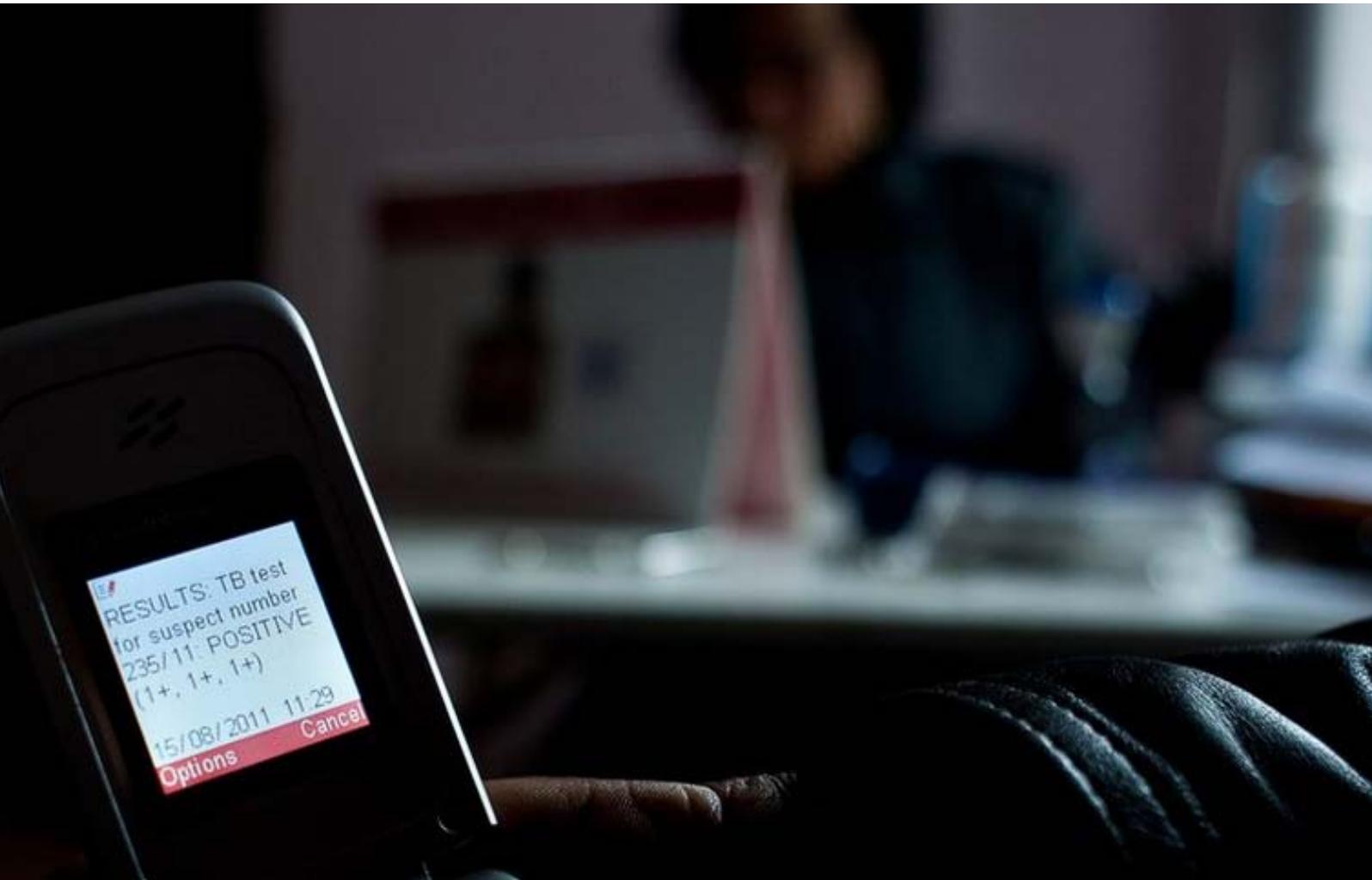
The logo consists of four vertical black bars of increasing height from left to right, followed by the text "mHEALTH" in a bold, red, sans-serif font.

mHEALTH

TO IMPROVE  CARE



Cover Image: WHO/Sam Nuttall
Below: Interactive Research and Development



CONTENTS

4 EXECUTIVE SUMMARY

7 PREFACE

8 INTRODUCTION

11 mHEALTH AND TB

Background

Overview of findings

Project areas

Treatment compliance

DOTS monitoring

Mobile diagnosis

Disease surveillance

Health awareness and information dissemination

31 NEXT STEPS

Public-private partnerships

Health systems strengthening

Encouraging developers and innovation

Evaluation

40 CONCLUSIONS

42 REFERENCES AND ENDNOTES

44 ACKNOWLEDGEMENTS

45 ACRONYMS AND ABBREVIATIONS

46 APPENDICES

Appendix A - Methods

Appendix B - TB case studies

Appendix C - General mHealth case studies

Appendix D - Further reference

EXECUTIVE SUMMARY

The expansion of mobile and wireless technologies around the world has set up an unprecedented opportunity for global health delivery. The International Telecommunication Union estimates that there are now over 6 billion wireless subscribers, with more than 70% of them residing in low- and middle- income countries. Mobile phone networks cover at least 90% of the world's population, including over 80% of those living in rural areas.¹

Mobile health, now commonly referred to as mHealth capitalizes on the successes of the mobile phone industry to deliver health information and care in an efficient and personalized manner. In the developing country context, mHealth is synonymous with using mobile phone technologies to access and care for vulnerable communities and individuals.



This report shares early experiences of projects and programs that have utilized mHealth in global tuberculosis (TB) control efforts, discusses their potential impact, and identifies challenges in scalability and evidence for policy makers. TB, a largely curable disease, remains a public health challenge for humanity. One-third of the estimated nine million people who become ill with TB every year are still not accurately diagnosed or effectively treated, and are at risk of dying. Interest in mHealth for TB control has escalated rapidly in the recent past, and new strategies and innovations are constantly being explored. mHealth can be a cornerstone of some of these efforts. Healthcare providers can establish and maintain lines of communication with patients equipped with increasingly ubiquitous mobile technology. Populations that were previously difficult to reach can now be included

in health coverage networks, empowering them to take on their own health decisions. Efforts at integrating mHealth into TB control programs are fledgling, with most not having moved beyond the pilot stage. Yet some projects have demonstrated successful outcomes at modest scale, and offer exciting new opportunities to improve the health of TB patients around the world.

This report highlights the successes and challenges associated with 31 projects identified from around the world. The area of TB control that most current mHealth projects focus on is treatment compliance, but significant work is also being done to bolster DOTS monitoring and mobile diagnostics. Using mobile phones to find, diagnose, treat, remind and track TB patients could prove to be very effective in resource-limited settings, especially where issues such as health worker shortages or geographical terrain hamper effective TB management and control.

The early experiences of some mHealth initiatives in TB control appear promising. However, the lack of formal evaluations - most often due to shortages of funding, time and expertise - is depriving TB programmes and their partners of information that would help them successfully design and launch local initiatives. Concrete steps will need to be taken to evaluate mHealth projects at scale to ensure that the potential benefits are accessible to all persons and communities affected by TB. Once this knowledge gap begins to be filled, creative partnerships for funding and implementation between partners should form more readily. Even at this early stage, consideration must be given to integrating mHealth implementations that support health systems, and not just one disease program.



Stop TB Partnership/David Rochkind

PREFACE

If we are to halve TB prevalence and death rates by 2015 (as compared with 1990 levels) we must innovate, or risk certain failure. With less than four years to go to meet that target as per the Stop TB Partnership's Global Plan to Stop TB (2011-2015), we must use every tool in our armoury that holds potential benefits. I consider mHealth to be potentially game-changing for global TB control efforts, one that holds enormous promise, perhaps second only to rapid molecular TB diagnostics in 2012.

Once a case is identified, we must first ensure that they get their laboratory result as quickly and efficiently as possible. Already sick people should not have to spend more time and energy to pick up a result that could be texted to them or a provider closer to their homes. We need to ensure that every case identified is notified to the national TB control programme, and that treatment is initiated rapidly. We need to monitor treatment compliance, minimize defaults, and integrate the patient's care as best as possible into the broader health system. I know of no tool that holds as much promise as the cell phone for closing the loop between diagnosis and successful treatment, effectively and affordably. To not pilot mHealth services in TB programmes and systematically evaluate their impact would be a disservice to our patients, and to the Partnership.

This report illustrates the potential of mHealth to enhance and improve TB awareness, case detection, treatment and monitoring by highlighting 31 projects from around the world. I expect that you will find much in here that will excite your imagination, and I hope that's enough reason to share it widely.

Aamir Khan, MD PhD
Executive Director
Interactive Research & Development
Karachi, Pakistan

Chair, MDR-TB Working Group, Stop TB Partnership
Member, Evidence Working Group, mHealth Alliance
Member, Steering Committee, openXdata.org

INTRODUCTION



The mobile telecommunications industry is booming. There are over 6 billion cellular subscriptions worldwide, representing greater than 75% of the global population.² More people now have access to a mobile signal than to water or electricity.³ Mobile network coverage extends to over 90% of the world's population, including over 80% of those living in rural areas.⁴ In the midst of this phenomenon, an interesting transition is taking place. The expansion of mobile telecommunications has been most dramatic in low-income countries where there are now more mobile subscriptions than in the developed world. The introduction of mobile technology into communities and households provides the healthcare sector with an unprecedented opportunity to target health interventions to people who otherwise would have minimal access to health care.

The accelerated penetration of electronic devices into new markets has fuelled interest in a new field known as eHealth, which is defined as “the use, in the health sector, of digital data - transmitted, stored and retrieved electronically - in support of health care, both at the local site and at a distance”⁵. The delivery of healthcare services through

mobile devices specifically has expanded and diversified into the field we now call mobile health (mHealth). The mobile telecommunication and multimedia technologies used for mHealth initiatives encompass “mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices”⁶.

The nascent field of mHealth presents enormous promise for health care and for TB control in low- and middle-income countries. In areas where infrastructure and resources are often lacking, mHealth initiatives are beginning to provide a wide range of services, including case notification in real-time, interactive health messaging, and performance-based incentives for health workers, all previously deemed impossible in these settings.

This report aims to describe the status of mHealth initiatives focusing on TB from around the world. It hopes to provide insight into how implementers have overcome the challenges faced during piloting and, for some, the scale-up of their programs. In highlighting TB control programs that embrace a wide range of mHealth components, the report seeks to identify successful frameworks that can be tailored and transferred to serve the needs of Partners in a wide-range of settings. It is hoped that this effort initiated by the Stop TB Partnership advances the potential for mHealth to recharge and revolutionize the fight against TB.



Interactive Research and Development

mHEALTH AND TB

BACKGROUND

Current TB management and control efforts are beginning to show success in decreasing the prevalence and incidence of TB globally, with the number of cases per capita falling by roughly 1% per year. Despite this, there are still close to 9 million new cases of TB reported each year, and almost 2 million people dying from the disease every year. The vast majority of cases occur in Asia and Africa, with over a third of all cases residing in India and China alone.⁷

TB is, in most instances, a curable disease. Treatment with first-line drugs can cure 90% of people with drug-susceptible TB in just six months. Drug-susceptible TB is treated using the directly observed therapy short course strategy (DOTS), which comprises a daily combination chemotherapy dose. In many places, insufficient resources and the risk of treatment noncompliance have rendered DOTS therapy very difficult to execute and have necessitated new approaches to tackling TB.

mHealth offers just that - using widely available and accessible technologies as tools through which to deliver health care. Early experience suggests that mHealth could be instrumental in TB case finding, rapid diagnosis and patient adherence to treatment. It also has the potential to provide parallel benefits to health systems providing TB control services. However, the lack of information on how mHealth has been used in TB programmes, and a much needed endorsement for promoting its use by partners could dampen the field's potential in TB control. This report aims to provide TB programme managers and partners with material that will guide the design, implementation, management, and evaluation of new and existing mHealth initiatives in TB control.

This report provides an overview of ongoing and recent mHealth initiatives for TB. The report documents several key aspects of these mHealth projects:

- the partners that developed them;
- their scope and scale;
- their current status;
- the barriers encountered during project implementation and, for some, during scale-up; and
- their successes and potentially beneficial outcomes.



OVERVIEW OF FINDINGS

In highlighting the work of 31 projects from around the world (see Appendix B), this report will show that:

- Most projects are the result of collaborations between governments, NGOs and the private sector.
- Over half of the projects are based in Africa, with South Africa leading the count. Many of the South African projects are focused primarily on mHealth and HIV/AIDS, with TB being a common co-infection.
- mHealth is most commonly being used to attempt to improve TB treatment compliance and to monitor DOTS. Projects using mobiles for diagnostic purposes are all in their early stages of development and few projects have been initiated that focus on disease surveillance and health awareness and information dissemination.
- mHealth initiatives in TB programs are varied in both scope and scale. The vast majority are currently piloting or have recently completed a pilot phase. A few have yet to begin field implementation. Very few projects have progressed beyond the pilot phase and there is no clear indication of whether they will scale-up.
- Mobile phones are the most common platform for mHealth initiatives. SMS text messages are by far the most common medium for mHealth data transmission.
- The principle barriers to project evaluation and scale-up are financial constraints.
- Many of the projects are small in size and do not have enough supporting information to validate their study design. Most projects lack formal impact evaluation and cannot effectively contribute to the already small body of scientific literature that exists on mHealth and TB.

PROJECT AREAS

Treatment Compliance

Directly Observed Therapy (short-course), or DOTS, requires patients to take TB medication on a regular basis for six months. For at least the first two months of the treatment regimen, someone must directly observe the patient swallowing her or his medication. In areas with high TB prevalence and few trained health workers, it is near-impossible for programs to fully implement and enforce DOTS for all patients. TB case detection, treatment and monitoring become difficult when health care networks are sparse and inaccessible to large subsets of the population, especially those in remote areas.

Treatment non-compliance and default puts patients at an increased risk for developing drug-resistant strains of TB (DR-TB), which are more expensive to treat and difficult for patients to comply with given the duration of treatment and side effects of second-line drugs. If patients adhere to treatment regimens, the risk of developing DR-TB is greatly reduced. Integrating mHealth components into existing TB control programs can dramatically decrease the strain on human resources created by DOTS programs and can aid in the monitoring of treatment compliance.



SMS (text) messages can be used in a diverse array of methods to communicate with patients who are normally required to visit a TB clinic or who must be visited by a health care worker at their home. SMS messages have been demonstrated to be successful in HIV control efforts and have been expanded to include TB treatment compliance. The most common form of these SMS messages are those that are sent to patients reminding them to take their medication. Project Masiluleke and On Cue have utilized this strategy to strengthen treatment compliance in South Africa. Other projects, including SIMpill and CoolComply, are exploring ways to incorporate SMS delivery technology into drug stock maintenance and dispensing units. Programmes contemplating the use of SMS must take into consideration the limited length of messages that can be sent and the literacy level of their recipients.

