

# USE OF MOBILE TECHNOLOGY TO SUPPORT PROVISION OF COMMUNITY-BASED MATERNAL AND NEONATAL CARE IN DEVELOPING COUNTRIES

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**Keywords:** Community-based maternal and neonatal care, Community health workers, Mobile technology, Electronic health records, Developing countries, Rural areas, Malawi.

**Abstract:** The health systems in many developing countries in Africa are facing critical shortages in nursing and midwifery health professionals and the situation is worse in the rural areas resulting in poor maternal and neonatal health outcomes. One of the interventions to address this challenge has been the use of Community Health Workers to supplement the provision of maternal and neonatal healthcare services within their communities. The international community is advocating for the use of Mobile technology in supporting various health service areas including community-based healthcare. This paper presents findings of a research on the information and communication needs of Community Health Workers in the provision of Community -Based Maternal and Neonatal care in the rural areas of a developing country, Malawi, and it examines the potential use for adopting mobile technologies in such a setting to meet their needs.

## 1 INTRODUCTION

Developing countries in Africa are struggling to make progress towards the achievement of health-related Millennium Development Goals (MDGs) particularly MDG 4 and 5 which are aimed at reducing child and maternal mortality (UNICEF, 2008). One of the challenges causing this is the acute shortage of nursing and midwifery health professionals which is particularly severe in rural areas due to poor infrastructure and working conditions (SaveTheChildren, 2010). In order to address this challenge, the international community recommends governments to scale up human resources for health including paid community health workers (MDGAfricaSteeringGroup, 2008). Thus, interventions are being implemented that involve Community Health Workers (CHWs) in the provision of Maternal and Neonatal Healthcare services at the community level; and countries such as Pakistan have already demonstrated the positive impact such interventions can make on improving health status of the community (GHWA, 2008).

The use of mobile technology to support various health services as advocated by the international community can be adapted for community/home-

based healthcare and (Illuyemi and Briggs, 2010) indicate that supporting Community Health Workers with mobile information and telecommunication technologies should be considered a top priority within the e-health agendas of developing countries. Many studies on mobile-health (m-health) applications implemented in developing countries have reported their use to support HIV/AIDs and Child health services (Kinkade and Verclas, 2008; Manda, 2009; UNICEF, 2009; Vital Wave Consulting, 2009). However, limited literature exists on the application and use of such technologies to support Maternal and Neonatal Healthcare even though this is a high priority health area in developing countries. Therefore, this study was conducted to investigate the provision of Community-based Maternal and Neonatal healthcare services in a developing country, Malawi, with the aim of exploring the potential of using mobile technology to support service delivery. In particular, the research had four objectives:

1. To investigate the duties and activities of Community Health Workers (CHWs) in relation to maternal and neonatal health care.
2. Identify the information and communication needs of these CHWs in their work

3. Identify the areas in which mobile health applications can be used to support their needs.
4. Define the design for a mobile-based maternal and neonatal health application.

Therefore, this paper presents the current activities of CHWs in the provision of maternal and neonatal health care at community level in Malawi and their associated information and communication needs. It further discusses the potential of using mobile technology to support the CHWs.

The study is part of an ongoing research on the use of ICT to support Maternal and Child Health service whose overall objective is to identify strategies, through action research, for designing and implementing ICT-based information systems for Maternal Health Care services in rural settings of developing countries.

## 2 RESEARCH CONTEXT - THE MALAWI HEALTH SYSTEM

This study was conducted in Malawi where the majority of the population (85%) is located in rural areas (NSO, 2008).

