How information and communication technologies can improve the quality of maternal and newborn care in low and middle income countries: A structured literature review

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Abstract
Background: With the rapidly rising use of information and communication technologies (ICTs) globally, particularly mobile phones, there has been growing momentum to use these technologies for the improvement of maternal and newborn health.

Objectives: Our literature review presents a rapid mapping of how ICT/mobile technology have been used in low and middle income countries for monitoring and improving the quality of maternal and newborn healthcare in general, as well as in the context of vital event registration and/or maternal death reviews.

Methods: A rapid approach to systematic mapping was used. This involved searching academic databases, a landscape scan of projects and programmes from websites and listservs, and personal communication with key informants for further information.

We conducted two separate searches. One looked at the use of ICT/mobile technology for the monitoring and improvement of quality of care in general. The second looked specifically at the use of ICT/mobile technology in the context of vital event registration and/or maternal death reviews. The findings from both searches have been presented together.

Findings: A total of 24 projects were identified covering four thematic areas where ICT has been used to help monitor and improve quality of maternal and newborn healthcare: 1) data management, which refers to the collection, transmission, and analysis of information; 2) point of care support by assisting decision-making and diagnosis; 3) training and disseminating knowledge to healthcare workers (e.g. latest research and guidelines); and 4) improving communication and networking between healthcare workers and health facilities, patients or other healthcare workers.

Discussion and conclusion: We have found that these technologies will have greater potential in improving and monitoring quality of maternal and newborn care if the following factors are considered:
- ensuring the deployment of technology that can be installed and maintained locally
- deploying devices and infrastructure that is of low cost and can be integrated within the health system
- ensure the buy-in and commitment of key stakeholders

The paper concludes that the future for ICT for quality of care is promising; however it must be complemented by other inputs such as adequate infrastructure and human resources.
Evidence for Action Literature Review Series: Literature Review 1

Evidence for Action (E4A) is a programme to improve maternal and newborn survival in Ethiopia, Ghana, Malawi, Nigeria, Sierra Leone, Tanzania and across Africa. The programme synthesizes and packages evidence to inspire and fuel effective and targeted advocacy and accountability efforts. This results in decisions and actions which change the level, distribution, and use of resources and improve the availability and quality of health services necessary to save maternal and newborn lives. To find out more please visit www.mamaye.com

Evidence for Action literature reviews are peer-reviewed by experts in maternal and newborn health.

Declaration of Transparency: This paper is a non-systematic literature review and does not claim to have systematically searched the evidence base.
Introduction

Every year, an estimated 289,000 women die globally from pregnancy related causes\(^1\), 2.6 million babies are stillborn and 2.9 million babies die within one month of birth\(^2\). Most of these deaths take place in low and middle income countries (LMICS)\(^3\). For those who access a health facility, one of the key determinants of death is the poor quality of maternal and newborn healthcare\(^4\). Nevertheless, in most LMICs, the focus has been on quantity rather than quality of services\(^3,5,6\).

There has been growing momentum to use information and communication technologies (ICTs) for the improvement of women’s and children’s health: we are encouraged by the Commission on Information and Accountability for Women’s and Children’s Health (CoIA) to integrate ICTs into health information systems and health infrastructure\(^7\). Moreover, CoIA’s 2014 progress report indicates that in all the countries with strategies on eHealth (the use of ICT for health), half of the initiatives are in the area of women and children’s health\(^8\). With the rise in use of mobile phones in developing countries - mobile cellular penetration rates in developing countries was expected to reach 90% by the end of 2019 - it is no wonder that there is a drive to using ICT or mobile technologies for health.

Our rapid mapping aims to bring together both the call for quality maternal and newborn healthcare and the use of ICTs for health by mapping out how ICTs can improve the quality of maternal and newborn healthcare in LMICS. In doing so, our mapping focuses on the use of ICT/mobile technology for the monitoring and improvement of quality of care in general, as well as more specifically the use of ICT/mobile technology in the context of vital event registration and/or maternal death reviews.

Background

ICT has been used for a variety of purposes in the context of maternal and newborn healthcare. Two literature reviews have found that ICT, specifically mobile technologies such as mobile phones and other wireless technologies, have been used for data collection and management, appointment reminders, point of care support, the dissemination of education, and emergency obstetric referrals\(^10,11\).

In the context of quality of care, it is firstly important to define what we mean. There is no universally recognised definition of quality of care\(^12\). Some have defined it in terms of inputs, processes and outputs\(^13,14\). While others have argued that we need to also consider quality in terms of women’s experience of care\(^15\). Assessments or improvement of care are not only about training health workers\(^16\), but also about interventions focusing on clients such as patient reported outcome measures\(^17\) or research on clients’ experience of care\(^18\).

Moreover, in cases where there are near misses or maternal and neonatal deaths, maternal, perinatal or near miss reviews have been invaluable to improving quality of care through their ability to provide in-depth evidence on the reasons for deaths and what could have been done to prevent them\(^19,20\).

In light of the above, for this mapping we defined quality of care for maternal and newborn health (MNH) as care that is effective, efficient, and accessible, that upholds reproductive rights and is safe. The assessment or monitoring of quality of care must consider elements which have to do with inputs, processes, outcomes, as well as client’s experience of care\(^13,15,21\).
Objectives

Given the growing importance of ICT, and particularly mobile technologies, in healthcare the aim of this paper is to present a rapid mapping of the literature relevant to how these technologies can improve the quality of maternal and newborn healthcare. Our overarching research question is: how can these technologies improve the quality of maternal and newborn healthcare in LMICS, with regard to their use for the monitoring and improvement of quality of care for maternal and newborn healthcare in general, as well as in the context of vital event registration and/or maternal death reviews?

The objectives include:

- Provide a mapping of examples of ICT/mobile technology used to monitor and improve quality of maternal and newborn healthcare
- Identify the lessons learnt and the challenges of using ICT/mobile technology to monitor and improve quality of maternal and newborn healthcare
- Provide a mapping of examples of ICT/mobile technology used for vital registration and/or maternal death reviews in the context of maternal and newborn healthcare
- Identify the lessons learnt and the challenges of using ICT/mobile technology for vital registration and/or maternal death reviews in the context of maternal and newborn healthcare

Methods

For this literature review, we included both peer-reviewed and grey literature. These were sourced from searches of academic databases and a landscape scan of projects and programmes from websites and Listservs (see annexes 2 and 3 for more detail). This methodology follows from Philbrick’s report on mHealth and Maternal, Newborn, and Child Health and Coast et al.’s systematic mapping of maternal care services and culture. The methodology used was a rapid approach to systematic mapping, which allows for a broader scope and inclusion of more literature.

We conducted two separate literature searches and scans. One looked at the use of ICT/mobile technology for the monitoring and improvement of quality of care in general. The second looked specifically at the use of ICT/mobile technology in the context of vital event registration and/or maternal death reviews.

First literature search and scan:

1) Search of bibliographic databases: PubMed, Google Scholar, Science Direct, Web of Science, and WHOLIS
2) Search of listservs: mHealth Alliance’s Health Unbound website
3) (http://www.healthunbound.org/), Knowledge for Health (https://www.k4health.org/), the GSMA (http://www.gsma.com/), Mobile active.org⁹, and The Royal Tropical Institute’s “mHealth in low resource settings” knowledge portal (http://www.mhealthinfo.org/projects_table)
4) Scan of reference lists of included documents.

The search was guided by the following exclusion and inclusion criteria:

Inclusion criteria:
- Type of documents include: academic articles, reports, programme/application profiles, and programme websites
- All documents listed above that relate to the research question or objectives
- Sources that provide information on challenges and lessons learnt

Exclusion criteria:
- Publications/documents published or produced before 2005
- No full text available
- A Masters or PhD thesis
- A protocol for a programme or intervention
- Not in a low-middle income country setting
- English was not the language of publication
- Did not relate to the research question or objectives

Second literature search and scan:
The literature search and scan was conducted in May 2013 for documents published from January 2005. We used a combination of terms to search for the literature that linked with the concepts of “Maternal Death Review”, “Vital Event Registration”, “Information and Communication Technologies”, “mobile technologies”, and “low-middle income” (see annex 1 for more detail).

