The Use of Cell Phone Technologies for Community-Based Surveillance

November 2011
Abstract

The use of cell phone technologies to facilitate community-based surveillance for maternal and newborn health in rural communities in northern Nigeria.

Nigeria contributes only 2% to the world population but yet accounts for up to 10% of the annual maternal deaths of about 358,000 worldwide. To assist program developers in creating effective interventions to reduce maternal and child mortality, the Population Council partnered with the Population and Reproductive Health Initiative (PRHI) to conduct the Community Based Surveillance (CBS) study. The purpose of the CBS study was to assess maternal and newborn health in a rural community near the city of Zaria, Nigeria. Although the CBS project was an overall success, there were challenges that hindered their ability to accurately record the impact the interventions were having on maternal and newborn health.

The Mobile Community Based Surveillance (mCBS) project was an add-on study designed to introduce technology components that would help to eliminate the challenges of data collection and patient tracking that the CBS team encountered. The technology components included an SMS system designed to allow for immediate vital event reporting as well as an accurate means of data collection. It was hypothesized that Traditional Birth Attendants—if trained and supported by the health services—can prove invaluable in detecting and reporting key morbidity and mortality events that otherwise may go undetected. They can also facilitate referral to health facilities for women who develop life-threatening complications. Overall it was hypothesized that the mCBS project would allow for more accurate data collection and better health outcomes for women and children.

The project resulted in the previous monthly reporting system being transformed into a real-time reporting and analysis system. The TBAs were able to correctly report 30% of the vital events seen in the village immediately and a midwife was able to report 100% of the vital events within 1 week of them occurring. A lack of literacy and health training proved to be the major hindrances for the TBAs to accurately report all of the vital events they witnessed. However, the combined effort between the TBAs and the midwife proved to be a winning combination by allowing for the midwives reports to be used for accurate data analysis and the TBAs reports to be used for immediate response to vital maternal and child health events.

## Acknowledgements

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# Table of Contents

Abstract .................................................................................................................................................. 2  
Acknowledgements ................................................................................................................................. 3  
Terms and Definitions ................................................................................................................................. 6  
Introduction ............................................................................................................................................... 7  
Project Description .................................................................................................................................. 8  
Project Planning ....................................................................................................................................... 10  
Training ..................................................................................................................................................... 12  
Implementation ........................................................................................................................................ 13  
Data Analysis and Results ............................................................................................................................ 17  
Conclusion ............................................................................................................................................... 21  
Recommendations ....................................................................................................................................... 22  
Project Future ........................................................................................................................................... 22
## Terms and Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBA</td>
<td>Traditional Birth Attendant</td>
</tr>
<tr>
<td>CHEW</td>
<td>Community Health Extension Worker</td>
</tr>
<tr>
<td>RapidSMS</td>
<td>RapidSMS 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. So far RapidSMS has been customized and deployed with diverse functionality: remote health diagnostics, nutrition surveillance, supply chain tracking, registering children in public health campaigns, and community discussion. Website: <a href="http://www.rapidsms.org">www.rapidsms.org</a></td>
</tr>
<tr>
<td>OpenDataKit (ODK)</td>
<td>Open Data Kit (ODK) is an open-source suite of tools that helps organizations author, field, and manage mobile data collection solutions. Our goals are to make open-source and standards-based tools which are easy to try, easy to use, easy to modify and easy to scale. Website: <a href="http://www.opendatakit.org">www.opendatakit.org</a></td>
</tr>
<tr>
<td>OpenMRS (OMRS)</td>
<td>OpenMRS is an open source electronic medical record system. It was designed for recourse constrained communities and is currently being used in 42 countries.</td>
</tr>
<tr>
<td>DHS</td>
<td>District Health Surveillance; Form used was adapted from MEASURE DHS (<a href="http://www.measuredhs.com">www.measuredhs.com</a>)</td>
</tr>
<tr>
<td>ANC</td>
<td>Antenatal Clinic</td>
</tr>
<tr>
<td>Sisterhood Method</td>
<td>Household survey to estimate maternal deaths in a community</td>
</tr>
<tr>
<td>PRHI</td>
<td>Population and Reproductive Health Initiative; partner organization based out of Ahmadu Bello Teaching Hospital and in partnership with the Bixby Center at University of California, Berkeley</td>
</tr>
<tr>
<td>MMR</td>
<td>Maternal Mortality Rate</td>
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<tr>
<td>CBS</td>
<td>Community Based Surveillance; The title of the initial project in which the mCBS project was an add-on</td>
</tr>
<tr>
<td>mCBS</td>
<td>Mobile Community Based Surveillance</td>
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<tr>
<td>Solar Suitcase</td>
<td>Sturdy solar system design in which the system can fit inside a suitcase. Designed by WE CARE Solar, a US based NGO.</td>
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</tbody>
</table>
Introduction

