Phone-based Prenatal Care for Communities and Remote Ultrasound Imaging

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Abstract. A proposed system based on low-cost mobile phones and portable ultrasounds aims at improving prenatal care in rural areas of low-income countries. The objective is to increase the number of prenatal visits and provide a more precise delivery date estimations. This can reduce complications related to the delivery. The initiative comprises a medical imaging platform, an SMS management system and a community initiative. Several mother-infant pairs were followed in their community, tracking pregnancy evolution through mobile phones and a portable ultrasound. A centralized system can send reminders about gynecological visits to volunteers within the rural community, which also sent alerts using an application for low-cost phones. Ultrasound scans were acquired directly in the rural areas, and immediately sent to be investigated in urban clinics. The pilot project was carried out in some Ghanaian rural communities. Community health workers were trained to support their community. The health workers followed 212 new pregnancy, sending more than 400 messages, cumbersome circumstances such as ectopic and breech delivery have been detected and addressed properly, thanks to the early detection performed using the portable ultrasound machine. The remote ultrasound scans allowed more precise delivery dates and the proportion of pregnant women who get registered on the project is also considered as an indicator of success.

Keywords: Ghana, pregnancy, mobile phones, ultrasound

1 Introduction

In 2013, Ghana reported 380 maternal mortality per 100,000 live births [1], a figure which is far above the 185 maternal mortality per 100000 lives births targeted in Millennium Development Goal (MDG) 5 [2]. Despite the progress, the MDG 5 is not likely to be achieved, especially in the rural isolated communities. The major causes of death are Pneumonia, Preterm birth complications, Diarrhea, Birth asphyxia and Malaria [3]. Ectopic and breech delivery are yet impossible to detect without the use of ultrasounds, and the poor prenatal care is mainly caused by the shortage of medical personnel in rural areas and poor transportation means. In rural area the distance to modern antenatal care providers can be considerable. One out of nine women have to travel more than 15 km to reach medical care, thus these women might restrain their demand for antenatal care [4]. Unsurprisingly, fewer prenatal care visits in rural areas are accompanied by more infant mortalities per 1000 live births (rural: 15, overall: 10) [5].

One way to improve the prenatal-care management is to enable access to remote medical expertise and technology for local health-care facilities by equipping them with advanced telecommunications services for telemedicine purposes, and then to appropriately use remote expertises and technologies. Despite the uneven infrastructures across the territory including the landline network (and therefore Internet), mobile phone penetration has increased exponentially. Africa has now more than 650 million mobile phone subscribers. More than either the United States or the European Union. Since 2000, the mobile phone market has grown 40-fold [6]. Given this large existing infrastructures, in the last years there has been a plethora of promising mobile phone application with several aims. RapidSMS was introduced in Malawi by UNICEF's innovation unit to allow health workers to enter a child's data and receive instant alerts on nutritional status [7]. Afterwards it has been used in numerous projects e.g. monitoring Malarias rapid diagnostic test by Uganda's National Malaria Control Program [8], or Zambia's SMS system to reduce delay in sending infant HIV testing results from centralized laboratory to a remote rural health facilities [9]. Similar technologies are FrontlineSMS [10], and CommCare-HQ (Dimagi Inc., MA USA). Commcare-HQ mobile application has been used so far in several projects for data collection and educational tool. It is not limited to SMS and it can include audio, image, and video prompts within the application itself [11]. For a review the reader is addressed to [12].

Community health workers (CHWs) are volunteer members from rural communities who fulfill the role of health promoter and home based provider. They are not professional medical doctors or nurses, but they are trained to carry out simple but effective tasks. CHWs have been shown to be particularly effective in supporting maternal care and helping reducing newborn mortality. A study in Bangladesh showed a 34% decrease of neonatal mortality in cases supported by CHW intervention against unsupported contexts [13]. Similarly, another study in India showed a 54% reduction of neonatal mortality in cases supported by CHWs [14].

In this manuscript, a pilot project in Ghana using CHWs endowed with mobile phones and trained technicians using portable ultrasound machines is reported. The goal is to make quality antenatal care easily accessible in rural communities where pregnant women have not been able to access quality antenatal care. The added value compared to previous similar approach is the integration of ultrasound scans acquired directly into the communities.

2 Methods

The project comprises three different tiers which are depicted in Figure 1:

1. A communities initiative.
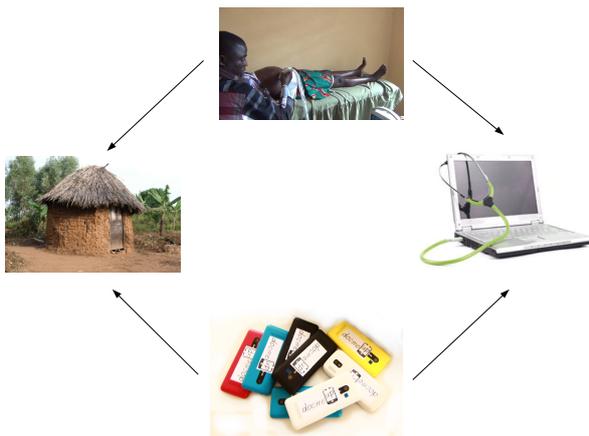2. An online platform.
3. Ultrasound image analysis.

Fig. 1. Chart depicting the main actors of the system: the community, the technician using a portable ultrasound, CHW represented by mobile phones and the online platform.