The search strategy consisted of four steps:
1) Search of bibliographic databases: PubMed, Google Scholar and Science Direct.
2) Search of listservs: mHealth Alliance’s Health Unbound website (http://www.healthunbound.org/) and The Royal Tropical Institute’s “mHealth in low resource settings” knowledge portal (http://www.mhealthinfo.org/projects_table).
3) Sourced literature from four key informants working in this field from November 2012-August 2013
4) Scan of reference lists of included documents

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Combined search results:
In the initial screening from bibliographic databases and listservs 12,931 citations and programme profiles were identified (see Figure 1). An additional 4 records were identified from personal communication with key informants and another 17 were snow-balled from reference lists or programme profiles of eligible documents. Most documents (12,832) were excluded (including duplicates) from the title and abstract screening because they matched one or more of the exclusion criteria. More than seventy (78) records were excluded from the final full screening because they were either duplicates, not relevant to the research objectives, not from an LMIC setting, or either a MSc/PhD or protocol. The final total of included records was 42. A number of studies or projects are described in more than one record, making up 24 examples of studies or projects using ICT/mobile technology to improve the quality of maternal and newborn healthcare in LMICs.

Findings

A total of 24 projects, described in 42 documents, were identified in this rapid mapping of the literature on how ICT has been used to monitor and improve quality of maternal and newborn healthcare care in LMICs. Four thematic areas have been identified:
1. Data management: the collection, transmission, and analysis of information to help facilitate the monitoring of services and/or patients, logistics and authentication, vital event registration, and conduct verbal autopsies.

2. Point of care support: improving clinical performance of health workers by assisting decision-making and diagnosis.

3. Training and dissemination of knowledge: improving the practice of health workers by providing them with training and disseminating latest research and guidelines on best practices.

4. Communication and networking: improving the communication between healthcare workers and health facilities, patients or other healthcare workers.

A detailed overview of the findings can be found in Table 1 (Annex 2).

Theme 1: Data management
In this mapping, nineteen projects provide some form of data management – the collection, transmission, and analysis of information. These examples used data management for a variety of purposes, including monitoring of services and/or patients, logistics, vital event registration and conducting verbal autopsies.

Monitoring of services and/or patients:
Eight projects used data collection to help monitor services and/or patients\(^23\)\(^{-37}\). For example, the Mobile Technology for Community Health (MoTeCH) project\(^27\),\(^33\) used ICTs to enable healthcare workers to record on a mobile phone care given to patients, as well as notify the healthcare worker if a patient has missed treatment or an appointment. Information on missed appointments or treatment can then be used to send reminders to patients (see more below).

Logistics and authentication:
Two projects used data management to support health care logistics - SMS for Life\(^25\),\(^26\),\(^34\) and mPedigree\(^32\). SMS for Life uses ICTs to provide real time data on drug stock levels to help improve drug management at district level and mPedigree enables users to verify the safety and efficacy of drugs.

Vital event registration:
Under the theme of vital event registration, seven projects used ICTs to help facilitate the systematic recording of births and deaths\(^23\),\(^24\),\(^35\)\(^{-40}\).

Verbal autopsy:
Four examples were identified using ICTs to support conducting verbal autopsies - a specially designed questionnaire to ascertain the cause of death from kin and caregivers\(^35\),\(^36\),\(^41\)\(^{-44}\). The examples demonstrate the use of mobile technologies, such as personal digital assistants (PDAs) and smartphones, to aid the collection and transfer of data during a verbal autopsy interview.

Theme 2: Point of care support
Three projects provided point of care support to healthcare workers. Two used ICTs to connect healthcare workers to colleagues and specialists in order to seek help and advice\(^5\),\(^6\),\(^46\). Connecting healthcare workers together links to the theme communication and networking noted below. The other project (eIMCI) provided access to electronic versions of the Integrated Management of Childhood Illnesses protocols on PDAs\(^57\).
Theme 3: Training and dissemination of knowledge
Two projects used technology to improve the practice of healthcare workers through training and dissemination of latest research and guidelines. The Kenyan workers adherence to mobile phone support treatment project and Mobiles for Quality Improvement (m4QI) used text messages on clinical protocols to help health workers keep up to date with best practices. m4QI went further and used mobile technology to send quizzes to health workers on the protocols that they receive.

Theme 4: Communication and networking:
Five examples were identified on the use of technology to improve communication between healthcare workers and health facilities, patients or other healthcare workers. We found that using these technologies as a means of communication and networking had three key purposes. Firstly, to send appointment reminders to patients via text message (SMS) or phone calls (e.g. MoTeCH) and the Better Border Healthcare programme. Secondly, to connect healthcare workers so they can contact each other for advice and pass on information to supervisors (e.g. the mHealth for maternal and newborn health (MNH) in resource poor and health system settings project in Sierra Leone). Finally, ICT and mobile technologies were found to support communication with healthcare workers in the field and health facilities. For example, the Mobile Community Based Surveillance (mCBS) project in Nigeria enabled Traditional Birth Attendants to communicate to referral facilities when they experience complications so that these facilities can provide clinical advice, dispatch a vehicle to transfer the patient to them and prepare for the patient when they arrive.

Discussion

Key challenges and lessons learnt:
Four areas of key challenges and lessons in using ICT for quality of care were identified in our mapping: technology and maintenance; costs and sustainability; buy-in and ownership; and local context.

Technology and maintenance:
A major technological challenge highlighted in our mapping was the limited infrastructure in-country or in the region where the project is being implemented, such as adequate network coverage or electric power supply. In addressing this challenge, it was recommended that the technology chosen be appropriate for the local infrastructural context and to use technology that is able to store data until it is possible to send. In terms of maintenance of technology, a number of authors recommend using local software developers when possible and purchasing devices at the site as the hardware is more likely to be supported locally, as well as build up local expertise. However, it was noted that due to the relatively new software industry in LMICS there is the challenge of limited skilled software developers in-country. Nevertheless, in addressing this challenge, it was recommended that senior and more experienced software developers work with local developers in order to share expertise and guidance.

A number of authors also advised that the technology being used is kept simple, such as SMS or voice options on mobile phones. Using simple technology will make it easier to support in terms of software, easier to train users, increase reliability, and more likely to be sustained by the health system.
Costs and sustainability:
Limiting costs was highlighted in our mapping as important to maintaining the sustainability of the project. Major costs to the development and implementation of a system include hardware and software development, data transfer (e.g. airtime costs), training, and system monitoring. However, these are often the initial costs of setting up a system, the on-going costs are likely to be far less. Lessons learnt in addressing these cost challenges included using low-end and low-cost devices, establishing public-private partnerships, and designing the ICT solution for integration within the health system:

Low-end and low-cost devices:
Choosing to use low-end and low-cost devices means that the cost of the devices are more likely to be covered if a project is expanded and/or the hardware needs replacing.

Public-private partnerships:
Our mapping found that establishing public-private partnerships have been suggested as important to the sustainability and even success of a system. For example, Magbity et al.'s paper on the mHealth programme for MNH implemented in Sierra Leone found that partnering with telecommunication companies reduced costs. Moreover, the project SMS for Life found that the public-private partnership established between Vodafone, Novartis, IBM, the Roll Back Malaria Partnership and the Government of Tanzania 'enabled a technical solution to be designed, built, and implemented' in Tanzania. Each played their part, for example, Novartis brought the problem of stock-outs to the attention of other companies, Vodafone designed the technical solution, IBM provided project management tools, Roll Back Malaria enabled the solution to be used by key proponents of the fight against malaria, and the Government made sure that the public health sector was engaged in the implementation of the project.