Healthcare services are mainly provided by the Ministry of Health and there are three levels of service provision in the health system: the primary level comprising of health centres, health posts, dispensaries, and rural hospitals; the second level is made up of district hospitals; and the tertiary level consists of the central hospitals and one private hospital with specialist services (ibid.). The health centre is the most easily accessible health facility and thus, it is where most women go to seek maternal health care. At this level basic maternal and child health services such as antenatal care, delivery (for normal cases), postnatal care, child immunisation, and family planning are provided and these services are provided by various groups of health professionals such as nurses, midwives, medical assistants and clinical officers (MoH, 2007;Sharan et al., 2009). The hospitals provide more comprehensive obstetric care therefore women observed with obstetric complications at health centres are referred to hospitals (ibid.)

The country is reported to have one of the highest maternal mortality ratios globally as it almost doubled between 1992 and 2000 from 620 to 1120 deaths per 100,000 live births (Sharan et al., 2009). Poor access and utilisation of services is one of the contributing factors to these high mortality rates and some of the barriers to the utilisation of

maternal health care services include social and cultural/traditional beliefs and practices (Sharan et al., 2009). Therefore, one of the strategies of the Ministry of Health for addressing these problems is to establish and strengthen community initiatives for Maternal and Neonatal Health (MoH, 2007).

### 2.1 Community Health Workers in Maternal and Neonatal Care

There are different types of health workers involved in maternal and child health services within the communities both from the formal/modern health system and the traditional side. The traditional health system consists of women known as Traditional Birth Attendants (TBAs). The TBAs used to have more established links with the modern health sector as some had been trained to support primary health care (MoHP, 2001). However, in 2007, the TBAs role changed from a service provider for antenatal care and deliveries to a safe motherhood advocate to refer women to health facilities (Kanjo and Kaasbøll, 2009).

The formal/modern health system has Community nurses, Health Surveillance Assistants (HSAs), and Village Health Workers involved in provision of community maternal and neonatal health service, having been recruited and associated with health facilities.

The community nurses are nurses in health centres responsible for organising and providing healthcare services in the community in addition to providing services at the health centre. These community nurses are expected to conduct outreach clinics to provide antenatal care services.

Village Health workers (VHWs) are volunteers who assist in various health programmes within their villages and their duties include following-up on PMTCT clients and facilitating community sensitisation on HIV/PMTCT. The VHWs also assist in identifying and registering pregnant women in the village and reporting births that take place in the village to the HSAs

The HSAs are the main link between the communities and the health facilities; however, their involvement in maternal and neonatal health services has been limited as this was not established as part of their duties. The research discovered it was only in 2008 that the Ministry of Health in partnership with donors started the establishment of Community Based Maternal and Neonatal Care (CBMNC) by piloting in three districts in Malawi (Dowa, Chitipa and Thyolo). Therefore, the duties and activities of HSAs in relation to maternal and

neonatal health vary among the districts as well as the health facilities.

In this study, the focus was on the HSAs as they are the major link between the communities and the health facilities and current Government efforts are focusing more on their involvement in CBMNC.

### 3 RESEARCH METHODOLOGY

The study was conducted in three districts in Malawi namely Lilongwe, Dowa and Machinga. A total of 17 rural health facilities were visited, the majority being health centres (12). Other facilities visited were rural hospitals (3) and district hospitals (2).

A qualitative research approach was adopted in order to obtain a deep understanding of the work and activities of the HSAs and their related information and communication needs. Thus, qualitative data collection techniques such as interviews and document reviews were employed. Additionally, review of existing software applications in use for data management and communication was done.

To acquire information on the HSAs and their work in relation to maternal and neonatal health care; 26 nurses, 12 Health Surveillance Assistants and 2 district coordinators of the community-based maternal and neonatal healthcare programmes were interviewed individually. The interviews provided data on the community based programme activities and procedures, data collected, reported and the reporting systems.

Documents such as service registers, CBMNC programme forms and Village Health Registers were reviewed to obtain data on the information requirements of the HSAs and the programme.

