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Reaching Remote Health Workers in Malawi: Baseline Assessment of a Pilot mHealth Intervention

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mHealth has great potential to change the landscape of health service delivery in less developed countries—expanding the reach of health information to frontline health workers in remote areas. Formative, process, and summative evaluation each play an important role in mHealth interventions. K4Health conducted a Health Information Needs Assessment in Malawi from July to September 2009 (formative evaluation) that found widespread use of cell phones among health workers offering new opportunities for knowledge exchange, especially in areas where access to health information is limited. K4Health subsequently designed an 18-month demonstration project (January 2010 to June 2011) to improve the exchange and use of family planning/reproductive health and HIV/AIDS knowledge among health workers, which included the introduction of a short message service (SMS) network. K4Health conducted a pretest of the mHealth intervention from June to October 2010. A baseline assessment was carried out in November 2010 before expanding the SMS network and included use of qualitative and quantitative measures and comparison groups (summative evaluation). Routinely collected statistics also guide the program (process evaluation). This article describes the approach and main findings of the SMS baseline study and contributes to a growing body of evidence measuring the effectiveness and efficiency of mHealth programs using a strong evaluation design.

The authors thank the participants in the K4Health/Malawi SMS network whose opinions and feedback formed the basis for this paper. Thanks also to the K4Health/Baltimore and MSH/Malawi project teams for their collaboration on the mHealth baseline study. Full support for this study was provided by the K4Health project, Leader with Associate Cooperative Agreement No. GPO-A-00-08-00006-00. The views expressed in this publication do not necessarily reflect those of MSH or the K4Health project.

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Mobile Health Programs

By the end of 2011, there were nearly 6 billion mobile subscribers worldwide, up from an estimated 4.7 billion subscribers in 2009. This means that mobile penetration rates (number of active mobile phone numbers within a defined population) in 2011 reached 87% of people globally and 79% in the developing world. Africa was the lowest region with 53% mobile penetration in 2011 (International Telecommunication Union, 2011). As of mid 2010, mobile penetration rate in Malawi was 14% (BusinessWire, 2010).

The explosion of cell phone use in developing countries has led to the growth of mobile health (mHealth) programs for connecting health workers to the information they need at their point of care so they can more effectively serve their clients (Earth Institute, 2010; Ranck, 2011; Vital Wave Consulting, 2009). These programs aim to improve treatment compliance, data collection, disease surveillance, health information systems, disease prevention, health promotion, and emergency medical response (Earth Institute, 2010).

Health programs with a mobile component are on the rise, yet many mHealth applications are pilot projects with limited measures of program effectiveness, efficiency or effects on health outcomes (Earth Institute, 2010; Mechael, 2009). This article describes a robust baseline, including measures of effectiveness and efficiency, for an mHealth project carried out in Malawi by the K4Health Project.

The K4Health Project

K4Health is a knowledge management project designed to increase the dissemination and use of the latest research and best practices to improve health systems, health service delivery and health outcomes worldwide. K4Health is funded by the U.S. Agency for International Development's Office of Global Health. It is implemented by The Johns Hopkins Bloomberg School of Public Health's Center for Communication Programs, Family Health International, and Management Sciences for Health.

K4Health conducted a Health Information Needs Assessment in Malawi from July to September 2009 to identify the gaps in how information on family planning and reproductive health (FP/RH) and HIV/AIDS is generated, shared, and used at all levels of the health system. Among the findings from this assessment, widespread use of cell phones offered a promising new opportunity for knowledge sharing, particularly at the district and community levels, where access to FP/RH and HIV/AIDS information is limited.

In response to this and other findings from the assessment, K4Health designed an 18-month demonstration project (from January 2010 to June 2011) intended to test different ways to improve the exchange and use of FP/RH and HIV/AIDS knowledge within the health system in Malawi. The project interventions included development of a short message service (SMS) network to improve communication and information sharing among community health workers (CHWs) at the district and community levels.

The SMS Intervention

In June 2010, the K4Health project established an SMS-based mobile telephone network using Frontline SMS in Salima and Nkhotakota districts of Malawi. The purpose of the network is to provide a fast, reliable, and inexpensive communication mechanism between CHWs and their district teams. The intervention began with the

provision of training and cell phones for an initial group of health workers in these two districts. The first 5 months—June to October 2010—served as the pretesting phase of the intervention. After implementing the pretest and before expanding the network to additional health workers, K4Health carried out a baseline assessment in November 2010.