Some projects require patients to confirm their drug administration, either through SMS or a missed call. SIMmed (South Africa) and Interactive Reminders (Pakistan) are two such projects. Patients send an SMS or a missed call to a centralized server when they have taken their medication. The server records their message and sends either SMS reminders or health workers to those patients whose response to SMS notifications is not registered.

The majority of projects cite finances as their main barrier to scaling up. mHealth projects often require a significant upfront investment in phones, computers, servers, coders and other equipment. These requirements often increase as projects jump to higher patient enrolment numbers. The privacy and security of TB patients is also a real concern when sending SMS reminders and when transmitting patient information to the server. In low-income settings one mobile phone is often shared by several members of a family, potentially revealing a patient's disease status and exposing him or her to stigma associated with having TB.

Few projects have been properly assessed and evaluated, despite many reporting improvement in compliance and successful outcomes. Just a handful of projects are currently conducting impact evaluations of mHealth technologies in TB care.

SIMpill

South Africa

Organizations responsible: SIMpill and Tellumat

Aim: To improve compliance monitoring by using a wireless pill bottle that sends an SMS to a central server notifying it of the patient's action.

Overview: SIMpill is an ordinary pill bottle with an attached device that includes a SIM card and transmitter. Each time the bottle is opened it sends an SMS message to a central SIMpill server, recording the date and time of the event. When this does not occur at the prescribed time (or within a set tolerance period) the SIMpill computer sends a treatment reminder message to the patient, family member and/or caregiver. If the patient still does not take their medication after the reminder then the clinic or DOTS health worker is alerted so they can telephone or visit the patient directly.

In 2005, 100 TB patients in Northern Cape Province were asked to participate in the SIMpill pilot project. This was done to determine the feasibility of using the electronic monitoring and reminder system to improve medication adherence rates. It was found that 97% of patients felt the technology helped them take their medicine, and treatment adherence increased from 83% to 92%.

A second, larger pilot with 130 patients was then conducted in Khayelitsha, Western Cape province in 2007. Compliance rates increased from 22-60% to 90%. Of these, early indication cure rates were as high as 99%.

An even larger trial is planned for the Northern Cape district, as well as others in Tshwane municipality and at Princess Marina Hospital in Gaborone, Botswana.

The costs of the SIMpill technology are an issue since it costs around \$17 per patient.

Reference sources:

<http://www.SIMpill.co.uk>

<http://free.financialmail.co.za/innovations/07/0302/minn.htm>

<http://www.itweb.co.za/sections/computing/2005/0501241215asp?S=IT%20in%20Healthcare&A=ITH&O=TE>

http://www.globalproblems-globalsolutions-files.org/unf_website/assets/publications/technology/mhealth/mHealth_compendium_remote_monitoring.pdf

DOTS Monitoring

The second most common type of mHealth projects focused on strengthening DOTS monitoring. High-burden TB areas often have limited resources, making the implementation of DOTS difficult. The use of paper-based forms for DOTS monitoring is labour-intensive and often results in copious amounts of paperwork that is later difficult to analyse. To address this, many TB programs in this area have incorporated mHealth systems to streamline the collection and monitoring of patient information.

Mobile-based data collection software provides on-the-spot data validation and automated skip logic in the field, greatly increasing the accuracy of collected data. Some projects have used GPS-enabled phones to monitor the location of where field workers enter patient data, ensuring that fraudulent data are not being entered from off-site locations. Open-source medical record systems such as OpenMRS are being used to facilitate data collection, export, and reporting for TB and DR-TB programmes. Field data collection is directly input to OpenMRS through cell phones using the openXdata software platform. Several organizations have incorporated this electronic data capture into aspects of their TB program, including mDOTS programs for DR-TB in Pakistan, Tajikistan and Nepal.



Many projects have sought ways to streamline the reporting system in labs, connecting lab technicians, lab directors, physicians, field workers, and, ultimately, patients, via SMS and mobile/web interfaces. In Peru, health workers use PDAs to collect bacteriology data from laboratories. The data is uploaded to an electronic medical recording system that is accessed by physicians to monitor patient progress.

A challenge to incorporating mHealth strategies for DOTS monitoring into existing health systems is the hesitation on the part of the health sector to invest in and adopt new technologies that have not been rigorously evaluated. The Dokoza System, which is already at a large scale, cites this as one of its main barriers to becoming fully incorporated into the South African health system. It is essential that monitoring and evaluation and cost-effectiveness studies be designed to demonstrate the potential benefits of mHealth for TB in light of the upfront investments required. Evaluation frameworks and approaches that have been contextualized for mHealth TB control efforts need to be developed and disseminated widely.

Another potential barrier to using mHealth for DOTS monitoring is the need for dual reporting. Despite the availability of mobile technologies to make reporting more efficient, paper-based systems are often mandated by existing programs, and also serve as back-up data entry tools in the event of technical problems. However, any system used for the programmatic management of TB can be streamlined by the application of mobile technology.



Dokoza System for Disease Management

South Africa

Organizations responsible: Dokoza, in partnership with Neil Harvey and Associates (NHA) for IT support, and Deloitte for data analysis and reporting, risk management and strategic advice. The initial pilot project was originally commissioned and fully funded by the State Information Technology Agency (SITA), Centre for Public Innovation (CPSI), the Centre for Scientific and Industrial Research (CSIR), Meraka Institute, and the National Department of Health. However, the private pilot in KwaZulu Natal (KZN) was completely funded by Dokoza and its partners.

Aim: To fast-track and improve critical services for HIV and TB patients by facilitating better data management

Overview: The South African Dokoza system demonstrates the multidimensional use of mHealth. It uses an SMS system as well as other mobile phone technology for patient information management, improving communication between the different players in the health network, and patient tracking.

The first pilot was initiated in 2004 for a period of 6 weeks and involved 190 patients. At the time, all health institutions used different modes for gathering and maintaining patient information, meaning that it was very difficult and expensive to conduct national surveys, gather health statistics, and share data, and so usually these were done manually. Furthermore, rural areas rarely had electronic systems, meaning that paper-based systems were used and that patient records had to be kept by patients themselves. The mobile system was used to fast-track and improve critical services to HIV and TB patients, particularly those in low-resource settings where there were no fixed line or internet networks available. The main objectives of the project were:

- a) To exchange real time data between mobile phones
- b) Capacity building via the mobile, enabling practitioners to access patient history, diagnosis, health status, the latest lab test results, and what medication was last dispensed.
- c) Authorisation via mobile phone i.e. indicating whether treatment falls within the protocol.
- d) National Patient Tracking

e) Establishing a common platform with organizations such as the National Health Laboratory Services

f) Confidential communication with patients, which also includes auto-reminders of next appointments.

Dokoza uses an SMS/MMS based system developed in South Africa that links to computer applications and software, and various components have been patented. The project relies on SIM cards that can be used across networks and which interact with a back-end system that integrates easily into existing information systems. It is extensively rules based and is catered for users with basic computer literacy, and can be accessed in real-time via various hardware and software platforms. Sensitive information is not displayed on the web, and there are various levels of security measures, firewalls and encryptions.

The Dokoza system was easily accepted and there was an increase in patient compliance and feedback from patients indicated that the system made treatment regimens much easier to maintain. The most effective element of the program was the ease and speed of accessibility to clinical data. Dokoza was short-listed within a major international consortium for a tender at the NHLS to provide mobile services for their laboratory information system in KZN.

This tender is due for re-issue as a national solution. Various health tender submissions for further scaling up have been directed to the SA government.

Reference sources:

<http://www.changemakers.net/node/1014>

http://www.nha.co.za/content/news/2005/9_june.asp

<http://www.mhealthinfo.org/project/dokoza-system-disease-management>

http://www.w3.org/2008/02/MS4D_WS/papers/cdac-mobile-healthcare-paper.pdf

<http://www.mhealthinfo.org/project/dokoza-system-disease-management>

http://www.nha.co.za/content/news/2005/9_june.asp

http://healthmarketinnovations.org/program/dokoza-system-disease-management/technology/mhealth/mHealth_compendium_remote_monitoring.pdf

Mobile Diagnosis

In areas where accurate TB diagnostic services are scarce, mobile technology can relay digital X-rays, slides, photographs and other imaging tools to an appropriate facility, which can then relay the results back to the local liaisons. CellScope, a project in Vietnam, has health workers at communal health posts take pictures of sputum smear slides using camera-enabled phones. They send these images to diagnostic hubs, from which lab results are sent back to the community health worker. As a result, someone living in a rural or remote area does not have to travel long distances to have her or his tests analysed and can instead get diagnostic services in their hometown.

Mobile phones with integrated diagnostic tools are now being developed, which will further shorten the process to get a TB patient on treatment. These include diagnostic hardware and software for mobile phones that make it possible for diagnostic information to be available more quickly, having passed through fewer hands. Researchers at Oxford University have developed a stethoscope that can be attached to mobile phones, enabling patients to monitor their own lung health. Such innovations are exciting developments in mHealth and further testing is needed to optimize them for accurate and efficient diagnosis of TB.



This area of mHealth in TB control efforts is relatively new, and two of the five case studies found had not yet been implemented. The potential for mHealth in this area is enormous, especially in increasing the capacity of TB control in rural or remote areas.

Stethoscopes for TB diagnosis

South Africa



Organizations responsible: Oxford University, University of Cape Town, Groote Schuur Hospital

Aim: To reduce the numbers of people dying of tuberculous pericarditis by equipping people with mobile phones that function as stethoscopes, enabling them to record and analyse their own heart sounds.

Overview: About 40% of people with tuberculous pericarditis die post-diagnosis from cardiac arrest. The onset of symptoms of this form of TB is insidious and can be detected through heart monitoring. Researchers have developed a low-cost technology consisting of a mobile phone that includes a stethoscope made of an eggcup that enables people to remotely monitor their heart to pick up early signs of deterioration.

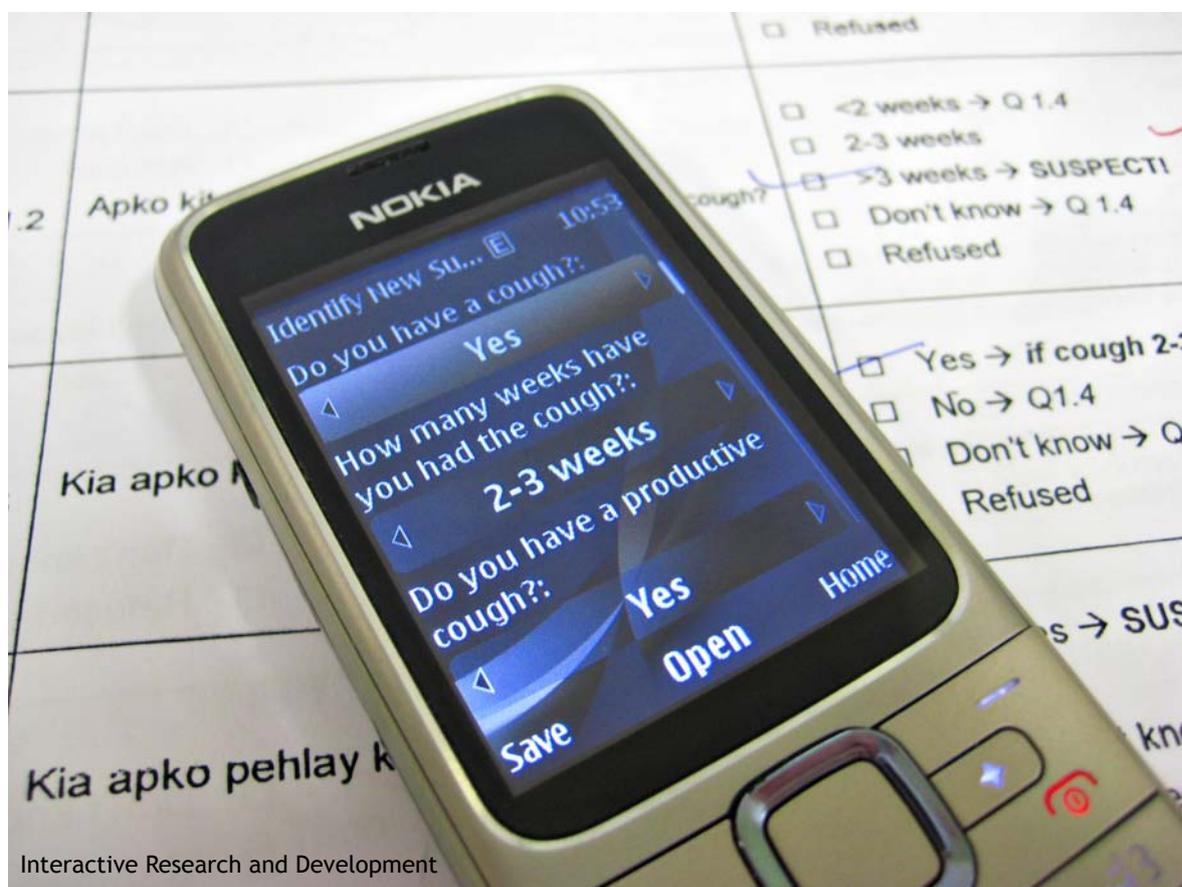
A trial of 150 phonocardiograms from volunteers with a range of cardiac conditions compared the heart rate estimation quality of a Nokia 3110 Classic, an iPhone 3G with a 3M Littman Electronic Stethoscope. Results showed that the Nokia out-performed the Littman in estimating heart rate.

A total of 2 313 additional patients are expected to be treated successfully (i.e. completed treatment) at 21 project sites in 4 administrative areas.

Disease Surveillance

It is estimated that one third of all TB patients go undetected. This means that over three million people are not receiving the treatment they require to cure them of TB, and risk infecting others in their communities. Disease surveillance efforts must be increased to deliver life-saving treatment to people living with TB. Electronic data capture makes it easy for health care personnel to collect and manage large volumes of data and shorten the time needed for analysis. This process streamlines the reporting of patient data to their respective national TB programme.

There were four projects working on improving TB surveillance in communities using mobile telecommunication technologies. The Uganda Health Information Network used PDAs to collect health information, including drug usage and stock, from community health centres. The data is sent to the capital, where the district health offices can update their disease surveillance records and provide appropriate care and services to their respective communities. If a certain community is experiencing a shortage of first line TB drugs, for instance, the district health office can make sure the stocks are refilled.



The Uganda Health Information Network (UNIH)

Uganda



Uganda Health Information Network

Organizations responsible: International Development Research Centre (IDRC), AED-Satellite, Uganda Chartered HealthNet, Makerere University

Aim: To use PDAs to help improve healthcare services delivery in Uganda by improving health workers' access to medical information and district health officers' access to current data.

Overview: The Uganda Health Information Network “provides two-way access to information utilizing existing cellular telephone network and low-cost, simple to use, and energy efficient PDAs for supporting health information dissemination, data collection and reporting, and email exchange. Data transfer from and to PDAs is facilitated using wireless access points and a server located in Kampala. Health workers use the PDAs to collect public health data at the community level. They then upload that data and emails they need to send to the wireless access points via infrared, Bluetooth or Wi-Fi at a rural health facility. The access points send 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.”

