percent agreed "ILS Gateway improved my diligence in conducting a stock count on time," and 93 percent reported that ILS Gateway alerts increased their likelihood of submitting report and requisition forms to the district on time. The SMS alert system was also shown to be as powerful an incentive as monetary rewards in increasing data reporting rates. Further, 87 percent of district respondents reported that ILS Gateway increased their attention to the management of the 20 tracer commodities, and 45 percent of facilities reported an increase in tracer product availability thanks to ILS Gateway.
Mode of assessment	Case study available via Dimagi: http://www.commtrack.org/static-resources/docs/case-studies/commtrack-ilsgateway.pdf
Sustainability and scale considerations	• MOHSW and JSI in Tanzania are currently deploying ILS nationally, and CommTrack is already in use in over 2,300 facilities in Tanzania • Implementing ILS Gateway alerted MOHSW of the issue of "data culture" among CHWs, meaning the workers' ability to easily access and understand data they

		generated in the field. The team aims to improve data visibility over time to boost decision-making capacity at every level of health service provision. • CommTrack is a highly scalable technology because it helps to streamline logistics systems; provide targeted, actionable information to supervisors; make reliable, real-time stock data available to decision makers; improve supervision of requisition and delivery; and identify and overcome supply chain bottlenecks.

C.3: cStock

Organization		John Snow, Inc. (JSI)
Technologies		CommTrack
Focus area		Supply chain management
Phase		Scaling
Locations		Malawi
Partners		JSI, Bill and Melinda Gates Foundation, Malawi Ministry of Health
Duration		201–present
Problem addressed		Poor data visibility of key health commodities leads to poor supply chain management. When decision makers at high levels of health systems lack accurate and timely data about stockouts and supply availability across their sub-units, it becomes difficult if not impossible to make strategic planning decisions. In Malawi specifically, health surveillance assistants (HSAs) are responsible for health commodity restocking and work with health centers as resupply points. Improved supply chain management will thus occur only through improved logistics reporting between HSAs and health centers.
Strategic plan		cStock is a supply-side SMS reporting mechanism that collects health commodity stock data from HSAs, automatically calculates resupply data, and sends requests via SMS to health centers for improved decision making about restocking.
Costs		• **SMS:** Minimal cost to running program. SMS costs are incurred only when HSAs send an SMS with product stock levels to health centers, and health center staff send an "order-ready" message when order is packed and available for pick-up by the HSA.
Results		• According to end users, cStock has "improved reporting, product resupply, and relations with HSA's In-Charges and supervisors . . . enhanced communication and minimized wasteful travel to facilities [and] . . . provides quick feedback and zero cost submission of reports." • In addition to improved communications between HSAs and HCs, district-level health system administrators also have access to an online dashboard that shows real time stock levels, reporting rates, and alerts for the 20 commodities managed by HSAs.
Mode of assessment		*Community Health Supply Chain Midline Evaluation Report,* published by the Government of Malawi and JSI: http://sc4ccm.jsi.com/files/2013/11/Malawi-Midline-Report_FINAL.pdf
Sustainability and scale considerations		• Over 1,500 HSAs across more than half the districts in Malawi are now using cStock. • The JSI team has completed a framework that integrates cStock with Malawi's national supply chain manager database, which will bring the same helpful visibility and communications improvements occurring at local levels up to a national supply chain level.

C.4: KENYA INTEGRATED MOBILE MNCH INFORMATION PLATFORM (KIMMNCHIP)