Methodology

Because the baseline study was carried out after the pretesting phase, it used a staged design to assess process data from the pretest and to establish baseline values for the next group of users to be included in the SMS network. The study compared three groups:

- SMS users in the pretest phase in Salima and Nkhotakota districts
- Nonusers in Salima and Nkotakota who were expected to enroll in the SMS system in the next wave of the project
- Nonusers in a nonrandom control district

Kasungu district was selected as the control because it had a socioeconomic profile similar to that of Salima and Nkhotakota, but health workers did not have access to an SMS network. Sampling in all three districts included health surveillance assistants and community-based distribution agents who are referred to as CHWs or health workers throughout this article.

The study aimed to answer two key questions:

- To what extent has the pretest SMS network in Salima and Nkotakota reduced the communication gap between health workers and their district teams and thereby increased access to technical information among these health workers?
- To what extent has the pretest SMS network in Salima and Nkotakota improved the ability of health workers to provide quality services and care?

We used qualitative and quantitative methods:

- Focus group discussions and key informant interviews with SMS users and nonusers and district health coordinators in the intervention districts (Salima and Nkotakota) and control district (Kasunga)
- Review of mobile statistics collected from the SMS server
- Structured questionnaire administered to CHWs (users and nonusers) in intervention and control districts

The project used Lot Quality Assurance Sampling (LQAS) as the sampling technique for the structured questionnaire (Valadez, 1992; Valadez, Weiss, Leburg, & Davis, 2003). The study covered two catchment areas: the two intervention districts (Salima and Nkhotakota) and one control district (Kasungu). Salima and Nkhotakota were combined because there were not enough pretest SMS users in each district to meet the sampling requirements. In each catchment area, five supervision areas were defined for sampling among the three target groups: SMS users in Salima and Nkhotakota,

Table 1. Summary of respondents

Catchment area	Target group	Number of supervision areas	Number of respondents/ supervision area	Total number of respondents
Salima and Nkhotakota	SMS users	5	Nkhotakota Central = 18 Nkhotakota North = 14 Nkhotakota South = 18 Salima Chipoka = 16 Salima Khombedza = 29	95
Salima and Nkhotakota	Nonusers	5 (same 5 as above)	19	95
Kasungu (control)	Nonusers	5	19	95
Total				285

nonusers in Salima and Nkhotakota, and nonusers in Kasungu. This yielded a total of five supervision areas in Salima and Nkhotakota (two in Salima and three in Nkhotakota) from which SMS users and nonusers were sampled and five supervision areas in Kasungu from which only nonusers were sampled.

We intended to sample 19 SMS users and 19 nonusers from each supervision area in the project area using a random number table and Ministry lists of all CHWs. However, a sampling challenge emerged. The sampling framework was the list of all CHWs in the project districts, including those who had received cell phones and those who had not. Using this list, the project sampled 19 cell phone users and 19 nonusers in each of the five supervision area in the intervention districts for a total of 95 respondents in each group (users and nonusers). Because of delays in distributing the cell phones, the list did not reflect the actual numbers of CHWs with cell phones on the ground. Therefore, there were insufficient numbers of cell phone users in the supervision areas to sample 19 in each, so the team oversampled users in one supervision area (Salima Khombedza) to compensate for under sampling in the other supervision areas in order to reach a total sample of 95 users.[1]

To determine the effect of having oversampled in Salima Khombedza (29 respondents, see Table 1) and lessen its possible disproportionate contribution to the aggregate results, we removed the additional 10 respondents from that supervision area. This yielded a total sample size of 85 SMS users. We reanalyzed the data and compared results for all the key indicators with the sample size of 85 and the full sample size of 95. No differences emerged, and so a decision was made to use the full sample size of 95 SMS users in order to have as narrow a confidence interval as possible. This yielded a total sample size of 285. Table 1 outlines the distribution of respondents by supervision area.

The project also conducted 35 focus group discussions with CHWs in the intervention and control districts in order to explore how they communicated with each other and with the district level, how often, how long, and for what purpose. In addition, the project conducted four individual interviews with the family planning and

[1]A minimum sample size of 95 is needed in order to calculate a mean and confidence interval for each indicator.