“District Health Offices receive data from various levels of health centres using the UHIN that include monthly Health Management Information System (HMIS) reports, disease surveillance data, reports related to HIV/AIDS, TB, 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 at doctors, senior nurses, and senior clinical officers (“tier-1”), and to community health workers (“tier-2”) is regularly broadcast through 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 TB. In addition health workers receive news from mainstream media on a daily basis through the network.”

There are about 600 health workers in Rakai, Mbale, Manafwa, Lyantonde, and Bududa districts using UHIN. The 175 remote health facilities are serving over 1.5 million people. AED-Satellife is replicating the project in Mozambique, where 110 health centres “are receiving medical updates and are collecting health information. It also launched in South Africa in Spring 2008”.

A “cost-effectiveness study of UHIN conducted by independent consultants in 2004/5 showed that the network delivered a 24% savings per unit of spending over the traditional manual data collection and transmission approaches.” “AED-Satellife has carefully documented its lessons learnt from years of using PDAs in delivering and collecting health information in developing countries. The organization has produced a ‘PDA Toolkit’ complete with a step-by-step guide on how to deploy PDAs, including information on the opportunities available and how to assess an organization’s readiness for using handhelds”. AED-Satellife determined that delivering news and popular content, such as gossip columns, onto the nurses’ PDAs was an effective method of getting the users used to the technology.

Technological difficulties have been encountered, which limited the number of health centres that can access and use the service. There exist technical incompatibilities of the PDAs with software depending on their models and manufacturers. Furthermore, power supply is unstable, and using alternative sources of electricity is very expensive. In addition, some areas do not have Internet or cellular network coverage.

Uhin has stated that to expand project like AED-Satellite, institutional support from the Ugandan national healthcare system is needed. After continuously updating the National Health Ministry on the project, the Ministry agreed to roll out the network to an additional 20 health districts. The aim of the network is to scale their work to reach approximately 3 000 additional health centres.

Reference sources:

<http://www.healthnet.org/uhin>

http://web.idrc.ca/uploads/user-S/12094975531UHIN-health_case2.pdf

http://idrc.org/uploads/user-S/12759249551UHIN_Best_Practices.pdf

<http://www.who.int/rpc/evipnet/Monitoring%20and%20Evaluation%20tool%20for%20the%20Uganda%20Health%20Information%20Network%20Project.pdf>

<http://www.hst.org.za/news/pilot-uganda-health-information-network-launched>

http://www.newsciencejournalism.net/index.php?/news_articles/view/uganda_to_adopt_electronichealth_records_system/

Health Awareness and Information Dissemination



Mobile phones make ideal tools for the wide dissemination of information relating to TB prevention, diagnosis, control and co-morbidity. The stigma associated with TB makes the use of mobile phones to raise awareness of TB and its symptoms somewhat complicated. As more and more individuals gain access to personal mobile phones, they can receive sensitive information and contact the appropriate health providers, while keeping their health status private from their families and communities. As an infectious disease, raising awareness relating to TB transmission, infection and prevention is of high importance for all programmes.

Very few projects have focused on TB awareness and information dissemination through mobile phones. Although several TB projects include increasing health awareness and information dissemination in their mHealth initiatives, only PSI in Laos was explicitly involved in this area. In other health fields, such as HIV/AIDS and maternal and newborn health, mobile phones are commonly used for such purposes. The Mobile Alliance for Maternal Action enables pregnant women to use their mobile phones to register their due date and then automatically receive SMS or voice messages with information relevant to their stage of pregnancy. Information disseminated to these women ranges from nutritional information to vaccinations to breast feeding practices and include prompts for when they might need to see a health care worker.

There are many ways in which informing communities about TB risk factors can bolster control efforts. For example, informing people in high-prevalence areas on TB transmission may lead them to improve their prevention efforts. Widespread information dissemination may also help dispel myths about TB that often lead to stigma associated with infected persons. Reducing the stigma associated with the disease increases the willingness of people to seek and/or accept treatment. It is important for more work to be done in this area as it holds tremendous potential for TB awareness and prevention.

Population Services International (PSI)

TB REACH wave 1 recipient

Lao People's Democratic Republic



Organizations responsible: PSI and the National Tuberculosis Centre collaborating with a local mobile phone company.

Aim: To incorporate the private healthcare sector into the national TB programmes by referring groups at high risk of TB to private-sector providers that have been equipped and trained by PSI to offer TB services. Educational SMS messages containing details of locally available PSI-supported TB clinics are sent to these high-risk groups

Overview: This public-private partnership enlists existing private clinics to expand their TB services to include remote and vulnerable populations. Many of these people turn to private care instead of the public health system due to the dubious quality of the latter.

PSI launched Sun Quality Health, a network of social franchise clinics that has already been successfully run in several countries. Over 50 private sector providers in 12 provinces have been trained and equipped by PSI to offer TB services and other services such as family planning and childhood illness management in their communities.

PSI Laos collaborates with a local mobile phone company to send routine educational SMS messages to populations at risk of TB. SMS messaging is used alongside Google Earth mapping to send messages with “Coughing for more than 2 weeks? It might be TB”, to individuals at high risk of TB and to monitor coverage of TB services. These tools monitor the location and demographic data for Sun Quality Health network clinics and allow PSI to identify gaps in TB service coverage.

Since the launch of the Sun Quality Health network at the end of 2010, PSI Laos has enrolled over 40 private clinics. Their initiative has prompted individuals to call PSI Laos TB Health Services for information about TB and other health issues, such as HIV.

References:

<http://www.psi.org/move-against-tb-laos>

NEXT STEPS

PUBLIC-PRIVATE PARTNERSHIPS

Public-private partnerships have been demonstrated to be the foundation of successful mHealth initiatives. There is remarkable capacity in the private sector to produce innovative new solutions for public health challenges. A key first step, therefore, would be to draw the focus of such entities towards TB control. According to a joint GSMA and PricewaterhouseCoopers report published in 2011, the mHealth market in Asia Pacific, a region including China and India, “will experience a 70 percent growth rate over the next six years”⁸, making it worth US\$7 billion by 2017. There is significant market potential for mHealth initiatives, and many groups, most notably IT and telecommunication companies such as Microsoft, Vodafone and Nokia, have already shown keen interest in contributing to the field. As the field matures, it will become easier for the private sector to engage with other partners, including grassroots organizations and TB programmes. The role of mHealth in TB control programmes needs to be firmly established and subsequently promoted with private sector organizations. To achieve this, a thorough analysis of the impact and cost effectiveness of mHealth projects needs to be synthesized into clear, concise and succinct messages that emphasize the need for partnerships between stakeholders. Active and sustained discussions should begin between these partners regarding the development and utilization of effective mHealth tools.

The public sector is equally as critical in ensuring the success of TB control programs. Governments have access to existing infrastructure and networks, making it vital to involve them in the successful integration of mHealth frameworks into health systems. Furthermore, they must take an active role in providing existing mHealth initiatives platforms from which to scale-up beyond their pilot phases. The Uganda Health Information Network stated that when they expanded their work to Mozambique, “engaging the Ministry of Health from the very beginning proved to be instrumental in ensuring project sustainability and facilitating rapid skills transference to Ministry technical personnel”⁹. A common reason why healthcare projects using telecommunications technology fail to move beyond pilot phase is that once the product has been tested, government policy requires it to go to a tender process before it can be rolled out in the public sector.

Interactive Research and Development (IRD) has been a leader in the development of PPM initiatives for disease management in Pakistan not only for TB control, but also pneumonia, rabies and other infectious diseases. As the recipient of wave 1 and 2 TB REACH grants to support intensified TB case finding in the private-sector, IRD and its partner organization, Indus Hospital, have actively engaged with National and Provincial TB Programmes of Pakistan to design studies, streamline electronic data capture with mobile phones, discuss modifications to existing reporting systems and monitor their impact.

Rwanda prides itself as being a leader in mHealth. Sometimes referred to as the ‘Singapore of Africa’, the landlocked country with a volatile history strives to be the tech hub for Africa, according to President Paul Kagame. Rwanda has a comprehensive technology program, which includes a government-driven eHealth plan to coordinate and promote the use of technology to support healthcare delivery nationwide. The plan is valued at \$23 million and “will support district health centres, develop community-based information systems and computerize the national health care system”. A large component of this plan is a rapidly growing mHealth portfolio, which focuses on healthcare delivery in remote and rural areas. Richard Gakuba, eHealth Coordinator to Rwanda’s Ministry of Health, states that “Rwanda sees mHealth as part of a larger eHealth vision, particularly in areas where we don’t have well-developed infrastructure, mobile-based programs are key”¹⁰.



Interactive Research and Development

The largest of these mobile-based programs is TRACnet, an electronic records system that is supported by the Rwandan Ministry of Health, Voxiva, and the Treatment Research and AIDS Centre (TRAC). TRACnet is used on mobile phones to oversee the distribution of medications, ensure drug adherence, electronically generate patient reports, and access information about treatment. Two hundred health centres around Rwanda are using the program to increase efficiency, decrease costs and improve health delivery. Gakuba hopes to see mHealth become fully integrated into Rwanda's eHealth program - a move that would both improve health care delivery and strengthen the case for private sector investment in health programs.

There are other positive signs that government interest in mHealth across the world is growing. In 2003, South Africa's Centre for Public Service and Innovation (CPSI) - in partnership with the Research and Development division of the State Information Technology Agency (SITA) and the Meraka Open Source Centre at the Council for Scientific and Industrial Research (CSIR) - issued a call for mobile technology proposals that would demonstrate the value mobile technologies could bring to improve access to government services and to facilitate e-democracy. A total of 27 proposals were received and evaluated by the project partners, resulting in the implementation of several pilot projects, including the Dokoza System. Initiatives that engage stakeholders in mHealth and present it as an important and effective strategy to advance health are crucial to integrating new technologies into national health systems.

Thus, the involvement of various sectors in creating a market for mHealth is necessary. In low-income countries in particular, partnerships between private and public sectors could be beneficial to both parties and the possibility should be explored.

HEALTH SYSTEMS STRENGTHENING



Stop TB Partnership/David Rochkind

The World Health Organization recognizes the vital importance of health systems strengthening for effective and extensive DOTS implementation. Mobile telecommunication devices ease the burden on limited resources, thus making health care available to more people than ever before.

To realize the maximum potential of mHealth projects, care must be taken to ensure their accessibility to those they seek to benefit. A user-centric framework is crucial to the success of mHealth initiatives. Project workers on the ground must communicate the realities and needs of their patients to make sure the project is tailored to subsume local cultural and language contexts, including literacy levels and security concerns. These must all be taken into account during hardware and software manufacturing, project design and implementation, and other logistical issues that cannot be anticipated by those removed from local realities.

Consolidating the efforts of several disease control programs into a few that are large in scope and size can also strengthen national health systems. mHealth initiatives focusing on TB control can be successfully launched by being integrated into existing mHealth projects in other health fields. Significant work has been done in the field of mHealth and HIV/AIDS and many of the projects are relatively well-established. They are often adequately funded and have secure partners in both the public and private spheres. They are the most likely to have been evaluated, and are frequently the largest in scale in the mHealth arena. Several projects highlighted in this report, namely the Dokoza system and Project Masiluleke, have incorporated TB control into their HIV mHealth initiatives, transitioning from the single-disease silo model to one that is multi-disease focused and more sustainable. This transition was a natural extension of programmatic needs to prevent TB co-infection and in turn, assures the effectiveness of the program's HIV/AIDS efforts. Health issues that are frequently involved in TB morbidity should be addressed by existing mHealth projects that have the capacity to effectively expand their scope.



Interactive Research and Development

ENCOURAGING DEVELOPERS AND INNOVATION

The potential impact of mHealth technologies on TB control programs is likely to be very significant. As demonstrated in these case studies (see Appendix B), mobile technology can be used in multiple ways. The most common technology is SMS messaging, but other technologies such as video messaging and function-specific phone add-ons are also proving to be useful. TB control programs can borrow relevant technologies from other programs. Furthermore, technological innovation specific to mHealth needs, as well as general changes in the mobile phone product itself, offer exciting new prospects for future mHealth projects.



The Vodafone and mHealth Alliance Wireless Innovation Awards are given out annually to projects that show the most potential to solve critical global problems. In 2011, the first place prize of \$300 000 went to NETRA, a clip-on eyepiece for mobile phones that allows health workers to screen for eye conditions and relay the data to an optometrist, allowing for quick diagnosis and early treatment of eye disorders and cataracts. CoolComply, an innovation designed to improve MDR-TB treatment compliance that is featured in this report, was awarded third place. Microsoft Research has two mHealth awards: Mobile Healthcare for Africa Awards as well as Cell Phone as a Platform for Healthcare Awards, both supporting researchers with innovative projects that demonstrate advances in using mobile technologies for

delivering healthcare. The second award also focuses on ‘the creation of appropriate services, systems, and infrastructures to provide solutions to the global healthcare community’. Thus, Microsoft’s focus is not singularly on technological innovations but also on mHealth organization and delivery.

Most recently, the UN Secretary-General’s Every Woman Every Child effort’s Innovation Working Group awarded eight grants for mHealth programs. The grants were funded by the Norwegian Agency for Development Cooperation (Norad) and ‘are designed to identify and foster innovative uses of mobile technology to advance maternal and newborn health, with a special focus on growing programs with sustainable financing models and early indications of impact’. Three of the winners, D-Tree International, Interactive Research and Development and the Rwandan Ministry of Health, focus on TB control and are featured in this report (see Appendix B). The inclusion of TB work in maternal and newborn mHealth programs is an excellent example of how the mHealth infrastructure for one health issue can be expanded to encompass or adapted to benefit other health issues.



Interactive Research and Development

EVALUATION

mHealth is a recently emerging field with little experience or guidance on evaluation frameworks for implementors. Only 31 TB control and mHealth projects could be identified for this report, and few of these had been formally evaluated. To offset this limitation, mHealth initiatives must synthesize and share their information to ensure the availability of diverse resources on the various aspects of project design, implementation, management and evaluation. The mHealth Alliance's Evidence Working Groups and its Health UnBound (HUB) initiative, USAID's Knowledge for Health (K4Health) projects and the Bellagio eHealth Evaluation Group seek to do just this. A global repository linking such databases should be developed to provide one central source from which mHealth stakeholders can access information (see Appendix D).



In an effort to determine best practices in TB control and mHealth, the Stop TB Partnership can facilitate the formation of an online forum where projects can share experiences and performance results. It would be useful to encourage the development of 'TB mHealth packages', which would include, amongst other things; accessible and manageable collections of software, software guidelines, partnering guidelines, regulatory frameworks and possible funding sources. These packages would be used by both new and existing mHealth projects and would help guide the appropriate design and implementation of their strategies.