**Contextual Background**

Nigeria contributes only 2% to the world population but yet accounts for up to 10% of the annual maternal deaths of about 358,000 worldwide\(^2\). The overall maternal mortality ratio for Nigeria of 545 per 100,000 live births masks the huge disparity in health outcomes found regionally in the country\(^3\). It is estimated that 59,000 maternal deaths occur in Nigeria yearly and the lifetime risk of dying in pregnancy and/or childbirth related death is 1 in 18\(^4\). This relative risk is comparable to maternal deaths in war-torn Afghanistan and 100-fold higher than that in the United States\(^5\). The risk of dying varies across Nigerian states with maternal mortality rates up to 10 times higher in northern Nigeria than in the south of the country\(^6\). The pattern of newborn deaths, while poorly documented, mirrors that of mothers.

The principal direct causes of maternal deaths in Nigeria include post-partum haemorrhage (23%); infection/sepsis (17%), pre-eclamptic toxaemia (PET) and eclampsia (11%), unsafe abortion and post-abortion complications (11%); obstructed labour (11%), malaria (11%), and anaemia (11%)\(^7\). These emergencies require prompt, appropriate clinical medical care for the mother and child to survive\(^8\). In northern Nigeria, the vast majority of women deliver at home, with minimal supervision from unskilled attendants\(^9\).

The project study site is the community of Tsibiri is in Giwa Local Government Area of Kaduna State. Tsibiri was chosen to serve as the study site because it has a high number of maternal and child deaths and the majority of women deliver in their homes. Tsibiri has a population of 1490 inhabitants, according to the reproductive health and demographic survey carried out by the PRHI in 2007. The community is representative of rural villages in the region in terms of ethnicity (predominantly Hausa-Fulani Muslims) and socioeconomic status. Using the sisterhood method of maternal mortality estimation, PRHI estimated an MMR for Tsibiri of over 1400 per 100,000 live births\(^10\). The accompanying reproductive health and demographic survey also found that 97% of women in the community deliver at home. Only 51% had attended ANC during their last pregnancy.

The median age at marriage for girls is 15 years. Many parents in Tsibiri view the onset of menarche as a sign of readiness for marriage and childbirth. About 86.5% of women have at least one child by the age of 19. 89% desire at least six children. Only 15.4% of the women interviewed had ever used modern contraception and only 23% knew where contraceptives could be obtained. Contraceptive prevalence at the time of the survey was 3.4%. Poor nutritional status, lack of physical maturity of girls at first pregnancy, low rates of girls’ school enrollment, and poor access to family planning and emergency obstetric care greatly increase maternal mortality and morbidity risks for women in Tsibiri.

\(^3\) NDHS 2008
\(^4\) FMoH (Nigeria) & WHO, Road Map for Accelerating the Attainment of the MDGs Related to Maternal Newborn Health in Nigeria (2005)
\(^6\) Health Reform Foundation of Nigeria (HERFON), Nigerian Health Review 2006
\(^7\) Some studies suggest even higher proportions, with eclampsia accounting for as many as 31% of maternal deaths and uterine rupture 10%. (Adamu, Sihlu, et al. Maternal mortality in Northern Nigeria: A population-based study. Europ J Gyn Repro Bio 109:153-159.
\(^10\) The PRHI fellows carried out an assessment of maternal mortality in Tsibiri in 2008 using the indirect Sisterhood method
Project Background

In 2010, the Population Council partnered with the Population and Reproductive Health Initiative (PRHI), a collaborative group between Ahmadu Bello University Faculties and the University of California, Berkeley, to conduct the Community Based Surveillance (CBS) study. The purpose of the CBS study is to assess maternal and newborn health in a rural community near the city of Zaria, Nigeria. The information gathered will be used to assist the community to develop interventions that will improve maternal and newborn health in a participatory way.