Integration within the health system:
Designing a solution that is integrated within the health system has been recommended to ensure sustainability. For example, this may mean, integrating the system with mainstream government programmes, integrating the system with the Health Management Information System, or addressing important systems factors that may affect the project such as adequate human resource capacity.

Buy-in and ownership:
Commitment and support by key stakeholders and the main users of the platform is important to implementing and sustaining the programme. However, there are challenges in ensuring this buy-in. For example, it has been noted that ensuring that health workers are committed to using the system can be difficult, particularly if it is seen as a task set in addition to their other work responsibilities. To address this challenge, it has been recommended that the tasks required to be undertaken by the user are integrated in the responsibilities set by the employer or that incentives are provided, such as phone credit or congratulating users for their efforts in using the system.

Although buy-in by key stakeholders is important, our mapping found that some projects faced challenges concerning conflicting needs and who has ownership. Lessons learnt from Project Mwana in overcoming these challenges include convening partners on a regular basis to develop the project strategy, and making sure that there was only one coordinating body and one technical working group led by the Ministry of Health. Some authors have called for one stakeholder to take ownership, such as the government.
Local context:
The impact of the ICT is heavily dependent on its appropriateness to local conditions and needs\textsuperscript{42}. This may be aided by ensuring that the technology chosen is appropriate for the local infrastructure in place, as noted above; that it is translated into local languages; and that the needs of both the users and the stakeholders are considered\textsuperscript{27,42,54}.

Conclusion
Globally, the momentum behind using ICTs for health, particularly for MNH, is growing\textsuperscript{55}. Our mapping has highlighted the potential in using ICT to improve and monitor the quality of maternal and newborn healthcare in LMICs, notably in the areas of data management, point of care support, training and dissemination of knowledge, and communication and networking. We have found that these technologies could have greater potential in improving and monitoring quality of care if the following factors are considered: ensuring the deployment of technology that can be installed and maintained locally, deploying devices and infrastructure that is of low cost and can be integrated within the health system, and ensure the buy-in and commitment of key stakeholders.

Nevertheless, it is important to note that stronger evidence is still needed on the impact of ICTs on maternal and newborn healthcare\textsuperscript{55}. Moreover, ICT alone is not the answer to improving quality of care; it is a tool that can help facilitate efforts\textsuperscript{27} and requires adequate infrastructure and human resources to do so. Thus careful decisions must be made on whether using ICT to improve and assess quality of maternal and newborn healthcare is appropriate.
References:


45. Magbity, E., Ormell, H., Jalloh-Vos, H., de Koning, K., Mbalu Sam, E., & et al. (2011). "I expect the health worker to call me": mHealth for maternal and newborn health in resource-poor and health system settings, Sierra Leone. Amsterdam: Royal Tropical Institute.


56. Andrew Kanter (asky002@dbmi.columbia.edu). (n.d.). Email to Victoria le May (v.lemay@options.co.uk) concerning information on verbal autopsy component on ICT applications (personal communication).


Annexes:
Annex 1: Additional details for the 2nd literature search and scan:

*Search terms:*

<table>
<thead>
<tr>
<th>Key terms</th>
<th>Search terms</th>
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<tbody>
<tr>
<td>Information and Communication technology</td>
<td>‘ICT’, ‘information and communication technology’, ‘eHealth’</td>
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<tr>
<td>Mobile technologies</td>
<td>‘mobile phone’, ‘mHealth’ ‘mobile health’, ‘cell-phone’, ‘text message’</td>
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<tr>
<td>Setting</td>
<td>‘low-middle income’, ‘low-middle income countries’</td>
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### Annex 2: Table of findings

<table>
<thead>
<tr>
<th>Thematic area</th>
<th>Project or study name/Setting/Time period</th>
<th>Problem &amp; Project/Study description</th>
<th>Technology description</th>
<th>Achievements/outcomes</th>
<th>Lessons learnt</th>
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| DATA MANAGEMENT FOR MONITORING OF SERVICES & LOGISTICS | SMS for life<sup>STF03</sup> | **Problem:** Stock out of antimalarials severely limits the extent to which quality malaria management can be provided in endemic countries | The system consists of two components: an SMS management tool and a web-based reporting tool.  
*The SMS management tool:*  
Health workers’ registered mobile phones are stored on a server (web-based reporting tool). Once a week, prompts are sent to health workers by SMS. The health worker responds by sending a stock quantity message for free using a standard coded format. If this stock message is sent in due time, the health worker’s mobile phone is credited as a reward.  
*The web-based tool:*  
Provides current and historical data on stock-levels, google mapping of health facilities with stock-level overlays and alerts, and SMS messaging and usage statistics. | Health care workers reliably used the technology. In Ghana there was more than 90% response rate in any given week.  
Having access to real time data on stock levels greatly helped improve drug management at the district level.  
SMS for life has enhanced workers’ ability to quantify not only the amount of antimalarials, rapid diagnostic tests and amoxicillin they need but also other drugs that may face stock outs.  
Weekly counting of drugs facilitates good storage and most importantly redistribution of drugs to balance facilities who are in demand and those who are in excess. | The solution can only be sustainable if it’s a system wide integrated solution. It needs to integrate with mainstream government programmes, as well as be integrated with the Health Management Information System.  
Health workers using the system should be able to see it as part of their routine work.  
Points out that SMS for Life is not sustainable if it is only used for one disease/drug.  
When using ICT in a project it is important to think about the cost and the appropriate technology to use.  
Interventions need to be simple.  
The public-private partnership model was crucial to the success of the project.  
Fixed timelines and strict project management is important to ensure the successful implementation of the system. |
| **Setting:** Tanzania, Ghana, Kenya, DRC, Chad, and Cameroon | **Project period:** Piloted from October 2009. | **Problem description:** SMS for Life is a combination of mobile phones, SMS messages, internet and mapping technology to monitor and manage weekly stock levels of ACTs.  
In 2009, a 21 week pilot of SMS for Life was implemented in three districts of Tanzania: Ulanga, Kigoma Rural and Lindi Rural covering 129 health facilities and 226 villages.  
SMS for Life has now been extended to all 5099 health facilities in Tanzania and pilots are taking place or have taken place in Ghana, Kenya, DRC, Chad, and Cameroon. |  |  |  |
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<tr>
<td>DATA MANAGEMENT FOR MONITORING OF SERVICES AND PATIENTS COMMUNICATION &amp; NETWORKING</td>
<td><strong>Mobile Technology for Community Health (MoTeCH)</strong> 27,33</td>
<td>MoTeCH is a mobile phone initiative launched in Ghana in July 2010. <strong>Aim:</strong> MoTeCH aims at enhancing the availability and quality of health information, increase the effectiveness of the services provided by Community Health Officers, and also increase the coverage of antenatal care, preventive treatment during pregnancy, the use of bed nets, attended delivery, post natal care and immunization.</td>
<td>MoTech provides two interrelated mobile health services, each with their own mobile phone application: 1) 'Mobile Midwife' application: enables pregnant women and their families to receive SMS or pre-recorded voice messages on personal mobile phones according to their gestation periods in their own language. 2) 'Nurse Application': enables Community Health Nurses to electronically record on a mobile phone care given to patients and identify women and newborns in their area that are due for care. The two services are linked so that if a patient has missed providing health education and appointment reminders to women increased their demand for antenatal care and immunization services. Through electronic record keeping patients records are stored securely. Health workers gain more time to attend to their clients for more efficient home visits. (Time saved through electronic record keeping was used for more home visits)</td>
<td>Providing health education and appointment reminders to women increased their demand for antenatal care and immunization services. Through electronic record keeping patients records are stored securely. Health workers gain more time to attend to their clients for more efficient home visits. (Time saved through electronic record keeping was used for more home visits)</td>
<td>Projects which use data collection by mobile phone requires training as some health workers may not be accustomed to sending text messages. Providing the same kind of phones to all participants in mHealth projects makes it easier during training. Due to poor network reliability it is good to get phones which can store data until it is appropriate to send. It is good to integrate the project into the health system in order to make it less likely for health workers to see it as coming from an external agent.</td>
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<td>Setting: Ghana</td>
<td><strong>Setting:</strong> Ghana</td>
<td><strong>Project period:</strong> 2010 (ongoing)</td>
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| DATA MANAGEMENT FOR MONITORING OF SERVICES AND PATIENTS | **Better Border Healthcare programme**<sup>8</sup>  
**Setting:** Thailand  
**Project Period:** Piloted | **Problem:** Access to health care in rural areas is a problem due to limited health resources and individuals’ poor perception on biomedical services due in part to their low levels of education.  
**Aim:** The Better border programme | Information on maternal care and child immunization stored in the existing health information system is transmitted to the mother and child care module (MCCM). The module then generates appointment dates for each client and also sends a prompts to health professionals.  
**Problem & Project/Study description:** For both applications:  
- Low-cost GSM mobile phones are used.  
- Java 2 Platform Micro Edition (J2ME) application is used to capture client data and store it on a mobile phone.  
- General Packet Radio Service (GPRS) is used to transfer this data from the phone to a central patient electronic medical records system (based on OpenMRS) that is stored on the MoTeCH server.  
  
