# Landscape analysis of mHealth approaches which can increase performance and retention of community based agents

This report was completed for the inSCALE project by Karin Källander, Malaria Consortium

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**inSCALE – Innovations at Scale for Community Access and Lasting Effects**

The inSCALE programme aims to increase coverage of integrated community case management (ICCM) of children with diarrhoea, pneumonia and malaria in Uganda and Mozambique. inSCALE is funded by Bill & Melinda Gates Foundation and sets out to better understand community based agent (CBA) motivation and attrition, and to find feasible and acceptable solutions to CBA retention and performance which are vital for successful implementation of ICCM at scale.

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## Preface

The scope of this report was not to conduct an exhaustive review of all mHealth projects in place in 2010, but instead to do a thematic overview of the mHealth landscape to guide the inSCALE programme team in its thinking around the role of mHealth in improving performance and retention of community based health workers in sub-Saharan Africa. Hence the report was written for an internal audience and the sole purpose was to enable the inSCALE team to make informed decisions during an innovation selection meeting that took place in October 2010.

This document is not an official inSCALE publication but rather an internal working paper.
Discussions about the content of this document are welcomed.

Karin Källander, September 2010.

## Contents

**Introduction and aim**

The general idea of mobile health, or mHealth, is that portable devices enabling transportability of software applications that can manage patient information could increase the reach and power to deliver health care services to the remotest areas possible (1). Because of ease of portability, mHealth has the potential to reach people living in most rural conditions where paved roads are scarce or do not exist (2). Reaching the underserved people in rural areas is a difficult challenge because of the paucity of healthcare providers in these countries. These factors enhance the feasibility of mHealth as a potential mechanism for delivery of healthcare services in remote locations in low and middle income countries (1).

The mHealth review aims to gather key lessons learnt, catalogue recommended practices and identify novel and innovative approaches from program and research experiences where health-related services have been provided via mobile communications. It will summarise concepts and strategies which can inform the design of innovative interventions to both increase coverage of integrated community case management (ICCM) and improve its quality through better performance and retention of health focussed community based agents (CBAs).

This report contains the methodology used for the literature review, an overview of the findings and a discussion on some specific approaches that have been documented separately (annex 1). In the final chapter concluding remarks are presented.

# 1. Background

## 1.1. Mozambique context

### 1.1.1. eHealth in Mozambique

Prior to 1992, the Mozambican health information system was completely paper-based covering the whole national health system that is built upon the national, province and district level including multiple health programs such as malaria, mother and child, family planning, immunizations, tuberculosis and others (3). After 1992, computer-based systems started to be used. SISprog was the first electronic database. It was installed in all the provincial directorates. As it did not support all the existing health programs and interest in using electronic systems was growing, many other electronic databases came into play. Today there are several electronic systems to support health care provision, used in the national health system, some implemented in each vertical program, some supported by different international donors, for example, HIV/AIDS programs have their own information system. The situation is described as "spaghetti" of various health information systems operating in Mozambique (4).

Most of the systems in use collect aggregated data and report to the upper levels. In general, at the health unit level, data is collected on paper based forms, sent to the district directorate, the district aggregates all the information from the health units and send to the province level. Then the province directorate aggregate data of all the districts under its responsibility and send to the

national level (the Ministry of health). Although proliferating all over the country, e-health systems are still used at the management levels and less at the patient / health worker level.

### 1.1.2. mHealth in Mozambique

Mobile telephone companies started to operate in Mozambique in 1997. The use of mobile telephones is now growing exponentially. In 2008 there were more than 4 millions subscribers in the country, which is 21 percent of the population, and this number is growing 50% per year. Mobile telephones have a direct added value to Mozambican individuals. People find it useful to communication, business, reduction of travelling costs and are willing to pay for it in order to have these benefits and others (5). Mobile phones are also common even in the very remote areas where there is no electricity to charge the phone, where literacy is very low, and where the network is erratic. Healthcare providers often use mobile phones in their practice. For example, mobile phones are frequently used by APEs to communicate with their supervisors and patients. In these type of conversations they often send a "please call me" message – a service from mobile operators that allow you to send a message to someone asking him/her to call you back. They can send several of these PCM SMS until supervisor answers them.

In Mozambique PDAs have been used in the malaria control programme which involved the Lubombo Spatial Development Initiative (LSDI), which was supported by the International Development Research Center (IDRC) in Canada in partnership with SATELLIFE based in US (6). LSDI introduced a data collection mechanism using a) PDAs for data collection and storage and b) GPS for collecting and reading geographical coordinates and c) cell phones for sending data remotely to a central database located at LSDI. Initially it was piloted in Maputo province, then in Gaza, Inhambane and Zambeze. Currently, the use of PDAs in the control of epidemic diseases is being expanded to the other provinces of the country. The experience showed to be innovative in the data collection process and reporting. Challenges faced included difficulties to get spare parts and the network was not compatible with the equipment.

## 1.2. Uganda eHealth context

The National Health Management Information Resource Centre (HMIS) was established in 1999 with the mandate to develop an enabling environment for efficient management of information of the entire health sector in collaboration with local government and other stakeholders through provision of technical support (7-8). The system has entirely depended on manual management and transmission of health data. Reporting of data into the HMIS is through a network of districts health offices whose role is to collect and summarize information from health sub districts and health centers. Summarized reports are submitted to Ministry of Health where they are compiled into national indicators of health and health management. Feedback occurs through monthly provision of a summary in terms of reporting, timeliness, completeness and selected indicators by the central data bank to the districts (9). Village Health Teams ( VHTs) and other community health care workers compile and report information to the nearest health centre (8). According to the integrated community case management (ICCM) guidelines, VHT are required to submit data to the nearest health facilities where the data are aggregated and reported to the district level (10).

A pilot study conducted by Uganda Health Information Network (UHIN) compared electronic based information systems using PDAs to the paper based system (11). Costs per form of paper based HMIS transmitted from the lower health centre to the district was compared with the cost of sending the same information with PDAs. Cost utility was measured using health utility index and cost utility ratios. Key findings were that although both methods performed registration well, PDAs were superior in that they aggregated data automatically, reduced errors and saved time. The costs of PDA based systems were estimated to be about ¾ the costs of a paper based HMIS (11).

## 2. Methods

What follows is not an exhaustive review of all mHealth projects in place in 2010, but instead a thematic overview of the diverse ways in which several mHealth projects have approached the intersection of cellular technology and public health. These seven themes— education / awareness, ii) data / health record access, iii) Monitoring / medication compliance / appointment, iv) Disease / emergency tracking / warning systems, v) Health administration systems, vi) Analysis, diagnosis, and consultation, and vii) other mApplications—represent approaches or best practices for mHealth.

The main method of inquiry was reviewing grey literature on the internet using Google Scholar searches and information provided at various websites where mHealth projects are summarized[1]. Review of other key review reports was also conducted (12-15). Peer reviewed information was collected from searches on PubMed but limited documents were found. Some sections include information provided by the International Stakeholder consultation report prepared by inSCALE (16). Information was also collected from two in-country reviews on ICCM history and context from Uganda and Mozambique, as well as from two in-country consultancy reports mapping out mHealth initiatives in Uganda and Mozambique.

Another consultancy report on simple and low cost laptops and smart phones was reviewed for the section describing potential devices that can be used for data entry, access and communication (17). The mobile devices were reviewed and rated based on the cost, qualitative impression, weight, operating system, user friendliness, durability, battery life, screen type, data transmission, ability to show video, and provision for user-specific applications.

### 2.1. Definition of eHealth and mHealth

According to Vital Wave Consulting (12) there is no widely agreed-to definition for these, but the public health community has coalesced around these working definitions:

- eHealth: Using information and communication technology (ICT)—such as computers, mobile phones, and satellite communications—for health services and information.
- mHealth: Using mobile communications—such as PDAs and mobile phones—for health services and information.

[1] Royal Tropical Institute (KIT): http://www.kit.nl/smartsite.shtml?ch=FAB&id=36964; The Communication Initiative Network: http://www.comminit.com

mHealth and eHealth are inextricably linked—both are used to improve health outcomes and their technologies work in conjunction. The definition of mHealth is now being broadened, exploring how mobile technologies can be best and most widely used to enhance access to health services and information and also to improve the way health professionals deliver health-related services to the general public (18). For this report, we will focus on programs in low- and middle income countries (with a focus on Sub-Saharan Africa) where ICT innovations have been introduced in rural areas to improve health of the population.

## 3. Analysis

All mHealth innovations and projects that were identified in this review was recorded in a table (see annex 1) and information was retrieved for category (a), innovation description (b), source (c) , methodology used (d), issues which may impact feasibility, acceptability and scalability (e), and moderators of impact (f).

a) Main purpose of the innovation, categorised as either i) education / awareness, ii) data / health record access, iii) Monitoring / Medication Compliance, iv) Disease/ Emergency Tracking, v) Analysis, Diagnosis, and Consultation, and vi) other mApplications.
b) description of innovation including key features
c) program or theoretical source of innovation
d) the methodological approach that has been used and the type of evidence that is available
e) the specific tools used for the measurement of the innovation
f) the available evidence for the impact of the innovation
g) aspects of innovation which may impact on feasibility, acceptability and scalability. These may include but not be limited to issues of cost, political and cultural sensitivity, required resources and logistics of implementation
h) lessons from other settings that indicate factors which may moderate impact

For the specific categories in (a), we used the following definitions, inspired by the report by Vital Wave Consulting (14):

| | |
|---|---|
| **Education / awareness** | Primarily one-way communication programs to mobile subscribers via SMS/text messaging in support of public health, behavior change campaigns. |
| **Data / health record access** | Applications designed to use mobile phones, PDAs, or laptops to enter and access patient data. Some projects may also be used by patients to access their own records. |
| **Monitoring / medication compliance / appointment** | One-way or two-way communication to the patient to monitor health conditions, maintain care giver appointments, or ensure strict medication regimen adherence. Some applications may also include in-patient and out-patient monitoring sensors for monitoring of multiple conditions (such as diabetes, vital signs, or cardiac.) |

| | |
|---|---|
| **Disease/ emergency tracking / warning systems** | Applications using mobile devices to send and receive data of disease incidence, outbreaks, geographic spread of public health emergencies, often in association with GPS systems and backend applications for visualization. |
| **Health / administrative Systems** | Applications developed for "back office" or central health care IT systems allowing for access by and integration with mHealth application. Such applications often tie in to regional, national, or global systems. |
| **Analysis, diagnosis / consultation** | Applications developed to provide support for diagnostic and treatment activities of remote care givers through internet access to medical information data bases or to medical staff. |
| **Other mApplications** | Applications developed for mobile phones that can aid health workers to perform better without necessarily requiring connectivity. Examples include applications or technologies that can be attached to the mobile device to make a diagnosis or to aid the health worker in decision making. |

### 3.1. Structure of the report

The report have been organised by the categories listed above as well as sections on acceptability, feasibility and scalability of different mHealth applications. Some categories may require the adoption of a new approach or the design of a new intervention while for others there may already be an established case for adoption in any scaled up community based agents (CBA) program. Both scenarios may lead to innovative practice. A couple of case studies will be presented where mHealth have been used for programs involving CBAs, and which are thereby directly applicable to the context of ICCM.

Towards the end of the report we will present the results from a review of the market of simple and low cost laptops and smart phones that can be used for mHealth activities for CBAs. The list of the top 10 devices that were identified will be summarised.

### 3.2. Definition of 'innovations'

Innovations can mean different things in different contexts. For the inSCALE project it means an activity, approach or underlying concept which may contribute to the performance and retention of CBAs. Innovations may:

1. be promising in practice,
2. be promising theoretically,
3. have been used before in Uganda and Mozambique but either not in the way proposed or in the way originally designed,

4. have been used effectively in other geographic locations and / or sectors.

An innovation may include adopting a new approach to activities we already know are likely to have a positive impact. It may simply be a method of ensuring that they are implemented as intended.

## 4. Results

Using the strategies noted above, minimal formal evaluations of mHealth was found. In a paper by Khan et al, 2010 (19) only two systematic reviews were found and both (20-21) indicated little formal outcome evaluation of mHealth in developing countries. In one of these reviews, the use of mobile calls and short message service (SMS), or text messaging, are explored in twelve clinical areas and found "significant improvements in compliance with medicine taking, asthma symptoms, HbA1C, stress levels, smoking quit rates, and self-efficacy (19). Process improvements were reported in lower failed appointments, quicker diagnosis and treatment, and improved teaching and training." However, this research was conducted in wealthier countries, except for one study in China (20). Khan et al (2010) also found a 2006 review written by Kaplan et al (21) which reported that "there is almost no literature on using mobile telephones as a healthcare intervention for HIV, tuberculosis, malaria, and chronic conditions in developing countries. Clinical outcomes are rarely measured." The most common documented use of m-health is text-message and phone reminders to encourage follow-up appointments and healthy behaviors. From the mHealth in-country mapping exercises in Uganda and Mozambique even less documentation was identified. In Mozambique for example, the literature found was restricted to the experience of using personal digital assistants (PDAs).

Communication between a sender and receiver can occur in more than one direction and between varying group sizes.

- One-way: This is similar to traditional mass media, which distribute information in one direction.

- Two-way: Interactive communication is more similar to interpersonal communication. For users, interactivity may require greater effort and generate greater interest. Hotlines, textlines and quizzes are forms of interactive communication.

- Multi-way: The number of senders and receivers can vary, including one-to-many, many-to-one, and many-to-many communication. Many-to-many includes social media such as Facebook. The social nature of social media can address social capital, social support and social norms.

One-way, two-way and multi-way communication, respectively, provide increased degrees of shared control over communication.

Figure 1 is taken from the Landscape analysis produced by Vital Wave consulting and illustrates the simplest value chain for mHealth solutions based on a one-way messaging application (14). In their report, Vital Wave consulting states:

"Examples of this type of application are medication regimen adherence and monitoring programs and education and support programs based on one- or two-way SMS alerts. For a small, local program, it is unlikely that one can obtain ongoing support for special modifications to handsets, for example. It is also unlikely that the program will be able to implement highly customized features for messaging functionality, since there is not enough volume to warrant contributions from the platform developer without prohibitive development and maintenance fees. On the other hand, the messaging service, even at small volumes, might dramatically reduce the costs and improve efficiencies of the health care provider who will no longer have to use manual labor to remind, educate or otherwise promote certain aspects of health care with patients (14)".

Figure 1. Value Chain Model for "One-way" mHealth Applications (14)

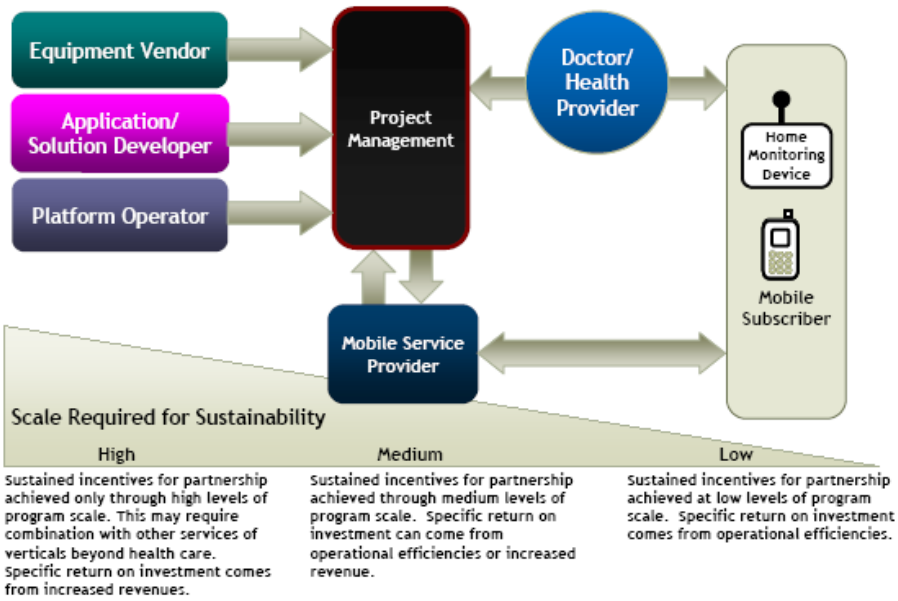


Figure 2 is also taken from the Vital Wave consulting report and presents a value chain model for a more complex service offering: a two-way data application (14). Here, the report states:

> "Two-way applications are developed for data access programs: remote data collection, access to client records, access to health information databases, and electronic health records creation and storage. While it is not likely that two-way services will provide the volume potential of one-way services, two-way data services have a much broader appeal to potential participants because of their reliance upon internet access. Because Internet access is an established mobile functionality on both phones and laptops and is the basis for other services, including voice over IP, participants in this value chain will have broadly based market interests and may find incentive to integrate mHealth services with those (14)".

Figure 2. Value Chain Model for "Two-way" mHealth Applications (14)

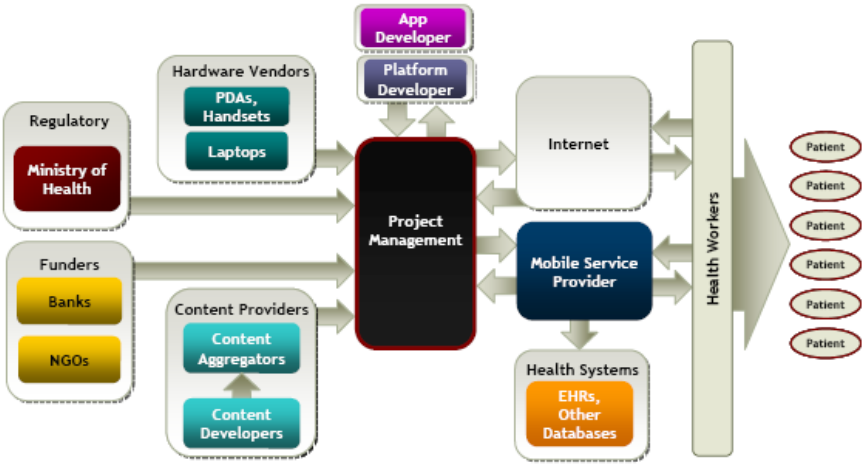
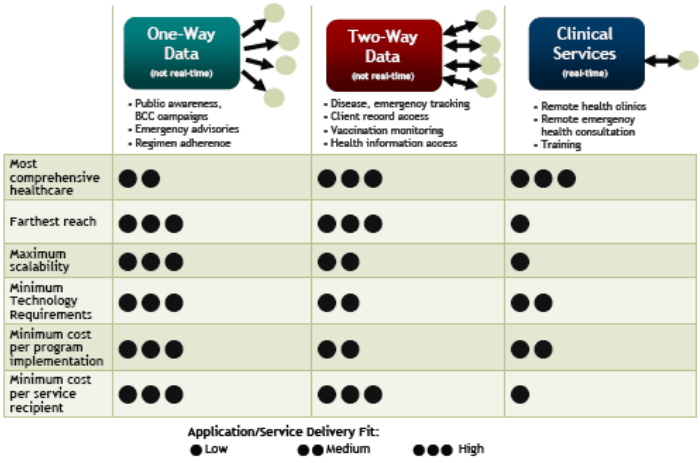



Figure 3 (next page), which is also taken from the above mentioned report by Vital Wave Consulting (14) shows the relationship of mHealth technology options and how their characteristics may dictate appropriate target applications. The report states:

> "In this graphic, mHealth solutions have been organized according to three corresponding technical application categories: one-way data, two-way data, and clinical services delivery. Each technology category has been rated for its ability to have positive impact on the program objectives stated in the left-hand column (14)".