The community-based surveillance project commenced fully in June 2010. There are 3 key project streams; community-based group ANC\textsuperscript{11}, surveillance of maternal and newborn health events by Traditional Birth Attendants (TBAs), and household ethnographic observations. Three groups of the group ANC hold Tuesday, Wednesday and Friday every fortnight, facilitated by a 2-person team of researchers/ PRHI Fellows. About 87 pregnant women of varying ages and parities are currently registered for the group ANC and the number keeps increasing steadily. TBAs from Tsibiri were trained how to recognize and respond to 10 vital maternal and child health events. They used a "stone and bottle" data collection method in which stones were put into colored bottles that represented each of the vital events. A midwife assigned to Tsibiri visits the TBAs each week to count the number of stones in each bottle. Using this method, the TBAs, who are non literate, can participate in data collection. The following is the list of vital events the TBAs were trained on and its corresponding colored bottle.

1. Eclampsia - Green colored bottle
2. Miscarriage - pink colored bottle
3. Pre-term labour/premature - yellow colored bottle
4. Referral to hospital - orange colored bottle.
5. Stillbirth - Half black colored bottle
6. Death of mother - Full black colored bottle
7. Both mother and child are well – White colored bottle
8. Blood before childbirth - Half red colored bottle
9. PPH - Full red colored bottle
10. If the mother took misoprostol tablet - Blue colored bottle

Although the CBS project has been an overall success, there have been challenges that have hindered their ability to accurately record the impact the interventions are having on maternal and newborn health. Two of the major challenges in the CBS study have been 1) Difficulties in ensuring complete and adequate records keeping, and 2) Tracking and follow-up of patients and newborns into the community.

\textsuperscript{11} The group care model integrated into the study enables a health worker to see many women in one visit. This was envisioned to enhance more prenatal care visits and follow-ups thereafter.
Project Description

The Mobile Community Based Surveillance (mCBS) project is an add-on to the CBS study. The mCBS project was designed to introduce technology components that will help to eliminate the challenges of data collection and patient tracking that the CBS team encountered.

Overview

The mCBS project was designed to give traditional birth attendants the ability to report vital maternal and child health events in real time using mobile phones. A text-message based system was designed which alerts near-by health officials, as well as the community midwife, when a TBA is witnessing a vital maternal health event. This system reduces the second delay in receiving maternal care (delay in reaching care), because it provides health officials with the opportunity to respond to the event immediately by phone or in person. Also, if a woman is traveling to a health facility, the health officials located at the facility will know that the woman is coming, what maternal complication she is experiencing, and can be ready to treat her when she arrives at the health facility.

The system also serves as a database in which the vital maternal and child health event, how the health professionals responded to the event, as well as the woman and child's health outcomes, are stored. This provides health officials with up-to-date and accurate health statistics.

A new DHS study will take place using a cell phone based data collection system called Open Data Kit (ODK). A modified version of the DHS will be programmed into Android phones and tablets which the PRHI fellows can take out into the village. Part of the DHS will be to collect the GPS coordinates of the houses in order to create a detailed map of the community.

Objectives and Research Questions

The objectives of the mCBS evaluation are:

1. To determine if using a text-message based alerting system can reduce the 2\textsuperscript{nd} delay (delay in reaching care)
2. To determine if automated data collection via SMS cellphone technology can improve vital event reporting quality as compared to hand-based tabulations
3. To determine if illiterate traditional birth attendants (TBAs) and community health extension workers (CHEWs) can effectively use SMS cellphone technology to conduct systematic surveillance of household vital events in their community
4. To determine if using cell phones to alert key health personnel of emergency obstetric situations will improve the health outcomes of mothers and children.