  The MoTeCH system then analyses the client data against care regimens to determine due dates for certain care events and sends reminders to healthcare workers and clients for these events. | The Mother and Child Care module (MCCM) effectively improved the punctuality of and attendance to ANC and EPI visits. ANC attendance increased from 43.79% to 58.68% during the project.  
**Achievements/outcomes:** The study revealed that electronic data collection and sending SMS reminders for appointments can improve ANC and EPI attendance and thus coverage.  
**Lessons learnt:** Without the support of the technology, the Mobile Midwife service sends a message to remind the patient to go to the clinic for that particular service and the nurse is also informed that the patient is due for treatment. | For software development it is good to build up local expertise by partnering with local software developers.  
Integration with different phone companies with different systems is a challenge which needs to be considered.  
It is advised that health workers are provided with mobile phones to use the system rather than use their own phones. This will ensure that in cases where phones are shared, patient data is kept confidential and phones are to an adequate standard to send the data. |
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<td>in 2007. Started in 2008.</td>
<td>aimed at developing a model for utilizing smart phones to improve maternal and child health focusing on antenatal care (ANC) and Expanded Programme on Immunisation (EPI) to monitor incidence of malaria and to ensure good treatment outcomes.</td>
<td>workers for follow up. A few days prior to the appointment date, an SMS is sent to the mother’s phone if she provided a contact number. The MCCM can also capture ANC EPI visit location so the health workers do not have to draw client mapping manually.</td>
<td>Reminders sent to women’s phones increased attendance over time and also reduce staff workloads by eliminating paper based appointments. The module also helped track clients. It made it easier for health care workers to follow up on newborn care and also update immunisation data thereby improving the effectiveness and efficiency of ANC and EPI.</td>
<td>ministries of health even the best designed and well implemented communication intervention could fail. Interoperability between the module and existing HIS is crucial as the success of the Better border project relied on the capacity to transfer data captured by the HIS to the module. This will also enable the use of information that is collected by other agencies. Whichever tools are used (paper or electronic), the effectiveness relies heavily on dedication of its staff.</td>
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| DATA MANAGEMENT FOR MONITORING OF SERVICES AND PATIENTS | Sene PDA<sup>29</sup> | Problem: Community officers often spend a lot of time in manually compiling data. Manually registering data also introduces the risk for human error and inaccurate data.  
Aim: The aims of the project are:  
To reduce the time community health officers spend generating monthly reports by using ICT.  
To help generate more accurate reports used for decision making by health workers and the district health management teams.  
To improve the follow up of children. | Pocket digital assistants with Java application were used to collect the data. A computer was dedicated to the data collection at the DHMT to act as a server where data is collated and reports are generated.  
PDA data is synchronized by either wireless or USB with that of the computer anytime the health worker goes to the district office. | Time saved from manual data entry enabled health workers to spend more time delivering services to their clients.  
It allowed health workers to track and target unimmunized children thereby increasing immunization coverage.  
Using ICT to capture and store data lead to more accurate and timely EPI data. | To ensure continuity, continuous training is needed to ensure that any health workers newly posted to the project area knows how to use the technology appropriately. There is the need for a focal officer for health information at the district level who could collate and analyse data and feed it back to the health worker to show them the bigger picture. It is important that measures are put in place to ensure that only personnel of the health service deal with the data in order to |
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<td></td>
<td>Using cell phones to collect postpartum haemorrhage outcome data</td>
<td>Problem: It is difficult to assess the health care needs of rural communities in low and middle income countries because data collection is hampered by low levels of literacy, limited access to health care and poor infrastructure.</td>
<td>Basic GSM handsets were used to send SMS text messages to a pre-programmed number. A reporting protocol was developed to include: a pre-assigned ID number; the age of the maternal patient; the patient’s PPH status; whether bimanual uterine compression was applied; maternal death outcome; neonatal death outcome. Health workers also indicated whether prenatal care had been received; and the number of prenatal care visits. Maternal age and the number of prenatal care visits were reported as discrete numbers. All other data were reported as “1” for “yes,” “0” for “no,” or “#” for “unknown.” Messages were sent to a particular phone and then transferred to a database for storage and analysis.</td>
<td>Both professional birth attendants and TBAs were able to use the specified reporting and text messaging protocol to report clinical outcomes. Illiteracy was not a barrier to being able to send the information via mobile phones. All the TBAs in the project were able to send in the data though most of them do not have formal education. The use of mobile phones promotes networking among health workers. These networks are important during emergencies. Health workers can get support from their peers in dealing with complicated cases.</td>
<td>It is possible to train people from the community with low level of literacy to use the cell phone to report health related outcome. Sending in real time data ensures that more accurate data will be collected about what is happening in remote rural areas. Data accuracy might be compromised. Health workers might not report outcomes which are unfavorable to them in order to avoid blame. Text message based data collection system depends on the reliability of the system. Erratic or absence of network coverage can hinder the ability to send SMS.</td>
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<td>Cell Phone to collect Pregnancy Data from Remote Areas</td>
<td>Problem: In most lower and middle income countries the technology that support the use of mobile phones has by far outpaced general components of the health system such as transportation, infrastructure, clean water, dependable electricity and even adequate sanitation systems.</td>
<td>Workshops were organized for trainers who in turn trained health workers in the construction and use of SMS to send pregnancy data from their remote rural communities.</td>
<td>Results from the project demonstrated that the three day workshop to train health workers improved their knowledge and skills on mobile phone usage. The project demonstrated that cell phones are an</td>
<td>With training non literate persons can collect and send health data through mobile phones for health research. Mobile phone features such as SMS and text messages offer an innovative and easier way of involving people who may be</td>
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| DATA MANAGEMENT FOR MONITORING OF SERVICES & LOGISTICS | mPedigree<sup>12</sup>  
Setting: Ghana and Nigeria  
Project period: Project started in 2008 (ongoing) | **Problem:** Every year many people in LMICs lose their lives due to the use of fake drugs.  
**Aim:** mPedigree allows patients and consumers to instantly verify the safety and efficacy of the drugs that they buy using a mobile phone | A mobile phone platform was created where a database for drugs was kept. Consumers were able to text in via SMS at no cost a code on the drug package to verify the safety and efficacy of medicines using their own or shared mobile phones. A reply was then sent to the phone of the consumer to indicate the veracity of the drug. | It has been successfully piloted in 6 African countries.  
It has contributed to the steady recovery of more than $200 million that pharmaceutical companies lose daily. | It is possible to reduce drastically the loss of life and revenue through simple technology. |
| POINT OF CARE SUPPORT COMMUNICATION & NETWORKING | mHealth for maternal and newborn health in resource poor and health system settings<sup>16</sup>  
Setting: Sierra Leone | **Problem:** Health outcomes for MNH has been poor in sub Saharan Africa especially in rural areas.  
**Aim:** The study was to find out the feasibility of introducing mHealth to improve communication between health workers in order to help outcomes for MNH. | Health workers in facilities which have low rates for antenatal and postnatal visits were provided with mobile phones and credit used to remind clients of upcoming ANC visits. A closed user group allowed health workers to call each other for free. | The project proved that using mobile phones improved the extent to which health workers managed referrals, shared advice with colleagues, passed on information to supervisors, and sent data to the HMIS. | When accepting the introduction of an mHealth solution policy makers should prepare for strains and demands on the health system such as a cost and increased workload on the health worker.  
Public private partnerships are |
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<tr>
<td>DATA MANAGEMENT FOR MONITORING OF</td>
<td>Project Mwana</td>
<td>In Zambia HIV rates are high. However, it is very difficult to get early infant HIV diagnostic testing and results to rural areas in a timely manner.</td>
<td>The project used rapid SMS to develop two applications ‘Results 160’ and ‘RemindMi’.</td>
<td>The time lag for receiving lab results was cut by half for early infant HIV diagnostics.</td>
<td>Confidentiality and accountability were huge concerns as test results were sent to the private phones of health workers.</td>
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<td>Setting: Zambia</td>
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**Project period:** March to July 2011.