Figure 3. Fitting technology and eHealth applications to health needs (14)




Many of the projects reviewed (Annex 1) used a combination of one-way and two way communication methods. Therefore they may cut across several of the below mentioned categories. For example, projects could send out SMS both for the purpose of sending information about HIV (health education and awareness) as well as reminding people about their drug intake or next appointment for collecting ARVs (Monitoring/ medication compliance). Similarly, some projects set up systems which cross over into even more categories, whereby CHWs received mobile phones to link them up with their health facility supervisors for advice (analysis, diagnosis, consultation), to receive information about drug stock-outs or epidemics (disease / emergency tracking), to use them for data reporting of patient records (data, health record access) and receive feedback from the system on simple project indicators (Health /admin systems). These programmes have been categorised based on the key function of the application.

### 4.1. Education and awareness

Typically, mHealth innovations to stimulate education and awareness are designed as one-way communications where the projects use what is termed "push" technology where messages are delivered to subscribers' phones using messages tailored to personal needs. These messages are sent at a frequency between once per week to once per day. Others, like Cellphones4HIV[2] in South Africa used *Unstructured Supplementary Service Data (USSD)* (i.e. the system used to load air time), *MXit* (a Java application installed on users' phones that allows for GPRS or 3G-based instant messaging) and *voicemail* message "pushed" into the user's voicemail inbox, and he or she is notified of its arrival by SMS. The designs below have differing capabilities, limitations and requirements. According to Mechael et al (15), the most common ones identified are:

[2] http://www.comminit.com/en/node/308917/2781

- Bulk SMS or robocalls to large audience
- Messages to registered users
- Interactive quiz
- Information menu
- Data collection and tailored response
- Hotline or textline
- Messaging to promote hotline
- Interactive voice response
- Peer to peer message forwarding
- Closed user group discussion
- Text diary

These technology designs can be combined, adapted, or further expanded as technology evolves.

In the programs reviewed for this report, SMS campaigns for health education, promotion and awareness typically:

- Use SMS to disseminate health information and prevention messaging, or direct patients to services
- use games and quizzes to create awareness of HIV/ADIS by Play and Learn method
- deliver educative messages about HIV using Please Call Me SMS Service
- Spread SMS with phone numbers for HIV/AIDS and TB centres offering information on health care, counseling and local testing clinics

Numerous countries in Africa and Asia have used SMS message campaigns to increase awareness about HIV/AIDS, to provide preventive healthcare information and to provide information about disease, counseling services and testing. However, as reported in a review by Lim et al (22), although SMS has been applied in many ways to improve sexual health and there is some evidence of its effectiveness, very few of the applications described in this article have been evaluated. We identified 6 projects in Uganda and 1 in Mozambique that use mHealth for education and awareness. These ranged from messages encouraging women to get STD testing, information, games and quizzes about HIV / AIDS, SMS search engines for people seeking information on agriculture, health etc and information about violence against children (annex 1).

The Key Points of SMS for health education and awareness, according to Mechael et al (15) are:

- Studies investigating the use of mobile technology for disease prevention and health promotion have found positive results when used to affect the health outcomes of patients managing smoking cessation and nutrition.
- Mobile technology has been a critical medium to promote and disseminate information regarding confidential and stigmatized issues such as sex, family planning, sexually transmitted infections, and HIV/AIDS.
- The literature found studies illustrating the use of mobile phones to strengthen the relationship between patients and providers, for example midwives and pregnant women.

This increase in communication allows health providers to monitor patients more closely, leading to earlier detection and treatment of health issues.

- Disease prevention and health promotion programs tailored specifically to a patient's needs and health profile are being created using intelligent back-end systems through the increasing integration of rulesbased engines and algorithms. Integrating solutions with platforms such as electronic health records can accelerate this development, which can be used to inform people-centric programming.
- Barriers to disease prevention and health promotion programming are commonly found in the limitations of SMS (i.e., 160 characters), language, and privacy. It has been found that mobile phones are often shared among family members in LMICs, leading to potential challenges with protecting confidential information.

Many project, such as **project Masiluleke**[3] in South Africa use the blank character space in "Please Call Me," or PCM, messages that are widely used in Africa because they are free for the sender, and can even be sent from a phone that no longer has call minutes. The project send out one million PCM messages per day for one year with contact information of local HIV and tuberculosis call centers to connect the population with health information.

Another project in Uganda called **Text-to-Change (TCC)**[4] uses bulk SMS platform to create dialogue in order to increase awareness of HIV and AIDS and achieve comprehensive knowledge levels among young people; to reduce HIV/AIDS-related stigma and discrimination; and to motivate people to seek HIV testing and treatment. TTC sends out quizzes and information about HIV prevention and testing via SMS, and those who pass the quiz and get tested are awarded airtime.

Projects for remote health information dissemination like Project Masiluleke and Text-to-Change have been very successful. In just five months after the launch of Project Masiluleke, calls to South Africa's National AIDS helpline had quadrupled[5]. Of the 15,000 subscribers contacted by TTC, 2,500 responded to each question.

Other projects use SMS for Behaviour Change Communication (BCC). For example, in the area of technology and education the **text2teach project**[6] gives Philippine teachers a way to text via mobile phone to receive videos delivered over school-based televisions via satellite; and mobile technology involving parents. BCC, as stated here, can be applied to family planning, HIV/AIDS and malaria awareness and prevention, agricultural/farming techniques, and teenage pregnancy, because it is

[3] http://www.fastcompany.com/tag/project-masiuleke

[4] www.texttochange.org

[5] http://www.fastcompany.com/blog/linda-tischler/design-times/welcoming-guest-blogger-robert-fabricant-designing-unpredictable

[6] http://www.mobilebehavior.com/2009/08/11/text2teach-empowering-classroom-learning-through-mobile/

easily orally transmitted through, for example, community radio and community theatre, using cultural understanding and clear language for communication.

#### 4.1.1. Education and Awareness innovations for CBAs

None of the mHealth projects identified in the area of education and awareness were specifically targeting CBAs. However, these types of innovations may still play an important role in community health programs, as was also noted in the International Stakeholder Review Report by Strachan & Benton (16). In this report, stakeholders mentioned several ideas of how one-way communication using mobile phones could be used to strengthen the CBA program, especially in relation to referral. These included:

a. Introduce a referral alert process where the CBA calls the health facility in advance of the referee's arrival.
b. Introduce an appointment keeping confirmation *via* text to alert the referring CBA that their referee has attended their appointment at the health facility.
c. Send appointment confirmation SMS to referred patients with the time, date and location of their appointment.
d. Instruct both health facility workers and CBAs to keep each other informed by SMS of relevant recent developments and upcoming events.
e. Establish a call in service for each health facility where CBAs can call in and receive the most up to date information on drug stocks, attendance records and other relevant information.
f. Promote the success of any technology based aids in the referral process to the community and encourage them to support its maintenance through raising funds for CBA airtime.

In the same report, stakeholders also mention the opportunities for utilising mobile technology to engage with the community and stimulate their acceptance and ownership of the program (16). In this context 'communities' were conceptualised both as the geographic community serviced by the CBA and the community of CBAs themselves. In the first instance the opportunity was suggested to lie in being able to communicate program and health messages directly and simultaneously *via* SMS with large numbers of community members (though the suggestion was made that radio may be just as effective in some cases). In the second instance mobile phones were seen as presenting an opportunity for CBAs to communicate directly with each other and to provide peer support from a distance. Suggested activities for stimulating community demand and ownership included (16):

a. Send SMS messages to mobile phone subscribers designed to raise awareness of and create demand for the services offered by the CBA.
b. Encourage CBAs to communicate with and provide support to each other *via* their mobile phones
c. Send an SMS to CBAs on their birthday.

### 4.1.2. Acceptability, feasibility and scalability: Education and Awareness

The main factor behind the success of projects such as TTC and Masiluleke is the simplicity of the project, and that it takes advantage of the already widespread use of PCM messages, instead of introducing a new technology to the local community. This project is also collaborative, which allows for much simpler widespread implementation once it has been evaluated after the conclusion of the pilot stage (23).

Though most of the mHealth interventions for disease prevention described the use of text messages for providing health information, motivating individuals, and encouraging self management, illiteracy is clearly an issue for future text based prevention interventions. Also the importance of culture-specific approaches to equipping patients with proper preventive information is important (15) and poorly designed campaigns can have negative unintended effects. According to the African Radio Drama Association (ARDA)[7], the success of their listening clubs for women farmers who used cell phones to interact with the radio, was the precipitation of two key male figures – a community elder and a school teacher – which helped curtail possible opposition from the spouses of participating women (24).

Hence, according to Mechael et al (15), before developing effective mobile health prevention programs there is a need for:

- Good understanding of context and culture
- Strategies for overcoming language and literacy barriers
- Clinician resistance to new technology is a significant barrier to implementation of mHealth systems. Broader discussion of incentives for adoption is required.

Other key features are[8]:

- Messages more effective if brief and personal
- Series of 5 messages well tolerated (in US)
- Incoming texts need to be monitored
- Implement mechanism to deal with unsolicited messages
- Provide other channel (e.g. land-line) for user to call
- Have voice message on the line texting from in case someone calls
- Allow for opt out and language choice (if needed)
- Need to validate content with target users
- Need to be careful of translations
- No abbreviations or slang, check tone
- Max 160 characters
- Need method to get cell phone numbers
- Limits of capacity of practices

[7] http://www.comminit.com/en/node/312117/38

[8] Guest presentation mHealth Working Group, 2010-05-12. Text4Health: Lessons Learned

The outcome level requires a clear definition of the target population and end user. For example, adherence support for patients addresses a different population than mobilization efforts for an entire community.

Some common barriers that were experienced across several of the projects reviewed included limiting the content to 160 characters for text messages or to a certain amount of time for voice calls; translating messages from one language to another; having sufficient technical and mobile phone provider support in remote areas; encountering language barriers; lacking sufficient qualitative data to explain certain findings; and addressing security and privacy issues.

Other challenges documented by Mechael et al (15) in the mHealth-related prevention interventions included technical problems, costs, and financial sustainability. Their report gave an example:

> "La Ligne Verte in the Democratic Republic of Congo described technical problems they had early on, such as setting up and running their hotline; however, these issues were resolved through collaboration with mobile phone provider VODACOM. Cost issues were reported to be barriers for some of the projects during pilot stages as well as in plans for scale-up or sustainability. The founder of mDhil had described frustrations of working with foundations that are not as willing to work with for-profit startups (15)."

Communication can be delivered by mobile phone in a variety of formats. Format selection can correspond to the needs of programs and the needs of users, keeping in mind the above issues for users and their phones. Each format will have its own interface and usability qualities, appeal, local familiarity, cost and IT requirements.

- Information capacity: each format has unique limitations on the amount, complexity and qualities of information, ranging from flashing, a binary message of call or do not call, to video, which conveys complex visual information.

- Standalone versus integrated capacity: The limitations of a format can be offset by integrating phone use with other sources, such as print materials or interpersonal communication.

Technological: The feasible options for formats are limited by the capability of users' handsets and subscribed services. These can vary from universally accessible SMS, to less universal Java-enabled phones, to high-cost and high-bandwidth phones with multimedia capability.

- Cost to user: Costs include handsets, SIM cards, credits, and payments to owner intermediaries or any social cost of borrowing, power, and repair.

- Convenience/burden of use: Beyond financial costs, each format has different requirements for users. For example, SMS allows users to read a message when convenient, but is difficult for illiterate populations to use.

### 4.2. Data and health record access

The widespread use of mobile technologies in LMICs for data collection and improving access to information as part of health information systems (HIS) is well-documented in the gray literature, but studies in peer-reviewed journals are generally weak and the results focus on intermediary benefits such as cost savings and improved reliability of data, but do not go to the next level to show improved work flow, efficiency, quality of care, and/or health outcomes (15). mHealth innovations that use electronic technologies, especially handheld computers, PDAs or laptops to collect and report data can use either one-way or two-way communication systems. Some examples are:

- **RapidSMS**[9] which establishes a two-way flow of communication that empowers stakeholders with a dynamic tool for advanced data collection, analysis and communication that is fast, efficient and accurate.
- **EpiSurveyor**[10] which allows users to download and fill in forms and then send it to central databases to be analyzed in real time. Has been most widely used for emergency response and tracking supplies,
- SMS based data for health care workers to identify, diagnose and track patients utilizing streamlined technology that is automatically updated in a central system.

Mobile data collection has the potential to be better, easier, faster, and cheaper than paper-based collection. In more specific terms, it can affect the quality, reliability, usability, time, and cost of data collection, all of which may be interrelated. In addition to the immediate impact of mobile technology on data collection, it can conceivably change how data is used in health programs.

- Faster decision-making and reallocation of resources
- Decentralization of decision making due to faster dissemination of data analysis
- Changes to health service delivery models based on faster access to data

We identified 12 projects in Uganda that had used mobile technology in the area of data collection and reporting. The majority of these were designed as one-way communication systems to improve data collection or data management in surveys, routine care (at community and facility level) and vaccine trials (Annex 1). Other projects, like **ChildCount+**[11], Mobiles for Healthcare in Malawi[12] and **Malawi RapidSMS Nutrition Surveillance**[13] designed their systems to facilitate activities for community based health providers to send and receive feedback on the submitted data.

[9] www.rapidsms.org

[10] www.datadyne.org

[11] Developed by the Millennium Villages Project aimed at empowering communities to improve child survival and maternal health: http://www.childcount.org/how-it-works/

[12] http://mobilesinmalawi.blogspot.com/2008/07/virtues-of-frontlinesms.html

[13] http://www.rapidsms.org/case-studies/malawi-nutritional-surviellence/

Overall, few studies have demonstrated the impact of the mHealth data collection on health outcomes and system strengthening. This was also concluded by Mechael et al (15) who state:

> "Commonly the documented findings primarily report lower or reduced error rates and time saved in the data collection process. Further, most studies adopted the use of PDAs to conduct trials. However, in LMICs today, low-end mobile phones are more prevalent, particularly in rural areas, and in high-income countries more and more people use either Java-enabled or other smart phones. As a result, updated studies are needed to investigate if the change in technology affects data collection and surveillance outcomes (15)."

The Key Points of using mHealth for data, health record access according to Mechael et al (15) are:

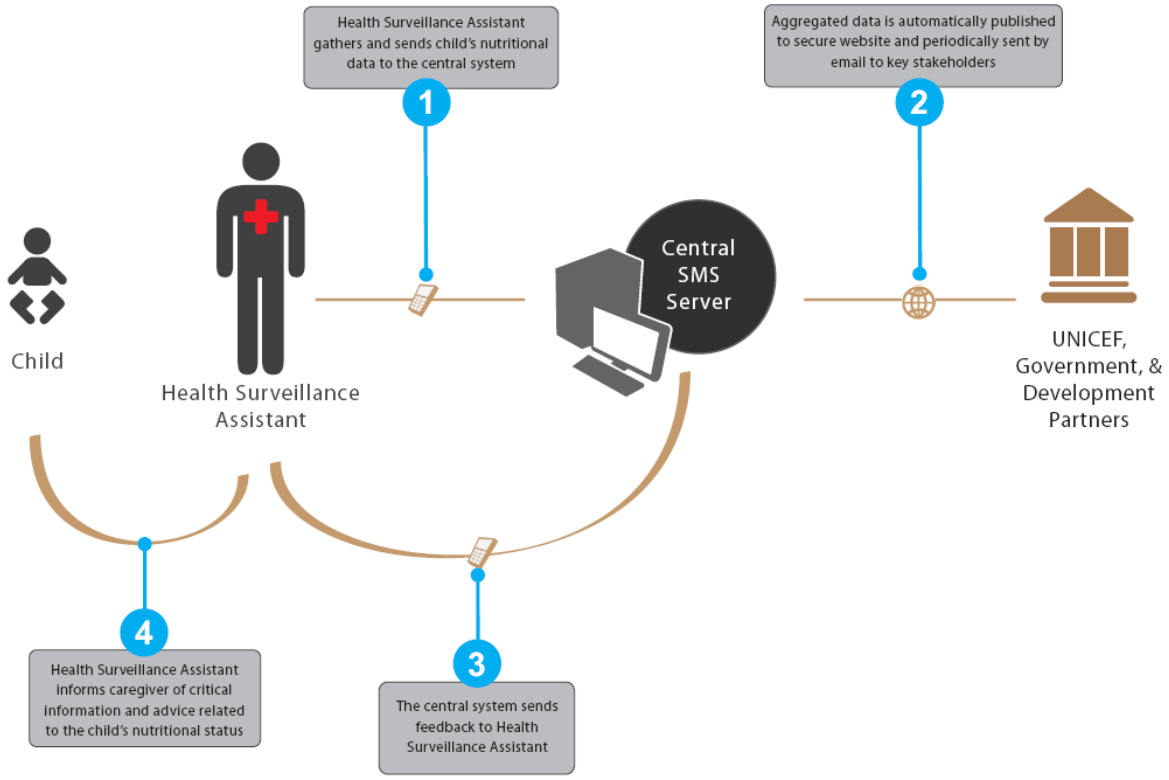
- Majority of the literature studying data collection focuses on comparing data quality, accuracy, time, training required, and cost between traditional paper and pen methods and mobile technology. Results were found to be inconclusive with effectiveness varying depending on the type and complexity of data being collected.
- Many data collection software programs have been developed using an open source platform, resulting in widespread adoption among small pilot projects (i.e., EpiSurveyor, PDACT, RapidSMS), many of which have not been documented or evaluated.
- Studies were found to primarily use PDAs, an older model of mobile phones and not as applicable in the current marketplace. Further studies are required to investigate data collection using low-end mobile phones found in LMICs and smart phones found in high-income countries and increasingly in LMICs.
- Data collection using mobile technology was found to be implemented using SMS, voice, and electronic forms. Increasingly, as mobile technology advances, GPS information is being used to tag data to specific locations. Further studies are required that investigate the effectiveness of different data collection methods using mobile phones.
- The primary gap in data collection is the focus on implementation as an independent system in comparison to partnering in the development of initiatives such as electronic health records that can act as a repository from which data can be extracted. Additionally, further integration between local, regional, and national data collection and access is required so that data being collected is benefiting the communities from which the data is taken.
- Barriers related to security, confidentiality, and ownership of data is central to this mHealth thematic area
- Mobile technologies in LMICs have been found to increase communication between health professionals and community health workers for advice and consultations, resulting in a collaborative support system and better patient care.