Table 2. Summary of focus group discussions

District	Target group	No. focus group discussions per respondent type		Total no. focus group discussions
		Health surveillance assistants	Community-based distribution agents	
Salima	SMS users	1	3	4
	Nonusers	4	1	5
Nkhotakota	SMS users	3	3	6
	Nonusers	5	4	9
Kasungu	Nonusers	7	4	11
Total		20	15	35

reproductive health and HIV/AIDS Coordinators in Salima and Nkhotakota. Table 2 summarizes the number of focus groups by target group and type of respondent.

Interviewers

Five interviewers hired by the project carried out data collection. The interviewers were trained for 2 days on best practices in data collection and use of the baseline study tools. The second day of training also involved pretesting the tools to be used in this study.

Data Entry and Analysis

LQAS survey data were entered, cleaned, and processed using SPSS software. Data from the SMS database (the server) were also exported to SPSS for analysis. For the qualitative data, four note-takers were trained to take detailed notes of the dialogue during each focus group and individual interview. The notes were analyzed using structured data summary tables highlighting the major focus areas of the study. However, individual quotations from respondents were not captured.

Results

Description of SMS Participants

Between June and October 2010, the project trained and provided cell phones and solar chargers to 253 health workers in Salima and Nkhotakota districts. This represents 30% of all health workers in Salima and Nkhotakota combined. An additional 385 CHWs received phones and chargers during a second distribution in November 2010, bringing total SMS coverage to 77% of health workers in both districts.[2]

[2]During the baseline phase, the project distributed Java-enabled phones to the pretest group of CHWs, whereas in subsequent phases, the project distributed cell phones with basic voice and text capability.

The project targeted the most remote health workers for the initial distribution of cell phones. Health workers participating in the pretest live an average of 10.9 km from the nearest health center while the nonusers in these districts live on average 8.2 km from the nearest health center. In the control district, the average distance from a health worker to the nearest health center is 13.6 km.

Project Indicators

LQAS data are typically analyzed in two ways: by individual supervision area and aggregated across all supervision areas. However, in this study the supervision areas did not have a uniform number of respondents (four had fewer than 19 respondents and one had more) because in the early months of the project it was difficult to find enough SMS users in some supervision areas to include in the survey. Because smaller sample sizes have wider confidence intervals, and each supervision area required a different decision rule, only the aggregate data are presented in this section, which allows the calculation of proportions and averages, depending on the particular indicator. Table 3 provides a summary of ten key project indicators from the pooled data (all five supervision areas together).

Use of the SMS Network

By the end of October 2010, a total of 1761 regular messages were sent and received through the network hub. Of the regular messages, 644 were sent from participating CHWs to the hub and 1117 were outgoing messages (group and individual) sent from the hub to CHWs. All CHWs who received phones from the project were trained on how to use them, and 100% of these health workers were able to send and receive messages to and from the hub. In addition, all participating CHWs sent at least one SMS to the hub since the project began, with an average of five messages per CHW per month during the 6-month pretest period. Average SMS use per CHW is calculated from reported data collected through a LQAS structured questionnaire because data from the SMS hub cannot be broken down by individual CHW.

Figure 1 shows the distribution of SMS traffic (all messages sent and received per month) in Salima and Nhkotakota during the pretest period. The decline in SMS use over time is likely attributable to periodic connection problems with the network hub following the launch of the project. These issues have since been resolved.

Purpose of SMS Messages

The main reasons for sending an SMS message during the pretest phase (from June to October 2010) are presented in order of frequency in Figure 2. These include reporting stockouts, asking general information, reporting emergencies, confirming meetings and requesting technical support.

Categorizing and monitoring the SMS messages over time allows the district team to uncover important trends in the health system that can affect service delivery. For example, high cases of stockout messages reported by CHWs triggered a review of the system, which revealed deficiencies in transport and logistics management. This led to changes in the frequency and quantity of stocks distributed to community health centers in the intervention districts. Following these improvements in the system, the number of stockout messages from CHWs declined dramatically, as shown in Figure 3.