2.1 Communities initiative

The communities initiative is the practical channel through which the project is carried out. In this initiative, some members of the communities as well as research assistants interact with the communities, 5 rural communities in the Mfantseman district of the Ghanaian Central region have been involved. For each community, a volunteer has been selected during a public assembly and trained to become a CHW. The volunteers were not expected to be formal health professional, but a female member of the community in high consideration by the stakeholders of the community. Further requisites were fluency in English language and a secondary school degree. The CHWs were trained and equipped with low-cost mobile phones (Nokia ASHA 206). Their duties are to sensitize community members about the need to attend prenatal care, send information to the sever using the phone application, register new pregnancies in the system, and report all danger signs. All the communications to the community are sent to the CHW and not to the pregnant women.

2.2 Online platform

The IT infrastructure is enhanced by an GPRS-based telecommunication system, accessible by affordable mobile phones (e.g. given to the CHWs). This IT infrastructure removes the need for the CHW of having a computer to communicate. The system is divided into server and client side. The server side comprises a password protected Web user interface, which gives access to aggregated and individual data and enables tracking the history of individual patients as well as automatic report generation. This latter web interface can give an overview including individual and aggregated reports, statistics, log of reminders and activity within the community. The client side is given by a mobile phone application called DocmeUP, which has been created using Commcare-HQ. CommCarHQ is an open source server-side tool to help manage community health workers, written in Django. The application allows the definition of an internal standard XML schema called CaseXML. Commcare-HQ is currently available for Java-powered phones (Nokia, Sony Ericson and Samsung) and Android devices. The DocmeUP comprises two main modules *"Register a pregnancy"* and *"Report a case"*. As shown in Figure 2, "Register a pregnancy" allows the CHW to register a new pregnant woman with her personal data as *First Name, Family Name, Mother's date of birth* if known, *estimated delivery* if known, and *Estimated month of pregnancy* if known. The module "report a case" allows to report a dangerous sign

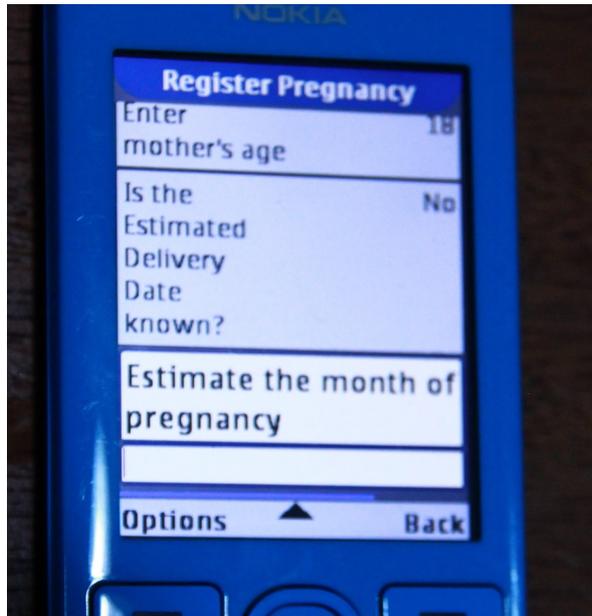for a previously registered woman, immediately receiving instruction.

Fig. 2. Screenshot of a mobile phone during the registration of a pregnant woman.

The system store as well in an anonymous manner ultrasound scans when available, this is carried out using the XNAT framework [15]. The upload process is carried out by a laptop connected to Internet (either landline or GPRS).

2.3 Remote ultrasound

Ghana has implemented a number of policies and strategies to achieve an improvement in the health of pregnant women and their babies and a reduction of maternal mortality. However, according to a recent survey [4] only 60% of the women attended the minimum number of four visits. 14% did not attend antenatal care at all, while 26% attended less than the recommended minimum of four visits.

During examinations, biometric features such as head size and femur length are examined, these measure the size of the baby and help getting an accurate due date of delivery and the initial status of the child. These tests are generally carried out by an expert gynecologist, the project aims to assure that mother involved will attend the tests carried out by a gynecologist. However, when this is not possible, a trained technician reaches the community and acquires some scans which will be in quasi real-time sent to a gynecologist in urban hospitals for analysis and immediate feedback.

3 Results

The project has currently 232 pregnant women registered with an average of 2 pregnant women joining each day. With the current work output, each pregnant woman included in the project visits an antenatal care (ANC) at least four times before labor if they have been registered in the first or second trimester, and 70% will have their labor attended by a professional birth attendant. Thanks to the portable ultrasound a case of ectopic pregnancy was detected and early medical intervention was sought by the pregnant woman involved. Moreover, women having breech presentation have been detected and specially assisted to have their delivery attended by a professional birth attendant. In this pilot study only one portable ultrasound was used (Mindray DP-20).

From data sent to our online platform by our community health workers using the mobile phones, it is possible to know the number of ANC visits by each pregnant woman and number of deliveries attended by professional/skilled birth attendants. The proportion of pregnant women who get registered on the project can also considered as an indicator of success.

4 Conclusion

The pilot project showed promising results by using an application for low-cost mobile phones and portable ultrasound machines. Proving professional monitoring and supervision in rural areas where ANC was previously difficult.

As future works there is the inclusion of other supports like providing ambulance on emergency cases, and to scale up the project to 18 deprived districts in northern Ghana and 6 in the Central region.

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DocmeUP project www.docmeup.org

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