As stated in another report by Mechael et al (16), "the effectiveness of other data collection methods that leverage functions of the mobile phone, such as voice, camera, and SMS, has also been studied. For example, Voxiva's Cell-PREVEN product uses interactive voice response and voice recording to monitor adverse events among female sex workers in Peru. During a threemonth pilot test, 797 reports were collected—30 severe enough to trigger an SMS alert to a team leader. All interviewers said they were satisfied or very satisfied with the system."

How RapidSMS works (see also figure 4) (25):

1) The CBA sends an SMS using a pre-determined format to the phone number of one of the GSM modems. Each GMC is assigned a 4-digit number which, combined with child ID (1-70), creates a unique child identifier.
2) The SMS is received by the server.
3) The server populates a master database with the SMS data and compares the data to previous SMS submissions and predetermined variable standards.
4) The server automatically sends an SMS back to the CBA confirming that the data sent is correct.
5) If the SMS sent indicates a data entry error (for example, the child's entered height is physically impossible), the server sends an SMS back to the CBA requesting that a corrected SMS be sent.
6) If the SMS sent indicates a health condition requiring further attention (for example, the child is malnourished based on his/her weight for height percent of median), the server sends back an SMS providing specific instructions to the CBA.
7) Simultaneously, the website is automatically updated with the new data received and child malnutrition indicators for each site are instantly adjusted.

Figure 4. RapidSMS information flow in Malawi (25)




### 4.2.1. Data and health record access innovations for CBAs

There is little evidence of the effectiveness of having CBAs collect data, self-reporting data, and obtaining data from clinic and hospital records. Yet, in the International Stakeholder Analysis conducted by Strachan & Benton (16) it was also suggested that mobile phones could be used for CBA data collection and submission, though the interviewer was advised that the use of PDAs in an ICCM program in Rwanda exacerbated the issue of volunteer workload rather than helped it (16). In that program mobile phone assisted data collection became onerous and was felt to have distanced CBAs from the human side of their role turning them into 'data collection robots'. It was also acknowledged that the paper based data collection obligations were heavy under the same program and therefore the negative impact may have been due to the transferring of an already cumbersome process to a PDA rather than the introduction of the technology itself.

One project which has successfully used mobile technologies for improving data use and reporting is the **ChildCount+**[14]. ChildCount+ is a mHealth platform developed by the Millennium Villages Project aimed at empowering communities to improve child survival and maternal health. ChildCount supports the delivery of CMAM (community-based management of acute malnutrition) programmes; home-based testing for malaria using RDT kits and immediate dispersal of treatments; and home-

[14] http://www.childcount.org/how-it-works/

based treatment of children with diarrheal illness. According to Blaschke et al (25), ChildCount+ uses RapidSMS text messages to facilitate and coordinate the activities of CBAs. In their report, Blaschke et al. explains:

> "Using any standard phone, CBAs are able to use text messages to register patients and report their health status to a central web dashboard that provides a real-time view of the health of a community. Powerful messaging features help facilitate communication between the members of the health system and an automated alert system helps reduce gaps in treatment. While RapidSMS has demonstrated its potential for improving child nutrition monitoring, it has also been effective as a means of sharing information among all stakeholders. UNICEF has previously used the RapidSMS platform for field data collection purposes in Ethiopia, Malawi and Kenya. The Ethiopia system was built to monitor the supply and distribution of a ready-to-use therapeutic food (RUTF) called Plumpy'Nut. With assistance from UNICEF Innovations, this platform was significantly modified to meet the needs of the Malawi INFSS system. From a technical requirements point of view, RapidSMS has extremely basic requirements. The RapidSMS platform is comprised of three parts – the end-user's mobile phone, the server-based backend, and the server-based frontend website. Minimum platform requirements include a central server with Internet access and attached GSM modems."

As a result, approximately three months after the initial child registration, 95% of the estimated 9,561 children under five in the cluster had been registered (25). Only about 10% of all incoming messages sent to the system were rejected due to improper formatting. The innovation also lead to significant reduction in data transmission delay compared to Malawi's current paper-based system. Other findings included:

- Increase in data quality reported by health workers.
- Elimination of the need for time-consuming manual data-entry.
- Increased two-way flow of information between stakeholders at the national government level and health workers in the field.
- Increased system and personnel monitoring capabilities.
- Elimination of costs related to transporting paper forms and manually entering data.

#### 4.2.2. Acceptability, feasibility and scalability: Data and health record access:

One key area that appears not to have been studied is related to the types of incentives that ought to be provided to health professionals to encourage adoption and proper use of mHealth-related health information systems. According to Waruingi & Underdahl (1), the key research questions in this area include: "How does software and hardware make the professional's job easier and more rewarding? How can mobile technology be part of an empowering two-way conversation, rather than single directional data entry? How can such tools be used as part of an effective human resource management system that rewards excellence and identifies errors and weaknesses in order to improve quality of care? Salary payments through cell phones would provide immediate reward for effective usage of mHealth applications. Similarly, payment in cash or minutes/message units could enhance public health compliance in the general public". These all need to be studied (1).

Other issues found by the projects using mHealth innovations for data use and reporting at community level included:

- Some users struggled initially and required additional training before they could effectively use the system.
- Several of the phones provided by the project malfunctioned and needed to be replaced.
- Several phones went missing
- Challenges with duplicated child registrations.
- While an average cost of an SMS at $0.05 USD could be considered potentially cost effective, it may be outside the means of some health care systems under current pricing practices.
- There needs to be guidelines outlining the rights to data and usage
- Issues about data storage, i.e., where servers should exist
- Coordination of data aggregation and sharing between local communities and regional and national health information systems to inform decisions
- Studies should explore alternative methods for data transmission such as Interactive voice recording (IVR), which is a technology that allows a computer to detect voice and dual-tone multi-frequency signalling (DTMF) keypad inputs.
- Difficulty of using devices for open-ended responses
- Advantages of GPS-based data collection over traditional cluster survey procedure
- It is crucial that someone at the national government level be dedicated to completing a more comprehensive analysis of the data collected. If no data analysis is done, faster transmission time will not produce the desired improvement in the surveillance system.
- Without close monitoring, the full benefits of mHealth projects collecting data, such as RapidSMS, will not be realized.
- Adequate training will be a critical component in a national rollout of mHealth projects collecting data.
- Duplicate reporting may pose a technical challenge by having CBAs collective data and registering children but it can likely be addressed through CBA training programs.
- While programs such as RapidSMS can improve data transmission and analysis, it cannot replace the crucial skill of accurate child measurement.
- How to best provide consistent feedback and training to CBAs is be a significant challenge during any large-scale implementation.

Potential solutions to these issues have been suggested both in the literature and in the International Stakeholder Analysis by Strachan and Benton (16):

- Need for feedback reports that can be distributed to each CBA on a frequent, initially a weekly, basis
- Providing CBAs with cheaper, basic entry level phones could mitigate problem of lost phones.
- Ensure mobile phones or any other supplied hardware is branded with the program or Ministry of Health logo.

- Data quality is improved by auto skips, option menus, compulsory fields and range-checks at the time of data entry.
- The existence of a functional health care system and motivated CHWs are required for this approach to be successful
- A drop in SMS rates to $0.01 USD could have a tremendous impact in sparking demand and driving innovation for service like this. Support from operators would also make it possible to scale these programs further.
- Need to ensure adequate backup system to guard against data loss

### 4.3. Monitoring / medication compliance/ appointment

This area describes the use of mobile technologies to monitor patient's use of medications, send reminders or monitor status. Mechael et al summarises (15):

> "Even though SMS reminders have been used for several years to send ART-reminders, it can also be used to send any other medium or long-term treatment reminders to patients, such as for TB as well as a PMTCT. There is also work towards a SMS alert Corporate package where the system can be integrated into a company's Employee Wellness / internal ART-management programme to support their staff who are on ART or TB-treatment."

According to Wave Consulting (12) and Blynn (13) mobile telephones has showed to be effective in monitoring patients prescribed medication, especially in tuberculosis and HIV/AIDS programs. South Africa - increased compliance rate in a trial with tuberculosis patients in South Africa. In Thailand a study done in 2007 showed that TB patients who received daily text message medication reminders jumped to over 90% adherence (cited in (13)).

Several mHealth pilot projects have been developed to increase drug adherence, especially with diseases such as tuberculosis, HIV, diabetes, and asthma for which drug adherence is especially critical. In many areas, to ensure adherence to treatment, patients must walk many miles to clinics to receive and take medication in the presence of a health worker.

However, as Blynn (13) concludes, "often this is not possible because of distance, lack of transportation, bad weather, or a worsening condition that prevents them from leaving home. The use of SMS technology for treatment compliance interventions was a prevalent theme in the literature across LMICs and high-income countries. While studies from high-income countries primarily focused on tackling non-communicable and chronic diseases, such as asthma and diabetes, as epidemiological shifts occur in LMICs these interventions will become more relevant."

Already, mHealth is being applied in LMIC settings for chronic infectious diseases such as tuberculosis and HIV/AIDS. Moving forward, translating these studies from a high-income country context to a LMIC context will be required to further understand effectiveness and usefulness (15).

The area of treatment compliance is particularly rich and multifaceted, with applications ranging in focus from drug adherence to appointment reminders. Only one project which uses mHealth to improve medicine compliance was identified in Uganda. This project, which aims to improve adherence to ARVs, use of a medical container called **Wisepill**[15] to transmit a cellular signal every time it is opened. Send weekly SMS at preset times as well as Interactive Voice Response. A similar project, with the name **SimPill**[16] has tried the same idea for monitoring adherence to TB drugs in South Africa. And as noted by Mechael et al (15):

> "While there were some applications of smart phones or other advanced phone functionality within the context of treatment compliance, on the whole, the evidence indicates that SMS is the most effective way of utilizing mobiles for disease management, drug adherence, and appointment reminders. The overlap between treatment compliance and health education and education is obvious, and alludes to the need to move toward comprehensive mHealth solutions instead of silos."

The Key Points of using mHealth for monitoring / medication compliance and appointments according to Mechael et al (15) are:

- Current literature on treatment compliance is focused primarily on the management of chronic diseases (i.e., diabetes, nutrition, smoking cessation, breast cancer) in high-income countries. As epidemiological shifts occur in LMICs, these studies and lessons will become more relevant.
- Additional studies investigated the use of mobile technology for drug adherence and appointment reminders. This highlights the natural overlap between treatment compliance, disease management, and prevention of primary and secondary illness.
- SMS is the main technology used for treatment compliance, with an increasing focus on voice, web browsers, and health hotlines that mimic traditional customer service call centers. Studies found mixed results regarding effectiveness and impact on health outcomes. Further studies that investigate which medium is the most effective for specific conditions are required to enable more thorough understanding of the role of mobile technology for behavior change related to treatment compliance.
- Some randomized control trials studying treatment compliance were found, but were often limited by sample size to produce statistically significant studies. A strong focus on feasibility and usability was found with little connection to health outcomes.

### 4.3.1. Monitoring / medication compliance / appointment in the context of CBAs

This section overlaps with the section on SMS for education and awareness above, where the use of mHealth applications in CBA programs to make appointments with referees or with CBAs for upcoming supervision visits were discussed (See 4.1.1).

[15] http://www.wisepill.com

[16] www.simpill.com

### 4.3.2. Acceptability, feasibility and scalability: Monitoring/medication compliance/appointment

In the studies included in the review, some have reported that there was positive acceptance by both patients and healthcare workers of using this technology for remote medication monitoring, health education, and communication.

Similarly to the issues mentioned under the section on education and awareness, language issues have posed challenges for using SMS reminders for adherence to medicines (see 4.1.2), as SMSs are limited to 160 characters. Scaling up of SMS reminders will also only be feasible if cellular networks provide severely discounted or free SMSs or if the SMSs can be geared toward certain groups. Content and timing of the SMSs for their information utility is also important. There is a need to explore whether receiving the SMSs makes recipients feel like they belong to a group or particular community which may represent a worthwhile benefit in itself.

The risk for these types of interventions is that they may complicate clinical practice with more communication options/burdens, and decrease the important element of direct human interaction. However, though the human aspect of patient / health provider interaction must not be forgotten or under emphasised, there's always great value in increasing communication between the patients and the clinicians.

Also, as noted by Mechael et al (15):

> ”The scope of mHealth for treatment compliance is limited in areas where access to health services and drug supplies is poor or inconsistent. Programs are most effective when patients are able to access treatment when needed. Health systems strengthening as a whole may be important to the success of mHealth for treatment compliance as reminders to attend clinics without reliable services and a steady drug supply is meaningless.”

## 4.4. Disease / emergency tracking / warning systems:

This category includes projects that have used technologies to provide early warning of diseases and epidemic outbreaks. As summarized by Open Mobile Consortium in their description of GeoChat (26):

> “When a major humanitarian crisis occurs, every second matters for the affect community. People may be trapped, injured, or sick, and the longer it takes responders to reach them, the poorer the outcome is likely to be. What is needed is a response that is agile, efficient, and effective, where diverse groups – NGOs, the UN, national governments, military, and the local community – self-organize temporarily into a coherent, coordinated whole to provide assistance to a population in need. Unfortunately, more often than not, coordination among relief organizations today is far from adequate. Responders in the field find it difficult to keep one another in the loop about what they are doing and where. They have a constant sense that they out of touch with headquarters, and headquarters with them. Often, they lack adequate means to engage members of the local community and

ensure that they participate meaningfully in the response. In this category we have also included projects set up to track medicine stock outs."

Several projects have used mHealth innovations to track incidents of epidemic diseases. For example, the **AESSIMS project**[17] in India (Andra Pradesh) aimed to improve immunization services for diphteria, hepatitis B, Japanese B encephalitis, measles, pertussis, tetanus and polio. The managed to tracked these diseases on a real-time basis with the support of a combination of mobile phones and web-based technologies.

In Uganda, only two projects were identified that was specifically targeting disease / emergency tracking. In this project carried out by **Healthy Child Uganda**[18], the purpose was for CBAs to use cell phones for sending emergency alerts, requisitioning for supplies in support of ICCM activities in treating children with diarrhea, malaria and pneumonia. The concept will look at supporting ICCM activities using mobile phones as alert devices in emergencies and to track supply. The other project is implemented by Foundation for Innovative **New Diagnostics (FIND)**[19] who has deployed RapidSMS in two districts in Uganda (Gulu and Kabale), working with Health Centers to submit and map weekly epidemiological, malaria case management and ACT stock reports.

Another project, which also focuses on medicine stock-outs, is SMS for life[20] in Tanzania. This initiative is a 'public-private' project use a combination of mobile phones, SMS messages and electronic mapping technology to generate information on stock availability of ACT and quinine injectables which is delivered on a weekly basis to all health facilities to eliminate stock-outs and improve access to essential medicines. The process enables timely tracking and management of supplies and their delivery to the communities where they are needed most. During the pilot, malaria medicine availability improved significantly in all three districts where the project was implemented, such that at the end of 21 weeks, stock-out rates were reduced to 0 %, 47 % and 30 % respectively.

The Key Points of using mHealth for disease / emergency tracking according to Mechael et al (15) are:

- The most natural linkage between emergency medical response systems and mobile phones is access to transportation using a centralized dispatch phone number. However, no studies were found that discussed this type of deployment in LMICs.
- Significant literature investigating the use of mobile technology for monitoring elderly patients in high-income countries with integrated feedback mechanisms during an emergency was found. It is evident that high-income countries are preparing for the

[17] In: Vital Wave Consulting. mHealth in the Global South Landscape Analysis. Washington, D.C. and Berkshire, UK: UN Foundation-Vodafone Foundation Partnership.2008

[18] http://www.healthychilduganda.org/

[19] http://www.finddiagnostics.org/

[20] www.rbm.who.int/psm/smsWhatIsIt.html

predicted demographic shift in the next 5 to 10 years. Such systems are appropriate for urban areas and increasingly for rural areas in LMICs.

- Reports were found that described the use of mobile technology during natural disasters such as the Indian Ocean tsunami, Hurricane Katrina, and the devastating earthquake in Haiti. Mobile phones were primarily used for citizen reporting of food, health, and shelter needs and to coordinate search and rescue missions.
- SMS provides a significant opportunity to alert citizens before, during, and after an emergency, given the fact that it is not only an audio signal, like a siren, but is also a method to communicate calls to action.
- Studies investigating the use of mobile phones for telemedicine during an emergency found them to be an effective means to treat patients faster and more accurately by consulting physicians via phone while in transit, sending images for faster diagnosis and using video capabilities when available.

Mechael et al (15) also concludes:

> ”No studies looking at the direct impact of mHealth in emergency response in a LMIC was found, outside of their use in mitigating the effects of natural disasters. Some studies conducted mock scenarios, which seemingly eliminate the panic and chaotic nature that defines an emergency, and likely skew outcomes. Most studies investigating the use of mobile phone and wireless technologies for remote patient monitoring and point of care emergency response were either proposed systems, pilot projects, or feasibility studies with small sample sizes. Almost no studies had conclusive clinical evidence, making the advancement of implementation challenging.”

#### 4.4.1. Disease / emergency tracking / warning systems in the context of CBAs

Few of the projects identified in this category would be applicable to CBAs directly. The main utility of mHealth innovations in this area that would be to set up systems for tracking medicine stock-outs at health facility level, such as the project run by SMS for life or FIND, which use RapidSMS to map medicine availability in health facilities. These projects have so far only focused on antimalarials but could easily be expanded to also include other ICCM medicines.