**Import**ant for the sustainability of mHealth projects. Negotiating with telecommunication companies can reduce costs.

Network coverage is an important factor to consider when setting up an mHealth project. Limited or unreliable network coverage is a major challenge.

When more than one health workers use the phone, efforts should made to make the phone available all the time so that health workers do not use their own phone and incur cost.

Closed user groups are a valuable tool to increase communication and lessons sharing amongst health workers. It helps in the management of emergencies and improves monitoring and supervision.

SMS is appropriate for communication amongst health workers but not between health workers and clients. A sizeable number of clients cannot send SMS due to illiteracy.
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<tr>
<td>PATIENTS</td>
<td>Project period: Started 2006 (ongoing)</td>
<td>timely manner.</td>
<td>‘Result 160’ allows HIV test results to be communicated in a timely, efficient way through SMS to health facilities which collect the samples.</td>
<td>There was also an increased coverage of HIV testing among infants.</td>
<td>Anonymising results is important as test results might be accessible to others.</td>
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<td>Aim: Project Mwana aims to use SMS technology to send early Infant HIV diagnosis results to community health workers</td>
<td>‘RemindMi’ is used to improve the rate of postnatal follow-up, by reminding mothers through SMS to return for their six-day, six-week and six-month postnatal visits as required in Zambia. The application also enables community health workers to register births.</td>
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<td>POINT OF CARE</td>
<td>ICTD for Healthcare study</td>
<td>Problem: Rural areas in developing countries are often afflicted by a shortage of qualified health workers. Medical doctors found in rural areas are often isolated and lack clinical care guidance and support.</td>
<td>The two ICT solutions examined were: Ghana Consultation Network (GCN) and One Touch Medicare line (ML). GCN is a computer based system which provided doctor to doctor consultation through a network of internet servers. Doctors access the web based system either by logging into a local server or by logging into one of the two public servers. On these servers they could upload problems and seek help and advice from colleague doctors. There was a possibility for this internet based network to be connected via mobile phones.</td>
<td>The study compared the effects of the use of GCN, which is more technology based, to ML, which relies on simple technology of mobile phone voice service. The differences included: Framing: GCN: Focused on connectivity in the rural North. It therefore targeted a small number of doctors, but those with the greatest need. ML: Focused on airtime cost, which affects the majority of doctors mostly in the urban South. Partnerships and deployment: GCN: were dependent on</td>
<td>In low income countries the adoption of technologically complex interventions is slow because of the lack of necessary infrastructure. In low income countries computer and internet access is limited. This can negatively impact access. Simple devices, such as mobile phones, are cheaper and require little training to enable effective use by participants.</td>
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<td>SUPPORT</td>
<td>Setting: Ghana</td>
<td>Aim: This study compares two ICT solutions developed to aid remote medical consultation in Ghana.</td>
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<td>&amp; NETWORKING</td>
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*Evidence for Action*
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<td>TRAINING AND DISSEMINATION</td>
<td>Kenyan health workers’ adherence to malaria by health workers often</td>
<td>Problem: Case management of malaria by health workers often</td>
<td>All health workers doing outpatient consultations in the</td>
<td>Findings from the study showed that simple one-way</td>
<td>The authors indicated that it should not replace the traditional</td>
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| OF KNOWLEDGE                        | mobile phone supported treatment guidelines  &lt;sup&gt;48&lt;/sup&gt; | differ from national guidelines.  
**Aim:** The study assessed whether text-message reminders sent to health workers’ mobile phones could improve and maintain their adherence to treatment guidelines for outpatient paediatric malaria in Kenya. | intervention group received text messages about malaria case-management recommendations from the Kenyan national malaria guidelines for 6 months. | communication of text-message reminders sent to health workers’ personal mobile phones improved the quality of artemether-lumefantrine management.  
First artemether-lumefantrine administration increased by more than 20% at facility level.  
There were improvements in health workers ability to advise clients on the correct timing for the second artemether-lumefantrine dose (nearly 30%) and the giving of the drug after a meal (nearly 20%) | package of case-management interventions such as in-service training, supervision, and dissemination of guidelines and job aids |
| DATA MANAGEMENT FOR MONITORING OF PATIENTS COMMUNICATION & NETWORKING | Mobile Community Based Surveillance (mCBS)  &lt;sup&gt;50&lt;/sup&gt; | Aim: It was aimed at improving data collection and patient tracking through the use of SMS and Open Data Kit (http://opendatakit.org). | A text based system was built whereby TBAs could register vital events via SMS. They also text in when they experience complications so that the referral facilities can be prepared for the patient. | TBA's and Midwives can through simple SMS contribute to reducing the time it takes to receive urgent care, improve follow-ups on deliveries, and thus improve MNCH outcomes.  
The project demonstrates that non- and semi-skilled health workers (TBAs) can be incorporated into a real time community-based data collection scheme. | Community members, if trained and supported by the health system, can be key to detecting and reporting key morbidity and mortality events that otherwise may go undetected.  
Proper training needs to be built in the programme to ensure community members use the technology effectively and appropriately.  
The use of mobile phone |
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<tr>
<td>TRAINING AND DISSEMINATION OF KNOWLEDGE</td>
<td>Mobiles for Quality Improvement (M4QI)¹⁰</td>
<td>Problem: Many developing countries have a grave shortage of qualified health workers. Many of the health care providers have severe gaps in their training needs. They also lack proper work aids and protocols.</td>
<td>Frontline SMS was chosen because of its ability to operate without internet. This functionality includes a databank of messages that can be stored by topic, quiz functionality with automated responses and remediation, ability to schedule in advance the delivery of messages and reporting to identify knowledge gaps for targeted follow up and support.</td>
<td>The programme was able to bring about a change in knowledge, practice and motivation. Participants indicated that that they were motivated by reminders to adhere to hand washing rules. They also reported that they were encouraged to refer to training manuals in order to refresh their knowledge in instrument sterilisation and also about pain management. There was also an increase in interaction and information sharing among health care providers.</td>
<td>When introducing technology supported interventions there is a need to dedicate resources for the provision of on-going IT support and problem solving. Training is important in technology programmes in order to ensure that responses conform to formatting procedures. When responding to messages is at a cost it is more appropriate if prepaid airtime is provided other than reimbursing respondent after they have used their own credit to send responses because health workers might be reluctant to use their private resources for work.</td>
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<td>DATA MANAGEMENT FOR MONITORING OF PATIANTS</td>
<td>Community based weighing of newborns and use of phones by village elders¹¹</td>
<td>Problem: The MNH Registry Study in Kenya found that 70% of newborns did not have exact weights measured and recorded in the first week of life.</td>
<td>The mobile phone provided was a Nokia 1202. It is a basic feature phone that can send and receive short text messages and voice calls.</td>
<td>Some information from stillbirths and early newborn deaths were recorded: 40% of the 324 still births and 61% of the 208 early neonatal deaths were weighed. Highlights the cultural practice of prompt burial of stillborns or infants who have died often before the elder or registry</td>
<td>Authors note that mobile phones may have been the major factor that enhanced communication between elders and the registry administrator. This enabled successful communication of birth weight data between the community and vital statistics data management system. However, they highlight that</td>
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|              | December 2010                            | This study is a pre- and post- analysis of changes when mobile phones and weighing scales were provided to 474 village elders from 16 clusters within Western Province, Kenya. It was part of the Global Network for Women’s and Children’s Health Birth Registry study. | for reporting of pregnancies and birth weights. Either via text or voice.  
- Once the village elders communicated the birth weights to the Registry Administrator, that administrator then inputted the data into a data management system.  
- Elders were provided with these mobile phones by the study.  
- Elders purchased airtime credit for the phones. Phones were not provided by the project. | administrator is aware of the birth.  
"Successful communication of birth weight data between the community and a vital statistics data management system is feasible" (p6). For instance, recorded birth weight increased from 41.5% to 96.3% between the pre- and post-distribution phases. Also, the birth weight distributions between infants born and weighed in a health facility compared to those born at home and weighed by village elders were similar. There was a significant increase in the percent of subjects who enrolled before delivery. This suggests that engagement of village elders enhanced pregnancy case discovery and subsequent enrolment. | there may be other factors to consider for this:  
- **Political**: Involvement of the district chief to bring village elders together to partake in the study.  
- **Equipment**: provision of the weighing scales. Need close cooperation and open lines of communication between village elders and data transcribe for the system to function.  
- Village elders, who are predominantly men, can also be considered a cadre of CHWs to obtain demographic information. |
| POINT OF CARE SUPPORT | Electronic Integrated Management of Childhood Illness (eIMCI) protocols” | **Problem:** Shortages in trained health workers in low-income countries means that there is a need to find ways to ensure that lesser trained health workers accurately diagnose and treat patients. Electronic technology has the potential to complement existing mechanisms to ensure consistency | An electronic version of IMCI protocol was developed (eIMCI) and used on a Personal Digital Assistant (PDA). The eIMCI protocol followed the same protocol as the paper system (pIMCI): health workers were guided through the child’s assessment classification, | • For all ten areas assessed in both systems, the level of adherence was greater for the eIMCI compared to the pIMCI: adherence for pIMCI ranged from 61% to 98% compared to 92% to 100% using the eIMCI.  
• Greater consistency in care | Not available |