### 4 M-HEALTH APPLICATIONS IN DEVELOPING COUNTRIES

The high diffusion of mobile technology in developing countries has led to the widespread conviction that the adoption of mobile applications can be beneficial in supporting health care delivery in developing countries (United Nations, 2007; VitalWave Consulting, 2009). Statistics indicate that in 2008, Malawi had 1.2 fixed phone lines per 100 inhabitants, mobile cellular subscription was at 12 per 100 people and the proportion of households with internet was 1.7, thereby indicating the diffusion of mobile telephony

is higher than that of the Internet and fixed line telephones (ITU, 2010).

There are various ways in which mobile technology can be used to support health service delivery. According to Iluyemi and Briggs (2009), sustainable improvement in healthcare in developing country can be brought about by providing CHWs access to reliable health information and mobile applications present opportunities to complement conventional methods of accessing and disseminating this information effectively. Additionally, the mobility of CHWs activities can very much be accommodated by using mobile applications to meet their information requirements (Chatterjee et al., 2009). (Mechael et al., 2010) also indicate that m-health applications present an opportunity to break down the traditional information barriers between diagnosis and treatment and surveillance activities.

Furthermore, (Mechael et al., 2010) report that mobile technologies have been found to increase communication between health professionals and community health workers in developing countries through the use of voice calls and SMS applications thereby resulting in a collaborative support system and better patient care.

Several studies have presented various uses of mobile applications for improving health service delivery at community level in developing countries with most cases focusing on their use to monitor and support treatment for chronic infectious diseases such as HIV/AIDS and TB (Mechael et al., 2010; Kinkade and Verclas, 2008; Manda, 2009; United Nations, 2007). Other cases have also presented the use of mobile technology for collecting child nutrition data and the Integrated Management of Child Infections (IMCI) data within the community (DeRenzi et al., 2008; UNICEF, 2009). Literature on the use of similar applications to support maternal and neonatal health care has been limited thus indicating limited use of m-health applications in this health domain. The few cases presented portrayed how mobile devices such as Walkie-talkies and cell phones were being used for voice communication among service providers for referral cases as well as consultation on delivery cases (Musoke, 2002; Mechael, 2005).

Nevertheless, more recently, several cases have been presented which are focusing on using m-health applications to support maternal and neonatal healthcare in various ways including collecting data on the mother and infant's condition for patient monitoring, referring the mother or infant to health

facilities and follow-up care (Dimagi;UnitedNations, 2007).

A summary of m-health applications and projects in use by community health workers is presented in table 1 below. Even so, (Mechael et al., 2010) indicate there is need for studies that investigate the use and development of Electronic Health Records (EHRs) on mobile phones because EHRs have the potential to create a foundation for which the scope of m-Health can be realized.

## 5 FINDINGS

The findings of this study are on the activities of the Health Surveillance Assistants (HSAs) who were involved in Maternal and Neonatal Healthcare at community level and the associated information and communication needs for those activities. Four main activities of the HSAs were identified and are presented in the subsections that follow.

### 5.1 Follow-up on Antenatal Clients

The HSAs conduct follow-up on pregnant women within their communities and there are basically two types of follow-ups. The first type is follow-up on pregnant women who had attended antenatal clinic and were expected to have delivered in a particular month but they had not gone to the health centre for delivery. The second type is part of the PMTCT programme whereby follow-up is done on HIV positive pregnant women who have missed their appointments. The follow-ups are initiated by the health centre nurses who provide the clients' residential details to the appropriate HSA. The HSA provide feedback on the follow-up in special cases e.g. if the woman has moved to another location.

In some health facilities, a mobile-based application, FrontlineSMS, is being used to communicate the details of clients needing follow-up to the appropriate HSA and/or VHW.