Organization	Safaricom
Technologies	eBanking, SMS, Smartphone
Focus area	Service delivery and governance
Phase	Pilot
Locations	Kenya
Partners	Safaricom, World Vision, the mHealth Alliance, CARE International, NetHope, The Partnership Initiative, D-tree, Dimagi, MOTECH
Duration	2011–present
Problem addressed	An ongoing challenge for eHealth initiatives, from a national perspective, is the lack of a coherent framework for their implementation. As a natural result of pilot development, most ICT solutions are focused on specific health interventions, even though such interventions are multidimensional and require coordination for outcomes to be realized. Many funders of ICT projects remain focused on application development, rather than development of pivotal inter-organizational relationships across government, private, NGO, and civil society sectors.
Strategic plan	KimMNCHip was built to show that more coordinated maternal/child care could be achieved through the use of an integrated package of services supported by mobile technologies. The KimMNCHip initiative began in early 2011 by bringing key maternal, newborn, and child health (MNCH) stakeholders together to work with Safaricom, the largest mobile phone provider in Kenya. This consortium united three existing technologies, all evidenced to work and scale independently of each other, into one integrated system for improved MNCH care. The three services include (1) an MNCHSMS-based advisory service for pregnant women who register and provide their due date; (2) mFinancial services for health that provide pregnant women with electronic vouchers to redeem in a collaborating clinic of their choice; and (3) mSupport services that track primary care along a continuum for new mothers. In the SMS advisory system, women receive a mix of “push” SMS and voice messages, and access to call-in advisory hotlines and information databases for MNCH issues.
Costs	• **SMS/voice charges** are funded via advertising that follows the health messaging • **The mobile phone–based financial management system** functions as part of a results-based payment system in which vouchers are an incentive for clinics to enhance the quality of their services and attract more pregnant women. The voucher also includes a social protection cash transfer to support the women with the costs of delivery.
Results	The KimMNCHip project currently remains in a pilot stage, and although individual partners are sufficiently experienced in implementing eHealth initiatives, the integrated nature of this project still requires a more complex business model. The technologies being used are both not-for-profit and for-profit, so the developing model must provide sustainable support for both types of partners. Success over time, and at a national scale, will depend on the sustainability of the public-private partnerships and integrated technologies that uniquely define the platform.
Mode of assessment	No impact evaluations of the tool’s efficacy are available online, but the tool is summarized in the USAID mHealth Compendium Volume 2 (pp 41–42): http://www.jhsph.edu/departments/international-health/_documents/USAIDmHealthCompendiumVol2FINAL.pdf.

Sustainability and scale considerations	• The power of multi stakeholder partnerships is well documented, especially when convergence is achieved among the various partners. KimMNCHip has both a partner brokering monitoring framework in place and an operational research that is currently being designed to measure the mHealth solutions effectiveness with scientific rigor, and these partnerships suggest that scale will be possible in the future. • The project is not donor funded at present, and Safaricom is developing a business case for affordable mHealth solutions for all CHWs in Kenya. Safaricom with M-PESA, banking for the unbanked, demonstrated its ability to create business models that are affordable for all. World Vision is using its own resources to support the partnership brokering process

C.5: MDHIL

Organization	mDhil (company backed by institutional venture capital and angel investors)
Technologies	Text messaging, mobile web browsing, and interactive digital content
Focus area	Service delivery and governance
Phase	Scaling
Locations	India
Partners	Not applicable
Duration	2009–present
Problem addressed	Several years of marketing research in India revealed that most Indians did not have easy access to accurate, reliable information about personal and public health and wellness. Without access to basic health information, everyday people lack the capacity to make healthy decisions that will create positive outcomes in their lives.
Strategic plan	mDhil gathers health information about common health conditions, diseases, and medications and designs this content for a variety of digital platforms, including those accessible by mobile phone. mDhil sources consumer queries from their Indian consumers in order to identify relevant topics for content, including queries from students, women's groups, NGOs, and a variety of health care centers and professionals. In addition to sharing health information, mDhil also strives to help establish healthy "norms" for consumers, such as routinely getting tested for certain diseases. The anonymity of a personal mobile platform helps to avoid the feeling of shame or embarrassment when seeking certain types of health information or services.
Costs	**Subscribers receive three health messages a day** on their mobile phone for a fee of 1 rupee (US$0.02) per day.
Results	mDhil currently provides health information to over 150,000 paid users on SMS subscription services.
Mode of assessment	No impact evaluations of the tool's efficacy are available online. Media write-up is available at Mobihealthnews.com (2010): http://mobihealthnews.com/6381/mhi-startup-boasts-150k-paying-mhealth-users/#more-6381
Sustainability and scale considerations	• mDhil's value proposition is the quality, relevancy, and access of their information, and takes advantage of the fact that more than 875 million Indians have a mobile phone subscription (Telecom Regulatory Authority of India 2013). • mDhil's health alerts are written by registered nurses, physicians, and other public health professionals. • The most popular topics sought out on mDhil include sexual health and weight management. Popular topics also include tuberculosis, dermatology, and diabetes.