The availability of practical information on mHealth implementation and evaluation can dramatically accelerate and ease the adoption of mobile technologies by groups working in TB control. For instance, a package could be created specifically for TB REACH projects that include software instructions for SMS reporting for GeneXpert systems, medication reminders for patients, data collection for health workers screening suspects, and mobile cash transfer facilities for incentives for patients, health staff, and/or community health workers. Similarly, a package might be created for advocacy groups that would include systems to connect and receive inputs from civil society. To reach this level of systematization, there remains a continuing need for research and evaluation of mHealth initiatives to ensure their appropriate and sustainable integration in national TB control programmes.

CONCLUSIONS



Project Masiluleke

Mobile health represents an innovative and exciting tool in the fight against TB, and it is in countries where TB prevalence is highest that mHealth initiatives stand to make the greatest impact.

In June 2011, the World Health Organization's Global Observatory for eHealth released a comprehensive report on the status of mHealth initiatives for health issues around the globe. Groups interested in piloting TB control projects using mHealth strategies not enumerated in this report are encouraged to review the publication to identify frameworks and best practices that could guide their project design, implementation and evaluation.

This report highlights the successes and challenges associated with 31 projects identified from around the world. The area of TB control that most current mHealth projects focus on is treatment compliance, but significant work is also being done to bolster DOTS monitoring and mobile diagnostics. Using mobile phones to find, diagnose, treat, remind and track TB patients could prove to be very effective in resource-limited settings, especially where issues such as health worker shortages or geographical terrain hamper effective TB management and control.

The early experiences of some mHealth initiatives in TB control appear promising. However, the lack of formal evaluations - most often due to shortages of funding, time and expertise - is depriving TB programmes and their partners of information that would help them successfully design and launch local initiatives. Concrete steps will need to be taken to evaluate mHealth projects at scale to ensure that the potential benefits are accessible to all persons and communities affected by TB. Once this knowledge gap begins to be filled, creative partnerships for funding and implementation between partners should form more readily. Even at this early stage, consideration must be given to integrating mHealth implementations that support health systems, and not just one disease program.

mHealth tools could prove to be instrumental in the fight against TB. By demonstrating the value of effective evaluation, partnerships, innovation and knowledge-sharing, this report aims to set some benchmarks for current and future mHealth initiatives. In strengthening existing strategies and spurring new efforts, the use of mHealth holds tremendous promise for all persons and communities affected by TB.

REFERENCES AND ENDNOTES

References

Blynn, E. Piloting mHealth: a research scan. Cambridge, MA: Knowledge Exchange; 2009.

Culver, D. Health check: key players in mobile healthcare. Pyramid Research; 2010.

Curioso, W.H. and P.N. Mechael. Enhancing 'm-health' with south-to-south collaborations. Health Aff (Millwood); 2010. 29(2): p. 264-7.

Delichte, J. Mobile health services marketing: an examination of current approaches to branding, pricing and promotion. GSMA; 2011.

Free, C., et al. The effectiveness of m-health technologies for improving health and health services: a systematic review protocol. BMC Research Notes; 2010. 3(1): p. 250.

Hoffman, J.A., et al. Mobile direct observation treatment for tuberculosis patients: a technical feasibility pilot using mobile phones in Nairobi, Kenya. Danya International; 2009.

infoDev. Framework for the assessment of ICT pilot projects: beyond monitoring and evaluation to applied research. Washington: The World Bank; 2005.

infoDev. Improving health, connecting people: the role of ICTs in the health sector of developing countries. Washington: The World Bank; 2006.

Kallander, K. Landscape analysis of mHealth approaches which can increase performance and retention of community based agents. Kampala: inSCALE, Malaria Consortium; 2010.

Kaplan, W.A. Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries? Globalization and Health; 2006. 2: p. 9.

Lemaire, J. Scaling up mobile health: elements necessary for the successful scale up of mHealth in developing countries. Advanced Development for Africa: Geneva; 2011.

Mechael, P., et al. Barriers and gaps affecting mHealth in low and middle income countries: policy white paper. New York: Earth Institute, Columbia University; 2010.

Mechael, P. The case for mHealth in developing countries. Innovations: Technology, Governance, Globalization; 2009. 4(1): p. 103-118.

Michael, P. Towards the development of an mHealth strategy: a literature review. World Health Organization; 2007.

Ranck, J. Health information and health care: the role of technology in unlocking data and wellness - a discussion paper. Washington: United Nations Foundation & Vodafone Foundation Technology Partnership; 2011.

Rao, M. Mobile Africa report 2011: regional hubs of excellence and innovation. MobileMonday; 2011.

Vital Wave Consulting. mHealth for development: the opportunity of mobile technology for healthcare in the developing world. Washington & Berkshire: UN Foundation-Vodafone Foundation Partnership; 2009.

WHO Global Observatory for eHealth. mHealth: new horizons for health through mobile technologies. Geneva: World Health Organization; 2011 (Global observatory for eHealth series).

World Health Organization. Global Tuberculosis Control 2011. Geneva: WHO, 2011.

Endnotes

- 1 International Telecommunication Union. The world in 2011 - ICT facts and figures. Geneva: ITU Telecom World; 2011.
- 2 Ibid.
- 3 mHealth Alliance and World Economic Forum. Amplifying the Impact: Examining the Intersection of Mobile Health and Mobile Finance. Washington and Geneva; 2011.
- 4 International Telecommunication Union. The world in 2011 - ICT facts and figures. Geneva: ITU Telecom World; 2011.
- 5 <http://www.who.int/eh/eHealthHCD/en/>
- 6 AT Kearney. Mobile health, who pays? GSMA; 2011.
- 7 Stop TB Partnership. The global plan to stop TB 2011-2015: transforming the fight towards elimination of tuberculosis. Geneva: World Health Organization; 2010.
- 8 <http://www.mobilehealthlive.org/articles/apac-mhealth-market-worth-us-7billion-by-2017/19478/>
- 9 Kinkade, S. and K. Verclas. Wireless Technology for Social Change: Trends in Mobile Use by NGOs. Washington and Berkshire: United Nations Foundation and Vodafone Group Foundation Partnership; 2008.
- 10 <http://www.mhealthalliance.org/content/issue-5>

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ACRONYMS AND ABBREVIATIONS

AFB	Acid-fast bacilli
AIDS	Acquired immunodeficiency syndrome
ART	Antiretroviral therapy
BCG	Bacilli Calmette-Guérin
CHW	Community health worker
CDR	Case detection rate
DOTS	Direct Observation Therapy Shortcourse
HIV	Human immunodeficiency virus
IT	Information technology
MDR-TB	Multidrug-resistant tuberculosis
mHealth	Mobile health
MMS	Multimedia messaging service
NGO	Nongovernmental organization
NTP	National tuberculosis programme
PDA	Personal digital assistant
SMS	Short Message Service
TB	Tuberculosis
UN	United Nations
USAID	United States Agency for International Development
WHO	World Health Organization

APPENDICES

47 Appendix A
Methods

48 Appendix B
TB case studies

52 Treatment compliance

62 DOTS monitoring

70 Mobile diagnosis

74 Disease surveillance

79 Health awareness and information dissemination

81 Appendix C
General case studies

84 Appendix D
Further reference

A - METHODS

To assemble this report, a review of recent and ongoing mHealth implementation focused on TB detection, treatment and control globally was conducted. Public information on mHealth in TB was reviewed. The mHealth projects are organized according to five core thematic areas related to TB:

- Treatment Compliance
- DOTS Monitoring
- Health Awareness and Information Dissemination
- Disease Surveillance
- Mobile Diagnosis

Although several of the cases presented in this report have multiple applications, they are organized by their dominant function.

B - TB CASE STUDIES

TREATMENT COMPLIANCE

1. SMS reminders, Catholic Relief Services, Nigeria
2. Wireless medical storage, CoolComply, Ethiopia
3. Interactive Reminders, Interactive Research and Development (IRD), Pakistan
4. Treatment and appointment reminders, Labour and Health Social Initiatives, Ukraine
5. MDOT technical feasibility pilot, Mbagathi District Hospital, Kenya
6. SMS reminders, OnCue Compliance Service Pilot, South Africa
7. Biometric treatment compliance tracking system, Operation ASHA, India
8. Phoned pill reminders for TB treatment, Chiang Mai Public Health Department, Thailand
9. Project Masiluleke, iTEACH, South Africa
10. SIMmed, CompuTainer, South Africa
11. Wireless pill bottle, SIMpill, South Africa
12. X out TB, Innovations in International Health, Indonesia and Nicaragua

DOTS MONITORING

13. e-TB module for health workers, D-tree International, Tanzania
14. Improving TB data management, Dokoza System for Disease Management, South Africa
15. SMS based specimen and results tracking system, Foundation for Innovative New Diagnostics (FIND), Lesotho
16. mDOTS, Interactive Research and Development (IRD), Pakistan, Tajikistan and Nepal
17. Electronic data collection system, PDAs to collect TB bacteriology data, Peru
18. SMS patient referral tracking system, Population Services International (PSI), Zimbabwe
19. SMS based intervention pilot, St. Gabriel's Hospital, Malawi
20. Mobile phones for patient screening and referral, TB/HIV Care Association, South Africa
21. Using smartphone technology for data-driven improvements, USAID, Nigeria

MOBILE DIAGNOSIS

22. Mobile phone-based microscopy, CellScope, Vietnam
23. Mobile phones for X-ray remote reading, Centre for Infectious Disease Research, Zambia
24. SMS messages to track and report TB specimens, Foundation for Innovative New Diagnostics (FIND), Uganda
25. Information exchange between diagnostic hubs and community centres, Sihanouk Hospital Centre of HOPE, Cambodia
26. Stethoscopes for TB diagnosis, Oxford University

DISEASE SURVEILLANCE

27. eMOCHA TB Detect, Johns Hopkins Centre for Clinical Global Health Education
28. TB REACH 1 and 2, Indus Hospital/Interactive Research and Development (IRD), Pakistan
29. Electronic surveillance system, uNotify System, India
30. Information sharing using PDAs, Uganda Health Information Network, Uganda

HEALTH AWARENESS AND INFORMATION DISSEMINATION

31. Educational SMS messages, Population Services International (PSI), Laos

	Page	Location	Phase				Treatment Compliance	DOTS Monitoring	Mobile Diagnosis	Disease Surveillance	Health Awareness and Information Dissemination
			Concept	Pilot	Post-Pilot	Scaled-up					
1. Catholic Relief Services	62	Nigeria		X			X				
2. CoolComply	62	Ethiopia	X				X				
3. IRD - Interactive Reminders	63	Pakistan			X		X	X			
4. Labour and Health Social Initiatives	64	Ukraine		X			X				
5. Mbagathi District Hospital	64	Kenya		X			X			X	
6. OnCue Compliance Service Pilot	66	South Africa		X			X				
7. Operation ASHA	67	India				X	X				
8. Chiang Mai Public Health Department	68	Thailand		X			X				
9. iTEACH	69	South Africa				X	X	X		X	
10. Computainer	70	South Africa		X			X				
11. SIMpill	71	South Africa			X		X				
12. Innovations in International Health	72	Nicaragua		X			X				
13. D-tree International	74	Tanzania			X			X	X		
14. Dokoza System for Disease Management	74	South Africa			X			X	X		

15. FIND - Lesotho	77	Lesotho		X				X			
16. IRD - mDOTS	78	Pakistan, Tajikistan, Nepal			X			X			
17. PDAs to collect TB bacteriology data	79	Peru		X				X			
18. PSI - Zimbabwe	80	Zimbabwe		X				X			
19. St. Gabriel's Hospital	81	Malawi				X		X		X	
20. TB/HIV Care Association	82	South Africa		X			X	X		X	
21. USAID	82	Nigeria			X			X			
22. CellScope	84	Vietnam	X						X		
23. Centre for Infectious Disease Research	85	Zambia			X				X		X
24. FIND - Uganda	85	Uganda	X						X		
25. Sihanouk Hospital Centre of HOPE	86	Cambodia	X					X	X		
26. Stethoscopes for TB diagnosis	87	South Africa	X						X		
27. eMOCHA TB Detect	88		X							X	X
28. Indus Hospital/IRD	89	Pakistan				X	X	X		X	
29. uNotify System	90	India	X				X	X		X	
30. Uganda Health Information Network	91	Uganda				X				X	X
31. PSI - Laos	93	Laos				X				X	X

TREATMENT COMPLIANCE

1. SMS REMINDERS, CATHOLIC RELIEF SERVICES

TB REACH wave 1 recipient
Nigeria

Organizations responsible: Catholic Relief Services and the Institute of Human Virology

Aim: To pilot a vigorous community-based TB detection, referral and treatment project.

Overview: The project targets pharmacists that are frequented by people who may be ill with TB in 22 communities in the states of Kogi and Enugu. The pharmacists refer potential TB patients to the nearest TB health care facility. Thus, these individuals can get immediate and effective care even when they visit a traditional provider for their health care needs. The health care facility sends SMS messages to patients reminding them to take their medication, improving treatment adherence.

2. WIRELESS MEDICAL STORAGE, COOLCOMPLY

Ethiopia



Organizations responsible: Massachusetts General Hospital, Innovations in International Health at the Massachusetts Institute of Technology, and the Global Health Committee

Aim: To provide community-based management of drug resistant TB patients while promoting adherence and drug efficacy.

Overview: CoolComply is a solar-powered refrigerator connected with a wireless detector that monitors the temperature of the medication and the dosages removed from the stock. Data is relayed to local healthcare workers via SMS messages to track each patient's treatment adherence, allowing them to intervene when necessary. CoolComply easily allows health professionals to monitor several aspects of a patient's treatment cheaply and remotely.

Reference sources:

<http://project.vodafone-us.com/current-competition/2011-winners/coolcomply/>
<http://globalchallenge.mit.edu/teams/view/183>

3. INTERACTIVE REMINDERS, INTERACTIVE RESEARCH AND DEVELOPMENT (IRD)

Pakistan

Organization responsible: Interactive Research and Development (IRD)

Aim: To improve TB treatment compliance in Karachi by reminding patients to take their medication via SMS messages.

Overview: The 'Interactive Reminders' randomized controlled trial is a multi-year joint venture between Interactive Research and Development (IRD) in Pakistan and researchers from the Abdul Latif Jameel Poverty Action Lab at the Massachusetts Institute of Technology (MIT). This trial aims to gauge the impact of Interactive Reminders, a two-way SMS reminder system for TB patients, on treatment compliance and outcomes. The Interactive Reminders system sends daily messages to patients, reminding them to take their TB medication. They are asked to respond back via SMS or a missed (unbilled) call after they have taken their medication to the project number connected to a server. Patients are sent up to three reminders each day if they do not respond. Patients who are non-responsive for seven days are followed up with over the phone. In this trial, TB patients are randomized into study arms, with half receiving Interactive Reminders and the control group receiving just the regular standard of care provided at their TB clinics.