In areas where outbreaks of malaria and cholera often take place, mobile telephones could potentially be used by CBAs to report cases observed in their communities. Daily statistics of cases can be delivered using rapidSMS. CBAs can also be instrumental in minimizing the impact of outbreaks by dissemination educative information to populations on how to prevent or handle these diseases.

### 4.4.2. Acceptability, feasibility and scalability: Disease/ emergency tracking / warning systems

Experiences from the SMS for life project in Tanzania, which set out to track ACT availability in health facilities concluded that organizations are much more likely to commit their resources for piloting new mHealth initiatives when the following conditions apply:

- The project is well documented including clear deliverables
- Participation is for a short pre-determined timeframe and exit date (one year or less)
- All partners display a strong affinity or emotional connection with the goal
- Each partner has control over its particular area of expertise and deliverable(s)
- Funds do not need to be approved and transferred to a third party

In the review conducted by Mechael et al (15), the team concludes that:

- There is a lack of emergency monitoring and tracking infrastructure in LMICs and the use of mHealth as an enhancement tool will be a challenge
- Beyond voice, text, and basic image transfer, funding in LMICs is not adequate to support more complex telemedicine systems for use in emergency monitoring and tracking
- Regulations such as network capacity bar the effectiveness of emergency monitoring and tracking
- There is a lack of nationwide alert systems that are understood by citizens during an emergency
- Infrastructure costs (transportation and roads) are prohibitive, especially for nationwide emergency call centers

## 4.5. Health administration systems

The definition of a health administration system is the back system that receives the health data and statistics for analysis, dissemination and use to support decision making (14). These systems are used for epidemiological research, tracking of indicators for monitoring and evaluation, and financial and cost reporting for supply management.

Mozambique has a number of experiences of using computer based applications for health administrative systems to support the collection of health data and statistics for analysis, dissemination and use to support decision making and handheld (PDAs) technologies for health record access. For example, the implementation of DHIS (14) was piloted in three provinces of the country and for several reasons it did pass the piloting phase (27). Today the system is implemented in all provinces in a system called "módulo básico". Módulo básico is installed in all the provinces and districts, but is still a standalone system. The first pilot of PDAs for monitoring malaria also faced its challenges that lead to the redesign of the application and now installed at all provincial directorates (6).

A key project in Mozambique is the **Mozambique Health Information Network (MHIN)**[21]. MHIN strengthens the Ministry of Health of Mozambique (Ministério de Saúde, MISAU) capacity to collect,

[21] http://www.healthnet.org/mhin

transmit and report Health Management Information System (HMIS) data. MHIN provides a two-way access to information utilizing the existing cellular telephone network and low-cost, simple to use, and energy efficient handheld computers (PDAs) for supporting health information dissemination, data collection and reporting, and email exchange. Data transfer from/to PDAs is facilitated using wireless access points (called African Access Points or AAP, developed by AED-SATELLIFE) and a linux server located in Maputo at MISAU. District Health Offices receive data from various levels of health centers using the MHIN that include immunization registers and reports, disease surveillance data, and reports related to other health problems as required by MISAU department of Health Information System. The DHO also use the network to receive data for monitoring drug usage and stocks, which is used for ordering medicines.

A total of 66 health facilities in Chockwe, Manjacaze, Morrumbene, Namacurra and Nicoadala districts are currently using MHIN for capturing and transmitting HMIS data, and for email exchange. MHIN allows district health offices to receive high quality HMIS data from rural health facilities in time. Data received from health facilities is seamlessly synchronized to MISAU database at the districts. The Districts automatically generate monthly reports and forward electronic copy of the report to Provincial Health Directorate without delay. AED and MISAU are currently working with Eduardo Mondlane University to conduct cost-benefit analysis of MHIN by comparing the data collection and report generation costs associated with MHIN and paper based approaches. The project also started delivering health content to rural health workers pertaining to diagnosis, treatment, and prevention of major health problems such as malaria and TB. Health content is "broadcast" from the server at MISAU via the cellular network to African Access Points located at health facilities. Health workers download relevant health content to their PDAs and use it as a reference for treating and/or providing better care to their patients. MHIN will expand its services to additional two districts in 2008-2009. Monitoring and evaluation results show that overall, there was up to 50% improvement in the quality of the data in the areas where the project has been implemented.

The same team who is implementing MHIN is also working in Uganda where they are involved in a project named **The Uganda Health Information Network (UHIN)**[22]. The project is set up in a similar way as MHIN and the server is located in Kampala. Health workers use the PDAs to collect public health data at the community level. They then upload that data and e-mails they need to send to AAP via infrared, Bluetooth or wi-fi at a rural health facility. The AAP sends the data and messages over the cellular network to the server in the capital, which routes them to the correct recipients and sends back messages, data, and health information clinicians need. For Uganda, which has one of the highest burdens of disease in the world but also some of the best cellular telephone coverage in Africa, the marriage of handheld technology and cellular telephony represents a watershed moment in the battle against information poverty. Currently there are about 600 health workers in Rakai, Mbale, Manafwa, Lyantonde, and Bududa districts using UHIN for facilitating data and information exchange. District Health Offices receive data from various levels of health centers using the UHIN

[22] http://www.healthnet.org/uhin

that include monthly Health Management Information System (HMIS) reports, disease surveillance data, reports related to HIV/AIDS, tuberculosis, malaria, data for monitoring drug usage and stocks, which is used for ordering medicines. Additional tools for electronic data collection of non-routine sources of information especially in relation to community-based health care, nutrition and environmental sanitation programs have been developed and rural health facilities are using the network for data capture and reporting to district health offices and the ministry of health. Rural hospitals also use the PDAs for capturing data on daily register forms such as PMTCT, inpatient, lab, HIV Counseling, ART administration, ART and pre-ART unit daily registers. Continuing Medical Education (CME) targeted to doctors, senior nurses, and senior clinical officers ("tier-1"), and to CBAs ("tier-2") is regularly broadcast though the UHIN. Both tiers of health workers receive content three times a week via PDA pertaining to diagnosis, treatment, and prevention of major health problems such as diarrhea, pneumonia, malaria, HIV/AIDS, and tuberculosis. In addition health workers receive daily news from mainstream media on a daily basis through the network. Cost-effectiveness study of UHIN conducted by independent consultants in 2004/5 showed that the network delivered a 24 per cent savings per unit of spending over the traditional manual data collection and transmission approaches.

The Key Points of using mHealth for health administration systems according to Mechael et al (15) are:

- Few studies investigating health information and administration systems for health workers in LMICs were found, indicating a need for further research in this mHealth thematic area.
- Electronic Medical Records are a key aspect of health information systems; however, no literature was found that supported the use and development of Electronic Medical Records on mobile phones. This foundation is a key cornerstone to mHealth development, which has the potential for collecting data and developing treatment compliance and disease management programs.
- The primary barrier found to implementing health information systems is clinician resistance. Mobile phones may enable access to information easier, but not necessarily faster, depending on the level of integration of systems, which stands to significantly hinder adoption.

### 4.5.1. Health administration systems in the context of CBAs

There is great potential to link CBAs to health administration systems by using mobile technologies to collect, analyse and disseminate data and receive reports with aggregated information for feedback. This would offer an added value to the government, which would have all the data integrated and a real picture of health care provision in the country.

Another project in Uganda is **ICT4MPOWER**[23]. The 3-year proof of concept project aims to increase the effectiveness of the Ugandan health system and empower CBAs in the Isingiro district and

[23] http://www.spidercenter.org/category/ict4mpower

Mbarara region for better health outcomes of the rural population. Launched in April 2009, it is not only meant to aid referrals and patients follow up, but should also ensure transfer of skills and knowledge to health workers, especially those working in rural settings. The objectives are:

1) Put in place the necessary E-infrastructure with support from UCC
2) Install an effective Electronic Health Record Management system
3) Creation of a unique patient ID system
4) Establish an Electronic Patient Referral and Feedback system
5) Establish a mechanism for Tele-consultation support
6) Establish a national drug and stock management system
7) Establish a system for Human Resource Development
8) Create opportunities for Networking with various stakeholders
9) Empower the VHT with m-learning materials
10) Facilitate communication between the facility and the VHT
11) Harmonize patient referrals procedure and feed back
12) Operationalise the concept of PHC at community level
13) Facilitate mobility of the VHT
14) Ensure the continuity of care throughout the health care system with Electronic Health Record (EHR) and Unique Patient ID
15) Provide for secondary opinions through telemedicine and
16) Improve health care seeking behavior of house holds

Phase 1 of the rollout of services to Isingiro is planned for October 2010-January 2011. Phase 2 of the rollout will cover the whole district, and around 1200 end-users, which includes VJTs, HC2, HC3 and HC4. Phase 2 will last until December 2012. Phase 3 of the rollout is planned to start from 2013 and onwards. Preparations for rollout to other districts are on the way with clear guidelines available sometimes in December 2010-July 2011.

Another relevant project is **CommCare**[24] in Tanzania. CommCare is a community health mobile platform with the aims to enable CBAs to provide better, more efficient care while also enabling better supervision and coordination of community health programs. According to a project paper (28):

> "CommCare software is open source code that can run on a wide range of Java-enabled phones. It is an extension to the JavaROSA codebase (code.javarosa.org), which is being used to support many different mobile health and data collection applications in low-income countries. CBAs are provided with a phone running CommCare that assists them to manage household visits and plan their day. Once registered, a CBA can login with a personal password to access their cases. CommCare guides the CBA through a particular type of visit, asking questions and dispensing advice for both the CBA and the patient (pregnant woman or patient). Upon completion of the visit, the CBA has the option to send their completed form immediately or at a later time. If a referral has been made during the follow-up visit, the

[24] http://www.dimagi.com/commcare/

referral will be stored on the phone until a referral form is filled out specifying that the patient went to the clinic and received care. Each of these four options is used at different intervals, some occurring only once (registration, close), some occurring monthly (follow-up), and some occurring only if circumstances require (referral). Once a new case is registered, the patient is visited by a CBA for both regularly scheduled follow ups and visits specific to clinic referrals. The registered case remains active until a close form is filled out, after which the case is considered complete. The data is submitted over the cellular network using GPRS, which is vastly less expensive than text messaging per data unit in Tanzania. When connectivity is not available, forms are saved on the phone and submitted later. The target is to have 1,400 CBAs using CommCare by 2014. During the study time, the CBAs conducted a total of 52 visits using CommCare. From initial observations, it seems clear that CommCare will save time and result in faster and more accurate reporting than the paper-based system. It took the CBAs two minutes and 10 seconds to fill a form on the phone. This is about the same as with the paper-based approach. However, the 4 hours each month spent by CBAs to compile reports is avoided. The initial training for the simplest version of CommCare took about two hours of group instruction."

### 4.5.2. Acceptability, feasibility and scalability: Health administration systems

Some lessons learned from ongoing projects in the area of health administration systems, according to Mechael et al (14) are:

- Shift from health information systems being designed solely for clinicians to including CBAs.
- Key to success weighs heavily on user friendly products and systems (i.e., portability, task structure, spatial mobility, system reliability), understanding of local information and communication technology (ICT) usage habits, and integration within existing health systems
- Clinician resistance to new technology is a significant barrier to implementation of mHealth systems. Broader discussion of incentives for adoption is required.
- Cost and infrastructure implications for nationwide community- and facility-based data collection and universal access to support systems are unknown.

With regards to acceptability of mHealth administration systems, the CommCare project learned that clients sometimes refused to allow the CBA to use the phone when she saw the CBA had a different phone than was used at the previous visit. They also concluded that simplicity is paramount and that it is better to include few specific functions rather than making a product that tries to do everything (28).

Other lessons learned were that true partnerships with the users throughout design and implementation are critical. The CommCare application was developed in rapid iterative cycles working closely with five CBAs over the course of several months which stimulated ownership among the CBAs and willingness to use the system (28). The recommendation to consider the acceptability of new technologies to the target user and target beneficiaries also came out in the

International Stakeholder analysis by Strachan & Benton (16), who concluded that "CBAs should be consulted on best approach when introducing any new technologies that require their uptake".

### 4.6. Analysis, diagnosis, and consultation

The use of electronic technologies (mobile and internet based) to provide support for diagnosis, analysis, consultation and treatment activities of remote caregivers is increasingly common. mHealth enabled diagnostics can help remote health professionals to diagnose the illness and prescribe treatment. Some examples are:

- Applications that can provide respiratory or pulse rate counters, gestational age dates calculator, drug dose calculator, drip rate calculator, and drug reminder alarm installed in a mobile phone and in some cases linked to a sensor.
- Health care providers use mobile phones to record information about the patient's status, medication adherence, and other relevant information. In some cases the health care provider can provide the treatment at the moment of collecting the data. In other cases the data is sent via SMS to a central data base, and through a web based application the managers can access and monitor incoming information before they respond.

Other applications still under development include mobile phone devices which can be used as diagnostic tools. One example is t the **CellScope**[25], where the health provider can load samples of blood, urine or other bodily fluids into a modified mobile for diagnosis of diseases such as malaria, HIV and TB.

According to Mecheal et al (15) :

> "The use of telemedicine can dramatically help overcome the barriers to accessing expertise and relevant information. While there are applications of telemedicine in the literature, there are considerable differences in how it is applied in LMICs, with different contexts and potential, and as a result, outcomes. Tele-consultation is defined as the electronic transmission of medical information (voice, data, video, documents, digital images, ECG, heart sounds) from one site to another using telecommunication technologies. This idea is further supported by a review of telemedicine in LMICs, which found that it allowed health care professionals to use connected medical devices in the evaluation, diagnosis, and treatment of patients over distances with the help of networking technologies, database management, and application software. Clearly, the definition is wide, and the review encompasses many diverse uses for the advancement of patient care."

A successful project that has implemented mobile decision support is the **Mobile e-IMCI**[26] project in Tanzania. Here, a pilot study was done to test the use of an electronic job aid on a PDA to improve

[25] http://cellscope.berkeley.edu/

[26] http://www.dimagi.com/mobile-e-imci/

adherence to the Integrated Management of childhood Illness (IMCI) protocols in rural Tanzania. According to a project document written by DeRenzi et al (29):

> "The team developed and piloted e-IMCI, a program that runs on a mobile device and guides a health worker step-by-step through the IMCI treatment algorithm. The current system covers only first visits for children 2 months to five years old, and does not cover immunizations or malnutrition. They field tested the prototype system at a dispensary in Mtwara, Tanzania. During early pre-testing the team extended e-IMCI to allow the clinicians more freedom to choose drugs and use approximate measures for certain investigations, to allow the use common sense to interpret the protocols when necessary. The formal investigation consisted of structured interviews with clinicians, and observation of patient encounters with and without e-IMCI. The team observed 24 patient encounters without e-IMCI, and 28 with e-IMCI. Using the e-IMCI prototype, clinicians performed 84.7% of investigations required by IMCI, a significant improvement over the 61% of investigations observed during conventional practice ($p < 0.01$). The current prototype is almost as fast as the current practice, where the book is rarely referenced. The team analyzed 18 trials comparing the time by the same clinician in a traditional IMCI session to one using e-IMCI; the average for both was about 12.5 minutes. The training time for e-IMCI was less than 20 minutes, after which clinicians were easily able to train each other. The four clinicians unanimously preferred e-IMCI, citing it as faster and easier to use than the chart book. These results and our experience suggest that e-IMCI is fast, improves adherence, and thus the quality of care, and also affords the health worker enough flexibility to apply their skills on a case-by-case basis."

In the review report produced by Mechael et al (15), the authors conclude:

> "The types of health information that have been shown to be more accessible through mHealth are treatment protocols, drug information, and guidelines for facility-based health workers. While programs exist to provide similar tools for CBAs, limited research has been done to assess their effects. These point-of-care support tools also enable real-time data collection through structured question and response fields, which may—if implemented effectively to capture the data needed for national surveillance and health information systems reporting—displace traditional approaches to HIS, which focus on the implementation of data collection platforms for aggregated facility- and community based health information within a service delivery context."

And:

> "There is a shift toward decision support tools aimed at improving quality of care that also enable data capture for more real-time reporting and use of information for management purposes. As in other areas, the trials have tended to be of single solutions, rather than integrating those with broader patient and provider information flows. Using PDAs and mobile phones at the point of care can provide health professionals and CBAs with access to pertinent information to increase the accuracy of diagnosis and treatment in an effort to improve quality of care and in turn health outcomes. One form of this links current patient information with historical patient information from the Electronic Medical Records (EMR)

and uses sophisticated decision support software to guide health professionals. At the same time, increasing numbers of support tools and mobile phone-based systems are being used to enable access to static and algorithm-driven health information for health professionals."

In Uganda, 6 projects were identified that have tested mHealth applications for analysis, diagnosis and consultation. These ranged from using mobile phones to send medical test results through SMS or email to patients and health workers, to use wireless devices to provide clinical training and patient care support services and to using mobile phones in combination with microscopes to conduct automatic classification of malaria slides using computer vision techniques.

### 4.6.1. Analysis, Diagnosis, and Consultation in the context of CBAs'

A number of programs in recent years have introduced 'rapid SMS[27]' to support the CBA during their encounter with a patient. RapidSMS has been used in various ways and by virtue of being open source can be tailored to program needs. The suggested use in the context of this exercise was as a job aide where the CBA sends in patient information *via* SMS and receives an SMS back instructing them how to proceed. Such an approach may present an opportunity for demonstrating the effectiveness of the program to the CBA thus motivating them both to stay in role and perform.

One such project that has been tested in Colombia is the **Cellphone GuideView system[28].** This system uses existing clinical guidelines created by medical experts and breaks down complex diagnostic and treatment procedures into simple steps using an authoring tool. Text, pictures, audio, and video are embedded in the individual steps to help with comprehension and ease of use. The guides are stored on a Smartphone's memory card, enabling CBAs to walk through the steps as they treat patients. The CHW can then transmit images, data, and audio to the remote expert for further advice. The guide views contain 225 steps each—in the areas of wound care, pediatric fever and musculoskeletal traumas such as contusions, dislocations and fractures.

### 4.6.2. Acceptability, feasibility and scalability: Analysis, diagnosis, and consultation

Some lessons learned from various mHealth projects using electronic technologies to provide support for diagnosis, analysis, consultation and treatment activities are:

[27] Rapid SMS is a free and open source framework for developing SMS-based applications. The open source nature of the underlying code allows implementers to build their own tools and design customized solutions. It can be used for dynamic data collection, for dynamic data collection, logistics coordination and communication, leveraging basic short message service (SMS) mobile phone technology (http://www.rapidsms.org/ accessed 30/07/2010).