Table 3. Key project indicators

Indicator	Salima and Nkhotakota		Kasungu
	Users ($n=95$)	Nonusers ($n=95$)	Nonusers ($n=95$)
Average number of SMS messages sent per CHW per month from June to October 2010	Average of five messages per CHW per month Median of four messages per CHW per month	N/A	N/A
Percentage of participating CHWs who sent at least five SMS messages per month from June to October 2010	44%	N/A	N/A
Average frequency of SMS use per month for all SMS participants (all messages from June to October 2010)	352 messages per month (uncategorized)	N/A	N/A
Reported use of SMS disaggregated by purpose	Emergencies ($n=61$) 64% Stockouts ($n=84$) 88% Meetings ($n=27$) 28% Tech information ($n=61$) 64% Tech support ($n=19$) 20%	N/A	N/A
Average time required to contact and receive feedback from the person providing technical support	9 minutes	1,207 minutes	1,681 minutes
Average time required for providers to report important events (stockouts, transportation breakdowns)	2 minutes	N/A	N/A
Average time required for providers to receive feedback on important questions (e.g., specific medical conditions, effects of contraceptive uses, dosage amounts)	12 minutes		
Average number of events reported per month, per CHW	1 stockout per month per CHW 16 referrals per month per CHW	N/A 13 referrals per month per CHW	N/A 31 referrals per month per CHW
Average number of clients visited per month per CHW	89 clients per month per CHW	109 clients per month per CHW	142 clients per month per CHW
Average amount of time saved (per CHW per contact with supervisor) by using SMS over walking or taking transportation to nearest health center to report and receive support	1,436 minutes per CHW per contact	N/A	N/A

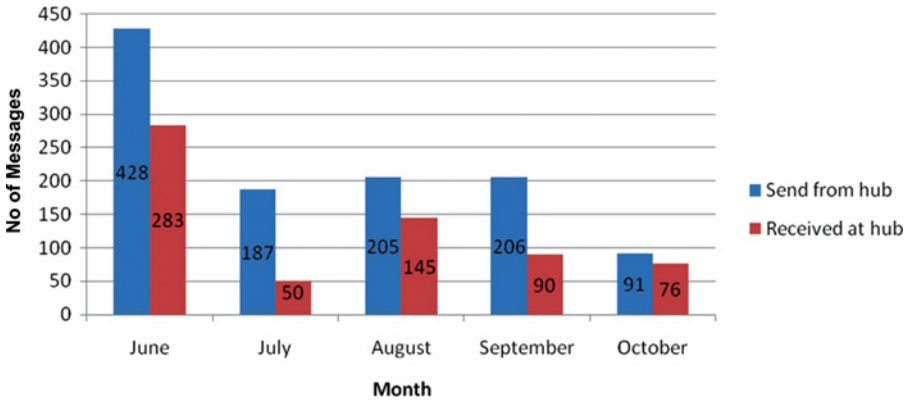

Figure 1. Frequency distribution of all messages per month (June to October 2010). (Figure available in color online.)

Modes of Communication

Among respondents who received phones, the most common modes of communication with their nearest health center included the following: SMS text messages (100%), phone calls (94.4%), and public transport so they could communicate face to face (8%). Among respondents who did not have access to the SMS network in Salima, Nkhotakota, and Kasunga, 92% used public transport and only 6% used phone calls as common methods of communication. None of these health workers indicated using SMS as a mode of communication.

Time and Cost of Communication

The study also documented the time and cost of communication (reporting and receiving feedback) between health workers and their immediate supervisors at the district level. For the purposes of the baseline, communication time was defined as the amount of time required for a CHW to arrive at their health center or the district level, find a supervisor, report an event or important question (e.g., stockouts, transportation breakdown, suspected communicable disease, dosage amounts), and receive feedback. Travel means included walking, bicycle and public transport (or some combination of these), depending on the location of the respondent.[3] SMS participants reported needing an average of 9 minutes to report issues and receive feedback from their supervisor at an average cost of USD $0.61 (K91.30) per communication.[4] This group of health workers communicated with their supervisor at least 5 times per month.

Health workers in Salima and Nkhotakota with no access to the SMS program tend to spend an average of 1,445 minutes (24 hours) to report and receive feedback on issues raised to their supervisor at an average cost of USD $2.70 (K405.16) per

[3]For the end line study, this indicator was improved by separating it into two indicators: timely report rate (average time required for CHWs to report important events [stockouts, transportation breakdowns]) and timely feedback rate (average time required for CHWs to receive feedback on important questions [e.g., specific medical conditions, effects of contraceptive uses, dosage amounts]) from district program coordinators.