4. TREATMENT AND APPOINTMENT REMINDERS, LABOUR AND HEALTH SOCIAL INITIATIVES (LHSI)

TB REACH wave 2 recipient

Ukraine

Aim: To introduce telephone prompting for treatment adherence. Patients will be contacted through phone calls/SMS messages to remind them to attend appointments at DOTS sites and to take their medication on time.

Overview: The project aims to establish a strongly improved system of TB services at the local level by engaging local units of State Social Services for Family, Children and Youth (SSSFCY) to provide services to promote TB diagnostics, TB treatment and TB treatment adherence. Patients will be contacted through phone calls/SMS messages to remind them for transport to DOTS sites and to take their medication on time. Patients are expected to be successfully treated through intensive counseling and social support, incentive packages, telephone/SMS prompting, and transport to DOTS sites. After release from intensive treatment, patients will be provided assistance by SSSFCY in for adhering to their treatment (incentive package, telephone/SMS prompting, organizing transport to DOTS sites, counseling, self-help groups etc.). The project will take place at 21 sites in 4 administrative areas in Ukraine. A total of 2 313 patients

are expected to be treated successfully (i.e. completed treatment).

5. MDOT (MOBILE DIRECT OBSERVATION TREATMENT FOR TB) TECHNICAL FEASIBILITY PILOT, MBAGATHI DISTRICT HOSPITAL

Kenya

Organizations responsible: Mbagathi District Hospital, Nairobi, Global Health Communication Team, the National Centre for Health Marketing (NCHM), the Coordinating Centre for Health Information and Service (CCHIS), the Centre for Disease Control (CDC), and the United States Department of Health and Human Services (USDHHS), Safaricom Limited, Nokia Siemens Networks, Voxiva, EPOS Health Consultants, Danya International, Inc.

Aim: Designed as a proof-of-concept pilot to provide MDOT for TB patients via mobile phone video capture and transmission.

Overview: Kenya's MDOT technical feasibility pilot was started to ensure patient compliance by monitoring them using mobile phone video. 3 health professionals and 13 TB patients took part in the trial. Video-capable mobile phones were provided to the patients, and their treatment supporters were asked to video document the patient taking her or his dose of medications. Every day these videos were sent via MMS to a secure central database where they were automatically logged and time- and date- stamped. The videos were then reviewed by medical nurses. Additionally, patients received about one MMS and 4 SMS health messages per week, containing testimonials from recovered patients, advice from physicians, and TB prevention messages. Finally, patients were asked to complete questionnaires about their experiences at different time points over the course of the program.

11 of the 13 patients completed the trial. All agreed that MDOT was a viable option, it appeared that the reminders and health messages were valued highly, and that the technology prevented patients from feeling isolated throughout treatment.

The project experienced some barriers to scaling up. Dependency on a shared hospital IT system and internet access created reliability challenges such as frayed Ethernet cables, and slow system access as a result of competition for bandwidth within the hospital. This highlighted the need for a centralized service model, which would improve service quality through providing dedicated IT and personnel, and would also benefit from economies of scale.

Sporadic availability of treatment supporters was another issue, since patients had to video-record themselves. Future work should include a detailed protocol for making recordings; including details on distance, lighting, timing etc.

To effectively scale-up, the project requires a wider distribution of video-enabled mobile phones throughout Kenya's general population. However, it is anticipated that lower-cost versions may become more widely available in the next few years. Nevertheless, it would require investment into IT and human resources in order to implement such activities on a larger scale. Further studies also need to be conducted to determine whether the MDOT strategy improves medication

adherence, and whether it is cost-effective.

Reference sources:

<http://mobileactive.org/research/mobile-direct-observation-treatment-tuberculosis-patients>
<http://www.danya.com/files/MDOT%20Final%20Report.pdf>
http://www.redorbit.com/news/health/1658441/pilot_study_using_video_cell_phones_for_mobile_direct_observation
[http://www.tropika.net/svc/review/Anderson-20100205-Review-Mobile-Phones\[1\]](http://www.tropika.net/svc/review/Anderson-20100205-Review-Mobile-Phones[1])
http://www.mobileactive.org/files/file_uploads/TBvideo.pdf
[http://www.ajpmonline.org/article/S0749-3797\(10\)00259-X/abstract](http://www.ajpmonline.org/article/S0749-3797(10)00259-X/abstract)

6. SMS REMINDERS, ON CUE COMPLIANCE SERVICE PILOT

South Africa

Organizations responsible: On Cue, an organization that sends out SMS reminders for various chronic conditions in various African countries. SIMpill also supported management of the project. Funding came from governmental organizations, and evaluation was carried out by Bridges.com.

Aim: Using SMS reminders to help with TB treatment compliance. The SMS messages were to be used as an auxiliary service and to supplement DOTS where possible.

Overview: On Cue Compliance is helping reduce non-compliance by sending patients timely SMS reminders via their personal cell phones. The technology used to send out the messages is extremely low-cost and robust, consisting of an open source software operating system, Web server, mail transport agent, applications, and a database. Client information is entered into a database and after every half hour the computer server reads the database and sends personalized messages to the patients, reminding them to take their medication.

Of the over 300 patients that took part in the pilot, more than 280 completed their course.

Currently, the system is being used in the treatment of TB patients in Cape Town, South Africa, with almost a 100% success rate.

The project management notes that issues of privacy, data protection, and security will affect the widespread use of technology in healthcare in Africa over the long-term.

Reference sources:

<http://idl-bnc.idrc.ca/dspace/bitstream/10625/32677/1/122116.pdf>, <http://www.nextbillion.net/archive/activitycapsule/1214> and contact david@SIMpill.com

7. BIOMETRIC TREATMENT COMPLIANCE TRACKING SYSTEM, OPERATION ASHA

India

Organizations responsible: Operation ASHA in collaboration with Microsoft Research and

Innovators in Health (IIH).

Aim: To provide a fingerprint-based biometric system to monitor patients on treatment, and to track and improve delivery of TB medications.

Overview: Operation ASHA integrates several electronic devices into its TB compliance tracking system. The biometric device used consists of easily available components such as a Netbook computer, a commodity fingerprint reader, and a low cost mobile phone. When a patient takes their medication, her or his fingerprint is scanned and they are identified using the computer component of the biometric device. This certifies that the dose has been successfully completed and the data is logged.



A complete log is sent via SMS to a central server in the cloud, where it can then be downloaded and uploaded onto an Electronic Medical Record (EMR) system by the program manager for review and analysis. If a patient fails to come in when expected, councillors get text messages from the system. They can then go and track the patient in her or his home and ensure that they take the necessary medication.

The system not only ensures that program managers can identify missed doses as soon as they occur and respond appropriately, but it also provides better incentives for providers, whose pay usually depends on the final treatment outcome of a patient. By logging each visit, the terminal enables compensation to be tied to each dose, incentivizing providers to be diligent on a daily basis.

27 eDOTS terminals operate in 20 Operation ASHA DOTS centres in South Delhi. These have been running for 18 months. Over 1 000 patients are registered with the program.

Operation ASHA has effectively integrated into the TB control program: patients feel a greater trust and satisfaction with the treatment regime, councillors have 30% more free time with which to conduct case-detections and patient visits, and it has resulted in a drop in the patient default rate from 2.75% (without mHealth intervention) to less than 1%. Thanks to the project's successes, 9 more eDOTS terminals will be inaugurated in Rajasthan.

Reference sources:

<http://research.microsoft.com/en-us/um/people/thies/thies-nsdr10.pdf>
<http://www.ghdonline.org/adherence/discussion/operation-asha-fighting-tuberculosis-in-india/>
http://www.samhita.org/system/datas/2199/original/Operation_ASHA_Annual_Report.pdf
<http://cdn.changemakers.com/sites/default/files/Operation%20ASHA.pdf>
http://www.uchicago.edu/features/20110411_asha/
http://www.stoptb.org/partners/partner_profile2.asp?PID=68918
<https://www.globalindiafund.org/ngos/operation-asha>

8. PHONED PILL REMINDERS FOR TB TREATMENT, CHIANG MAI PUBLIC HEALTH DEPARTMENT

Thailand

Organizations responsible: The Chiang Mai Public Health Department

Aim: To improve patient adherence to TB treatment by using an inexpensive calling promotion to remind patients when it is time to take their medication.

Overview: The Chiang Mai Public Health Department piloted a program where 60 TB patients on 6 month TB treatment were given mobile phones that could only receive incoming calls. Trained volunteers who were former TB patients gave the patients calls to remind them to take their medication.

During the 3-month pilot the drug-taking consistency rate for the patients was over 90%, significantly higher than the rate of successful treatment observed in the province's standard TB treatment program. The project was cost-effective, costing just \$3 per person.

Reference sources:

<http://listmanager.bps-limit.com/read/messages?id=49295>

http://nationmultimedia.com/2007/01/28/national/national_30025286.php

<http://healthmarketinnovations.org/program/phoned-pill-reminders-tb-treatment>

<http://www.aegis.com/news/ads/2007/ad070244.html>

<https://www.newtbrx.org/news/index.cfm?id=385&fuseaction=detail>

9. PROJECT MASILULEKE (PROJECT M), iTEACH

South Africa

Organizations responsible: iTEACH (integration of TB in Education And Care for HIV/AIDS) based in KwaZulu-Natal District, South Africa, with collaborators from Pop!Tech, The Praekelt Foundation, and Frog Design.

Aim: To increase patient adherence to TB treatment regimes, as well as to make existing DOTS programmes more efficient by linking the various healthcare providers and receivers. Furthermore, the project works to raise awareness of TB and its treatment.

Overview: Project M was implemented at Edendale Hospital, the largest ARV roll-out site in South Africa. The hospital is located in KwaZulu-Natal, a district with exceptionally high rates of HIV and TB infections. Although many of the project components are HIV-focused, there are some major TB-specific activities: 'TxtAlert-TB,' is an open-source, SMS based treatment reminder system

linked to an electronic medical record (EMR) system that provides monthly reminders to patients over the course of their treatment. Patients also have the option of choosing a 'celebrity treatment buddy' from whom their treatment reminders will come from.

'SMS Connecting DOTS' (SMS C DOTS), is a second initiative aimed at monitoring the treatment adherence of 1 000 patients. It facilitates the tracking of TB services throughout the process of care, from diagnosis to treatment completion. Patients are enrolled after diagnosis and a staff member collects their baseline health information on a mobile phone. They then send an SMS message to both the clinic and a community health worker (CHW) who lives in the same area as the patient, and who makes patient home-visits (validated using SMS messaging). The patient must also go to a local clinic to pick up with their monthly medication. To confirm their attendance, a clinic staff member sends an SMS message to the hospital. If the patient misses this visit within the period of a week, then they are deemed 'high risk' and the CHW is alerted to make extra home visits to them. Further action is also taken as necessary. The overall process is continued monthly for a six-month treatment period.

Finally, the 'SocialTxt' project involves the delivery of approximately one million 'Please Call Me' (PCM) messages each day, reaching virtually 100% of the adolescent and adult population of South Africa. 350 million PCMs have been sent throughout South Africa, and the PCM campaign tripled average daily call volume to the National AIDS helpline in Johannesburg. PCM messages are a special, free form of SMS. SocialTxt inserts HIV and TB related information into the unused space of PCM messages. Recipients who read the messages are connected to call-centres, referred to free healthcare centres. Messages are culturally relevant and are written in local languages.

Project M has successfully integrated into the existing public health services. It has also worked to strengthen links between clinics and CHWs, when previously they had not been engaged in any capacity. There have been high CHW training attendance rates because the CHWs are 'hungry' to acquire expertise, which in turn makes them better respected in the community and helps to improve local community TB care.

The roll out of innovative new software and applications may be facilitated once the project's underlying infrastructure has been fully established. This could allow other activities to be pursued, such as epidemiological surveillance, and engaging with civil society through social networks and campaigns for instance. Hence, gradually over time, the project could provide a platform for integrating all relevant TB mHealth programs at a country-wide level.

Reference sources:

http://poptech.org/project_m

http://poptech.org/system/uploaded_files/27/original/Project_Masiluleke_Brief.pdf

<http://nexus.som.yale.edu/design-project-m/>

<http://www.mobileactive.org/case-studies/project-masiluleke>

10. SIMMED, COMPUTAINER

South Africa

Organizations responsible: SIMmed, CompuTainer

Aim: To improve TB treatment compliance in South Africa by reminding patients to take their medication.

Overview: Patients included in the SIMmed trial use their mobile phone to press a speed dial after having taken their TB medication. A compliance database receives the messages and records the event. If a patient fails to call within the prescribed period, the database sends them a generated SMS message to remind them. If the patient still does not take their medication and press speed dial, the database will send an SMS message to the patient's friend or family member, who will then call or visit the patient to ensure the drug administration. Data on the patient's treatment compliance is stored for future analysis and use.

SIMmed's first trial, which took place in Khayelitsha TB clinics, yielded a treatment compliance rate of over 90%, much higher than the compliance rates of between 20% and 60%, observed prior to the trial. CompuTainer is working with the South African government to reach 45 000 new patients with the programme.

The project is planned to expand in South Africa.

Reference sources:

<http://www.mhealthinfo.org/project/simmed>

<http://www.computainer.com/tb-hiv-treatment-compliance.php>

http://www.thelancet.com/journals/lancet/article/PIIS0140673608619388/fulltext?_eventId=login&rss=yes

<http://healthunbound.org/content/simmed>

<http://healthmarketinnovations.org/program/simmed>

http://www.consultancyafrica.com/index.php?option=com_content&view=article&id=615:an-sms-a-day-keeps-the-doctor-away-the-use-of-mobile-phones-to-improve-african-health-care-outcomes&catid=57:africa-watch-discussion-papers&Itemid=263

<http://thdblog.wordpress.com/2007/06/22/improved-patient-drug-compliance-using-sms/>

<http://eforums.healthdev.org/read/messages?id=17548>

<http://eforums.healthdev.org/read/messages?id=17549>

11. WIRELESS PILL BOTTLE, SIMPILL

South Africa

Organizations responsible: SIMpill and Tellumat

Aim: To improve compliance monitoring by using a wireless pill bottle that sends an SMS to a central server notifying it of the patient's action.

Overview: SIMpill is an ordinary pill bottle with an attached device that includes a SIM card and transmitter. Each time the bottle is opened it sends an SMS message to a central SIMpill server, recording the date and time of the event. When this does not occur at the prescribed time (or within a set tolerance period) the SIMpill computer sends a treatment reminder message to the patient, family member and/or caregiver.

If the patient still does not take their medication after the reminder then the clinic or DOTS health worker is alerted so they can telephone or visit the patient directly.

In 2005, 100 TB patients in Northern Cape Province were asked to participate in the SIMpill pilot project. This was done to determine the feasibility of using the electronic monitoring and reminder system to improve medication adherence rates. It was found that 97% of patients felt the technology helped them take their medicine, and treatment adherence increased from 83% to 92%.