Hypothesis

We hypothesized that members of a community—if trained and supported by the health services—can prove invaluable in detecting and reporting key morbidity and mortality events that otherwise may go undetected. They can also facilitate referral to health facilities for women who develop life-threatening complications. Overall we hypothesized that the mCBS project would allow for more accurate data collection and better health outcomes for women and children.
**Research Framework**

This evaluation will determine the feasibility of introducing technology into a community with little to no experience using any form of technology. It will also address the feasibility of using electronics in a setting where the majority of households do not have any form of power. The study will deploy epidemiologic surveillance based continuous monitoring and longitudinal quantitative data collection. Observational data will be collected over the study period.

**Importance of the Study**

The attainment of MDGs 4 and 5 is a priority for the Government of Nigeria, as exemplified by the roll out of the Integrated Maternal, Newborn and Child Health Strategy in 2007. However, the importance of these goals is not limited to Nigeria; the reduction of maternal and newborn mortality in Nigeria will have a substantial impact on the attainment of Millennium Development Goals (MDGs) 4 and 5 on the African continent as a whole. At current levels of performance, Nigeria and thus sub-Saharan Africa will not reach the millennium goals unless its efforts are complemented and strengthened.

This study will serve as an important reference in three ways; 1) It will demonstrate the effect technology has on data accuracy, 2) It will demonstrate the effect that real-time health reporting has on health outcomes, 3) It will demonstrate one way to include local TBAs, who are normally excluded from modern health interventions.

**Project Planning**

**Text-Message Reporting System Creation**

RapidSMS was used to create the text-message based data collection and alerting system. The mCBS Reporting System is installed on a Inveneo Hub R4 Server that has 4 GB RAM, duel core Atom processor. A modem is connected to the server and has an MTN SIM card which collects and sends the text-messages. The mCBS Reporting System is used by the TBAs, the Midwife, and the doctors located at the nearby hospital.

The mCBS Reporting System was modified slightly to make it easier for the non-literate TBAs to use. In the normal RapidSMS set-up, each text message must begin with a form code so that the server knows which form the text message refers to. For the TBAs, we eliminated the form code so that they only need to send in a text that has one number. The mCBS Reporting System is being used with the TBAs in 3 ways.

1. TBAs text vital event numbers to the server which are recorded in the database
2. If the TBA reports an urgent vital event (an event that needs immediate attention), the server sends alert text-messages to key health personnel
3. If the TBA sends the vital event to the server correctly, the server sends back a confirmation SMS that has a "smiley" face
The Midwife uses the mCBS Reporting System by sending her weekly summaries of vital events seen by each TBA in the community (both the TBAs who are using the mCBS Reporting System as well as the TBAs who are not) via text message. This allows for immediate and accurate reporting which can be monitored by staff at the hospital.

Doctors at the hospital use the mCBS Reporting System in the cases of urgent vital events. When they receive a text message alerting them of an event in the village, one of the doctors responds immediately. That doctor is then responsible for sending in a follow-up text message describing how the staff responded to the event and the health outcome of the woman and child.

See appendix 1 and 2 for the mCBS Reporting System Training Manuals

**DHS Survey Creation**

In order to get a baseline of maternal health events along with their outcome in the community, a modified version of the Demographic and Health Survey was given to every woman of reproductive age. Open Data Kit was used to transform the DHS into a mobile phone based survey.

An ODK server was set up at eHealth Nigeria's data center and the DHS survey was created using ODK build. The survey included skip logic to help surveyors move through the questions quickly.

The GPS coordinates were taken using ODK at every house so that a map of the community could be created.