[28] http://research.microsoft.com/en-us/collaboration/focus/health/smartphone_clinical_guidelines.aspx and http://www.slideshare.net/gueste312b0/the-guideview-mhealth-system

- Procuring and setting up the necessary equipment and phone lines was time consuming and arduous. Many health-care providers lack telephone and Internet connectivity, which affects their ability to access the online services.
- It is necessary to provide phone lines to hospitals and health centers, which will help care providers tap into the online services
- Patient triaging with lay counselors is feasible using decision support on hand held devices
- Required training of health facility providers in using PDAs take less than 1 hour
- Clinicians, nurses and counselors were receptive to the technology of clinical decision support in PDAs
- Developing questions in local language is important
- Clinicians who have tried clinical decision support on PDAs preferred these to following the paper based algorithms, citing it as faster and easier to use.
- Technologies will not get health workers to take temperatures, but it might help supervisors to get them to.

### 4.7. Other mApplications

One project that used an interesting mHealth approach, but that did not fit under any of the aforementioned categories, was **Mobile Video for Community Health Workers**[29] in Tanzania. The project involved the creation of a series of health education videos that could be played on cell phones by BRAC Tanzania's CBAs during home visits. Each CBA visits 150 - 200 homes each month, asking health related questions and providing healthcare information. The videos were designed to provide the CBA with additional support material they could use in conjunction with a mobile phone based tool, CommCare.

### 4.8. Mobile devices: Forms and Shapes

The type, nature and size of the devices used in the m-health innovation cases also had impact on the CBAs. In a report by Iluyemi and Briggs (30) the type of potential mobile technologies for CBAs are reviewed. The authors conclude:

> "Smartphones can enable almost real-time access to health data over the internet which can assist the CBA for "bed-side" decision making. This is to allow CBAs to be able to analyse collected health data on the devices for immediate decision making. To forestall this and to improve the devices' durability, they need devices that are tropicalised in order to optimize their performance. An action-oriented research focussed on developing appropriate mobile computer devices for CBAs has also found this innovative engineering as important to sustainable mHealth innovation diffusion. First generation mobile phones were initially deployed with the CBAs in the Cell-Life case because of the security concern of carrying about an expensive device in a crime-ridden environment. However, due to negative impacts on the CBAs healthcare activities, newer devices including Smartphones and advanced PDAs

[29] http://www.comminit.com/en/node/320595/38

were subsequently deployed. It has therefore been reported that these newer technological innovations with bigger screens, improved and longer battery life and ability to receive feedback on sent information were rated positively by the CBAs. Longer battery life is very important as most developing countries do not have the guaranteed and continuous power supply required for recharging device batteries, especially in the rural regions. The effect of this environmental constraint was also reported and solar energy has been adopted to overcome this constraint. As these different device characteristics could impact on CBA's PHC activities by ensuring sustainable m-health innovation's diffusion, a case can be made for newer advances in mobile ICTs. Low-cost laptops currently epitomised by the One Laptop Per Child (OLPC) device (codenamed XO1), presents a opportunistic solution for developing countries' CBAs. The XO1 is built to withstand the harshest environmental conditions with an intuitive user interface. It could enhance the sustainable diffusion of mhealth innovations for CBAs in developing countries. XO1 and its inspired competitors have bigger screens, longer battery life and more processing power. Consequently, they have more to offer developing countries' CBAs than smaller PDAs and mobile phones. In addition, the presently quoted cost of USD180 is more or less equal to or competitive with the costs of mobile phones and PDAs."

And:

"Advanced eHealth applications such as ECG, digital stethoscope, electronic health records and tele-consultation web services are currently being pilot with the XO11. The advanced camera and wireless connectivity embedded on the XO1 could also be very useful for real-time tele-consultation between a CBA and a remote superior. Moreover, laptops were initially deployed with the CBAs in the EHAS case but these were not sustainable because of frequent breakdowns induced by "technology-environment misfit". Most of these laptops have since been replaced with cumbersome, power hungry and archaic desktop computers."

In the Laptop and Smartphone review conducted by Malaria Consortium, five main groups of devices were reviewed (17):

1) Laptops
2) Notebooks (small/compact laptops)
3) Tablet PCs (laptops/notebooks with touch screen)
4) Smart phones
5) Low cost rugged laptops
6) Miscellaneous

A total of 60 devices were reviewed and rated based on the criteria mentioned in the methods section. Each criterion was weighted (1-5) based on the importance of this criteria in relation to CBA worker performance, and given the specifications of the device they were all scored and ranked. The ten devices that scored highest were:

| Type of device | Manufacturer | Brand name | Price (USD) |
|---|---|---|---|
| Computer | Quanta Computer | OLPC | 100 |
| Computer | 2GoPc | 2go™ | 529 |
| Computer | Dell | Inspiron 2100 | 363 |
| Computer | Hivision | NB0700 | 98 |
| Computer | Hong Kong Easybuyberry Co. Ltd | 10.2' Zenithink | 170 |
| Computer | Archos | 10.1 . | 295 |
| Smartphone | Huawei | U8800 | 239 |
| Smartphone | LG | GT 450 | 270 |
| Smartphone | Cesim | V800i | 130 |
| Smartphone | CIPhone | G15 | 139 |
| Smartphone | Fly Ying | F029 | 89 |
| Smartphone | Tecno | | 180 |

A number of the abovementioned devices will be tested in field conditions in an upcoming study by Malaria Consortium in 2010.

## 5. Conclusions and areas for further research

A key challenge for mHealth projects have been to move from pilot projects to national scalable projects. However, with partnerships formed between governments, technologists, NGOs, academia, and industry there is great potential to improve health services delivery using mobile health in low income countries. mHealth harnesses the increasing presence of cell phones among diverse populations and uses phones to deliver increased healthcare services to those receiving incomplete care.

In a paper produced by Waruingi and Underdahl (1), the following conclusions are made:

> "A successful mHealth project will be driven by the needs, environment, and existing technology of local users in light of recent experience. Collaboration with local organizations and government as well as the ability of the program to develop organically within the targeted population are the only ways to ensure both long-term sustainability and scalability. For effective implementation, a mHealth solution must start on a small scale with relatively simple cellular technology, and the best and most cost-efficient pilot will be open source. A pilot project that reflects these characteristics—understanding the mobile context of end-users, building on past experience, and making the program scalable and open source—holds the greatest potential to improve public health services delivered in the developing world."

And:

> "The use of mHealth applications requires health literacy skills. Patients cared for via mHealth must be able to understand and interpret basic health information in ways that enhance health. Patients must understand their medication, nutrition, and treatment regime to manage their disease. mHealth applications can enhance this knowledge, but patients

with low health literacy are less likely to use technology for information health information. Cultural diversity and language in developing countries are limitations of mHealth applications. Various cultural values, belief systems, and customs affect how patients are willing to care for their health. Customizing mHealth applications to meet the needs of this diversity is one solution. Access to mHealth technology is another drawback. Mobile phone consumes chargeable minutes; extra minutes needed for medical consultation may not be affordable to many people living in developing countries. Mobile operators generate significantly less revenue from customers in emerging markets than they do from customers in more developed regions."

According to Waruingi & Underdahl (1), the following points are recommendations for implementing mHealth at the national scale:

- Assess the current state of eHealth, telemedicine, and mHealth. Then use these assessments to identify informal/organic practices and formal mHealth implementations, opportunities to strengthen or extend existing eHealth systems to more remote areas, and gaps in information and communication flows that can be supported through mobile technologies.
- Identify and document existing eHealth/telemedicine initiatives and systems, to ensure that they are interoperable and use an ecosystem approach, as well as formal and informal mHealth practices.
- Identify priority diseases and health conditions, including country-specific MDG targets, and explore critical pathways for integrating or extending technology.
- Examine and document current workflow and working relationships (information and communication).
- Identify the role of voice and visual data or other media and channels.
- Identify eHealth capacity and business cases for services including software customization, project management, monitoring and evaluation.
- Develop a short- and long-term strategic plan, implementation plan, and budget and define roles and responsibilities as well as mechanisms for accountability.
- Develop guidelines, policies, and accountability systems.
- Establish targets and measures of success.
- Monitor and evaluate and adapt to findings and changing environment."

According to Mechael (18), three factors will likely contribute to making mHealth solutions scalable:

1) increased demand for the services from consumers
2) strategic partnerships between industry, governments, implementers, and researchers to support large-scale implementation and evaluation of bottom-up and top-down mHealth systems and applications, and
3) an enabling policy and operational environment.

As concluded by Blynn (13):

"mHealth has been shown to be able to greatly improve the health and lives of many individuals in the developing world. As more pilot projects are deployed, some will fail while others will deliver exciting successes, but the outcome depends on characteristics of the projects to determine whether they can be scaled up for widespread sustainable use. Previous practice has illustrated success through remote drug monitoring, information dissemination, data collection, and diagnostic support. If a project meets the needs of the population and uses existing technology, is relatively simple, has the ability to develop within the population to meet varying needs, and collaborates with local organizations, it has the greatest chance of bridging the gap between knowledge and action to save lives."

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**Annex 1. Table for the presentation of mHealth projects**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Category** | **Innovation** | **Source** | **Methodology** | | | **Issues which may impact feasibility, acceptability and scalability** | **Moderators of impact** |
| | | | **Approach** | **Tools** | **Evidence** | | |
| **Education & Awareness** | **One way SMS Messages:** Typically using: -delivery of educative messages about HIV in Please Call Me SMS Service or Text to Change - spread of SMS with phone numbers for HIV/AIDS and TB centres offering information on health care, counseling and local testing clinics -use of games in mobile phones to create awareness of HIV/ADIS by Play and Learn method | Implemented by ZMQ Software Systems. Landscape analysis by VitalWave 2008 and http://www.comminit.com/en/node/133100/2781 | **Freedom HIV/AIDS (also Africa Reach Program) / various countries** Targeting school-age cellular subscribers in India, Kenya, Malawi, Mozambique, Namibia, Tanzania, Uganda. A gaming initiative that uses mobile phones and computers to engage people in entertaining, awareness-raising activities regarding HIV/AIDS. This project draws on IEC methods to educate people about HIV/AIDS | | Reaching over 42 million mobile subscribers in India, with download of 10.3 million game sessions in 15 months from launch; more games downloaded in smaller cities and towns than large urban areas. | | Designed to appeal to different gaming mind-sets as well as the psychology of mobile phone users, the games were crafted in such a way that both the casual player and the game enthusiast might be drawn to play. |
| | | Landscape analysis by VitalWave 2008 | **Frontline SMS / various countries** Text-message program offered free-of-charge to non-profit organziations | Mobile phone, computers. The FrontlineSMS pays for software. | | | A potential downside is that poorly designed or implemented messaging risks antagonizing, |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | for use in various mServcies. Target is NGOs in Africa | | | | desensitizing, or confusing the public. |
| | | - DPS Health 2010, DPS Health and UCLA Launch Text Messaging for Health Program in South Africa, Press release, 22 Apr. 2010<br>- O'Sullivan, M. 2010, Project Uses Texting to Help South African Diabetes Patients, Voice of America, 10 June 2010 | **Text Messaging for Health / South Africa**<br>The initiative aims to study the effectiveness of a SMS intervention among low-income women in South Africa living with type-2 diabetes. The pilot study is designed to determine if regular support from a peer (who also has diabetes) using a new text messaging application can provide simple and affordable approaches of peer-to-peer social support and offer effective educational and motivational messages. | | | | |
| | | - Dimagi Inc. 2009, HIV Confidant<br>- Dimagi Inc. 2009, HIV Confidant Screenshots<br>- Welz, T., Herbst, K. 2008, Anonymous HIV Testing With Participant-Controlled Access to Results Using Handheld | **HIV Confidant / South Africa**<br>The HIV Confidant project aims to encourage HIV/AIDS testing by ensuring secure distribution of test results through the use of handheld | | No reports of breaches in confidentiality or unauthorized access to HIV results. The system was cost-effective by optimizing the use | Has potential for use in any research or program requiring the anonymous linkage of confidential data (which participants may choose to know) with clinical or epidemiologic information. | Besides HIV, examples would include screening for sexually transmitted infections or genetic abnormalities. The system also has potential in VCT outreach where it |

| | | | | | | | |
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| | | Computers..., Sexually Transmitted Diseases, vol. 35, no. 4, pp. 372-376 | computers and standard encryption techniques. The project wants to contribute to enhancing a number of national indicators and addressing excluded groups and problems. | | of fieldwork, counseling and laboratory staff. It removed the need for separate blood draws and laboratory tests for parallel VCT as well as for printing and dissemination of thousands of results. | | would allow the paper-free, confidential dissemination of HIV results to hard-to-reach populations in nonfacility settings. In this large population-based HIV survey, the system allowed us to successfully address a multitude of ethical, logistic, and scientific challenges. |
| | | | **"Smile for You" campaign.** To provide cleft palate surgery for children in South Africa used "Please Call Me" text messages, which mobile phone users send at no cost, to identify potential candidates for this free care | Vodacom donated spare space in a million "Please Call Me" messages to ask recipients if they knew of children needing this specialized surgery | Phone and text message inquiries rose tenfold, and forty-two children were identified for surgery—more than three times the number identified during a traditional media campaign lasting six weeks. | | |
| | | Implemented by the African Radio Drama Association (ARDA). http://www.comminit.com/en/node/312117/38 | **Majalisar Mata Manoma / Nigeria** A project that involved creating spaces for women farmers in the rural community in Nigeria to meet and engage with radio. The project, involved the | Women in the listening clubs were also trained to use a cellphone to interact with the radio programme. | Women ask more questions about issues to be addressed on the programmes, and are generally much more vocal in discussions. The club has also recently evolved | | According to ARDA, the participation of two key male figures - a community elder and a school teacher - helped curtail possible opposition from the spouses of participating women. However, mobilising |

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| | | | development and broadcast of a radio programme designed for rural farmers, particularly women, as well as the establishment of a listening club. | | into a formal association to be used as a vocational development group. | | the women was still a challenge, as their heavy daily workload made listener group activities a secondary priority. |
| | | http://www.mobilebehavior.com/2009/08/11/text2teach-empowering-classroom-learning-through-mobile/ | **text2teach / Philipines** Project provides a way for teachers to request educational videos via text message, with the videos delivered to a television at the school via satellite. | | | | |
| | | http://www.comminit.com/en/node/291748/38 Clemmons, L.G. 2009, Cell Phone Technology Supports Stigma Reduction and Increased CT Uptake Among MSM in Ghana, HIV/AIDS Implementers' Meeting, 12 Jun. 2009, Namibia | **Text Me! Flash Me! Helpline / Namibia, Ghana** Uses cell phone technology to provide most-at-risk populations in Ghana with friendly and accessible HIV and AIDS information, referrals, and counseling services from qualified providers. | | In the first month of the Helpline 5 Helpline counselors counseled 439 MSM clients. This amounts to an average of 88 MSM clients per Helpline counselor per month - compared to 50 MSM clients per peer educator or health worker per month in facilities and communities. | Although FGD and M&E data clearly indicate that promotions of free airtime increased the number of clients accessing services, only 3% of survey respondents indicated their primary reason for accessing the Helpline was to "get free units". | Relies on a database of cell phone numbers collected by peer educators and social networks. Outgoing SMS texts are sent with educational and promotional messages, either through a "phased communication" strategy or in response to trends noticed through ongoing quality assurance and monitoring and evaluation (M&E). |
| | | - Learning About Living 2009, About The Program | **Learning About Living / Nigeria** | | It received more than 53,000 text | | |

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| | | - OneWorld UK, Learning About Living<br>- Butterfly Works, Learning: Learning About Living | Learning about Living is a 2-year project that was launched in 2007 and uses different educational tools to teach reproductive health and promote the HIV/AIDS awareness and prevention programme among adolescents in Nigeria. In addition to an e-learning tool on sexual and reproductive health and rights which is aimed at students as well as teachers and parents, MyQuestion and MyAnswer is a Q&A service that uses mobile phone technology to engage young people and offer confidential advice. | | messages within the first year | | |
| | | http://www.comminit.com/en/node/280980/38<br>Text to Change 2009, How does it Work?<br>- Text To Change 2009, Projects<br>- Text To Change, AIDS Information Centre 2009, HIV/AIDS SMS Program | **Text To Change / Uganda**<br>Using a bulk short message service (SMS) platform for health education, by partnering with local Ugandan NGOs and mobile phone | The organisers chose a list of 15,000 Zain subscribers in Mbarara district and sent them an introductory SMS asking if they would like to | Of 15,000 subscribers contacted, 2,500 responded to each question. | | |

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| | | Arua, Uganda<br>- ICT4Uganda 2009, Text To Change: Spreading the Message to Stop the Virus<br>- Medical News Today 2008, Text To Change and AIDS Information Centre Continue Successful SMS Quiz to Fight AIDS in Uganda | providers to conduct projects designed create dialogue in order to increase awareness of HIV and AIDS and achieve comprehensive knowledge levels among young people; to reduce HIV/AIDS-related stigma and discrimination; and to motivate people to seek HIV testing and treatment. | participate in a free interactive quiz about HIV, with the incentive of handsets and airtime as rewards for correct answers. A question was sent each week. | | | |
| | | http://www.comminit.com/en/node/317076/2781<br>-frog design 2008, Pop!Tech Unveils Project Masiluleke, Press Release, 24 Oct. 2008<br>- iTeach 2008, Project Masiluleke<br>- Pop!Tech 2009, Project Masiluleke<br>- Leach-Lemens, C. 2009, Using Mobile Phones in HIV Care and Prevention, HIV&AIDS Treatment in Practice, no. 137, pp. 2-7 | **Project Masiluleke / South Africa**<br>Designed to harness the mobile phone as a high-impact, low-cost tool in the fight against HIV/AIDS and TB in South Africa. Works to address the challenges that result in avoidance of HIV testing, delayed initiation of treatment, and high rates of treatment default. Project is built around the use of specialised text messages to the general public each day. The messages are | | Testing of the service has helped triple the average daily call volume to the National AIDS Helpline in Johannesburg. | | Messages are culturally relevant and written in local languages. Trained operators provide callers with accurate healthcare information, counselling, and referrals to local testing clinics. |