Table 1: Mobile-Health Applications used by Community Health Workers.

m-Health Application	Functions	Goals	Countries Implemented
CommCare	<ul style="list-style-type: none"> <li>- Manage household visits</li> <li>- Assist in planning daily activities</li> <li>- Record information on mother and child's conditions and birth data</li> <li>- Transmission of data/information to a central repository</li> <li>- Referral of infant or mother in need of medical attention</li> </ul>	<ul style="list-style-type: none"> <li>- To provide better and efficient health care</li> <li>- Enabling supervision and coordination of community health programs</li> <li>- Enabling monitoring and evaluation of the community health programs</li> </ul>	<ul style="list-style-type: none"> <li>- Tanzania</li> <li>- Bangladesh (Dimagi;Lesh)</li> </ul>
Nacer	<ul style="list-style-type: none"> <li>- Communicating and exchanging critical health information among health professionals for: patient monitoring, patient referral, follow-up care and disease surveillance</li> </ul>	<ul style="list-style-type: none"> <li>- To improve communication among health professionals</li> <li>- Share data with hospitals when referring patients</li> <li>- Receiving feedback for follow-up</li> </ul>	<ul style="list-style-type: none"> <li>- Peru (United Nations, 2007)</li> </ul>
MoTeCH	<ul style="list-style-type: none"> <li>- Recording patient encounter information (i.e. mother/child assessment and treatment given)</li> <li>- Tracking of patients</li> </ul>	<ul style="list-style-type: none"> <li>- To increase the quality and quantity of antenatal and neonatal care in rural Ghana</li> </ul>	<ul style="list-style-type: none"> <li>- Ghana (Heatwole, 2010)</li> </ul>
Cell-Life	<ul style="list-style-type: none"> <li>- Accessing real-time health records of ART clients</li> <li>- Collect information on drugs and side effects, and relevant socio-economic indicators.</li> <li>- Monitoring and providing feedback to the CHWs as required</li> </ul>	<ul style="list-style-type: none"> <li>- Management of the HIV/AIDS epidemic by providing real-time voice communication between the care manager and CHWs</li> </ul>	<ul style="list-style-type: none"> <li>- South Africa (United Nations, 2007)</li> </ul>
e-IMCI	<ul style="list-style-type: none"> <li>- Provide decision support tool to guide health workers in the management of childhood illnesses based on WHO protocols</li> </ul>	<ul style="list-style-type: none"> <li>- Facilitate standardised diagnosis and treatment of common childhood illnesses.</li> </ul>	<ul style="list-style-type: none"> <li>- Tanzania (DeRenzi et al., 2008)</li> </ul>
FrontlineSMS	<ul style="list-style-type: none"> <li>- Communicating patient condition and treatment given during home-based care</li> <li>- Provision of treatment guidance</li> </ul>	<ul style="list-style-type: none"> <li>- Enables communication and coordination among health workers on home-based care.</li> </ul>	<ul style="list-style-type: none"> <li>- Malawi (Manda, 2009)</li> </ul>

## 5.2 Provision of Community based Maternal and Neonatal Care

The HSAs are required to conduct household visits during the antenatal period and the early postnatal period, thus, they need to identify and maintain lists of all pregnant women within their catchment areas.

The HSA is expected to conduct at least three household visits to the woman during her pregnancy in which the following activities are done:

1. Review of the woman's health record which is in form of a health passport.
2. Assessment of the client's current health status by interviewing the woman. If danger signs are discovered, the HSA refers the client to the health centre.
3. Provide health education and counselling based on the findings of the review and assessment.
4. Develop a birth plan to help the woman prepare for delivery and the newborn.

The HSA is also required to make at least three visits at home after delivery and within 8 days after delivery, the first visit being day 1 after delivery especially for home deliveries. In order to make these visits in the appropriate timeframe, the HSA needs to be informed when the delivery has occurred. This is done by either the woman's guardian, a village health committee member or a VHW who sends a message or either visits the HSA in person.

During the postnatal visits, the following activities are conducted by the HSA:

1. Obtain the labour and delivery details by reviewing the health passport if a delivery occurred at a health centre. Other details are also obtained from interviewing the woman since not all the details are recorded in health passports.
2. Assessment of the current health status of mother and baby and if any danger signs/illnesses are discovered, they are referred to the health centre.
3. Provide health education and counselling on danger signs and family planning.