APPENDIX D: COMMUNITY CASE STUDIES

D.1: mTRAC

Organization	FIND Diagnostics
Technologies	RapidSMS
Focus area	M&E
Phase	Scaling
Locations	Uganda
Partners	FIND Diagnostics, Uganda Ministry of Health, WHO, UNICEF, the Department for International Development (DFID)
Duration	2010–present
Problem addressed	Malaria accounts for a staggering 26 percent of Uganda's burden of disease and 20 percent of health facility admissions. ACT, the first-line medicine to treat malaria in Uganda, is crucial for effective case management. However, regular stockouts of ACT plague a supply chain that lacks infrastructure and contains many bottlenecks.
Strategic plan	mTrac is an SMS-based monitoring system established in over 140 health facilities across two districts in Uganda, where supervisors were expected to use a toll-free short code to report on malaria outbreaks and ACT supply. An online mTrac dashboard website enables district health teams to review, verify, and approve the data submitted by their health workers on a weekly basis. Supervisors can easily follow up on inaccurate, questionable, or unreported data.
Costs	**Phones**: Health facilities used the phones that staff already owned, minimizing program costs.
Results	During a pilot evaluation, it was reported that more than 85 percent of participating health facilities reported weekly even without monetary incentives or additional supervision at a monthly cost of around US$14 per district. Ultimately mTrac can be a cost-effective way to strengthen disease surveillance and engage communities in health system accountability activities to reduce ACT stockouts.
Mode of assessment	No impact evaluations of the tool's efficacy are available online. Report from Ugandan MOH upon launching is available at http://www.finddiagnostics.org/export/sites/default/media/news/pdf/sms-uganda/mTrac_report-9dec2011.pdf
Sustainability and scale considerations	Real-time data collection means that bottlenecks can be immediately identified and addressed while accountability at all levels is strengthened.

D.2: MOBILE TECHNOLOGY FOR COMMUNITY HEALTH (MOTECH)

Organization	Grameen Foundation
Technologies	CommCare; InStedd's Nuntium and Verboice technologies (for SMS and IVR capabilities, respectively); OpenMRS
Focus area	HRH
Phase	Scaling
Locations	Ghana, India (CommCare software has been deployed across Afghanistan, Haiti, India, Indonesia, Malawi, Mexico, Mozambique, Nicaragua, South Africa, Tanzania, the United States, and Zambia).
Partners	MOTECH Development Partners: Grameen Foundation, Dimagi, ThoughtWorks, the University of Southern Maine, and inSTEDD; MOTECH Ghana Partners: Ghana Health

	Service, Grameen Foundation, and Columbia University's Mailman School of Public Health; MOTECH India Partners: Grameen Foundation, CARE, BBC World Service Trust, World Health Partners, and Jonson & Johnson; MOTECH is also being used in KimMNCHip in Kenya.
Duration	2010–present
Problem addressed	CHWs are invaluable health human resources in rural communities; they promote preventive care, encourage safe pregnancies, and refer ill people for diagnosis and treatment at appropriate facilities. Studies demonstrate that CHW cadres have helped reduce 30–50 percent of infant mortality in low-income countries (Darmstadt et al. 2005). However, CHWs can be a difficult cadre to organize and manage for the same reason they are so effective: they live and work in the communities they serve. There is often little day-to-day management or supportive supervision. Community-based interventions are not always coordinated with other service delivery efforts, and few tools are available to analyze and monitor the activities of CHWs to evaluate and improve the overall performance of programs (Bogan et al. 2009). Furthermore, it is not only CHWs but also their patients who are often isolated and marginalized, and who are in need of health information so that they can make more knowledgeable choices about the health services they receive.
Strategic plan	• MOTECH supports both patients and caregivers through a system of SMS and voice messaging, timed alerts, and strategic data collection. Using CommCare software on mobile phones, MOTECH offers CHWs a unique app through which they collect data on care provided to patients and receive alerts about patients due or overdue for services. Correspondingly, a patient-focused Mobile Midwife app enables pregnant women and their families to receive weekly SMS or IVR messages that provide time-specific information about their pregnancies. Messages included a mixture of alerts and reminders for care seeking (prenatal care, vaccinations, etc.); actionable information and advice, such as tips for saving money for transportation to deliver at a health facility; nutrition information; promotion of good health practices; and educational tools about breastfeeding. • The MOTECH system connects the patient and provider apps, both run on low-end mobile phones, by making sure that patients get the same care reminders that their providers get, in an attempt to reduce the number of clients defaulting on recommended health care. Using the data nurses have submitted to the server, MOTECH also generates the monthly reports that facilities are required to submit to their district and regional management offices, eliminating a formerly burdensome three- to four-day process of report compilation.
Costs	• **As an open source development platform**, MOTECH is integrated with several other open source health initiatives such as OpenMRS and CommCare, and as an open source tool incurs no software costs. There are also time savings that come with an open source tool, as the large development and user community base allows for rapid iteration and product customization.
Results	Initially piloted in two provinces in 2011, the project moved into a national rollout phase beginning in 2012. The MOTECH Ghana implementation has been adopted by the Ghana Health Service and is being incorporated as part of Ghana's Community-based Health Planning and Services Initiative. The pilot program found, notably, that 90 percent of women patients preferred IVR to SMS, since voice messages were available in local languages and SMS available only in English.
Mode of assessment	• Tropical Medicine & International Health (2011): http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3156.2011.02824.x/abstract • Some reports (not formal RCTs/IEs) suggest MOTECH was *not* effective, but did pave the way to understanding the necessary parameters and components of a scalable mHealth system, that is: http://ghsmotech.files.wordpress.com/2012/02/awoonor-williams-motech-working-paper.pdf