See Appendix 3 for the Android and ODK Training Manual

**Solar Suitcase**

In the village of Tsibiri, reliable power is not available. In order to ensure that the TBAs would have a way in which to charge their cell phones in the village, a solar system was set up at the village leaders house. The solar system was provided by WE CARE Solar, a US based non-profit organization. The system can charge 3 phones simultaneously and the battery must be recharged every 2 to 3 days.
Training

**ODK Training**
A training on Open Data Kit was given to the PRHI Team on February 24, 2011. The ODK training lasted 1 day and taught 12 members of the PRHI team how to use touch-screen, Android phones, as well as Open Data Kit. After the initial demonstration, the PRHI members interviewed each other in order to practice the survey. At the end of the training, all of the members could perform the survey.

Challenges:
- Initial hesitation of the PRHI members to use the phone
- Difficulty with using the touch-screen keyboard for the first time
- GPS did not work inside

**Cell-phone Literacy Training**
A Cell Phone Literacy Training for TBAs was the first training the TBAs received. It was initially planned for only 2 days, however because of the TBAs lack of experience using a cell phone, difficulty in seeing the screen on the phone because of poor eye sight, and difficulty with number recognition and counting, the training was extended to 4 days. The training was held on Feb 14-18 and taught 8 TBAs who had little to no experience using cell phones the basics of how to use a cell phone. By the end of the training, they all understood how to maintain a cell phone, how to turn on and off a cell phone, how to receive a call, and how to make a call. Additionally, the TBAs practiced counting to ten, and recognizing the numbers 0-9.

Challenges:
- TBAs hesitant to use a cell phone because in the beginning they thought only men should use a cell phone
- TBAs had difficulty with counting and number recognition
- Many of the TBAs had poor eye sight, which made seeing the numbers and the screen difficult
- The buttons on the cell phone chosen did not have any spaces in between them, which caused many of the TBAs to hit 2 numbers instead of 1.

Anecdotes:
- The TBAs began to get competitive with one another on who could count the best and who could use the phone the best which lead to the group progressing quickly
- On the second day of the training, before the TBAs were trained on how to answer a phone call, one of the TBAs received a phone call during the training. She was able to answer the call correctly, hold the phone to her ear, and have a conversation with her son (who we found out later had traveled and was calling to tell his mother he arrived safely). However, she did not know yet how to hang up the phone.

Training Material:
A Cell phone Training Guide was developed using the Tostan methodology.
**RSMS Training for TBAs**

The group of TBAs was separated into 2 groups. The first group got training on RSMS on Feb 17 while the second group got trained on July 25-28. The group was split based on how well they could use the cell phone. The first group that was trained was able to pick up how to use the cell phone very quickly. The second group needed more practice with the phone and was given the extra 2 months to practice before they were asked to use RapidSMS.

For both of the groups, the RapidSMS training lasted 2 days and focused on teaching the TBAs how to write text-messages that reflected the vital events that they witnessed. By the end of the training, all of the TBAs understood how the RapidSMS system worked and were able to send text-messages to the RapidSMS system.

Anecdotes:

1. The TBAs were not able to figure out how to open the "confirmation" text message to see if the text message was sent correctly. However, they were able to determine that the message was sent correctly if they heard the "beeping" noise of an incoming text message.
2. Without any instruction, the TBAs were able to immediately recognize that the colored bottles on their "helper card" was referring to the bottles they use to collect stones.
3. During the training for the second group of TBAs, the first group of TBAs became the trainers and helped the new TBAs understand the system and send the text messages

Training Materials:
A training guide was created specifically relating to the activities the TBAs were already doing in order for them to easily transition to RapidSMS.

**RSMS Training for Midwife**

The RapidSMS training for the Midwife was scheduled to occur during RSMS training of the TBAs. Since the midwife was well educated and had experience using her cell phone, it took only about 30 minutes to explain the system, practice sending the text message, and review the types of responses.

Training Materials:
The Training materials were originally designed for a CHEW.