A second, larger pilot with 130 patients was then conducted in Khayelitsha, Western Cape province in 2007. Compliance rates increased from 22-60% to 90%. Of these, early indication cure rates were as high as 99%.

An even larger trial is planned for the Northern Cape district, as well as others in Tshwane and Princess Marina Hospital in Gaborone, Botswana.

The costs of the SIMpill technology are an issue since it costs around \$17 per patient.

Reference sources:

<http://www.SIMpill.co.uk>

<http://free.financialmail.co.za/innovations/07/0302/minn.htm>

<http://www.itweb.co.za/sections/computing/2005/0501241215.asp?S=IT%20in%20Healthcare&A=ITH&O=TE>

http://www.sagoodnews.co.za/health_and_hiv_aids/sa_innovation_makes_taking_meds_SIMpill_.html

http://www.globalproblems-globalsolutions-files.org/unf_website/assets/publications/technology/mhealth/mHealth_compendium_remote_monitoring.pdf

12. X OUT TB INNOVATIONS IN INTERNATIONAL HEALTH

Nicaragua

Organizations responsible: Innovations in International Health (IIH) group at Massachusetts Institute of Technology (MIT)

Aim: To reduce the necessity of a daily health worker in monitoring TB patients by offering patients incentives for compliance.

Overview: X out TB uses paper urine test strips are used to detect metabolites present in the urine of TB patients on a treatment regime. Chemicals in the strip react with the metabolites present in the urine of patients who have administered their dosage, leading to the strip changing colour and revealing a unique number. Patients are given a device that dispenses one strip every 24 hours, and after taking the test they have about two hours to SMS the number on the strip to a central

database that records that they have taken the drug. Patients with a high compliance rate receive free cell phone minutes, and so the strategy acts as an incentive scheme.

The efficacy of the urinalysis test strips remains to be thoroughly evaluated by X out TB.

Reference sources:

<http://mobileactive.org/x-out-tb-addressing-tb-noncompliance-mobile-phones>

<http://healthmarketinnovations.org/program/x-out-tb>

<http://iihlab.wordpress.com/2009/06/11/x-out-tb%E2%80%9D-monitoring-patient-compliance-with-tuberculosis-treatment-regimens-has-been-selected-for-funding-under-3ie%E2%80%99s-first-round-of-open-window-grants/>

DOTS MONITORING

13. E-TB MODULE FOR HEALTH WORKERS, D-TREE INTERNATIONAL

Tanzania

Organizations responsible: D-tree International

Aim: To develop and test a module with which to extend their HIV-mHealth program to include guidelines for health workers to evaluate TB among HIV-infected persons.

Overview: D-tree International is developing an e-TB module to extend their current program, which uses mobile phones to assist health workers at HIV care and treatment centres. The new module adds guidelines for health workers to evaluate TB among HIV patients. The module screens people who may be ill with TB using standardized screening questions about common symptoms. Based on the patient's answers, TB care referral is triggered. The e-TB module maintains a list of clients by recording their basic identification information and keeps a running history of each client, including their test results and status. Thus, if the health worker has already interacted with a client in the past, they can retrieve their information and continue with the next stages of the algorithm. Furthermore, the algorithm prompts the user if information is inserted incoherently. It also helps troubleshoot for many cases where things might not go as planned.

Reference sources:

<http://healthmarketinnovations.org/program/d-tree-international-0>
<http://www.d-tree.org/our-projects/tb-tanzania/>

14. IMPROVING TB DATA MANAGEMENT, DOKOZA SYSTEM FOR DISEASE MANAGEMENT

South Africa

Organizations responsible: Dokoza, in partnership with Neil Harvey and Associates (NHA) for IT support, and Deloitte for data analysis and reporting, risk management and strategic advice. The initial pilot project was originally commissioned and fully funded by the State Information Technology Agency (SITA), Centre for Public Innovation (CPSI), the Centre for Scientific and Industrial Research (CSIR), Meraka Institute, and the National Department of Health. However, the private pilot in KwaZulu Natal was completely funded by Dokoza and its partners.

Aim: To fast-track and improve critical services for HIV and TB patients by facilitating better data management.

Overview: The South African Dokoza system demonstrates the multidimensional use of mHealth. It uses an SMS system as well as other mobile phone technology for patient information management, improving communication between the different players in the health network, and patient tracking.

The first pilot was initiated in 2004 for a period of 6 weeks and involved 190 patients. At the time, all health institutions used different modes for gathering and maintaining patient information, meaning that it was very difficult and expensive to conduct national surveys, gather health statistics, and share data, and so usually these were done manually. Furthermore, rural areas rarely had electronic systems, meaning that paper-based systems were used and that patient records had to be kept by patients themselves. The mobile system was used to fast-track and improve critical services to HIV and TB patients, particularly those in low-resource settings where there were no fixed line or internet networks available. The main objectives of the project were:

- a) To exchange real time data between mobile phones
- b) Capacity building via the mobile, enabling practitioners to access patient history, diagnosis, health status, the latest lab test results, and what medication was last dispensed.
- c) Authorisation via mobile phone i.e. indicating whether treatment falls within the protocol.
- d) National Patient Tracking
- e) Establishing a common platform with organizations such as the National Health Laboratory Services
- f) Confidential communication with patients, which also includes auto-reminders of next appointments.

Dokoza uses an SMS/MMS based system developed in South Africa that links to computer applications and software, and various components have been patented. The project relies on SIM cards that can be used across networks and which interact with a back-end system that integrates easily into existing information systems. It is extensively rules based and is catered for users with basic computer literacy, and can be accessed in real-time via various hardware and software platforms. Sensitive information is not displayed on the web, and there are various levels of security measures, firewalls and encryptions.

The Dokoza system was easily accepted and there was an increase in patient compliance and feedback from patients indicated that the system made treatment regimens much easier to maintain. The most effective element of the program was the ease and speed of accessibility to clinical data. Dokoza was short-listed within a major international consortium for a tender at the NHLS to provide mobile services for their laboratory information system in KZN. This tender is due for re-issue as a national solution. Various health tender submissions for further scaling up have been directed to the SA government.

Reference sources:

- <http://www.changemakers.net/node/1014>
- http://www.nha.co.za/content/news/2005/9_june.asp
- <http://www.mhealthinfo.org/project/dokoza-system-disease-management>
- http://www.w3.org/2008/02/MS4D_WS/papers/cdac-mobile-healthcare-paper.pdf
- <http://www.mhealthinfo.org/project/dokoza-system-disease-management>
- http://www.nha.co.za/content/news/2005/9_june.asp
- <http://healthmarketinnovations.org/program/dokoza-system-disease-management>

15. SMS BASED SPECIMEN AND RESULTS TRACKING SYSTEM, FIND LESOTHO

TB REACH wave 1 recipient

Lesotho

Organizations responsible: FIND (Foundation for Innovative New Diagnostics), Lesotho Ministry of Health and Social Welfare, WHO, Partners in Health

Aim: To facilitate early TB detection by developing and implementing an SMS based system to track sputum specimens and report results.

Overview: An SMS system has been implemented in 4 highland districts of Lesotho for the identification of people who may be ill with TB, referral and testing of sputum specimens, and registering and monitoring of TB patients on treatment within the NTP (National Tuberculosis Program). 48 health centres, 5 laboratories that provide microscopy services and the Central Reference Laboratory, which provides culture and drug susceptibility testing, are included in the project. Since its inception, 2 031 suspected TB patients and 754 follow up patients have been registered in the system (giving a total of 6 888 sputum samples).

The system is based on the open-source RapidSMS framework and requires minimal investment in terms of hardware or devices for data entry. TB coordinators/officers and district microscopy laboratories have been provided with Netbook computers for the management of TB patients, and for receipt of specimens, entry of results and specimen referral to the Central Laboratory for drug susceptibility testing.

Health workers use simple coded SMS messages for registering suspected TB patients and for starting patient treatment. They also receive test results and any alerts by SMS. Messages containing test results and treatment reminders are sent to patients. Laboratory workers and programme coordinators can access the system using the web in order to receive specimen results directly, and to monitor the progress of patients on treatment using a real-time report programme.

The system is also being used to track project implementation and overall performance in the districts involved, as well as to monitor the effectiveness of different programme activities (such as horse rider services and village health worker screening) in TB case detection.

RapidSMS software, developed by the Foundation of Innovative New Diagnostics (FIND), is being used for the project. Health workers use their personal mobile phones to send SMS messages via a toll-free number. The SMS server is hosted locally in Maseru, Lesotho, contributing to local ownership and sustainability.

Of those registered with the SMS programme, 8% (169 people) of suspected TB patients and 5% (35 people) of follow-up patients were smear-positive. The rapid delivery of results and information to both patients and programme workers has saved a significant amount of time. Moving from paper-based recording to digital systems relieves human resource strains in a country where

there are 5 physicians serving 100 000 people. The SMS system is simple and rapid and can be used by all sectors of the health network with minimal training. In using mHealth, it facilitates communication, making information sharing, monitoring and referral possible in real time.

Reference sources:

<http://www.finddiagnostics.org/media/news/110914.html>

16. mDOTS, INTERACTIVE RESEARCH AND DEVELOPMENT (IRD)

TB REACH wave 1 & 2 recipient

Pakistan, Tajikistan and Nepal

Organizations responsible: IRD is a non-profit research and service organization focusing on information technology and its integration into health related programs, including surveillance and control of infectious and non-communicable diseases. IRD has a strong implementing partner in Indus Hospital, a donation-funded tertiary care facility located in a poor district of Karachi. Together, IRD and Indus Hospital have built a TB control program that now ranks as the second highest volume treatment centre in Pakistan.

Aim: To streamline all aspects of MDR-TB patient management and to maximize treatment success rates by using electronic data capture and real time analysis of data.

Overview: The mDOTS program, started in 2010, was designed to monitor MDR-TB patient treatment at Indus Hospital. It replaces traditional paper-based reporting systems with mobile phone-based data collection (openXdata software). This system of data collection provides many advantages, including data validation at the time of data collection, enhanced monitoring of field staff and real time analysis of patient data. After 8 months of small-scale operation and testing, the pilot was recently expanded to 18 treatment supporters and their patients. In the coming 4 years, IRD plans to scale-up the program to 11 different sites across Southern and Western Pakistan managed by Indus Hospital.

No formalized assessment of the mDOTS project has been conducted to date. However, it is clear that real time data analysis has improved the monitoring of treatment compliance and shortened the time Indus Hospital physicians are alerted of serious side effects of medication.

IRD has faced many barriers to the scale-up of these pilots, the most significant being the availability of funds to establish infrastructure. To start all of these pilot projects, large investments have been made in servers and highly specialized staff. As the mDOTS project adds study sites across Pakistan, it will become more difficult to monitor the project and troubleshoot software and hardware issues from a distant location. Additionally, as the project moves to more rural sites, mobile phone literacy also decreases to a point where recruitment of capable field workers becomes difficult.

17. ELECTRONIC DATA COLLECTION SYSTEM, PERSONAL DIGITAL ASSISTANTS (PDAs) TO COLLECT TB BACTERIOLOGY DATA

Peru

Organizations responsible: Harvard-MIT Division of Health Sciences and Technology, Partners in Health, Division of Social Medicine and Health Inequalities and Decision Systems Group at Harvard Medical School, Socios en Salud Sucursal Peru.

Aim: Using low cost PDAs to create an electronic bacteriology collection system, in order to decrease errors and time delays in the initial entry of data.

Overview: Several players have collaborated to establish an mHealth system that uses personal digital assistants to record patient data.

Prior to implementing the project, a paper-based method of data collection was routinely used to document bacteriology results onto a central database. At each health centre, this involved taking records of smear test results on paper, and similarly at each regional laboratory recording both the culture result and the smear result on a comparable paper sheet. This method was used since Internet availability was poor or non-existent at these facilities. Staff brought the paper records to a Central Office where they were verified, manually copied onto additional clinical and administrative forms, and then typed into the web-based Partners in Health Electronic Medical Record System (PIH-EMR). This had major disadvantages, including processing delays, data quality issues due to errors made, and a heavy workload for those involved.

A PDA-based system for data collection was thus designed to alleviate these issues. Project staff visited health centres and laboratories and copied data on sputum samples and smear results directly from the laboratory register or chart using the PDA. At the Central Office, users uploaded the data from the PDA to the Electronic Medical Record system. Data from about 100 health centres and 5 regional laboratories that care for MDR-TB patients was acquired.

The project used the Avant-Go software as a web platform and linked the PDA-EMR with their existing web based EMR. This allowed them to construct the interface in standard HTML. Reports are updated by synchronizing the PDA to a computer that is connected to the Internet.

The PDA-system had a significant impact on processing times and errors and greatly reduced delays from 9.2% to 0.1%. It also worked to reduce work-hours necessary to process results by 70%.

With the increased availability of Internet at health centres and laboratories, such a system is not now necessary. However, it may be a useful tool in highly limited resource settings in other regions/countries.

Reference sources:

<http://groups.csail.mit.edu/medg/people/hamish/yasin.pdf>

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1839734/?tool=pubmed>

http://www.ehs-chile.com/wp-content/publicaciones/2009_Use_of_PDAs_to_collect_tuberculosis_bacteriology_data_

18. SMS PATIENT REFERRAL TRACKING SYSTEM, POPULATION SERVICES INTERNATIONAL (PSI)

TB REACH wave 2 recipient

Zimbabwe

Organizations responsible: Population Services International Zimbabwe (PSI Zimbabwe)

Aim: To integrate TB screening, smear microscopy and GenExpert technology at HIV testing and counseling centres (HTC), and to improve community-based TB diagnosis using mobile vans and mHealth tools. To establish a referral system between HTC and TB treatment centres, including referral tracing using SMS messaging and active referral tracking.

Overview: To ensure that referred clients are actually reaching the TB referral centers, the program will set up an SMS messaging system using Frontline SMS, a two-way communication system, to actively follow-up on referred clients with specific emphasis on confirmed TB cases with smear positive results or GeneXpert positive results. All referred TB cases will be offered active follow-up by the HTC site and will be asked to provide their contact details. Agreeing clients will receive SMS reminders until they start treatment. Referred clients have also the possibility to respond to the referring HTC center by sending toll free SMS messages.

19. SMS BASED INTERVENTION PILOT, ST. GABRIEL'S HOSPITAL

Malawi

Organizations responsible: FrontlineSMS:Medic/Medic Mobile (an amalgamation of the projects Mobiles in Malawi and MobilizeMRS), working with the Office of Innovation at the US Department of Stat, Digicel and Viola.

Aim: To eliminate communicative and geographical barriers between understaffed hospitals and their patients, who reside a great distance from them. The lengthy trips made by community health workers could be replaced by text messages for patient adherence reporting, appointment reminders and physician queries.

Overview: Software developers built on the FrontlineSMS platform to create a lightweight patient records system called PatientView, and a text-based information collection module called TextForms. Community Health Workers (CHWs) use PatientView software to collect data on HIV/TB patients. Mobile communication is also employed by CHWs to report TB patients taking treatment (via SMS), to coordinate patient care, and to provide diagnostic services. In less than a

year the project has expanded from 75 to 1 500 end users in Malawi, linked to clinics serving about 3.5 million patients.