**Setting:** rural and semi-urban areas of Tanzania
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|               | Project period: March 2008-December 2009 | and improve quality of care.      | treatment, and communication of instructions to the care provider. | using the eIMCI protocols was also observed compared to the pIMCI system.  
• Qualitative research indicated that the health workers preferred using the PDA eIMCI system rather than the pIMCI system because the former was easier to use and seemed that the children and their care providers had greater confidence in it. | |
|               | Millennium Villages Project’s MGV-Net Vital Registration and Verbal Autopsy (VRVA) System | Study description: This study evaluates the impact of electronic technology on the adherence of health workers to the Integrated Management of Childhood Illness (IMCI) protocols compared to paper-based protocols at 18 health facilities in four districts in Tanzania. | | |
|               | Project period: 2007-2009 | **Aim of the VRVA system:** To produce information on the cause and social circumstances surrounding the death in order to inform the delivery of health and development interventions.  
**Components of the MGV-Net VRVA system:** | | |
|               | The Millennium Villages Project (MVP) involves the delivery of proven health and development interventions in village units of 1,000-10,000 households with the aim of accelerating progress towards the MDGs. Bonsansso village in Ghana is one of these MVPs where a Vital Registration and Verbal Autopsy (VRVA) component of the Millennium Global Village-Network was tested. | MGV-Net: An open source health information system built on the OpenMRS platform that generates data to be used in tracking progress and informing decision-making and management.  
**VRVA system’s tools:** *Birth registration form* to evaluate circumstances of the birth, such as attendance of skilled professional and condition of the child (not mobile based at the time of this article).  
**Cause of death module:** Includes questions to assess signs and symptoms of the deceased before their death. Consists of both closed and open-ended sections following best practice guidelines. | | |
|               | Setting: Bonsansso MVP, Amansie West District, Ghana | **Deaths registration and verbal autopsy:** This programme was still being piloted at the time of writing. In email conversation with Andrew Kanter from Columbia University who has been involved in the programme, it is clear that the death registration and verbal autopsy programme is still on-going and uses a number of mobile phone based tools:  
1) ChildCount+: a SMS based | | |
|               | Project period: 2007-2009 | Though the registration of births seems to be accurate and easy to implement, high community mobilisation and awareness by CHWs is required.  
Under-reporting of deaths is likely due to the social and emotional sensitivities of it within a household. It is recommended that cross-sectional validation is conducted to address this problem. | | |
|               | DATA MANAGEMENT FOR VITAL EVENTS REGISTRATION & CONDUCTING VERBAL AUTOPSIES | (No information available from more recent developments of the death registration and verbal autopsy system) | | |
1) **Community Health Workers (CHW):** introduced to enable the delivery of health information and services to households in the project clusters. Ratio of 1 CHW/100-200 households undertaking a visit every 1-2 months. Quickly aware of vital events in households.

2) **Verbal autopsy (VA) specialist:** a non-clinical health worker trained in the VA methodology. They have primary responsibility to conduct VAs.

3) **Data entry and assessment of cause of death:** All of the VRVA forms are entered monthly into an OpenMRS database from their paper-based versions. A series of algorithms are then used to determine the probable cause of death and social circumstances leading up to the death.

The data collected from the system is compiled and used in ‘morbidity and mortality rounds’. These meetings are conducted by clinic staff, VAs and the CHWs. They provide a platform to address the medical and social autopsy data with recommendations being made for new or existing health programmes.

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**Social autopsy module:** Enables the collection of information on the social circumstances surrounding the death, such as health seeking behaviour and access barriers, and economics.

**OpenMRS:** a web-based, open source electronic medical record platform that can be used to collect person-level health information from several different technologies.

**OpenMRS platform**

**OpenDataKit (ODK):** an open source platform that enables data collection on mobile phones and data submissions to a central server

**CommCare:** a mobile and web platform for gathering and distributing healthcare-related information

The death registration and VA programme connects peripherally to ChildCount+ by first notifying the death. CommCare is also used for the initial documentation of the death. The data collection of information surrounding the death is currently performed using ODK into OpenMRS. Once the data is in the OpenMRS central database, a series of algorithms are run to calculate the social and medical causes of death.
## Monitoring of Vital Events – Information Technology (MOVE-IT)

### Setting:
Multiple countries in Africa and Asia

### Project period:
Started 2010 (ongoing)

### Problem:
More than three-quarters of all births and deaths that are uncounted are in sub-Saharan Africa and south-east Asia.

### Aim:
MOVE-IT is a Health Metrics Network led project launched in 2010 in a number of different countries in Asia and Africa. It aims to harness innovation and advances in information technology to record every birth, death and cause of death.

**Example - Kenya:**
This project uses mobile phone technology to speed up and improve the registration of births and deaths in three districts in Kenya. Two platforms are used: RapidSMS and OpenXdata.

RapidSMS allows users to send a text message to local authorities about a birth or death in their designated area. Once the message is received, a registration agent registers the event with Kenya's Department of Civil Registration using OpenXdata.

A prototype of the mobile platform supporting MOVE-IT is being tested, and training of community health workers.

### RapidSMS:
Rapid SMS is a SMS-based (text message) framework that manages data collection, complex workflows, and group coordination using basic mobile phones — and can present information on the internet as soon as it is received.