**RSMS Training for PC and PRHI staff on System Use and Maintenance**

The Population Council and PRHI staff were both trained on the use and maintenance of the RapidSMS system. The system administration is done online, therefore both teams (based in Nigeria and the US) could use the system simultaneously. The training for PRHI focused on how to monitor the system in order to check for data accuracy, provide women with emergency health care, and do analysis on the data that was collected. The training for Population Council focused more on data analysis and the different ways the system could be upgraded and expanded for different projects.
Implementation

Testing
In order to determine if the first group of TBAs fully understood the RapidSMS system and its use, we designed a 2 week testing period. One of the PRHI staff called each TBA during the day and described one of the 10 vital events. The TBA was then asked to text in the correct vital event number to the RapidSMS server. The RapidSMS system was being continuously monitored throughout the day to determine if the TBA had sent in the correct vital event number. After two weeks of practice, it was determined that 3 of the 4 TBAs understood the system well enough to begin doing real data collection.

The second group of TBAs were able to pick up the RapidSMS system very quickly since they had observed the other TBAs send in text messages for 2 months prior to their own training. Because of this, it was not necessary to carry out a testing period for the second group.

DHS
The ODK surveys began on June 4th and finished on June 17th. In total, 319 women between the ages of 15 and 45 were interviewed and the average amount of time it took to do each survey was 15.3 minutes.

After the completion of the DHS surveys, some of the surveyors were interviewed about their opinions on whether they liked using paper or electronic forms better. Every surveyor interviewed responded that they liked the electronic forms better. The following are the reasons why:

1. The phone/tablet was lighter to carry out into the field than a stack of paper records
2. Since the electronic form had skip logic built into it, it was faster than the paper forms
3. The people in the community were more willing to speak with the surveyors because the phone/tablet looked professional and important
4. People in the community were more willing to talk to them because they could not see the length of the survey. In the past, some people would be hesitant to talk to them because the survey was too long.
5. In general, they felt that the electronic form was faster and more accurate.

Challenges
One of the main challenges in completing the DHS was the lack of desire to participate by some of the women in the village. A few of the households in the village do not like the interventions put there by outside organizations and chose to either not participate in the survey or to answer the survey questions incorrectly. Some of the women gave false names or told the interviewers lies about their history. These inconsistencies could be seen during the analysis of the data.

Another of the challenges faced was that the survey should have been designed to avoid the possibility of error. The questions being asked should have been more specific and more instruction should have been given on each question. For example, 3 of the questions asked were 1) How many live births did you have? 2) How many were females? 3) How many were males? The questionnaire should have avoided including the first question because it could be inferred using the following two questions. During analysis, we saw that many of the times, the number of live females and males did not add up to the total number of live births. Because of this, many people had to be re-interviewed to determine
what were the correct numbers.

**Vital Event Reporting**

The first round of TBAs began sending real vital events on May 19th. The second round of TBAs began sending vital events on June 29th. The following tables show the vital event reporting frequency of each TBA as well as the types of vital events reported.

**Illustration 1**: Total number of times each vital event was reported during the 5 months

**Illustration 2**: Total number of vital events reported by each TBA (TBA 5 and TBA 2 reported no events)
One of the major challenges of the vital event reporting was the lack of an easy way to provide the TBAs with credit on their phones. A small amount of money was sent to each TBA every week, however that money was being used up by people making phone calls on the TBAs phones. The other problem with sending credit via text message was that it was not always reliable. Many times the service would go down for a day so sending credit on a weekly basis became a hassle to manage.

The other complication was the lack of vital maternal and child health events. Since such a low number occurred in the village, many of the TBAs only used the system 1 or 2 times. Because the TBAs used the reporting systems so infrequently, some of them forgot how to use it from the time they were trained till the time they actually needed to use it.

**User Experience Protocol**

The UXP was designed to capture the opinions of two categories of people in the community; the TBAs and the community stakeholders. Two types of questionnaires were administered, one to each category. The information that was discovered during the UXP were that:

- Not all community members understand why the TBAs are using cell phones
- All TBAs except one constantly use the solar system to charge their mobile phones
- Stakeholders in the community who are aware of the TBAs use of mobile phones are able to list the advantages of the mobile phone to reducing maternal/child mortality.
- Most of the TBAs share credit on their phones with friends and family members
- Other than recharge cards sent to TBAs on the project, TBAs have other sources of credit

**Data Analysis and Results**

**Text Message Reporting System Analysis**

Analysis on the text-message reporting systems was done to determine:

1. If the TBAs were able to correctly and accurately send in maternal and child health events
2. If the Midwife was able to correctly and accurately send in maternal and child health events
3. The number and types of maternal and child health events that occurred in the village during the time of the study.