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| | | | broadcast in the unused space of "Please Call Me" (PCM) text messages. The messages connect mobile users to existing HIV and TB call centres. | | | | |
| | | MobileForGood 2008, Our Services | **MobileForGood Health Services (M4G) / Kenya** M4G is a social franchise that wants to help alleviate poverty and improve the lives of people in the developing world by using mobile technology and receiving text messages for a nominal fee. The Health Tips SMS service provides subscribers with tips on various pertinent health issues. MyQuestion service allows customers to anonymously ask HIV/AIDS and breast cancer related questions. | Partners/Sponsors: Safaricom, Hivos, ZMQ, MobilePlanet, OneWorld.net, Zain | | | |
| | | - The South African Depression and Anxiety Group 2006, Teens Can | **Teen SMS Helpline to Stop Suicide / South Africa** | | | | |

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| | | SMS to Stop Suicide - Bosch, T. 2008, Cell Phones for Health: An Exploration of Intervention in South Africa, Draft Paper, 30 Jun. 2008, University of Cape Town | The South African Depression and Anxiety Group has a service for communicating with teenagers via text messaging. The content ranges from requests for basic information to requests for help in a crisis situation and responded to by skilled counselors. | | | | |
| | | Star Programme 2009, SMS Bulktool | **SMS Bulktool for HIV/AIDS Education / Kenya** NGOs are using this online application since 2007 to send multiple SMS messages to their target groups. It is used to raise awareness of the risks of HIV/AIDS, to inform about upcoming events and to send reminders on taking medication. | Partners/Sponsors: Hivos Star Programme, Straight Talk, other HIV/AIDS organisations | | | |

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| | | - Khan, R. 2009, Health Education Response: SMS Based Health Information Distribution, HIV/AIDS Implementers' Meeting, 12 Jun. 2009, Namibia<br>- Peace Corps 2009, Volunteers in Namibia Use Text Messaging for Health Education, News Release, 22 Jul. 2009 | **Health Education Response (HER) / Namibia**<br>Sexual health information is provided either through SMS with pre-written content from an automated database, or through direct caller contact with a counselor. | Partners/Sponsors:<br>Peace Corps, Childline/Lifeline | | | |
| | | http://www.comminit.com/en/node/308917/2781<br>Evaluation of Cell Phone for Life for Cell-Life Baseline Report<br>Donald Skinner, Research on Health and Society; Cell-Life Research: Information Needs and Information Delivery<br>William Mapham | **Cellphones4HIV/ South Africa**<br>A range of cell phone services to assess their viability for content delivery.<br>*1) Unstructured Supplementary Service Data (USSD)* using Mobile phones for real-time or instant-messaging phone services<br>2) *MXit is a Java application installed on users' phones* that allows for GPRS or 3G-based instant messaging. 4WAP net: Looking at piloting HIV-related chatrooms through MYMsta, LoveLife's WAP offering | Smartphones and mobile phones<br>SIM cards<br>SMS/GSM/GPRS/3G<br>Mobile web | 1) In a 2-minute USSD session, people could make it through about 9 screens of content. At 150 characters per screen, this makes for a total of about 1,350 characters equivalent to 8 SMSs.<br>2) They said they would tell their friends to use the service, and they supported the idea of Mxit chatrooms with counsellors to discuss HIV-related issues. The participants indicated that they preferred MXit as a | 1) Half of those surveyed experienced one or more fails: the service never initialised, or "crashed." These were due mostly to problems with the USSD itself.<br>2) MXit was very stable, unlike USSD, and only one learner reported a fail during the pilot. From a content perspective, the learners found the information easy to understand and locate in the menu structure.<br>3) This development could help overcome barriers related to: restrictions in terms of number of characters, constraints linked to screen size and usability factors, illiteracy, and language. | 1) While most users reportedly found the content very easy to understand, most said that they would prefer to read it in their own language. USSD was not well suited for the delivery of "narrative" content, but that, rather, it should be used for providing menus that allow users to "drill down" to content they want.<br>2) "The main strength of MXit is chat, and this needs to be explored further for counselling purposes. However not all phones are able to support MXit and technical support may |

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| | | | 3) voicemail message "pushed" into the user's voicemail inbox, and he or she is notified of its arrival by SMS. | | medium because it is cheap, fast, and anonymous. | | be required to assist new users install the application on their phones.<br>3) Content can be delivered by a "trusted source", such as a popular character in a local soap opera, sports stars, or a local nursing sister known to the recipient |
| | | Landscape analysis by VitalWave 2008 | **Mobile4Good/Kazi560** Provide information about health, employment and community via SMS to inform and empower disadvantaged individuals. | Targeting cellular subscribers in Kenya. End user pay for service. Originally funded by Vodafone Group Foundation, now under Mobile for Good Kenya company with additional support by Accenture and MacArthur Foundations. | Approximately 70,000 use mobile phone services; 60,000 got employment through the Kazi560. | | |
| **Data, Health Record Access** | **Two-way communication using mobile phones and PDAs for transmitting data:** This is usually the use of electronic technologies, | Landscape analysis by VitalWave 2008<br>- EpiHandy, Homepage<br>- Jada, A.R. 2009, Preventing and Managing Cardiovascular Diseases in the Age of mHealth and global telecommunications<br>- Engebretsen, T. 2005, | **EpiHandy/ Burkina Faso, Uganda, Zambia** Various medical research and survey projects in different African countries have used EpiHandy software since its first release in 2003, either | Survey design and data collection for health research using PDAs. Remote health care workers. Ethiopia and Uganda. | | | |

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| | especially handheld computers or laptops to collect and report data from the field. For example: - RapidSMS which establishes a two-way flow of communication that empowers stakeholders with a dynamic tool for advanced data collection, analysis and communication that is fast, efficient and accurate. -EpiSurveyor which allows users to download and fill in forms and then send it to centrall databases to be analyzed in real time. Has been most widely used for emergency response and tracking supplies, -SMS based data for health care | Acceptance of Information Technology by Health Research Projects in Low-Income Countries, Master's Thesis Agder University College<br>- UN Department of Economic and Social Affairs 2007, Compendium of ICT Applications on Electronic Government, Volume 1, New York | on PDAs or on mobile phones. It was developed to overcome problems in the management of data collection in remote areas. The system is able to transmit data via the available mobile networks. | | | | |
| | | Landscape analysis by VitalWave 2008<br>- Datadyne 2008, WHO/AFRO Episurveyor Rollout<br>- BBC News 2008, Mobiles Combat Kenyan Polio Outbreak, 18 Sept. 2008 | **EpiSurveyor Mobile Health Data Collection / Cameroon, Ghana, Kenya, Senegal, Sierra Leone, Uganda, Zambia**<br>Since 2006, regional/provincial health officers in every country of sub-Saharan Africa continue to be trained in the use of EpiSurveyor mobile electronic data collection software. The application is used for the collection of information regarding clinic supervision, vaccination coverage, or outbreak response. It helps to identify and manage important | | | | |

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| | workers to identify, diagnose and track patients utilizing streamlined technology that is automatically updated in a central system. | | public health issues including HIV/AIDS, malaria, and measles. In September 2008 Kenyan health workers modified the survey forms used by EpiSurveyor to track an emergency vaccination campaign against polio and managed to stop a potential epidemic in its tracks. | | | | |
| | | Developed by the Millennium Villages Project aimed at empowering communities to improve child survival and maternal health http://www.childcount.org/how-it-works/ - Berg, M. et al. 2009,childCount.org - ChildCount.org, - Oluoch, J. 2010, Millenium Villages Blog | **ChildCount+.** ChildCount+ uses RapidSMS to facilitate and coordinate the activities of community health workers (CHWs) to actively monitor 9,500+ children under five. ChildCount supports the delivery of CMAM (community-based management of acute malnutrition) programmes; home-based testing for malaria using RDT kits and immediate dispersal of treatments; and home-based treatment of children | ChildCount+ is free and open-source software built with RapidSMS both available under the LGPL. | - Approximately three months after the initial child registration, **95%** of the estimated 9,561 children under five in the cluster had been registered.<br>- About 10% of all incoming messages sent to the system were rejected due to improper formatting.<br>Significant reduction in data transmission delay compared to Malawi's current paper-based system.<br>• Increase in data | - Some users struggled initially and required additional training before they could effectively use the system.<br>-Several of the phones provided by the project malfunctioned and needed to be replaced.<br>-Several phones went missing<br>-System lacks the ability to accurately record deaths or to<br>capture when children receiving inpatient care default, recover or do not recover.<br>-Initial challenge with duplicate child registrations.<br>- Assuming an average | - Need for feedback reports that can be distributed to each CHW on a frequent, initially a weekly, basis<br>- Providing CHWs with cheaper, basic entry level phones could mitigate problem of lost phones.<br>- The existence of a functional health care system and motivated CHWs are<br>required for this approach to be successful<br>-A drop in SMS rates to $0.01 USD could have a tremendous impact in sparking demand and driving innovation for |

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| | | | with diarrheal illness. Using any standard phone, CHWs are able to use text messages to register patients and report their health status to a central web dashboard that provides a real-time view of the health of a community. Powerful messaging features help facilitate communication between the members of the health system and an automated alert system helps reduce gaps in treatment. | | quality reported by health workers.<br>• Elimination of the need for time-consuming manual data-entry.<br>• Increased two-way flow of information between stakeholders at the national government level and health workers in the field.<br>• Increased system and personnel monitoring capabilities.<br>• Elimination of costs related to transporting paper forms and manually entering data. | cost of $0.05 USD an SMS, it would cost about $2,500 ($833/month) in credit to pay for the estimated 50,000 text messages used. While this could be considered potentially cost effective,<br>it may be outside the means of some health care systems under current pricing practices. | service like this. Support from operators would also make it possible to scale these programs further. |
| | | Landscape analysis by VitalWave 2008 | **M-DOK.** Electronic patient record using a SMS-based health data collection program for PDAs. For remote health care workers Philippines (not presently operating). | Using GPRS on phones or PDAs to send SMS data. | | | |
| | | - Nesbit, J. 2008, Virtues of FrontlineSMS, Mobiles in Malawi Blog | **Mobiles for Healthcare/ Malawi** Using FrontlineSMS | Using FrontlineSMS | | | |

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| | | -- Leach-Lemens, C. 2009, Using Mobile Phones in HIV Care and Prevention, HIV&AIDS Treatment in Practice, no. 137, pp. 2-7 | software, an SMS-based communications network was set up for rural hospital and its CHWs. It allows the hospital to respond to requests for emergency medical care, record HIV and TB drug adherence, record patient status, mobilize remote communities for outreach testing, provide instant drug dosage/usage information, and connect HIV/AIDS support group members. | | | | |
| | | http://www.ushahidi.com<br>http://stopstockouts.org/ | **Ushahidi.**<br>The open source platform was built for information collection, visualization and interactive mapping or timeline for anyone who wants to gather distributed data via SMS, email or web. The goal is to create the simplest way of aggregating information from the | | Has become a popular watchdog for the stock-out situation and have generated several news paper articles in the various countries where it is implemented. | | |

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| | | | public for use in crisis response. One project using it was stop-stockouts in Kenya, Malawi, Uganda, Zimbabwe and Zambia where researchers visited public health institutions and checked on the availability of a list of 10 essential medicines. | | | | |
| | | http://www.comminit.com/en/node/320930/38<br>- Blaschke, S. et al. 2009, UNICEF Malawi and UNICEF Innovations, Jun. 2009<br>- Earth Institute, UNICEF, RapidResponse<br>- http://www.rapidsms.org/case-studies/malawi-nutritional-surviellence/ | **Malawi RapidSMS Nutrition Surveillance.** Addressing constraints identified with slow data transmission, incomplete and poor quality data sets, no feed-back to CBAs, high operational costs, and low levels of stakeholder ownership. Using the RapidSMS system, CBAs input information into mobile phones which was transmitted and immediately captured by a computer that stores the national nutritional and food-security statistics. | Using RapidSMS through mobile phones.<br>For the pilot study, 30 CBAs were trained in RapidSMS reporting and registered 210 children and tracked them for a period of four months. | The system significantly improved data quality. 15 data entry errors were reported, and these occurred during the first reporting period. During the final three months, there was not a single unusable data set. | UNICEF and government are interested in expanding this to a country-wide campaign to register child births, as well as deploying RapidSMS in other sectors, including education and HIV/AIDS. UNICEF hopes to make the system available, free of charge, to organisations and other implementing partners. | The Malawian programme was developed after UNICEF's success with the system in monitoring and delivering the protein-rich ready-to-use therapeutic food, Plumpy-nut, in drought-hit Ethiopia in October 2008. The RapidSMS system was designed by UNICEF and Columbia University's School of International and Public Affairs. It won first prize in the Development 2.0 Challenge, run by USAID, for its innovative design, adapting a commonly |

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| | | | CBAs sent text message with child's data and received instant feedback on nutritional status and if data indicates malnutrition, they receive an SMS with instructions for treating the child. Unique child registrations were also implemented and tracked longitudinally, linked to specific geo-spatial coordinates, as well as automatic triggers identifying child 'no-shows' if no follow-up report is inputted within 40 days. They have also integrated automated monthly data summaries texted back to health care workers. | | | | accessible technology to monitor the health and nutritional status of children. |
| | | | **TeleDoc / India**<br>Addressing Remote health care needs using The TeleDoc Mobile Information System (MIS) uses mobile phones to input patient data. | *Smartphones*<br>*GSM/GPRS*<br>*Mobile web* | This innovation empowered the CBHWs to be able to offer quality PHC services to usually underserved rural communities through second | | |

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| | | | | | opinions obtained from urban-based physicians. In addition, PHC telepharmacy services were implemented, as drugs prescribed during any clinical encounter are delivered to the patient's home through a sort of "community courier network" | | |
| | | Landscape analysis by VitalWave 2008 | **Rural Extended Services and Care for Ultimate Emergency Relief (RESCUER) / Uganda** RESCUER program was a referral project designed to address the high maternal mortality rate in Uganda and to empower Traditional Birth Attendants (TBAs). Using A solar-powered VHF radio system, "walkie talkies". | Implemented by Ugandan Ministry of Health. Funded by Ugandan Ministry of Health and United Nations Population Fund (UNFPA). | Maternal mortality reportedly declined by more than 50 percent over three years. | | |
| | | Landscape analysis by VitalWave 2008<br>- U.S. President's Emergency Plan for AIDS Relief, | **TRACnet / Rwanda** Program to collect, store, retrieve, and disseminate critical | Implemented by Government of Rwanda's Treatment and | -More than 200 site level users; more than 90% of users access the system | -TRACnet has enabled HIV/AIDS practitioners to monitor ARV stocks in real | |

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| | | - Voxiva, TRACnet<br>- UN Department of Economic and Social Affairs, 2008, TRACnet y,<br>- Nkurunziza, S. 2009, The New Times of Rwanda, 4 May 2009<br>- Donner, J. 2005, Vadoafone Receiver Magazine, no. 14 | program, drug and patient information related to HIV/AIDS care and treatment. Targeting public health workers in Rwanda using mobile phones, computers. Government paid for the application and there was 90% access via toll-free PSTN. The data is mapped and analyzed automatically and immediately available to health authorities via the web. The system also supports SMS alerting and notification. | Research AIDS Centre (TRAC). Set up a nationwide internet /mobile /landline information system which uses the mobile network to extend coverage out to every participating clinic in the nation. | via a toll-free PSTN interface.<br>-At the end of 2007, the system covered the 168 health facilities offering ARV therapy in Rwanda accounting for 100 per cent of the 43,000 ARV patients in Rwanda.<br>-the number of days between obtaining a blood specimen for a CD4 analysis and physicians' receiving results has been significantly reduced | time, allowing local hospitals to send urgent requests to central managers to replenish stocks.<br>-It gives rapid and reliable access to CD4 molecule and viral blood test results in remote health facilities.<br>-Authorities get timely access to critical tracking indicators<br>which permits a better public monitoring of HIV/AIDS<br>patterns of transmission.<br>- Disease outbreaks at various levels can be better managed through national/regional/ local tables which compile all sources of information related to HIV. | |
| | | | **Satellife / Uganda**<br>Addressing health improvement in rural areas and health information through global communication network with free or low-cost email and access to HealthNet Information Services; provides locally generated | Implemented by AED-SATELLIFE and East African ministries of health with Multiple funding partners. | HealthNet Uganda has trained nearly 100 medical personnel in basic Internet tools; currently about 60 sites connected to HealthNet, including the Mulago Hospital, the main referral and teaching | | |

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| | | | information resources, information technology (IT) training, electronic conferences and web based services. Targeting care providers in rural areas in Uganda using Web telephone, PDAs. Collaborating organizations (including WHO) and governments pay for application. | | hospital in Uganda | | |
| **Monitoring/ Medication Compliance/ appointment** | **Mobile phones technology for drug adherence and monitoring:** This is the use of mobile technologies to monitor patient's use of medications, send reminders or monitor on status.<br><br>Even though SMS reminders have been used for several years to send ART-reminders, it can also be used to send any other | - Wired Mothers Project Team 2009, FFU Application<br>- Lund, S. 2009, Presentation, Institute of International Health of the University of Copenhagen<br>- Lund, S. 2009, Profile Global Health | **Wired Mothers / Zanzibar (Tanzania)** Wired Mothers designed a software system to send sms textmessages according to the women's stage of pregnancy and date of last visit to the health facility. The messages focus on simple health education and encourage attendance to routine healthcare appointments. Each woman is given a phone voucher and a card with the phone number of her local health centre. All | Comparing a group of 1200 wired mothers with 1200 nonwired pregnant women<br>• From 1st ANC to 42 days after delivery<br>• Included in health centres at their first ANC visit<br>• Random selection done at health centre level | No results out yet. | | |

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| | medium or long-term treatment reminders to patients, such as for TB as well as a PMTCT. There is also work towards a SMS alert Corporate package where the system can be integrated into a company's Employee Wellness / internal ART-management programme to support their staff who are on ART or TB-treatment. | | health centres and hospitals included in the study have "watch phones" in place for key personnel such as the medical doctor on call, the midwife and the ambulance driver. This simple and cheep intervention shifts some of the responsibility of care and referral to the health system rather than to the women and their families | | | | |
| | | Landscape Wave 2008 http://www.comminit.com/en/node/308917/2781<br>- University of Cape Town, Cell-Life<br>- Cell-Life, Cellphones 4 HIV<br>- Leach-Lemens, C. 2009, Using Mobile Phones in HIV Care and Prevention, HIV&AIDS Treatment in Practice, no. 137, pp. 2-7<br>- Hessels, X. et al. 2007, Development Southern Africa, vol. 8, no. 4, pp. 607-621<br>- Kahn, T. 2007, BusinessDay, 2 Oct. 2007<br>- Tolly, K.d. 2009, W3C Conference 2009 | **Cellphones4HIV / South Africa**<br>A range of cell phone services whereof one is an *SMS antiretroviral reminders* provided daily to members of "adherence clubs". | | -Members of adherence clubs who were not invited to participate in the pilot expressed displeasure. Of 800 members sent the SMSs; only 5 people chose to opt out.<br>- In the United Kingdom, use of text-message reminders in a STI clinic had two important benefits: decreasing time to treatment for chlamydia, and decreasing | Language issues have posed challenges; SMSs are limited to 160 characters. Scaling up of SMS reminders will only be feasible if cellular networks provide severely discounted or free SMSs or if the SMSs can be geared toward certain groups. | Content and timing of the SMSs for their information utility are important. Need to explore whether receiving the SMSs makes recipients feel like they belong to a group or particular community which may represent a worthwhile benefit in itself.<br>The risk for these types of interventions is that they may complicate clinical practice with more communication options/burdens, and |