### OpenXdata:
OpenXdata: an open-source software for designing web-based forms on mobile devices (Health Unbound).

Is an open source platform for data collection via Java based phones that can be sent over GSM (SMS), GPRS (WAP), or Bluetooth. A wide variety of data types can be collected, including GPS. User-hosted server allows for the management of groups, users, creation of forms, and performing surveys.

### Five countries in Africa (Burkina Faso, Egypt, Ghana, Kenya and Rwanda) are conducting an in-depth assessment of their civil registration and vital statistics systems. These assessments will identify key priorities for action and develop roadmaps for improvement.

### Seven countries (Bangladesh, Cambodia, Egypt, Ghana, Kenya, Mozambique and Rwanda) have established coordination committees to ensure that all relevant stakeholders are involved in addressing the weaknesses of civil registration and their systems.

### Five countries (Bangladesh, Ghana, Ethiopia, Kenya and Rwanda) are using outreach health workers to record and transmit via mobile phones data on births and deaths at the community level.

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*In email conversation with Saira Qureshi from MVP, it was noted that the programme is considering switching from ODK-OpenMRS to CommCare. Reasons for this switch include: a) CommCare is already used in other MVP programme which would enable cross-validating and analysing data for the two systems, as well as be a better use of human resource capacity and funding; b) CommCare is supported under Dimagi, which means you can pay for support plans and are guaranteed server security and up-time.*
workers and registration agents is planned. The project is expected to be piloted in a few areas before rolling out nationwide.

Three countries (Egypt, Kenya and Mozambique) are working to improve the training of medical professionals in determining causes of death following international standards.

### Mobile Verbal Autopsy Tool (MIVA)

**Setting:** Agincourt Health and Socio-demographic Surveillance System (AHDSS) study site in Mpumalanga Province, South Africa

**Project period:** seven days over two weeks (dates not known).

**Problem:** The World Health Organization receives reliable causes of death statistics from only 31 of its 193 member states. The World Health Organization has recognised that there is an urgent need for a mobile device that combines both direct data capture and analysis.

**About the study:** A field test was conducted across two weeks to evaluate a mobile application that met WHO requirements of a VA instrument: simplicity, feasibility, adaptability to local contexts, cost-effectiveness, and programme relevance.

Within those two weeks, AHDSS VA fieldworkers were trained in using the MIVA system and conducted ten real VA interviews.

In addition to the fieldworkers’ use of the MIVA system, the researchers also conducted interviews with key stakeholders in the VA process in order to assess the ethical implications of the technology.

The Mobile Verbal Autopsy Tool (MIVA) is designed to use the existing InterVA-4 software. InterVA-4 runs on windows and stores the 245 WHO VA signs and symptoms questions. The software is able to calculate the most likely cause/s of death based on the ‘yes’ answers inputted.

Following as much as possible of InterVA-4, the MIVA software consists of:

1. An HTML page that is stored on the mobile device.
2. JavaScript that is used to implement data collection and storage.

The device used in the field study was a Sony Xperia U smartphone. It was chosen for its:

- Low cost: GBP160
- Battery life: one day
- Small size

Key elements of the system, such as language, can be changed and updated using a spreadsheet application and uploading it via a USB connection. Thus non-programmers are able to maintain and adapt it.

**Simplicity:**

- All users were able to use the touch interface after a short training session.
- Questions were answered without a problem.
- Non-programmers were able to maintain and adapt the software.

**Feasibility and Acceptability:**

- Ten successful VA interviews conducted in 4 days. The mean interview time was 22 minutes. This is in contrast to the paper-based tool that takes one to two hours to complete.
- Mobile phone batteries lasted all day and charged each evening.
- Several hundred interviews can be stored on the device.
- All fieldworkers liked the system’s ability to automatically skip irrelevant questions, but impossible to miss relevant ones. Made the interviews flow naturally and efficiently.
- Non-programmers are able to maintain and adapt the software.
- Users recommended including a “refuse to answer” option in order to capture respondent’s unwillingness to answer.
- Users highlighted the need to consider security risks in other settings, such as urban areas.
- Users felt a sense of ownership over the tool since they were involved in its translation from English to Shangaan.
- Highly skilled VA interviewers are important in order to ask questions sensitively and explain them so that they’d be understood.
- Data security: advised that data be backed-up onto encrypted SD cards on the mobile phone and uploaded as often as possible to a central database.
The interface is simple with each question presented on a single screen. There are two types of closed questions: 1) multiple choice and 2) simple questions with ‘yes’, ‘no’, and ‘don’t know’ answer options. The user must answer the question on each screen before they can move onto the next or previous question.

Once all questions have been answered, MIVA stores the responses in the browser’s local storage. MIVA can then display the results of the InterVA 4 analysis and demonstrate a calculated probable cause of death.

**Adaptability to local contexts:**
- One and half days taken to translate and localise WHO questions and MIVA.
- Training fieldworkers to use MIVA on the mobile phones took ~1 day.
- None of the fieldworkers felt that the WHO VA questions were too sensitive.

**Cost effectiveness:** A rigorous evaluation of cost-effectiveness is not possible in this study. Nevertheless, there were clear signs of the overall cost-effectiveness of the tool compared with paper-based methods. These include reduced interview time allowing for greater interview rate per day, the growing affordability of mobile phone technology, and the lessening need for a data entry stage.

**Programme relevance:**
- For the AHDSS, MIVA provided timely, standardised data capture and analysis that were likely to be cost-effective.

<p>| DATA MANAGEMENT FOR CONDUCTING VERBAL AUTOPSIES | PDA’s to collect and analyse VA data | Study description: As part of a research project to evaluate a safe-motherhood programme, PDAs were used to collect and analyse VA data. | InterVA software was used on a Personal Digital Assistant (PDA). | Successful implementation with hundreds of VA interviews completed over 6 months with an assigned cause of death. | Need to explore further issues from directly feeding back information on cause/s of death to respondents. |</p>
<table>
<thead>
<tr>
<th>Project period: carried out in 2008. No other information reported.</th>
<th>Mobile Vital Records System (Mobile VRS)</th>
<th>Problem: Only one in five children under the age of five years old are registered among the nearly 1.5 million babies born annually in Uganda. Project description: In the third quarter of 2010, Uganda Registration Services Bureau (URSB), with UNICEF and Uganda Telecom (UTL), started developing and testing a Mobile Vital Records System (Mobile VRS). Mobile VRS uses mobile phones in communities and internet-connected computers in hospitals, to send birth and death notifications via Unstructured Supplementary Service Data (USSD) to the central government server at URSB.</th>
<th>Unstructured Supplementary Service Data (USSD): USSD allows data to be sent via GSM (Global System for Mobile Communications). In contrast to SMS messages, USSD allows for real time connection and thus transmission of data and can be up to 182 characters in length.</th>
<th>Challenges: • The mobile phone network infrastructure is weak in some areas. Has led to incomplete coverage and some communications failures. • Unreliable electric power supply in many parts of the country makes it difficult to install a working computer and printer in every sub-county and hospital, as well as the charging of mobile phone batteries. Lessons learned: • Gaps in key staff at local government levels negatively affect programme implementation. • Inadequate transport makes it difficult for district and sub-county staff to provide system supervision. Important to have adequate HR capacity to address increases in the volume of work.</th>
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<td>DATA MANAGEMENT FOR VITAL EVENT REGISTRATION</td>
<td>Mobile Birth Registration (MBR) project in Liberia</td>
<td>Problem: In Liberia, the birth registration rate for children under 5 was estimated to be about 5% in 2007. Aim: To create a functioning mobile birth registration (MBR) data collection system to be deployed in rural areas in Liberia.</td>
<td>The UBR project uses Nokia Data Gathering (NDG) solution to collect birth registration information through tailor-made data collection forms and transmit this information via GPRS to the main birth registration service. NDG consists of two modules: the NDG server and the mobile</td>
<td>Findings of the mid-term review: • Successful implementation of an MBR system in the pilot county. • Though the project has not yet gone to scale nationwide, as planned, the success of the pilot</td>
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<td>Setting: Uganda Project period: 2010 (ongoing)</td>
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<td>Setting: Liberia Project period: 2008 (ongoing)</td>
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</table>
**Project description:** The Crises Management Initiative (CMI) began scoping the idea of an MBR-project in Liberia in 2007.