**TBA Vital Event Reporting Results**

The TBAs were only able to correctly send in 30% of the vital events seen in the village. However, the majority of the text-messages they did send were correct.
A major contributor to the low percentage of correctly reported vital events was a lack of initial training on the types of vital events the TBAs were monitoring. Not one of the TBAs remembered to text in the vital event that a woman took Misoprostol. This accounted for 8 of the vital events witnessed. If this vital event was excluded from the analysis, then the TBAs would have reported 50% of the vital events correctly.

The other major contributor to the low percentage of vital events reported was the common complaint from TBAs that they did not have credit on their phones. The TBAs explained that they wanted to send the vital event as instructed however the text message would not send because of the lack of credit.

**Midwife Vital Event Reporting Results**
The midwife reported a total of 65 events during the study period. All of the midwifes text-message reports were compared to the paper forms and it was determined that the 2 forms of data collection gave the same results. From the midwifes reports, the following data was collected:

<table>
<thead>
<tr>
<th>Maternal Health Statistics</th>
<th>Total Number</th>
<th>% in community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Deliveries</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Total Complications</td>
<td>18</td>
<td>21.95%</td>
</tr>
<tr>
<td>Total Deaths</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Total Took Misoprostol</td>
<td>54</td>
<td>65.85%</td>
</tr>
<tr>
<td>Total Women Transported to Hospital</td>
<td>9</td>
<td>10.98%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Child Health Statistics</th>
<th>Total Number</th>
<th>% in community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Birth</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Total Live Birth</td>
<td>74</td>
<td>87.06%</td>
</tr>
<tr>
<td>Total Stillbirth</td>
<td>11</td>
<td>12.94%</td>
</tr>
<tr>
<td>Total Died within 1 day</td>
<td>2</td>
<td>2.35%</td>
</tr>
</tbody>
</table>

**Analysis of TBA and Midwife Reporting Results**
Although the TBAs were not able to accurately text-message each vital event, they were still successful at text-messaging 30% of the events they saw in the field. Because previously they were not doing any form of immediate reporting, this is a huge improvement to the situation in the village.
A combined effort from the TBAs and the Midwife seems to be a winning combination. The reports from the midwife can be used for data collection and analysis while the reports from the TBAs will focus more on the immediate reporting aspect of the project.

Meeting The Objectives

Objective 1: To determine if using a text-message based alerting system can reduce the 2nd delay (delay in reaching care)

Because there were no "Urgent Vital Events" reported during the time of the analysis, this can not be determined. However, since the TBAs were able to correctly identify and text in non-urgent vital events, it can be assumed that they would be able to text in an urgent vital event. By doing the immediate reporting of the urgent vital event, it would thus reduce the delay the woman would experience in receiving care.

Objective 2: To determine if automated data collection via SMS cellphone technology can improve vital event reporting quality as compared to hand-based tabulations

The two aspects that we analyzed to determine this are 1) if the vital event reporting is more accurate and 2) if the reporting is more timely. Since the reporting method went from a monthly reporting system to a real-time reporting system, we can definitively say the the SMS cellphone technology improves the vital event reporting system by reducing reporting delay.

However, because little was known about the quality of the hand-based data collection, it is difficult to analyze the difference in data collection quality. What we can definitively say is that the SMS cellphone technology took a system with an unknown data quality and transformed it into a system with 100% data accuracy.

Objective 3: To determine if illiterate traditional birth attendants (TBAs) and community health extension workers (CHEWs) can effectively use SMS cellphone technology to conduct systematic surveillance of household vital events in their community
Based on the data collected by the TBAs and the Midwife, we have proven that in combination, the midwife and TBAs can effectively use SMS cellphone technology to conduct systematic surveillance of household vital events in their community.

**Objective 4: To determine if using cell phones to alert key health personnel of emergency obstetric situations will improve the health outcomes of mothers and children.**

Again, because no urgent vital events were witnessed during the time of the analysis, this objective could not be analyzed.