Sustainability and scale considerations	• Though initially used for MCH services in Ghana, MOTECH has grown to be used more broadly in countries such as India where it helps improve patient adherence with antiretroviral therapy and trains frontline health workers. MOTECH has also developed formal systems integration code to work with other open source platforms such as OpenMRS and CommCare. • As the project grows, unlike many other ICT initiatives, MOTECH has conducted two in-depth interim evaluations that detail not only accomplishments of the initiative but also the various implementation issues that arose, including lack of provider motivation to enter data into phones, women's unanticipated low access to phones, and difficulties integrating MOTECH into the larger health system. MOTECH has mitigated some of these challenges by involving Ghana Health Service supervisors to monitor health worker participation, data entry, and data uploading. Planning explicit evaluations early on in a project cycle and making findings public in a timely manner suggests a desire for continuous quality improvement.

D.3: CHANGAMKA

Organization	Changamka MicroHealth Ltd
Technologies	Smartcard, eBanking
Focus area	Health care financing
Phase	Scaled
Locations	Kenya
Partners	GA Insurance, Safaricom (M-PESA); Changamka is also being used in the KimMNCHip initiative
Duration	2008–present
Problem addressed	Roughly 1.7 billion global citizens lack access to a bank but have a mobile phone. Efficient health care financing mechanisms could improve their health outcomes by increasing their ability pay for services, and could also help streamline health systems management and eliminate waste in procurement and payment systems. However, access to traditional health insurance or savings accounts remains limited in developing-country health systems. Currently, the pairing of mobile technologies and offline mobile money agents has created the field of mobile finance services (MFS), enabling mobile operators to act as banks, thus taking the place of ATMs or bank branches. However, such tools are not yet widespread. Of the 630 mobile network operators in the world, only 124 have implemented mobile money initiatives.
Strategic plan	• Changamka MicroHealth Ltd is a private, for-profit firm partnered with Safaricom, Kenya's largest mobile network operator, offering health-related microfinance products to low-income Kenyans. In addition to developing new products based on its basic business model, it has also entered into several partnerships with other firms and with the Government of Kenya to provide services over a wider range. • Smartcards are ready for use upon purchase at any of more than 30 accredited medical establishments in Nairobi, Kikuyu, and Mombasa, where common health services are lumped into predetermined price-contracted packages. The "outpatient" card sells for KSh 500 and comes pre-loaded with KSh 450; the "maternity" card is sold at participating Hospitals for KSh 25 (patients have 9 months to save up the recommended amount required for maternity at their facility of choice, and the smartcard ensures access to potentially lifesaving maternal health services).
Costs	• **Smart cards**: Subscribers to the service are issued a personalized "smart card," to which they can add money in whatever increments they want, whenever they way, through their mobile phone or at a general packet radio service (GPRS) terminal,

		allowing them to save at their own pace. An unlimited amount of money can be added to the card, there is no expiration date, and the smartcards come in four broad categories: out-patient, maternity, third-party payer, and in-house. • Changamka estimates that moving from a paper voucher to an mVoucher system could reduce administrative costs of a voucher program by approximately 15 percent to 27 percent, and could save up to 30 percent on administrative costs of institutions such as universities, which run their own clinics. • While the patient benefits from procuring services at discounted prices, medical providers also benefit from a higher volume of patients and ensured and timely payments, free of administrative costs.
Results		As of June 2011, 9,500 smart cards and 3,200 maternity cards had been distributed, 2,300 pregnant women had been given monthly health education, and 600 hospital transactions were completed using the cards every month. The usage rate is 500 "top ups" per month, and there were 600 hospital transactions using the cards every month; by June 2011, 35 providers accepted the cards. In addition, it was found that since hospitals began accepting the cards, they have seen the number of women making regular routine checkup appointments increase by 30 percent.
Mode of assessment		No impact evaluations of the tool's efficacy are available online, but PowerPoint slides of user interview results are available at http://www.abtassociates.com/Study-of-Changamkas-Maternity-Savings-Card.aspx
Sustainability and scale considerations		• With nearly 10,000 clients currently using a Changamka smart card, there remain several challenges for scalability and sustainability of the business model because of the costs of smart cards and GPRS terminals, and because of a lack of venture capital. • However, Changamka is developing a new mobile-based business model that connects to the government-sponsored health insurance plan. Supporting an expanded public-private partnership between Changamka, the Kenyan government, and Safaricom would hasten the move to a fully mobile-based application, addressing a number of logistics issues and increasing the likelihood of a more widely scaled product. Because M-PESA is employed in other EAC countries, there is also a potential for broader regional adoption.