[4]Here, cost is a function of the fee charged for sending and receiving a text message. It does not take into account CHW salary costs.

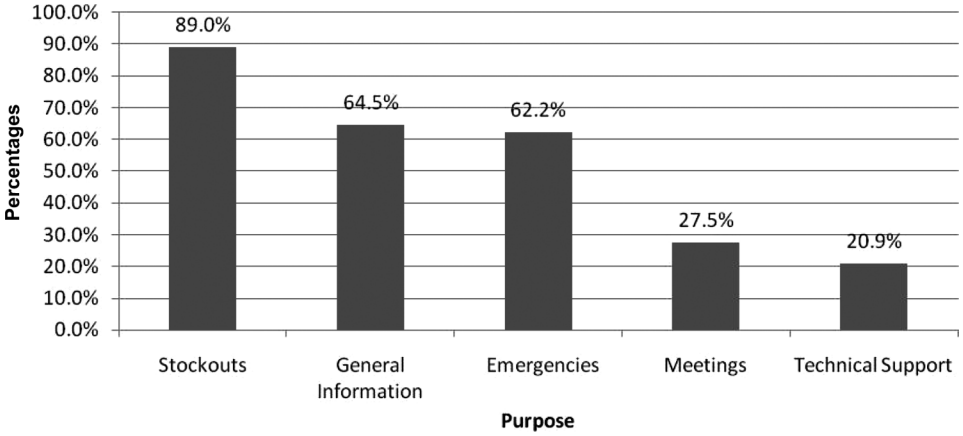

Figure 2. Primary reasons for sending text messages.

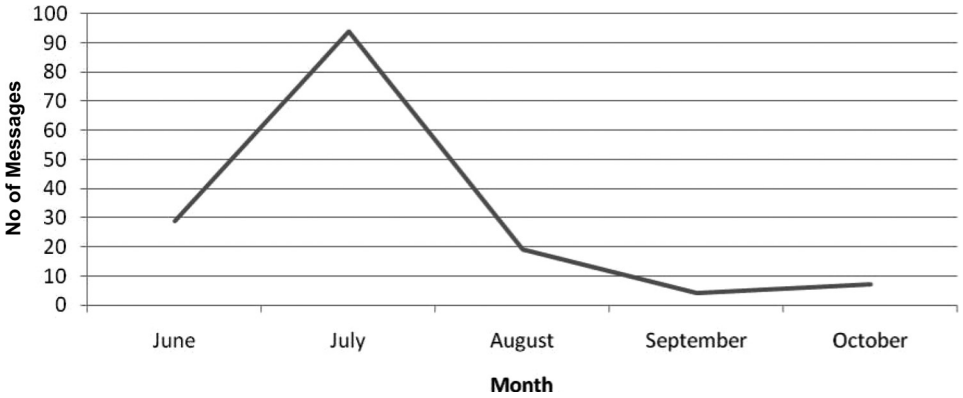

Figure 3. Frequency distribution of stockout messages per month (June to October 2010).

contact, and an average contact frequency of 4 times per month.[5] In the control district, Kasungu, it takes health workers an average of 1,681 minutes to report and receive feedback on issues at an average cost of USD $4.56 (K698.00) per contact, and with an average contact frequency of 6 times per month. Findings indicate that the SMS messages and phone calls are at least 4 times cheaper and at least 134 times more efficient in getting feedback than the traditional and most common method of walking, biking or using public transport to reach and communicate directly with supervisors at the district level.

Discussion

The SMS baseline assessment served three purposes: (a) it provided baseline information on health workers who had not yet enrolled in the SMS network in the two project districts; (b) it provided monitoring data on the performance of the SMS network during the pretesting phase of June to October 2010; and (c) it established

[5]Here, cost is a function of the transportation used to travel to and from the health center or district level and does not take into account CHW salary costs. The most common transportation means include bicycle (their own or hiring one) public transport and walking.

baseline values in a nonrandom control group, which will strengthen the rigor of the pre/post evaluation at the conclusion of the project.