The project saved staff 1 200 hours of follow-up time and over \$3 000 in motorbike fuel. Over 100 patients starting TB treatment were reported by CHWs, and the SMS network brought the Home-Based Care Unit to the homes of 130 patients. SMS use saved 21 ART monitors 900 hours of travel time and eliminated the need for paper reports.

Programs have now been established in 40% of the country's district hospitals and projects are being implemented in 9 other countries: Honduras, Haiti, Uganda, Mali, Kenya, South Africa, Cameroon, India, and Bangladesh (note: these are not TB-specific projects).

Reference sources:

<http://www.ncbi.nlm.nih.gov/pubmed/20495253>

http://www.w3.org/2008/10/MW4D_WS/papers/nesbit.pdf

20. MOBILE PHONES FOR PATIENT SCREENING AND REFERRAL, TB/HIV CARE ASSOCIATION

TB REACH wave 2 recipient

South Africa

Organizations responsible: TB/HIV Care Association

Aim: To determine the effectiveness of mobile phones for TB contact tracing and case finding by community health workers.

Overview: Mobile phones will be provided to 10 Community Health Facilitators (CHFs) and 100 Community Care Workers (CCWs) to allow the CHFs to refer new patients and arrange for the CCWs to do home assessments and contact tracing. The CCWs will use the cell phones to collect and transmit information about the number of people screened and referred as well as the number of people provided with adherence support and the results of pill counts to assess adherence.

Reference sources:

http://www.stoptb.org/partners/partner_profile2.asp?PID=1093

<http://www.tbhivcare.org/>

21. USING SMARTPHONE TECHNOLOGY FOR DATA-DRIVEN IMPROVEMENTS, USAID

Nigeria

Organizations responsible: USAID's Health Systems 20/20, Nigerian National TB Program

Aim: To strengthen supportive supervision to improve performance and treatment outcomes.

Overview: Before intervention, TB supervision in Nigeria was entirely paper based and cumbersome, with each state using different forms. Furthermore, the results of the paper-based data collection were not available for immediate feedback and corrections due to complicated structures of checklists. Data and analysis was time consuming and prone to human error. The USAID-led project introduced PDAs or smartphones to improve data collection in an effort to improve the supervision, assessment and creation of action plans to increase the quality of TB is diagnosed and treated. 16 facilities in 4 states (Abia, Kano, Lagos, and Rivers) were selected for initial implementation.

Existing paper-based checklists were reviewed, consolidated and uploaded onto PDAs. Supervisors were trained on PDA use and data managers were trained on programming and maintaining forms on PDAs. The approach was tested prior to implementation with 2 rounds of data-collection.

The new system was reviewed and reprogrammed based on field experience. 20 supervisors have been trained to use the consolidated checklist and PDAs.

The project's use of smartphones eliminated the use of printed forms, minimized human error in data entry, reduced the lag time of availability of data for policymakers and managers, and helped pinpoint ways to improve delivery of care. The project aims to scale-up through September 2012 by developing and launching an online database for data aggregation, analysis and dissemination and to provide quality control for the data. Furthermore, the project aims to design and distribute new/updated forms to PDAs and expand the use of smartphones to more facilities so that up to 4 states are completely covered. The project also plans to develop interactive training materials for new supervisors and managers, with a mentoring and support system in place though scale-up.

MOBILE DIAGNOSIS

22. MOBILE PHONE-BASED MICROSCOPY, CELLSCOPE

TB REACH wave 2 recipient
Hanoi Province, Vietnam

Organizations responsible: CellScope in partnership with the National Tuberculosis Control Programme of Vietnam.

Aim: Using novel technologies to increase the accessibility and accuracy of TB diagnostic services in Hanoi Province, Vietnam.

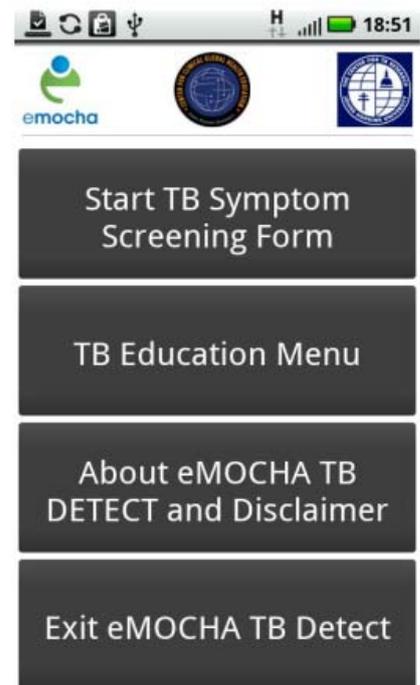
Overview: Current TB diagnostic services in Vietnam are centralized, with TB suspects identified at primary-level health centres being referred to microscopy units at district health centres. This project seeks to decentralize diagnostic services by implementing a novel, mobile phone-based microscopy technology called CellScope to provide same-day LED fluorescence microscopy services at communal health posts. It aims to be implemented in 4 districts in Hanoi Province, reaching a total population of 1 081 454 people. Within these districts, 40 health centre posts will receive CellScope.

With the device, a minimally trained health worker can capture diagnostic-quality LED fluorescence images of stained sputum smears. These high-resolution images, compressed to require minimal bandwidth, can be transmitted over the mobile phone network for review by trained microscopist or analysed on site using automated image analysis software. Each health centre will be provided with an inexpensive Netbook computer equipped with CellScope software to assist with identification and enlargement of fluorescent particles within images. Trained microscopists will review the images and transmit traceable results back to community health workers via SMS messages, ideally within 30 minutes. Transition to same-day microscopy (two spot sputum specimens collected at the initial health visit) will also help to increase accessibility without reducing diagnostic accuracy.

The pilot will begin in late 2011 subject to funding.

Reference sources:

<http://beyondprofit.com/can-the-cellscope-cell-phone-microscope-revolutionize-rural-health-testing/>
<http://cellscope.berkeley.edu/index.html>



23. MOBILE PHONES FOR REMOTE DIAGNOSIS, CENTRE FOR INFECTIOUS DISEASE RESEARCH

TB REACH wave 1 recipient

Zambia

Organizations responsible: Centre for Infectious Disease Research in Zambia (CIDRZ) working in Lusaka Central Prison

Aim: To train inmates at Lusaka Central Prison as inmate TB Peer Educators to screen fellow inmates for TB and make referrals.

Overview: Peer Educators at Lusaka Central Prison are inmates trained by the Centre for Infectious Disease Research to screen for TB by assembling inmates and collecting sputum samples for testing under fluorescence microscopy. Clinical officers and nurses then oversee the inmates passing through registration, TB symptom screening, HIV counseling and testing and finally a chest X-ray inside a mobile digital X-ray unit. If the X-ray images need to be consulted by more experienced physicians, the images are sent via mobile phone network for remote reading. The inmates diagnosed with TB are referred to the national TB Programme for treatment and follow-up. The programme has found a 2.5% TB rate in the screened inmates. Similar activities are taking place in two other Zambian prisons.

Reference sources:

http://www.stoptb.org/news/features/f11_001.asp

24. SMS MESSAGES TO TRACK AND REPORT TB SPECIMENS, FIND UGANDA

TB REACH wave 2 recipient

Uganda

Organizations responsible: FIND, in collaboration with Uganda's National TB Reference Laboratory (NTRL)

Aim: To use SMS messages to track and report TB specimens referred to the National TB Reference Laboratory from across the country.

Overview: FIND already has established the first-ever use of an SMS-based messaging platform for getting weekly data reporting on communicable diseases, malaria cases, and drug stocks with coverage of over 170 peripheral health centres across 2 districts in Uganda. They are now adopting the existing Rapid SMS based sputum referral/EQA system (presently being

implemented by NTRL/FIND in pilot scale at 4 north-east districts: Mbale, Kabong, Nakapiripirit and Apac) to include an XpertMTB/rif based sputum referral and tracking system in the selected 15 districts.

This TB REACH intervention proposes SMS tracking of cases and outcomes - measures that would bring in prompt and timely recording and reporting of TB cases. If successful, this could be adopted by the National Tuberculosis and Leprosy Program (NTLP). The present proposal does not intend to introduce any extensive additional forms but would utilize the extra space in the existing forms and registers for Xpert-MTB results and reporting (in the remarks section of lab register, TB unit register, district TB register, and quarterly report forms). For TB/HIV coordination, a TB/HIV referral form would be extensively advocated, likewise the intensified TB case finding form for the TB/HIV patients. The SMS system will contribute towards corroboration of the NTLP data.

This system also addresses the external quality assurance for sputum microscopy-random blinded rechecking of the routine microscopy smears. It is envisaged that this technology will also help to monitor impact of new diagnostics interventions since real-time data are available and monthly reports are generated summarizing specimens tested and results per facility and per district.

25. INFORMATION EXCHANGE BETWEEN DIAGNOSTIC HUBS AND COMMUNITY CENTRES, SIHANOUK HOSPITAL CENTRE OF HOPE

TB REACH wave 2 recipient
Cambodia

Organizations responsible: Sihanouk Hospital Centre of HOPE

Aim: To promote effective information exchange on a variety of TB-related issues.

Overview: Training will be provided to program workers in the use of simple text and voice messaging to: 1) send lab results down the health chain from diagnostic hubs to the community level in real time; 2) refer identified cases into treatment networks; 3) provide warnings for missed follow-ups; 4) utilize text and phone messaging to trace defaulters; and 5) communicate with health centres, district hospitals, and/or SHCH staff in case of medical concerns.

26. STETHOSCOPES FOR TB DIAGNOSIS, OXFORD UNIVERSITY

South Africa

Organizations responsible: Oxford University, University of Cape Town, Groote Schuur Hospital

Aim: To reduce the numbers of people dying of tuberculous pericarditis by equipping people with mobile phones that function as stethoscopes, enabling them to record and analyse their own heart sounds.

Overview: About 40% of people with tuberculous pericarditis die post-diagnosis from cardiac arrest. The onset of symptoms of this form of TB is insidious and can be detected through heart monitoring. Researchers have developed a low-cost technology consisting of a mobile phone that includes a stethoscope made of an eggcup that enables people to remotely monitor their heart to pick up early signs of deterioration.

A trial of 150 phonocardiograms from volunteers with a range of cardiac conditions compared the heart rate estimation quality of a Nokia 3110 Classic, an iPhone 3G with a 3M Littman Electronic Stethoscope. Results showed that the Nokia out-performed the Littman in estimating heart rate. A total of 2 313 additional patients are expected to be treated successfully (i.e. completed treatment) at 21 project sites in 4 administrative areas.

DISEASE SURVEILLANCE

27. eMOCHA TB DETECT, JOHNS HOPKINS CENTRE FOR CLINICAL GLOBAL HEALTH EDUCATION

Organizations responsible: Johns Hopkins Centre for Clinical Global Health Education

Aim: To use smartphones, in-country servers and wire+wireless networks to help health workers in developing countries.

Overview: eMOCHA TB Detect is a free software package that consists of two applications. The first runs on Android-based smartphones and features data collection in multiple formats, including single or multiple choice answers, text entry, pictures, bar codes, audio and video. Users can edit the information collected and the data is automatically uploaded to a back end server. Back end server users can define configuration and security properties. eMOCHA also features distance learning applications such as multimedia courses and lectures, and then features a quiz based on the contents of the sessions. Back-end users manage the courses and analyse their impact. The calling capabilities and camera on the phone make it possible for users to communicate with a consultant doctor on call. The second component runs on a web server that features device authentication and functions for data transfer to and from the server, administration of the content on the devices, and facilitating data collection and analysis.

eMOCHA uses XML based forms to gather data. The web server has a MySQL database and features API communication with devices. Content for devices include: simple touch-screen forms, clinical algorithms and checklists to assist providers in implementing best clinical practices in the field, video files to demonstrate specific clinical or lab procedures, interactive training courses and links to webcasts, clinical support tools, consult options, clinical updates. The server application allows the browsing and searching for form data, exporting of tabulated form data and mapping of household or patient locations using Googlemaps.

Reference sources:

<http://emocha.org/>

<http://www.ccghe.jhmi.edu/ccg/index.asp>

28. TB REACH 1 AND 2, INDUS HOSPITAL/INTERACTIVE RESEARCH AND DEVELOPMENT (IRD)

TB REACH wave 1 and 2 recipients

Pakistan

Organizations responsible: Indus Hospital is a donation-funded tertiary care facility located in a poor district of Karachi. IRD is a non-profit research and service organization focusing on information technology and its integration into health related programs, including surveillance and control of infectious and non-communicable diseases. Together, IRD and Indus Hospital have built a TB control program that now ranks as the second highest volume treatment centre in Pakistan.

Aim: Indus Hospital was awarded a TB REACH wave 1 grant in 2010 and IRD was awarded a wave 2 grant in 2011, both designed to increase TB case detection and treatment in the private sector.

Overview: The projects use a mobile phone-based software built in house to screen over 600 000 individuals for TB, with recruitment continuing to date. Dozens of TB patient encounters, including follow up sputum smear microscopy, drug distributions, medication side effects, etc., have been captured using the software. A progressive incentive scheme was devised to incentivize GPs to participate in the project and for health workers to find and recruit as many cases as possible. The TB REACH wave 1, while still ongoing, has resulted in a 450% increase in enrolment at the Indus Hospital TB program to date. TB patients are now being referred to Indus Hospital without disrupting the complex finance networks of local GPs.

Indus Hospital and IRD has faced many barriers to the scale-up of these pilots, the most significant being the availability of funds to establish infrastructure. To start this pilot project, large investments have been made in servers and highly specialized staff.

29. ELECTRONIC SURVEILLANCE SYSTEM, uNOTIFY SYSTEM

India

Organizations responsible: Innovators in Health (IIH), Operation ASHA, Prajnopaya Foundation, MIT, Microsoft Research, Birla Institute of Technology

Aim: “To electronically record, authenticate, wirelessly relay, and analyze delivery of medication with the goal of lowering costs and improving cure rates, thus helping programs scale”.

Overview: uNotify is a four-pronged system comprising support for cell phones, smart pillboxes and fingerprint loggers. The smart pillbox, named uBox, enables patients to take their medication themselves, without having to travel to providers. The fingerprint logger, named uPrint, was developed to ensure that patients received their drugs from providers.

The primary mHealth components of uNotify are called uPhone and uPrint. The uPhone is an ordinary cell phone with software that allows workers to record detailed health indicators, while uMessage is a basic version of dosage recording.

“The uPhone has been successfully tested in three user studies in Bihar, India. It has a custom menu in the local language (and optionally English) that allows community workers with basic training to check off indicators related to TB. The uPhone may be used for detecting new cases and periodically checking up on patients undergoing treatment. Programs can intervene, for instance, if side effects interfere with therapy, or if the patient continues to be symptomatic despite treatment”. It can use both SMS and GPRS (data) to transfer records.