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| | | - Willmers, M., et al., 2009, Centre of Education Technology, University of Cape Town | | | appointment no-show rates.<br>- In Hangzhou, China, text message and telephone reminders improved appointment attendance by 7 percent, and messaging cost less than telephone reminders.<br>A recent RCT of patients with chronic diseases in Malaysia found that nonattendance rates were about 40 percent lower in the text messaging and phone groups than in controls. | | decrease the important element of direct human interaction. |
| | | - Global Business Coalition on HIV/AIDS, Tuberculosis and Malaria 2009<br>- U.S. President's Emergency Plan for AIDS Relief 2009,<br>- Ngirachu, J. 2009, Daily Nation Kenya, 17 Apr. 2009<br>- Leach-Lemens, C. 2009, HIV&AIDS Treatment in Practice, no. 137, pp. 2-7 | **Home-based Testing Initiative / Kenya**<br>Launched in 2009, the public-private partnership provides home-based HIV counseling and testing. It aims to reach two million people in western Kenya with their services over the next two years. | The counselor carries hand-held PDA and GPS devices to collect and enter data on family health, record test results and identify the physical location of the household for treatment, education, counseling and | To date, 97% of households in communities reached by the Health at Home /Kenya Impact Initiative have welcomed HIV counselors inside their homes. More than 4,400 people have been found to be HIV positive and | | |

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| | | | | data collection follow-up. | directly connected to treatment programs on the spot. | | |
| | | -Stockholm Challenge 2006, -SIMpill 2008, -Tellumat 2007, Press Release, 2 Mar. 2007 -Planting, S. 2007, Financial Mail South Africa, 2 Mar. 2007 - Barclay, E. 2009, e, The Lancet, vol. 373, no. 9657, pp. 15-16 | **SimPill system.** Developed in South Africa to manage TB patient treatment compliance. A device attached to a medicine bottle sends a text message to a central computer database when the cap is removed. When the cap is not removed according to the specified treatment regimen, the system sends a text message to the patient, with a reminder to take the medication. | | - The SIMpill® system achieved a 94% compliance rate for a TB trial in South Africa which resulted in a 92% cure rate - The SIMpill® system was used in a RCT trial in the US where the compliance rate of the group using the SIMpill service doubled compared to the non-managed control group. -In addition to helping patients adhere to their treatment, SIMpill also frees up health workers from daily observation of patients taking their medication. | | Though the human aspect of TB care and control must not be forgotten or underemphasised, there's always great value in increasing communication between the patients and the clinicians |
| | | -Hoffman, J. et al. 2009, Danya International Inc., 2 Mar. 2009 -PRNewswire 2009, redOrbit, 23 Mar. 2009 | **DOT Mobile Direct Observation Treatment for TB Patients / Kenya** The purpose of this | Patients, patient assistants, and healthcare workers completed a brief questionnaire | Results showed that overwhelmingly, all participants were extremely satisfied | The study indicated positive acceptance by both patients and healthcare workers of using this technology for | Further research is needed to assess the impact of this technology on medication adherence |

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| | | | pilot study was to assess feasibility and acceptability among healthcare workers and patients in using video-enabled mobile telephones to monitor patient adherence to TB medication, as well as to assess patient response to having both text and video health messages sent to them via the mobile phone. | regarding their experiences at intake, 15 days, and 1 month post-intake. Participants rated their experiences in topic areas such as comfort levels with being videotaped, acceptability of receiving messages, types of messages most helpful, and technical issues with sending or receiving messages. | with the study procedures and technology with a mean overall rating of 4.6 on a 5-point Likert scale, with 1 being "Awful" and 5 being "Great." | remote medication monitoring, health education, and communication. | rates, as well as cost-effectiveness of implementing this technology on a wider scale to more patients as well as for other types of diseases |
| | | - Universities of Nairobi and Manitoba 2010, Weltel.org<br>- Lester, R.T. et al. 2009, *Trials,* vol. 10, pp. 87<br>- Lester, R.T. et al. 2009, BCCDC Research Symposium, 30 Sept. 2009 | **Weltel Support for Clinical Management of Patients in Resource-Limited Settings / Kenya**<br>This programme is operating a clinical trial in Kenya since 2008 that is measuring the effectiveness of using SMS in improving patient adherence and response to highly-active antiretroviral therapy (HAART). It currently operates at | A multi-site randomized controlled open-label trial. No results out yet. | | | |

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| | | | two sites in Nairobi and a site in Kajiado District. | | | | |
| | | Landscape analysis by VitalWave 2008 http://www.freedomhivaids.in/mCST.htm | **m-CST Manager (Mobile Care, Support & Treatment Manager) / South Africa**<br>Client-server application for people living with AIDS. Monitoring of HIV/AIDS patients. Targeting people living with AIDS. Main features are:<br>**1. Test Lab:** Keeping records of every Test (and Diagnosis) of a patient or a group of patients<br>**2. Medical History**: It | The user will Login on a mobile phone with a secured Username and Password. The Group user will enter with its Group ID and their individual Username and Password to manage and monitor patients in their group. | | | |

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| | | | will list the complete medical history of the patient with respect to the HIV infection and other Opportunistic infections<br>**3. Drug & Dosage Alert**: It will define various stages of medication and medication plan, defining the drug and dosage. It will also remind the patient for daily medication.<br>**4. Nutrition Planner**: It will plan the daily nutritional plan for the patient<br>Other features of the application are:<br>1. Counseling & Support; 2. Emergency Call; 3. Address Book/Hotline to communicate with Consultants, ART Centers, Counselors, NGOs etc; 4. FAQs, Query Submission & Retrieval System; 5. Setting Alerts, Reminders & Alarms for medication; 6. Helpline | | | | |

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| | | Developed by Praekelt Foundation http://www.praekeltfoundation.org/txtalert.html | **TxtAlert** A mobile technology sending automated, personalized SMS reminders to patients on chronic medication. Apart from notifying patients of their upcoming appointments, TxtAlert also allows patients to reschedule their appointments if they are unable to attend, or if they've missed an appointment. Once a "Please Call Me"-message is received from a patient, a TxtAlert administrator will phone back the patient and assist them to confirm or reschedule an appointment. | The system utilizes a "Please Call Me"-message system ensures that a patient can be in contact with the clinic / doctor to reschedule a missed appointment, even if they do not have any airtime available to call. | Apart from minimal set-up and installation costs, TxtAlert's main running costs involve the SMS costs to the patient, which generally works out to around one Rand per patient per month. | | |
| | | http://developers.sun.com/champions/nardon.html | **Virtual Mascot (Virtual Health Pet).** Addressing the monitoring of elder health. A tamagochi, or virtual pet, is installed in the cellular phone and interacts with the user, | Implemented by Atech and Vidatis. Self-funded. | | | |

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| | | | reminding to take medication while it checks the patient's well-being. | | | | |
| | | -mPedigree 2009, Homepage<br>- Global Development Commons 2009<br>- Schenker, J.L. 2008, Mpedigree's Rx for Counterfeit Drugs, BusinessWeek, 3 Dec. 2008<br>- Vital Wave Consulting 2008 | **mPedigree**.<br>SMS service for drug verification using mobile phones. MPedigree is a non-profit based in Ghana that advocates for the development of strategies to fight counterfeiting. Targeting pharmaceutical stores in Ghana. The scratch card method reveals a single-use numeric code on drugs that users can text for free from their mobile phone, instantly receiving information if the drugs are genuine or counterfeit. After a 2008 pilot in Ghana, extension is planned initially to Nigeria and India. | Syncrytel, its partners and its end-users pays for application. Targeting care providers of elderly, diabetic patients in Brazil. Uses mobile phones. Company pays for application. | | | |
| | | | **Wireless Health Monitoring System.**<br>Addressing remote health care. Monitors health data for | Implemented by Beijing Perfect Sky Information Technology Company. | | | |

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| | | | cardiogram readings, pulse, blood pressure, body temperature, vital signs; wireless transmission. Targeting Physicians in China using Wireless technology. End users pay for airtime. | | | | |
| | | Landscape analysis by VitalWave 2008 | **On Cue Compliance / South Africa** SMS or text messages sent to patients as reminders for medication, appointments. Target users are patients. | Implemented by SIMpill. | | | |
| | | -CompuTainer,<br>-Barclay, E. 2009, The Lancet, vol. 373, no. 9657, pp. 15-16 | **SIMmed / South Africa** The patient takes their medication and presses a speed dial on the mobile phone. If the compliance database has not been received that message within the prescribed period it generates an SMS to remind the patient. If the patient still does not take their medication and presses speed dial, the database will generate a SMS to a local care giver who will visit the patient and get them | | | | |

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| | | | to take their medication. After a pilot study the programme is now being expanded in South Africa. | | | | |
| | | Landscape analysis by VitalWave 2008 | **Alerta DISAMAR / Peru** Report and access disease incidence data using either telephone or Internet. Disease monitoring. Public health workers, doctors | Peruvian Navy. Funded by government. | | Benefit: Rapidly lower exposure to ecological or epidemic threats; obtain field reports; provide advice; coordinate response; efficiently direct scarce resources | RiskIncorrect information (through error or malfeasance) may create alarm or havoc |
| **Disease/ Emergency Tracking** | **Warning systems:** Use of technologies to provide early warning of diseases and epidemic outbreaks. When a major humanitarian crisis occurs, every second matters for the affect community. Peopl e may be trapped, injured, or sick, and the longer it takes responders to reach them, the poorer the outcome is likely | Landscape analysis by VitalWave 2008 | **AESSIMS / India** Report disease by telephone and webbased Technology to Improve immunization services for diphtheria, hepatitis B, Japanese encephalitis, measles, pertussis, tetanus, polio and TB. Public health workers. | Andhra Pradesh. Funded by PATH, Voxiva and the Government of Andhra Pradesh (GoAP). | More than 2 million women andchildren vaccinated under this program each year confirmed by 2006 study. | | |
| | | Landscape analysis by VitalWave 2008 | **HealthMapper / various countries** Surveillance and mapping software product for infectious disease information; facilitates data standardization; allows collection and | WHO and Google Maps. Funded by WHO and state governments. | | | |

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| | to be. What is needed is a response that is agile, efficient, and effective, where diverse groups – NGOs, the UN, national governments, military, and the local community – self-organize temporarily into a coherent, coordinated whole to provide assistance to a population in need. Unfortunately, more often than not, coordination among relief organizations today is far from adequate. Responders in the field find it difficult to keep one another in the loop about what they are doing and where. They have a constant sense that they out of touch with | | updating of data on epidemiology and interventions, visualization of data. GIS programme, based on ArcView. Government, health agencies in Indonesia, East Africa, Afghanistan, Niger, Ethiopia | | | | |
| | | http://www.rbm.who.int/psm/smsWhatIsIt.html<br>- Roll Back Malaria 2010, SMS for Life Tanzania Pilot Project Report<br>- Roll Back Malaria 2010, 'SMS for Life' Pilot Increases Availability of Malaria Treatments Threefold at Participating Health Facilities, Press release, 21 April 2010<br>- Roll Back Malaria 2009, SMS for Life: An RBM Initiative<br>- PRNewswire 2009, Saving Lives with SMS for Life: IBM, Novartis and Vodafone Join Forces to Help Halt Malaria in Africa, Press release, 14 Dec. 2009<br>- Mobile Marketing Magazine 2009, SMS for Life Saves Lives in Tanzania | **SMS for Life / Tanzania**<br>The initiative is a 'public-private' project that harnesses everyday technology to eliminate stock-outs and improve access to essential medicines in sub-Saharan Africa. The process enables timely tracking and management of supplies and their delivery to the communities where they are needed most. Implemented in Tanzania to make sure all malaria patients have easy access to the life saving antimalarials ACTs and quinine injectables | Novartis has teamed up with Roll Back Malaria, Vodafone and IBM to design, develop and implement the 'SMS for Life' pilot in Tanzania. SMS for Life Tanzania Pilot Project Report Summary Report. RBM. It will use a combination of mobile phones, SMS messages and electronic mapping technology to generate information on stock availability of ACT and quinine injectables and deliver it on a weekly basis to all | During the pilot, malaria medicine availability Improved significantly in all three districts, such that at the end of 21 weeks, stock-out rates were reduced to 0 % in Lindi Rural, 47 % in Kigoma Rural and 30 % in Ulanga. | We found that organizations are much more likely to commit their resources for piloting new initiatives when the following conditions apply:<br>-– The project is well documented including clear deliverables<br>-–Participation is for a short pre-determined timeframe and exit date (one year or less)<br>-– All partners display a strong affinity or emotional connection with the goal<br>-– Each partner has control over its particular area of expertise and deliverable(s)<br>-– Funds do not need to be approved and | |

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| | headquarters, and headquarters with them. Often, they lack adequate means to engage members of the local community and ensure that they participate meaningfully in the response. When key contacts are excluded from the process, they are left with an incomplete understanding of what is needed, and they cannot act as one. Delays mount up, too little arrives too late, and the cost may be measured in human lives. | | and deliver it on a weekly basis to all health facilities. | health facilities. | | transferred to a third party | |
| | | Landscape analysis by VitalWave 2008 | **InSTEDD / Asian countries** (Innovative Support to Emergencies Diseases and Disasters). Designs programs using technologies and services to more rapidly detect and respond to global health threats and natural disasters. Runs on computers, mobile phones, PDAs. Government, health agencies in Cambodia, Lao, Myanmar, Thailand, Vietnam, Yunan Province of China. Governments and companies pay for the application. | **InSTEDD GeoChat** The service lets mobile phone users broadcast location-based alerts, report on their situation, and coordinate around events as they unfold, linking field, headquarters, and the local community in a real-time, interactive conversation visualized on the surface of a map. **InSTEDD Mesh4X** is an adaptive data integration platform designed to break down barriers to information flow, allowing organizations and individuals to share awareness reliably, selectively, and securely, with anyone, using any | | | |

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| | | | | device, from any database, over any network. | | | |
| **Health/ Admin Systems** | **e-health and m-health district based information systems:** These are systems to support the collection of health data and statiscs for analysis, dissemination and use to support decision making. Data comprises data for epidemiological research, indicators for monitoring and evaluation, financial and cost reporting for supply management. | - Kagumire, R. 2009, How Uganda's Health Care Problems Can End with a Phone, The Independent Uganda, 16 Jun. 2009<br>- The Swedish Program for ICT in Developing Regions (SPIDER) 2009, ICT4MPOWER: ICT for Medical Community Empowerment<br>- ProjectPlace 2009, ICT4MPOWER Project Website<br>- Ministry of Health Uganda 2009, ICT4MPOWER Project Proposal | **ICT4MPOWER / Uganda**<br>The 3-year proof of concept project "ICT4MPOWER" aims to increase the effectiveness of the Ugandan health system and empower CHWs in the Isingiro district and Mbarara region for better health outcomes of the rural population. Launched in April 2009, it is not only meant to aid referrals and patient follow ups, but should also ensure transfer of skills and knowledge to health workers, especially those working in rural settings. The objectives are:<br>**1.** Put in place the necessary E-infrastructure with support from UCC<br>2. Install an effective Electronic Health Record Management | i. Empower the VHT with m-learning materials<br>ii. Facilitate communication between the facility and the VHT<br>iii. Harmonize patient referrals procedure and feed back<br>iv. Operationalise the concept of PHC at community level<br>v. Facilitate mobility of the VHT<br>vi. Ensure the continuity of care throughout the health care system with Electronic Health Record (EHR) and Unique Patient ID<br>vii. Provide for secondary opinions through telemedicine and<br>viii. Improve health care seeking behavior of house holds | Phase 1 of the rollout of services to Isingiro is planned for October 2010-January 2011.<br><br>Phase 2 of the rollout will cover the whole district, and around 1200 end-users, which includes VJTs, HC2, HC3 and HC4. Phase 2 will last until December 2012.<br><br>Phase 3 of the rollout is planned to start from 2013 and onwards. Preparations for rollout to other districts are on the way with clear guidelines available sometimes in December 2010-July 2011. | | |

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| | | | system<br>3. Creation of a unique patient ID system<br>4. Establish an Electronic Patient Referral and Feedback system<br>5. Establish a mechanism for Tele-consultation support<br>6. Established a national drug and stork management system<br>7. Established a system for Human Resource Development<br>8. Created opportunities for Networking with various stakeholders | | | | |
| | | http://www.comminit.com/en/node/320774/38<br>- Bogan, M. 2009, W3C Workshop on the Role of Mobile Technologies in Fostering Social and Economic Development in Africa, 1 Apr. 2009, Mozambique<br>- Dimagi Inc., CommCare http://www.dimagi.com/commcare/ | **CommCare / Tanzania** Community Health Mobile Platform. This mobile-phone based application aims to enable community health workers to provide better, more efficient care while also enabling better supervision and coordination of community health | During the study time, the CHWs conducted a total of 52 visits using CommCare. | From initial observations, it seems clear that CommCare will save time and result in faster and more accurate reporting than the paper-based system. It took the CHWs two minutes and 10 seconds to fill a form on the phone. | - The initial training for the simplest version of CommCare took about two hours of group instruction.<br>- Clients refused to allow the CHW to use the phone when she saw the CHW had a different phone than was used at the previous visit. | -Form a true partnership with the users throughout the design process. The CommCare application was developed in rapid iterative cycles working closely with five CHWs over the course of several months<br>-Simplicity is |