The details and findings of the activities conducted during antenatal and postnatal household visits are recorded on CBMNC register forms.

Two kinds of reports are submitted by HSAs to their supervisors: a CBMNC register form containing client-level data and a monthly reporting form containing aggregated data for the catchment area. The CBMNC register forms are reviewed then forwarded to the district programme offices where

the data is entered into a Microsoft Access database application and different types of reports are produced. On the other hand, the submitted monthly reports are compiled by the supervisor to produce a report for the whole facility and this is then submitted to the district programme coordinator. It was noted that availability of reporting forms to the HSAs was usually a problem and requests for stationary (e.g. reporting forms) were at times communicated by the HSAs to their supervisors using mobile phones.

In addition to these activities, the HSAs follow-up on the clients they refer to the health centre in order to make sure the clients have gone to the health centre. This follow-up is done by asking the nurse at the health centre or by checking the health centre service registers. Alternatively, the HSA may also visit the client again after several days to check whether they actually went to the health centre.

## 5.3 Monitoring the Antenatal and Delivery Service Provision using Village Health Registers

The HSAs are required to capture demographic and health information of each individual in their catchment areas as a way of monitoring the implementation of the Essential Health Package (EHP) at household level.

Village Health Registers (VHR) are designed to fulfil this purpose and the details recorded include household demographic information and antenatal care and delivery, among others. These details are obtained from health passports and interviewing individuals.

## 5.4 Provision of Maternal Health Education and Counselling

The HSAs provide education and counselling on maternal health issues to the community through community gatherings and outreach clinics. The community sensitisation gatherings are sometimes conducted based on information from health centres. For instance, one nurse explained that they were getting cases of women delivering before arrival at the health centre from a particular area and therefore informed the HSA of that area, who then conducted a sensitisation campaign.

## **6 PROSPECTS ON USING M-HEALTH APPLICATIONS**

The findings in section 5 indicate that HSAs are using mobile phones for communicating with their supervisors and voice phone calls are the most common use of the mobile phones. This is similar to cases presented in literature (Mechael et al., 2010;Mechael, 2005;Manda, 2009). In some health centres, the FrontlineSMS platform is being used to request for follow-ups and provide feedback on the follow-up cases thereby improving communication among the health workers. This is also similar to other studies presented in literature

However, based on the activities of the HSAs and the associated information requirements, we examine the potential areas in which Electronic Health Records (EHR) and m-health applications could be used in tandem to support the information and communication needs of the HSAs.

### **6.1 Shared Access to Healthcare Records**

The findings indicate the HSAs require information on healthcare provided at health centres and this information is currently obtained from health centre staff, service registers and health passports. This demonstrates the need for shared access to the health records of clients and this can be achieved through implementing an EHR system that is accessible through mobile technology to CHWs as implemented in other projects presented in the literature (UnitedNations, 2007).

The HSAs also require feedback on the clients they refer to health centres and this is currently obtained by asking the nurse at the health centre, or checking the service registers or visiting the client again. All this is time-consuming and having an EHR/mobile health application that enables the HSA to follow-up on a client's health record would be beneficial in saving time on the follow-up.

Additionally, some new clients are identified by the HSAs in the community and then referred to the health centre for healthcare services. With an EHR and a mobile application, the HSAs would be able to register new clients and refer them to the health centres electronically as is done using the CommCare application.

### **6.2 Data Collection and Guiding Healthcare Protocol**

The findings indicate that data is collected on the

condition of the women and /or their newborn babies in order to assist in the early identification of danger signs. This client-level data is then sent for data entry into a computer database at the district level which results in a bulk of forms needing to be entered at the district level. With a mobile-based health application, the HSAs would be able to capture the data directly to an EHR system thereby improving timeliness and availability of the data. Additionally, this would increase the access to information on deliveries occurring at home or by TBAs thereby enabling health centre staff to monitor births taking place within the community.