D.4: TRAC FM

Organization		Trac FM
Technologies		Radio, SMS, Internet
Focus area		Governance and service delivery
Phase		Pilot (scaling)
Locations		Uganda
Partners		Twaweza, Text to Change, African Technology and Transparency Initiative, various Uganda radio broadcasters
Duration		2011–present
Problem addressed		Radio remains the most widely used ICT platform for information, education, and communication in the Africa region, even as mobile telephony rapidly expands. Successful radio programs report extensive audience reach, often in the millions, incurring relatively inexpensive production and distribution costs. Some talk show formats even allow listeners to call in to a show and participate, although high connection costs limits participation and public dialogue, thus relegating radio to mostly a one-directional, "push" technology.
Strategic plan		Trac FM allows radio audiences to interact with a broadcast via SMS and to make their opinions known on a range of public service topics, including health care. Such

	interactive mobile polling is an increasingly used approach, enabling stations to solicit listener comments via SMS, discuss comments on air, and then create and post online visualizations of the results on Facebook. Questions cover topics such as quality of public services (reporting on teacher absenteeism, availability of text books, drug stockouts, waiting time at clinics, election proceedings, functionality of water points, etc.), and thus create a powerful feedback loop that allows citizens to share views and hold leaders accountable for public services.
Costs	• **Trac FM** is a relatively low-cost solution that is licensed to participating radio stations. Rather than fit the station to the software, the Trac FM software is embedded into existing radio programming. • The system has encountered some sociopolitical struggles, such as streamlining the process with different parties involved in running a poll, such as telecom providers and radio station management.
Results	Trac FM is currently used by four radio stations in Uganda and has conducted 44 interactive polls. Upon submission of replies, the system employs a string distance algorithm that can filter out minor typos, detect "aliases" by linking every word to a certain category, and sort hard-to-identify words under a category of "unknown" so that the team can manually assign the response to the correct category. Submitted SMSs receive a confirmation message and the option to respond via keyword to join an active user group, meaning that anyone submitting data to one poll will receive SMS updates on upcoming polls. The Trac FM software then plots a data visualization of replies, and radio presenters can get an overview of where reports are coming from and what key issues are.
Mode of assessment	No impact evaluations of the tool's efficacy are available online, but a detailed case study is available in the Hivos report (p. 19): http://hivos.org/sites/default/files/ids-userlearningstudyont4tais.pdf
Sustainability and scale considerations	• A similar SMS-based public polling system is UNICEF's U-Report launched in Uganda in May 2011. In this system, users send an SMS message to register and then are polled from time to time on issues of social and community importance. For example, during the recent outbreak of a mysterious epilepsy-related illness known as "nodding disease," over 3,000 cases were reported via U-Report, which helped UNICEF with their response to the outbreak. There are currently over 89,000 registered users of U-Report, and while it remains available only in English, efforts are underway to include other local languages as well. • Trac FM and U-Report could very easily be combined to provide a robust community-focused platform for social accountability and local knowledge sharing that could be a model for other countries in the region. • The ability to engage underserved and rural populations in a governance dialog around issues of health services and concerns has enabled an information feedback loop in health service delivery, and could lead to a "routine reporting system" for public input on a wide range of health (and other sectors) issues.

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ICT for health—or eHealth—solutions hold great potential for generating systemic efficiencies by strengthening five critical pillars of a health system: human resources for health, supply chain management, health care financing, governance and service delivery, and infrastructure. This report describes the changing landscape of eHealth initiatives through these five pillars, with a geographic focus on Sub-Saharan Africa. This report further details seven criteria, or prerequisites, that must be considered and addressed in order to effectively establish and scale up ICT-based solutions in the health sector. These criteria include infrastructure, data and interoperability standards, local capacity, policy and regulatory environments, an appropriate business model, alignment of partnerships and priorities, and monitoring and evaluation. In order to bring specific examples of these criteria to light, this report concludes with 12 specific case studies of potentially scalable ICT-based health care solutions currently being implemented across the globe at community, national, and regional levels. This report is intended to be used by development practitioners, including task team leaders at the World Bank, to strengthen their understanding of the use of ICT to support health systems strengthening (HSS) efforts as well as to highlight critical prerequisites needed to optimize the benefits of ICT for health.

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