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| | | | programs. CHWs are provided with a phone running CommCare that assists them to manage household visits and plan their day. CommCare is also designed to collect and report data that will help monitor and evaluate community health programmes themselves.<br>The target is to have 1,400 health workers using CommCare by 2014. | | This is about the same as with the paper-based approach. However, the 4 hours each month spent by CHWs to compile reports is avoided. | | paramount. Better to include few specific functions rather than making a product that tries to do everything. |
| | | - Microsoft Research<br>- Masizana-Katongo, A.N. et al. 2009, Proceedings of the World Congress on Engineering 2009, vol. 1, pp. 88-92 | **Integrated Healthcare Information Service Through Mobile Telephony (IHISM) / Botswana**<br>A research team is developing an internet-based healthcare information service that accepts SMS-based inquiries from mobile phones and responds with personalized information about how to effectively prevent and manage chronic diseases. It is | Not yet evaluated | | | |

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| | | | meant to improve awareness and prevention particularly among people living in remote rural areas. | | | | |
| | | Landscape analysis by VitalWave 2008 | **The Africa Health Infoway/ African countries**<br>Addressing Health IT by a system to support the collection of subnational health data and statistics, dissemination of data, strengthen capacity of African countries to use information in decision making. | | | -The problems observed in the process of sending data discouraged the teams to work with the PDA and instead the teams in the district continued to travel to send the PDAs with the data collected and in some cases only in paper versions.<br>- Many respondents said that they would prefer to continue using pen and paper while they gain experience in the use of PDA and guarantee that the district have a copy of the information sent by them. | -Need for regular on-the-job training and monitoring of the process of introduction of PDAs.<br>-Need to develop a local support capacity (help-desk) to attend to the concerns of the districts on a timely basis. |
| | | - IDCR 2006, PDAs for Malaria Monitoring in Maputo and Gaza Provinces<br>- AED SATELLIFE 2009, ICT for Health – Empowering Health Workers to Save Lives<br>- Macanze, J. 2007, Final Monitoring and Evaluation Report of PDAs for Malaria Monitoring in Maputo and | **Mozambique Health Information Network (MHIN) / Mozambique**<br>Handheld computers with mobile phone connectivity were distributed among district health personnel in 2006 to facilitate efficient mapping of malaria | Survey using project document, the reports of the activities performed, observations during field visits, interviews conducted to the managers of each | -Data collected on household spraying efforts were presented on maps, clearly indicating where dwellings had or had not been sprayed. The visual map results were presented to the | | |

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| | | Gaza Provinces, IDRC | control activities. Two-way access to information supports health information dissemination, data collection and reporting, and email exchange. District Health Offices receive data from various levels of health centers using the MHIN that include immunization registers and reports, disease surveillance data, and reports related to other health problems as required by MISAU department of Health Information System. The DHO also use the network to receive data for monitoring drug usage and stocks, which is used for ordering medicines. | area, surveys targeted at all technicians involved in the data collection and transmission process using GPS, PDA and cell phone. | community and leaders motivated greater support for the spraying program. -Overall, there was up to 50% improvement in the quality of the data | | |
| | | - Electronic Government 2005, Wireless Patient Data – A Reality in Pilot Phase, 9 Jun.2005<br>- ChangeMakers 2006, Mobile Technology to Improve Health Serivce Delivery Within Government | **Dokoza System for Disease Management / South Africa**<br>The system has been developed initially for use in HIV/AIDS anti-retroviral therapy and TB treatment, with | | -Quicker access to better quality information related to patient healthcare<br>-Allowed all health care workers registered via | | |

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| | | - Patel, I., et al. 2005, M-Government: South African Approaches and Experiences, EURO mGOV 2005 | the plan to include other diseases, and was tested in a pilot study in 2004. SMS and mobile technology are used for information management and personal communication. It makes use of a standard SIM card that works across all networks. Dokoza is easily integrated with existing hospital systems and can be accessed in real-time via PC, PDA or smart phone, and is able to interact with fax and email. | | Dokoza to perform real time 24-hour patient specific data and transaction via his/her registered cell phone<br>-Allowed all health care workers and patients registered via Dokoza to access in real time general health information posted by Dept of Health via his/her registered cell phone.<br>-Allowed for individual patient rules for easier drug management and stock control.<br>-Assisted with compliance regarding member disease management protocols, or deviation from approved treatment protocols.<br>- Allowed all existing hospital/ clinic systems to | | |

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| | | | | | interact with the National Laboratory system. | | |
| | | - IICD, Mobile Devices Help Monitor Access to Healthcare in Ghana | **SEND / Ghana**<br>The Ghanaian government instituted a National Health Insurance Scheme in 2003 to remove the financial barriers to quality health care for the poor. An open source monitoring tool was developed for use on handheld mobile devices to collect and share data on whether the poor are actually benefiting from the scheme. Using mobile technology enables the transmission and sharing of data with grassroots organisations and others despite a generally poor communication infrastructure. | SEND will develop an Open Source monitoring tool in cooperation with software developers to be used on handheld mobile devices to collect and share data. Due to the poor communication infrastructure, this will enable SEND to transmit data and share monitoring information with grassroots organisations and others. | | | |
| | | Landscape analysis by VitalWave 2008 | **Nacer / Peru**<br>A phone- and web-based database information and communication system for exchange | Implemented by Voxiva and Pathfinder International. Funded by USAID. | | | - Delivering news and popular content—including gossip columns—onto the nurses PDAs is a great way to get users used |

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| | | | of health information among providers and regional hospitals; accessed by wireless or wireline for maternal and child health. Ucayali, Peru (not presently operating). Targeting health posts, medical experts, regional Hospitals using phone (satellite, fixed-line, mobile or community pay phone) | | | | to using them. |
| **Analysis, Diagnosis, and Consultation** | **mHealth enabled analysis, diagnosis and consultation;** The use of electronic technologies (mobile and internet based) to provide support for diagnosis, analysis, consultation and treatment activities of remote caregivers. mHealth enabled diagnostics can help remote health professionals to | - AED SATELLIFE 2009, ICT for Health - Empowering Health Workers to Save Lives<br>- International Development Research Centre 2009, Uganda Health Information Network (UHIN) - Phase IV<br>- Kinkade, S. et al. 2008, Connecting Health Clinics and Remote Health Workers (Uganda), Case Study 2, In: Wireless Technology for Social Change, UN Foundation, Vodafone Group Foundation | **The Uganda Health Information Network (UHIN) / Uganda, Mozambique & South Africa**<br>Since 2003, 175 remote health facilities serving more than 1.5 million people are able to send and receive data and medical updates using PDAs. The system is used to transmit disease surveillance data, reports related to HIV/AIDS, tuberculosis, malaria, and data for monitoring drug usage and stocks. | Personal Digital Assistants<br>Portable wireless servers<br>GSM/GPRS<br>Mobile email | - Four years into the project in Uganda, 175 remote health facilities serving more than 1.5 million people are able to send and receive data and medical updates.<br>- Handheld computers result in more rapid, accurate, and cost-effective data collection and reporting.<br>-Handheld computer network spanning two districts indicated a 24% savings over | | |

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| | diagnose the illness and prescribe treatment. Some examples are: -applications that can provide respiratory or pulse rate counters, gestational age dates calculator, drug dose calculator, drip rate calculator, and drug reminder alarm installed in a mobile phone and in some cases linked to a sensor. -Health care providers use mobile phones to record information about the patients status, medication adherence, and other relevant information. In some cases the health care provider can provide the treatment at the | | Capacity building among health workers is achieved through regular broadcasts of content pertaining to diagnosis, treatment, and prevention of major health problems. AEDSatellife is replicating the project in Mozambique, having translated the software and materials into Portuguese, | | traditional paper-and-pencil methods. | | |
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| | | - Netsquared 2008<br>- Africa Teledermatology Project, Homepage<br>- ClickDiagnostics 2008, Knowledge Center<br>- Moore, J. 2009, Lives of a Cell, Government Health IT | **Mobile Teledermatology Service / Uganda, Botswana, Malawi, Swaziland, Burkina Faso, and Lesotho** The Africa Teledermatology Project operates in six Afircan countries, using cameras and laptop PCs to capture and send images of patients to specialists in other African countries, Austria and the United States providing diagnostic | | | | |

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| | moment of collecting the data. In other cases the data is sent via SMS to a central data base, and through a web based application the managers can access and monitor incoming information before they respond. | | and treatment support to local physicians, dermatologists, and health care workers in hospitals and clinics in underserved regions. In Botswana and Malawi a system to use mobile technology is tested to avoid problems from inconsistent access to the Internet. | | | | |
| | | | **Cellphone GuideView system/ Colombia** Uses existing clinical guidelines created by medical experts and breaks down complex diagnostic and treatment procedures into simple steps using an authoring tool. Text, pictures, audio, and video are embedded in the individual steps to help with comprehension and ease of use. The guides are stored on a smartphone's memory card, enabling CHWs to walk through the steps as they treat | Implemented by University of Texas Health Science Center at Houston; and informatics research scientist, NASA Johnson Space Center, Houston | For the field tests, the research team created guideviews—containing 225 steps each—in the areas of wound care, pediatric fever and musculoskeletal traumas such as contusions, dislocations and fractures. | | |

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| | | | patients in Colombia. The CHW can then transmit images, data, and audio to the remote expert for further advice. | | | | |
| | | http://fletchlab.berkeley.edu/research_cellscope.htm<br><br>Professor Daniel Fletcher, Bioengineering, University of California Berkeley | **CellScope**. Loads samples of blood, urine or other bodily fluids into a modified mobile. The images are captured using a special light source and the phone's camera, and then sent by multimedia message to a central station, from where a computer program returns a diagnosis as a text message. Is being tested for diseases like malaria, HIV and tuberculosis. | Development ongoing | | | |
| | | Researchers at the Nossal Institute, University of Melbourne in Australia | **smartphone-powered "oximeter and the "RMA".**<br>A prototype device that will allow health workers to use their mobile phones to better diagnose and treat pneumonia. | Development ongoing | | | |
| | | | **STAR Analytical Services**.<br>Working to develop | The American and Australian scientists at STAR have | | The cost of each Mashavu system will be around $200, not | |

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| | | | software that can analyze the sound of a cough and identify it as either associated with a common cold, the flu, or something worse - like pneumonia or another serious respiratory disease. | received a $100,000 grant from the Gates Foundation to develop the cough-analyzing software for developing countries where access to health care is more limited than in first world nations. | | including a cell phone or internet link. The customer base will include orphanages, community centers, churches, and medical entrepreneurs. Medical entrepreneurs will own their own Mashavu system, similar to owning a part of a franchise, and will charge between $0.80 and $1.00 for each visit. | |
| | | - Mashavu 2009, Homepage<br>- PennState Live 2008, Press Release, 18 Mar. 2008<br>- The Magazine of Information Sciences and Technology 2009, 10 Mar. 2009 | **Mashavu: Networked Health Solutions for the Developing World / Kenya, Tanzania**<br>This pilot project uses a telemedicine platform that allows healthcare professionals from around the world to connect with patients in rural areas. Trained operators at the Mashavu kiosk will take photographs and collect essential medical information of each patient. This data will be transmitted to a web-based portal and | During summer 2008, a team conducted a survey in Tanzania in order to determine the feasibility of establishing such a business. The people of Tanzania overwhelmingly supported this venture. | | Procuring and setting up the necessary equipment and phone lines was time consuming and arduous. Many health-care providers lack telephone and Internet connectivity, which affects their ability to access the Warmline's services. | Necessary to provide phone lines to hospitals and health centers, which will not only help care providers tap into the Warmline's call-in services, but also allow them to access a wealth of HIV/AIDS resources and guidelines |

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| | | | made available to remote doctors using a GRPS or 3G mobile network | | | | |
| | | - OneWorld.net 2009, 15 May 2009<br>- Ethiopian AIDS Resource Center 2009<br>- Utan, K. 2009, Global Health Magazine, Spring 2009 | **Fitun Warmline AIDS Hotline / Ethiopia**<br>While access to antiretrovial treatment has significantly improved in recent years, especially in remote areas of Ethiopia there is still a shortage of experienced HIV-care providers. Since May 2008, the free hotline provides health-care professionals across the country with answers to their questions about HIV/AIDS care and treatment. | | The Warmline has fielded some 16,000 calls - mostly from mobile phones -and six e-mail queries in one year. These days, about 400 calls a week are made, half of which originate in Addis Ababa. | | |
| | | - University of Washington 2009<br>- Kurth, A.E. et al. 2007, AMIA 2007 Conference Proceedings, p. 1018 | **Pambazuko PALM / Kenya**<br>A web-based application delivered on PDAs collects patient risk assessment data, and delivers counseling protocol training and evaluation to nurses involved in HIV care. | - In-depth interviews with PLHA in two clinics in Lima, Peru and among female PLHA in Mombasa, Kenya. | Data from PLHA on ART in Lima (n=31) revealed that 74% reported their willingness touse PDAs as a support for their HIV care. Data from interviews among female PLHA in Mombasa Kenya | -Patient triaging with lay counselors is feasible<br>- required PDA training took less than 1 hour<br>-Clinicians, nurses and counselors were all receptive to the technology | - Developing questions in local language is important<br>- |

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| | | | | | (n=10 HIV+ on ART) revealed that only 1/10 had ever used a computer, though most expressed willingness to be taught, and all had or had access to cell phones. All expressed interest in receiving text/audio messages for ART and safer sex. | | |
| | | - Dimagi Inc., HIV Mobile Decision Support<br>- Mitchell, M. et al. 2009, Presentation by D-Tree International, International Conference Global Health, 26-30 May 2009 | **HIV Mobile Decision Support / South Africa**<br>In a pilot study, screening protocols on PDAs were used to reduce the workload of physicians and increase access to high quality care of HIV patients. | -751 patients participated in the study<br>-randomised into intervention or control group | -High validity<br>-Reduced the burden of clinicians by 25%. | -The training time for e-IMCI was less than 20 minutes, after which clinicians were easily able to train each other. The four clinicians unanimously preferred e-IMCI to following the chart booklet, citing it as faster and easier to use. | |
| | | - DeRenzi, B. et al. 2008, e-IMCI: Improving Pediatric Health Care in Low-Income Countries, Computer Human Interaction Conference, 5-10 Apr. 2008, Florence, Italy<br>- Dimagi Inc., Mobile E-IMCI | **Mobile E-IMCI / Tanzania**<br>A pilot study was done to test the use of an electronic job aid on a PDA to improve adherence to the Integrated Management of childhood Illness (IMCI) protocols in rural Tanzania. | Field tested the prototype at a dispensary in Mtwara,Tanzania staffed by five clinical officers, who had all been previously trained in the use of IMCI. The team observed 24 patient encounters without | Using the e-IMCI prototype, clinicians performed 84.7% of investigations required by IMCI, a significant improvement over the 61% of investigations observed during conventional practice.($p < 0.01$). | | |

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| | | | | e-IMCI, and 28 with e-IMCI. | The current prototype is almost as fast as the current practice, where the book is rarely referenced. The team analyzed 18 trials comparing the time by the same clinician in a traditional IMCI session to one using e-IMCI; the average for both was about 12.5 minutes. The training time for e-IMCI was less than 20 minutes, after which clinicians were easily able to train each other. The four clinicians unanimously preferred e-IMCI, citing it as faster and easier to use than the chart book. These results and our experience suggest that e-IMCI is fast, improves adherence, and thus the quality of care, and also affords the health worker enough | | |

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| | | | | | flexibility to apply their skills on a case-by-case basis. | | |
| **Other mApps** | Mapping - Community mapping, also mentioned in the participatory section below, is described as being a tool to: raise awareness and educate communities; preserve culture; increase local communications capacity; assist in collaborative planning and management of land; enhance participation in monitoring and evaluation; and aid in conflict resolution. Some tools include Geodjango, Ushahidi, Google Earth Outreach, and CyberTracker. A CBIS with integrated community mapping exercises | | **Community Radio** Both traditional and interactive community radio is exemplified with possible applications including:<br>• Public service announcements connected to e-governance applications<br>• Interactive edutainment radio programming involving text message educational contests - Contests can be announced via radio and replies can be sent via test messaging<br>• More traditional applications to open spaces for marginalised social groups such as women and youth | | | | |
| | | http://www.comminit.com/en/node/320595/38 | **Mobile Video for Community Health Workers /Tanzania.** The project involved the creation of a series of health education videos that | Implemented by a volunteer working with BRAC Tanzania and D-Tree International in May 2010. | | | |

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| | could, as stated here, enhance the MVP sectoral initiatives in environment, water, agriculture, and health. | | could be played on cell phones by BRAC Tanzania's Community Health Volunteers (CHV) during home visits. Each CHV visits 150 - 200 homes each month, asking health related questions and providing healthcare information. The videos were designed to provide the CHVs with additional support material they could use in conjunction with a mobile phone based tool, CommCare. | | | | |

**Notes**

Column 1 – description of innovation including key features

Column 2 – program or theoretical source of innovation

Column 3 – the methodological approach that has been used and the type of evidence that is available

Column 4 – the specific tools used for the measurement of the innovation

Column 5 – the available evidence for the impact of the innovation

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Column 6 – aspects of innovation which may impact on feasibility, acceptability and scalability. These may include but not be limited to issues of cost, political and cultural sensitivity, required resources and logistics of implementation

Column 7 – lessons from other settings that indicate factors which may moderate impact

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| **Education & Awareness** | Primarily one-way communication programs to mobile subscribers via SMS/text messaging in support of public health, behavior change campaigns. |
| **Data, Health Record Access** | Applications designed to use mobile phones, PDAs, or laptops to enter and access patient data. Some projects may also be used by patients to access their own records. |
| **Monitoring/ Medication Compliance** | One-way or two-way communication to the patient to monitor health conditions, maintain care giver appointments, or ensure strict medication regimen adherence. Some applications may also include in-patient and out-patient monitoring sensors for monitoring of multiple conditions (such as diabetes, vital signs, or cardiac.) |
| **Disease/ Emergency Tracking** | Applications using mobile devices to send and receive data of disease incidence, outbreaks, geographic spread of public health emergencies, often in association with GPS systems and backend applications for visualization. |
| **Health/ Administrative Systems** | Applications developed for "back office" or central health care IT systems allowing for access by and integration with mHealth application. Such applications often tie in to regional, national, or global systems. |
| **Analysis, Diagnosis, and Consultation** | Applications developed to provide support for diagnostic and treatment activities of remote care givers through internet access to medical information data bases or to medical staff. |
| **Other mApps** | Applications developed for mobile phones that can aid health workers to perform better which may not necessarily require connectivity. Examples include applications or technologies that can be attached to the mobile device to make a diagnosis or to aid the health worker in decision making. |