Furthermore, the research discovered that HSAs faced challenges in the assessment of clients which resulted in clients wrongly diagnosed as having danger signs and this can be attributed to the fact that the HSAs have a non-medical background and are new to maternal and neonatal healthcare. Thus, with an application that guides the health worker in the assessment of clients, as is implemented in CommCare, the accuracy on the assessment (and data) would be improved. This has been demonstrated in other applications such as the implementation of the e-IMCI in Tanzania (DeRenzi et al., 2008) and (Mechael and Dodowa Health Research Centre, 2009) advocate for such an application.

### **6.3 Providing Notification on Deliveries**

The HSA needs to be informed when a delivery occurs and the woman has been discharged. However, the current mechanisms for obtaining this information are unreliable and chances are the HSA can go for days without knowing or being informed about the birth especially with the fact that one HSA's catchment area spans over several villages. Thus to ensure the HSA is informed on time, getting updates from the EHR system when a birth/delivery occurs at the health facility would ensure the HSAs are immediately informed and therefore, can schedule the necessary postnatal visit.

### **6.4 Providing Follow-up Requests**

The health centre nurses use the HSAs to follow-up on certain clients and this requires that the nurse should identify the clients, identify the right HSAs and then communicate the details of the clients needing follow-up to the HSAs. The findings, however, indicate that due to high workload and low staffing levels in health centres, the nurses are not able to compile such information hence resulting in

poor follow-up service. With an EHR system that can automatically identify clients needing follow-up, and incorporates mapping of clients to appropriate HSAs based on their residential addresses, the EHR system would enable automated requests to be sent to the HSAs, thereby relieving the nurses of this cumbersome task.

## 6.5 Overall Design of EHR / M-health System

In essence, the proposed overall setup of the system, represented in Figure 1 below, is to have an Electronic Health Record system implemented on a server located at the health centre which the HSA is associated with. The EHR system will be accessible to local health workers at the health centre using workstations connected to the server on a LAN. The Server will have a GPRS modem to enable remote access to the health records by HSAs using a mobile-based application.

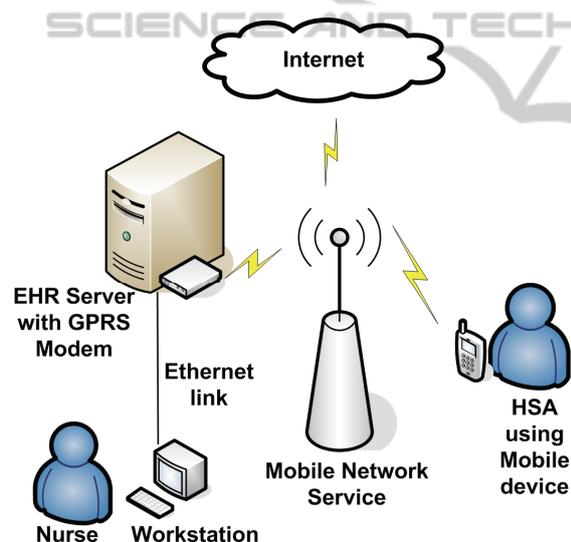


Figure 1: Overall design of the EHR/m-health system.

## 7 CONCLUSIONS

Adaptation of mobile technology in the HIS in developing countries is in the infant stages however promising results have been identified in different contexts showing improvements in health care delivery (Dimagi; Manda, 2009; United Nations, 2007). Through a detailed analysis of the current activities of Community Health Workers, the findings have indicated potential benefits of using mobile technology coupled with EHRs in improving

delivery of maternal and neonatal health at the community level in Malawi.

Thus, the next stage of this ongoing research is the implementation of the EHR/mobile applications. The study will continue to explore existing systems such as CommCare and MoTECH with the aim of building on these already existing infrastructures and collaborating with other organisations implementing similar interventions.

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