All treatment workers are given a cell phone that can send and receive SMS messages. “Providers text the patient ID to the uNotify system when dispensing the dose. At the end of each day, the system generates a list of all the patients who did not receive their dose, and sends it to program personnel for follow up. Two mechanisms are used to provide a measure of authentication. First, the uNotify system responds to a provider text with a random 4-digit acknowledgement code. The provider copies the code on a coupon and hands it to the patient. Periodic checks discourage false reporting. Second, the system occasionally alerts managers when dose notifications are received. Managers can then call providers and ask to speak with the patient.”

The uPhone is currently in its third revision. The uMessage system is currently under development, and a trial was planned in Bihar in 2010. Extensive coverage and reliability testing of the cellular infrastructure was conducted in target communities.

Reference sources:

<http://innovatorsinhealth.org/solutions/index.shtml>

30. INFORMATION SHARING USING PDAs, UGANDA HEALTH INFORMATION NETWORK (UHIN)

Uganda

Organizations responsible: International Development Research Centre (IDRC), AED-Satellite, Uganda Chartered HealthNet, Makerere University

Aim: To use PDAs to help improve healthcare services delivery in Uganda by improving health workers' access to medical information and district health officers' access to current data.

Overview: The Uganda Health Information Network “provides two-way access to information utilizing existing cellular telephone network and low-cost, simple to use, and energy efficient PDAs for supporting health information dissemination, data collection and reporting, and email exchange. Data transfer from and to PDAs is facilitated using wireless access points and a server located in Kampala. Health workers use the PDAs to collect public health data at the community level. They then upload that data and emails they need to send to the wireless access points via infrared, Bluetooth or Wi-Fi at a rural health facility. The access points send 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.”

“District Health Offices receive data from various levels of health centres using the UHIN that include monthly Health Management Information System (HMIS) reports, disease surveillance data, reports related to HIV/AIDS, TB, 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 community health workers (‘tier-2’) is regularly broadcast through 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 TB. In addition health workers receive news from mainstream media on a daily basis through the network.”

There are about 600 health workers in Rakai, Mbale, Manafwa, Lyantonde, and Bududa districts using UHIN. The 175 remote health facilities are serving over 1.5 million people. AED-Satellite is replicating the project in Mozambique, where 110 health centres “are receiving medical updates and are collecting health information. It also launched in South Africa in spring 2008”.

A “cost-effectiveness study of UHIN conducted by independent consultants in 2004/5 showed that the network delivered a 24% savings per unit of spending over the traditional manual data collection and transmission approaches.” “AED-Satellite has carefully documented its lessons learnt from years of using PDAs in delivering and collecting health information in developing countries. The organization has produced a ‘PDA Toolkit’ complete with a step-by-step guide on how to deploy PDAs, including information on the opportunities available and how to assess an organization’s readiness for using handhelds”. AED-Satellite found that delivering news and popular content, such as gossip columns, onto the nurses’ PDAs was an effective method of getting the users used to the technology.

Technological difficulties have been encountered, which limited the number of health centres that can access and use the service. There exist technical incompatibilities of the PDAs with software depending on their models and manufacturers. Furthermore, power supply is unstable, and using

alternative sources of electricity is very expensive. In addition, some areas do not have Internet or cellular network coverage.

UHIN has stated that to expand project like AED-Satellite, institutional support from the Ugandan national healthcare system is needed. After continuously updating the National Health Ministry on the project, the Ministry agreed to roll out the network to an additional 20 health districts. The aim of the network is to scale their work to reach approximately 3 000 additional health centres.

Reference sources:

<http://www.healthnet.org/uhin>

http://web.idrc.ca/uploads/user-S/12094975531UHIN-health_case2.pdf

http://idrc.org/uploads/user-S/12759249551UHIN_Best_Practices.pdf

<http://www.who.int/rpc/evipnet/Monitoring%20and%20Evaluation%20tool%20for%20the%20Uganda%20Health%20Information%20Network%20Project.pdf>

<http://www.hst.org.za/news/pilot-uganda-health-information-network-launched>

HEALTH AWARENESS AND INFORMATION DISSEMINATION

31. EDUCATIONAL SMS MESSAGES, POPULATION SERVICES INTERNATIONAL (PSI)

TB REACH wave 1 recipient

Lao People's Democratic Republic

Organizations responsible: PSI and the National Tuberculosis Centre collaborating with a local mobile phone company.

Aim: To incorporate the private healthcare sector into the national TB programmes by referring groups at high risk of TB to private-sector providers that have been equipped and trained by PSI to offer TB services. Educational SMS messages containing details of locally available PSI-supported TB clinics are sent to these high-risk groups.

Overview: This public-private partnership enlists existing private clinics to expand their TB services to include remote and vulnerable populations. Many of these people turn to private care instead of the public health system due to the dubious quality of the latter.

PSI launched Sun Quality Health, a network of social franchise clinics that has already been successfully run in several countries. Over 50 private sector providers in 12 provinces have been trained and equipped by PSI to offer TB services and other services such as family planning and childhood illness management in their communities.

PSI Laos collaborates with a local mobile phone company to send routine educational SMS messages to populations at risk of TB. SMS messaging is used alongside Google Earth mapping to send messages with “Coughing for more than 2 weeks? It might be TB”, to individuals at high risk of TB and to monitor coverage of TB services. These tools monitor the location and demographic data for Sun Quality Health network clinics and allow PSI to identify gaps in TB service coverage.

Since the launch of the Sun Quality Health network at the end of 2010, PSI Laos has enrolled over 40 private clinics. Their initiative has prompted individuals to call PSI Laos TB Health Services for information about TB and other health issues, such as HIV.

Reference sources:

<http://www.psi.org/move-against-tb-laos>



Interactive Research and Development

C - GENERAL CASE STUDIES

EPI SURVEYOR

EpiSurveyor is a mobile phone and web-based data collection solution developed by DataDyne. It is used to design mobile forms for data collection using a web-based form design application accessible from any browser, fill the forms out on mobile phones and then upload and analyze the data in real-time.

Included in the free version of EpiSurveyor are 20 forms with 100 questions per form. A maximum of 5 000 forms can be uploaded to the EpiSurveyor website per year and the website can store up to 500 records per form at a time. Data collection can be done when unconnected to a network and can be saved and transmitted when back in network range.

As of February 2011, EpiSurveyor has more than 3 000 users in over 160 countries. It is the most widely used mHealth software. The project was successfully piloted in collaboration with the health ministries and WHO in 12 sub-Saharan African countries. The outcome of the pilots was more timely and accessible healthcare data, which promoted the strengthening on district level healthcare programs. Country health workers can be self-sufficient in creating and overseeing health surveys and there is no need to contract expensive consultants.

Reference sources:

<http://mobileactive.org/tagging/episurveyor>

<http://www.datadyne.org/?q=episurveyor/home>

<http://siteresources.worldbank.org/DEVMARKETPLACE/Resources/205097-1099409088482/>

Brief-DataDyneEpiSurveyor.pdf

<http://www.unfoundation.org/global-issues/technology/mobile-health-for-development.html>

mPEDIGREE

mPedigree aims to combine mobile technology and cloud computing to fight counterfeit medicines by providing free access to an instant drug verification system via text messaging.

The WHO estimates that counterfeit or substandard drugs compose up to 25% of the drug market in developing countries. mPedigree is a non-profit that partners with the principal telecom operators, pharmaceutical associations and technology companies in Africa to protect consumers from pharmaceutical counterfeiting. The program enables its users to use basic text messaging to establish whether their medicines are genuine or potentially dangerous imitations. The network is available wherever a mobile signal exists. The mPedigree program strives to establish an “Electronic Resource System” for the African health sector to boost transparency in the

pharmaceutical marketplace and efficiency in the regulatory process. The program won first place in the Emerging Markets category of the Nokia Innovators contest and more recently was one of the Top 11 in 2011 Innovators Challenge, presented by the mHealth Alliance and the Rockefeller Foundation.

Reference Sources:

<http://www.bbc.co.uk/news/business-15208595>

<http://www.mhealthalliance.org/news/mhealth-alliance-and-rockefeller-foundation-honor-leading-mobile-health-innovators-year>

http://www.mpedigree.net/mpedigree/index.php?option=com_content&view=article&id=46&Itemid=53

<http://www.hp.com/hpinfo/newsroom/press/2010/101206b.html>

SMS FOR LIFE

Tanzania

The project was overseen by Novartis, who established a public-private partnership with the Roll Back Malaria Partnership, IBM, Vodafone and the Ministry of Health in Tanzania.

SMS for Life aims to reduce/eradicate stock-outs of five key medicines at the outer edge of the Tanzanian Public Health System using SMS, Internet and mapping technology.

Health workers use their own personal cell phone to send a weekly SMS stock count message into a centralized database. The system does not require a mobile network and instead utilises a free short-code number; enabling messages to be sent at zero cost. District Management or National Malaria Control Program Management then uses any Internet browser on any PC (or device such as a Blackberry) to access the data. Training and resources were provided for staff throughout. Stock information was provided via Blackberry mobile phones or the Internet and subsequently accessed by district management and the project team staff through a reporting website. The project team designed and implemented a data repository application system with automated workflow and error message handling along with online statistical analysis, graphing and stock reporting.

Following a year of system construction and training, a 21-week pilot project was run to monitor stock levels in three districts. These regions supplied a catchment population of 1.2 million people. The system worked to facilitate better stock management, and significantly reduced stock-out rates. It was simple and easy to use, produced highly accurate data, and gave a comprehensive countrywide view of the stock situation on a weekly basis. Data was collected and analysed to provide a quantitative evaluation of the project's progress throughout. The pilot showed the potential of the public-private partnership model for use in successfully tackling social problems; facilitating a wide range of skills, expertise and resources to be accessed.

Reference sources:

<http://www.rollbackmalaria.org/docs/SMSdetailReport.pdf>

<http://www.rbm.who.int/psm/smsWhatIsIt.html>

<http://mobilemarketingmagazine.com/content/sms-life-saves-lives-tanzania>

<http://www.corporatecitizenship.novartis.com/patients/access-medicines/access-in-practice/sms-for-life.shtml>

TRACNet

Rwanda

The Treatment and Research AIDS Centre (TRAC), part of the Rwandan Ministry of Health, aims to collect, store, retrieve, and disseminate critical patient, drug, and program information.

Voxiva CareNet is a solution designed to support the monitoring of clinical trials and adverse side-effects, and to report on the ongoing care of patients with chronic conditions, including HIV/AIDS, TB, or diabetes. Patients can report on symptoms, treatment progress and other key information using multiple technologies (phone, web, PDA). Clinicians can monitor multiple patients through the Voxiva CareNet web interface, and receive automated notifications via SMS when patients report specific pre-defined symptoms. The system can also be used to send out automated reminders to patients to improve adherence to treatment and drug regimens. The benefits of the system include closer supervision of patients, reduced burden on clinicians, and reduction in costly office visits. Voxiva CareNet is being used in Asia, Latin America and the US, to report on adverse events following vaccinations, to support treatment for sexually transmitted disease, and to monitor services for women with high-risk pregnancies.

TRACnet has been “deployed in all 225 health facilities offering ART in Rwanda, accounting for 100% of all ART patients in Rwanda. In September 2009 there have been more than 12 000 user sessions adding to the more than 900 000 user sessions since the program’s inception in 2004. More than 1 200 site level users, power users and system administrators have been trained to submit monthly program indicator reports, patient data and weekly consumables (drug) reports; review and analyze the resulting data; and administrator TRACnet”.

Reference sources:

<http://www.gsm.org/newsroom/press-releases/2104.htm>

http://www.voxiva.com/content/case_studies/Rwanda%20Ministry%20of%20Health.pdf

<http://www.thinkinnovation.org/en/innovation/innovation.php?c=2&id=79>

<http://www.columbia.edu/itc/sipa/nelson/newmediadev/Health.html>

http://www.kiwanja.net/database/project/project_voxiva_hivaidrelief.pdf

<http://healthmarketinnovations.org/program/tracnet>

<http://www.unpan.org/Directories/ICTApplications/tabid/826/ctl/ProductDetail/mid/2182/ProductID/15/language/en-US/Default.aspx>

D - FURTHER REFERENCE

Center for Health Market Innovations (CHMI)

<http://healthmarketinnovations.org/>

The Center for Health Market Innovations (CHMI) identifies, analyzes and connects programs working to improve health and financial protection for the poor. Health Market Innovations are programs and policies - implemented by governments, non-governmental organizations (NGOs), social entrepreneurs or private companies - that have the potential to improve the way health markets operate.

Knowledge for Health (K4Health)

<http://www.k4health.org/>

Knowledge for Health (K4Health) is a health information dissemination project funded by the U.S. Agency for International Development's (USAID) Office of Global Health. The project aims to increase the use and dissemination of evidence-based, accurate, and up-to-date information to improve health service delivery and health outcomes worldwide. K4Health works to respond to user needs, provide access to quality health information, and strengthen knowledge management communities. The website contains e-toolkits on various topics.

mHealth Alliance (mHA)

<http://www.mhealthalliance.org/>

Health UnBound (HUB)

<http://www.healthunbound.org/>

Powered by the mHealth Alliance (mHA), Health Unbound (HUB) is the interactive network and online knowledge resource center for the mobile health (mHealth) community. Through HUB, the mHA brings together individuals from all disciplines of the mHealth community to generate collective solutions and inspire new innovations that will transform health with technology. HUB

is also where the mHA offers its comprehensive database of mHealth technologies, programs, organizations, and policies to promote collaboration of efforts and best practices from lessons learned.

[MobileActive.org](http://mobileactive.org/)

<http://mobileactive.org/>

MobileActive.org connects people, organization, and resources using mobile technology for social change. It works together to create the resources NGOs need to effectively use mobile phones in their work: locally relevant content and services, support and learning opportunities, and networks that help MobileActives connect to each other. The MobileActive.org community includes grassroots activists, NGO staff, intermediary organizations, content and service providers, and organizations who fund mobile technology projects.

[Mobile Health Live](http://www.mobilehealthlive.org/)

<http://www.mobilehealthlive.org/>

Mobile Health Live serves as a critical information resource for both the mobile and health industries. It delivers fresh, dynamic content and networking opportunities to mobile health industry executives. It contains discussion between members of the mobile health ecosystem, videos of mobile health sessions at GSMA events, interviews with industry executives, health news, research reports and white papers, and links to mobile health events. Mobile Health Live also contains a deployment tracker, a tool which tracks deployments of mobile health services around the globe, both those in their pilot phase and full active services.

[Royal Tropical Institute \(KIT\), mHealth in Low-Resource Settings](http://www.mhealthinfo.org/)

<http://www.mhealthinfo.org/>

KIT's website aims to offer an up-to date source of information and a platform for sharing knowledge on the current use, potential and limitations of mHealth in low-resource settings. The mHealth resources database contains more than 300 articles, presentations, websites, news and events.