**Demographic and Health Survey**

The DHS survey collected information about each woman's reproductive history. In total, 320 women participated in the survey. The survey contained 7 sections (Demographic Information, Reproductive History, Information on most recent pregnancy, Child Health, Family Planning, Sisterhood Method, Mobile Phone) with a total of 75 questions and each survey took approximately 15 – 20 minutes to complete.

**Community Mapping**

In order to create an easy ways to visualize the results of the DHS survey and to better allow PRHI to create effective interventions, interactive maps were created. The following are screen-shots of the different types of maps created. The maps are hosted on a server located at eHealth Nigeria's Data Center to be used by PRHI and Population Council administration.
**DHS Individual Markers**

Individual survey markers allow for program managers to easily track individual women in the community.
**DHS Household Aggregate Data**

Household aggregate data allows programs to see which areas of the community need more interventions.
Addition of an Electronic Medical Record System

Towards the end of the mCBS project, it was decided that the addition of an Electronic Medical Record system would be beneficial for both the mCBS and the CBS project.

In the CBS project, 6 health professionals provide health services to 103 woman and 44 children. Each woman and each child has their own personal health record, creating 147 different paper health records that must be managed and organized by the PRHI staff. Additionally, the health records are not kept at the Centering Building in the community, they are kept at the PRHI office, making it necessary for the health records to be transported back and forth multiple times a week. Managing paper health records in this way leads to the loss of health records, inaccurate reporting, and decreased productivity by the PRHI health staff.

An electronic medical records system running on low-power laptops will provide the PRHI staff with an electronic way to manage the health records while still allowing the staff the ability to give care in the village. An EMR system will eliminate the problem of lost health records, increase health worker productivity, and will provide immediate electronic reporting.

The EMR system will digitize the current forms already being used by the PRHI staff, allowing for a seamless transition from paper forms to electronic forms. Reports as well as research and analysis are made easy with the addition of an EMR system. Monthly reports can be programmed into the system and can be generated at any time, for any time period. Analysis can be done on many different health indicators at one time, allowing for increased research potential.

The system will begin with 2 laptops, both will act as servers and will hold all of the patient information. At the end of each centering session, both laptops will synchronize the new patient information between each other along with a secure, back-up server located at eHealth Nigeria's Data Center in Kano. In this way, if the laptops are ever lost or damaged, all of the patient data will remain safe.

Conclusion

The Mobile Community Based Surveillance project was concluded in Novemeber, 2011 and ran for almost 1 year. The project determined that non-skilled illiterate TBAs can be trained to effectively report MNCH vital events. Also, using a mobile reporting system, it is believed that TBAs and Midwives working together may 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 can be incorporated into in a real time, community- based data collection scheme. Furthermore, the project offers a pathway to engage TBAs as productive members of health reporting and referral systems in a severely resource-deprived setting setting.

Outcomes

The outcomes are as follows:

- Fully functional text-message based data collection and alerting system
• Training manuals on cell phone literacy, RapidSMS, and Open Data Kit
• A video showing the Cell Phone Literacy training
• A video describing the mCBS project

**Deliverables**

• Training Manuals
  ◦ TBA RapidSMS Manual (Appendix 1)
  ◦ CHEW RapidSMS Manual (Appendix 2)
  ◦ ODK Manual (Appendix 3)
  ◦ OpenMRS Manual (Appendix 4)

• Videos ([http://www.youtube.com/ehealthnigeria](http://www.youtube.com/ehealthnigeria))
  ◦ mCBS Project Description Video
  ◦ How to Turn on and Off a Cell phone
  ◦ ODK Training Part 1-3
  ◦ Opinion of Paper DHS vs. Electronic DHS

• Interactive Maps
  ◦ Individual Survey Map
  ◦ Household Aggregate Map

• Technical Systems
  ◦ RapidSMS System
  ◦ ODK System
  ◦ OpenMRS System
  ◦ Mapping Server
  ◦ Project Administration Website
  ◦ Project Publicity Website