The project was first piloted in 2009 in Bomi County for approximately 20 users and administrative personnel of the MoHSW. During this pilot, the trainees were taught how to use the survey software in the mobile phones for registering a birth of a child, how to transmit the data and also how to manage the mobile BR system.

After this planning phase, CMI launched the MBR project in 2009 with funding from the Finnish Ministry for Foreign Affairs (MFA). It is planned to run until 2012.

Also, as part of this project, CMI have worked with the Universal Birth Registration (UBR) task force in helping to implement Plan International’s UBR programme in Liberia. UBR is a computerized birth system that launched in Liberia in 2010.

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**DATA MANAGEMENT FOR VITAL EVENT REGISTRATION (BIRTHS)**

**Birth Registration using RapidSMS**

- **Setting:** Nigeria
- **Project period:** 2011 (ongoing)

Since January 2011 the National Population Commission of Nigeria has been implementing decentralized monitoring of birth registration using the mobile-phone based platform RapidSMS.

Each Registrar reports the number of birth registration cases every other week. Those reported cases are then tracked.

**RapidSMS:**

- It is an SMS-based (text message) framework that manages data collection, complex workflows, and group coordination using basic mobile phones — and can present information on the internet as soon as it is received.

As of September 2012, RapidSMS was operational in 33 states (686 Local Government Authorities (LGAs); 2,887 registrars/registration centres).

- The RapidSMS training is underway for the final three

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- The evaluation team stress that the inclusion of new services with the existing mobile service platform is critical for sustainability. For example, the MBR solution could be used as a generic data gateway used for multiple purposes.
- Government ownership is necessary to ensure the sustainability of the MBR.
| DATA MANAGEMENT FOR VITAL EVENT REGISTRATION (BIRTHS) | Mother and Child Tracking System (MCTS) | Problem: In India, an estimated 60,000 women die every year from complications related to pregnancy and delivery and an estimated 1.25 million newborns die before their first birthday. The reason behind these deaths is that the health care delivery system is not able to deliver low cost medical technology to all pregnant women and children. | MCTS is a web-enabled name based tracking system. The names of pregnant women/mothers and their newborns are inputted into the system along with their mobile phone numbers. This information is then organised on a dashboard and workplans. The system then sends both the beneficiaries and the health workers SMS reminders of scheduled services. |
| Setting: India | Project period: 2009 (ongoing) | Aim: Will help to facilitate the monitoring of universal access to maternal and child health services by pregnant women and children. | More than 40.6 million pregnant women and 33 million children have been registered in the system since it began. |
| Project description: MCTS was launched in December 2009 by the Ministry of Health and Family Welfare, and the National Informatics Centre in collaboration with Indian States/Union Territories. It is currently being implemented throughout the country. It is a web-based computer application that captures and tracks all pregnant women and all newborns up to five years of age in order to ensure that they receive a ‘full’ set of medical services such as antenatal check-ups, postnatal visits, and vaccinations. | Recommendations to improve the implementation of the MCTS: |
| | | | - MCTS should not be a separate entity and be a part of the Child Health or Maternal Health division or HMIS. |
| | | | - Enough human resources & logistics support is important to ensure regular and up to date data entry. For example, a full time data entry operator with functional computer hardware & software is important. |
| | | | - Standardised recording registers of all entries are needed. |
| | | | - All work plans should be in the local language and not just in English so that health workers can use them. |
| | | | - Would be good to have the option of uploading data offline. MCTS is currently only online and is difficult to use when there is no or poor connectivity. |
| | | | - Processes should be put in place to enable the triangulation of data from MCTS and HMIS, as well as its use. |
| | | | - A mechanism for regular review and feedback should be established. |
| | | | - The data collected should be updated on the RapidSMS dashboard that can be accessed online. |
**DATA MANAGEMENT FOR CONDUCTING VERBAL AUTOPSIES**

| **Electronic Verbal Autopsy (VA) tool used on hand held devices**<sup>43,44</sup> | **Problem:** The VA instrument (before it was developed to use on a hand held device) was created to address three research limitations of VA validation studies: 1) Comparison of poorly recorded deaths in hospitals in resource limited settings to verbal autopsies; 2) No published information on important causes of deaths such as COPD or cancers due to small sample of causes of deaths recorded due to community based and thus small sample 3) Lack of information on a study’s key features, such as the VA instrument used or the coding of death certificates. | **The instrument is based on WHO’s standardised verbal autopsy instrument. It is made up of four modules: a general information module, an adult module, a child and neonatal module. Features of the electronic VA instrument include:**<br>• It can be administered using any Android device via the open source platform Open Data Kit [http://opendatakit.org/](http://opendatakit.org/).<br>• The VA questionnaire will take approximately 45 minutes to complete in the field on the device.<br>• The data can then be transferred to a server (local or cloud) via wifi or being directly connected to a computer.<br>• The instrument can be programmed into multiple languages or images if the required language is not available.<br>• If the phone has GPS it is possible to note the location of each interview/household.<br>• If the phone has a camera, it is possible to take photos of certain key items such as consent forms or medical records.<br>• Though no information could be obtained on the outcomes of using the electronic VA tool, information provided by Summer Ohno does provide some insights into the benefits of the device:<br>• No need to manually enter data into a database since it can be automatically transmitted after a questionnaire has been completed. This reduces the time between data collection and analysis.<br>• Increases data quality by programming the instrument: to correctly skip or follow patterns, to ensure that questions are fully completed, and to prevent implausible responses.<br>• Monitoring the interviewers in real time is possible, which can help to improve the quality of data collection as it is easier to be notified if more training is required. | **Aim:** To address these research limitations by collecting a data set of gold standard deaths from health facilities of which verbal autopsies were conducted to validate the accuracy of different methods for assigning verbal autopsy causes of death.<br>**Study description:** In 2005, the Population Health Metrics Research Consortium (PHMRC) developed and tested diagnostic criteria to identify gold standard deaths from health facilities and a VA instrument in six sites in four countries: Andhra Pradesh, India; Bohol, Philippines; Dar es Salaam, Tanzania; Mexico City, Mexico; Pemba Island, Tanzania; and Uttar Pradesh, India. | **Project period:** 2005-2010 | **open to everyone to see. This will strengthen accountability by reporting officials.**<br>(No other information on lessons learnt in using this device for VAs was available at the time of research)**

| **Setting:** Six sites in four countries: Andhra Pradesh, India; Bohol, Philippines; Dar es Salaam, Tanzania; Mexico City, Mexico; Pemba Island, Tanzania; and Uttar Pradesh, India. | **Setting:** Six sites in four countries: Andhra Pradesh, India; Bohol, Philippines; Dar es Salaam, Tanzania; Mexico City, Mexico; Pemba Island, Tanzania; and Uttar Pradesh, India. | **Setting:** Six sites in four countries: Andhra Pradesh, India; Bohol, Philippines; Dar es Salaam, Tanzania; Mexico City, Mexico; Pemba Island, Tanzania; and Uttar Pradesh, India. | **Setting:** Six sites in four countries: Andhra Pradesh, India; Bohol, Philippines; Dar es Salaam, Tanzania; Mexico City, Mexico; Pemba Island, Tanzania; and Uttar Pradesh, India. |

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*Evidence for Action*
Tanzania; and Uttar Pradesh, India.

This research gave way to the development of a VA instrument that can identify more than 50 adult causes of death, 40 child and newborn causes of death, and stillbirths. This instrument has recently been further developed to enable data collection with a hand held electronic device such as a smartphone or tablet.