Convenient Communication at Low Cost

Findings indicate that the SMS network is cost cutting, convenient, and allows quick feedback from district staff to CHWs. It is especially useful for reaching CHWs in remote areas and helps complete the cycle of information flow from the national level down to the periphery and back up again. District health teams in the project area use the new SMS network to alert CHWs about new resources, training opportunities, changes in protocols, public health activities, and knowledge exchange forums within their district. CHWs, in turn, use the network to report their information and resource needs to district managers. For example, CHWs use the network to request specific technical information from district managers (e.g., specific medical questions, drug adverse effects, effects of contraceptive uses, or dosage amounts), to report important events to the district level (e.g., stockouts, transportation breakdowns), or to coordinate referrals and care.

According to the district coordinators in Salima and Nkhotakota, the SMS network is bridging the communication gap between district staff and CHWs. Before the network existed, district coordinators used ambulances to deliver letters to the community level, which often did not reach the recipient in time to act. They also sent messages by radio that could reach the health centers but not health workers. Landlines were also commonly used by the district level, but again, this was usually restricted to communication with the health centers alone.

CHWs without access to the SMS network tend to request information or support from their supervisors during established supervision days at the health centers, which usually occur on a monthly basis. In case of urgent issues, these health workers use their own bicycles or public transportation to report problems and seek feedback from their health center. This approach is time consuming and costly, and health workers only go when the matter is very urgent. Consequently they have limited contact with their immediate supervisors and even less contact with the district level.

Improved Status of CHWs in the SMS Network

CHWs report that their participation in the SMS network has resulted in local recognition and improved status among their clients and communities. CHWs in the network are able to support their clients better, and more quickly. As a result, they are winning the confidence of the community. Participants also mentioned that having a phone has reduced the need for participating CHWs to refer clients to the next level because they can solve more problems on their own without leaving their community. Some health workers even reported that using the SMS system has linked them to other district coordinators, which was never the case before. Once the SMS network is fully scaled up, the district team will be able to communicate with any health worker or group of health workers with a single text message.

Effects on Quality of Care

Findings show that timely information exchange between the district and community levels can directly affect the quality of care clients receive. For simple technical questions and support, health workers in the SMS network usually send an SMS or call their

supervisors for guidance and support. For example, when clients seek information that CHWs do not have on hand, the CHW can call or send an SMS to their supervisors for an immediate response. Similar findings regarding quality improvements among frontline health workers using mHealth have been found in Indonesia and Uganda (Chib, Lwin, Ang, Lin, & Santoso, 2008; Musoke, 2001).

It is worthwhile noting several emergency cases that were managed in time thanks to the SMS system. In Nkhotakota, a community-based distribution agent sent an SMS message to the hub reporting a suspected case of measles after visiting a symptomatic client. District staff immediately traveled to that community and confirmed and treated the measles case, which could have spread had it not been managed in time. In another part of Nkhotakota, a health worker sent an SMS message to the district level about three mysterious deaths that had occurred in one village over a period of 2 weeks. The district responded by visiting the village on the following day and their findings revealed an outbreak of meningitis. CHWs working in Salima, community-based distribution agents met two cases of women who complained of continuous bleeding as a side effect of the family planning method they were using. CHWs sent an SMS message to the district family planning coordinators who, in turn, approved the use of the ambulance to send the two clients to the district hospital the next day.

Access to the new SMS network allows health workers in Salima and Nkhotakota to quickly report an issue to their supervisors and district coordinators and receive rapid feedback in return. This, in turn, allows CHWs to efficiently respond to client needs. This assessment supports what other studies have found. MHealth applications can cut costs, increase efficiency and improve service quality (Vital Wave Consulting, 2009; Mahmud, Rodriguez, & Nesbit, 2010). Coupled with increased mobile network access in remote areas, ease of use, and decreases in handset costs (Mishra & Singh, 2008; Kahn, Yang, & Kahn, 2010), the study findings suggest that mHealth provides a viable way to reduce the digital divide in Malawi.

Recommendations

This study has demonstrated the potential of the SMS network to improve the efficiency and effectiveness of community health services in terms of managing logistics, reporting events, and addressing emergencies. If the SMS network had a broader coverage, it could have the potential to change the landscape of health service delivery in Malawi. It could expand the reach of health information to frontline health workers in remote areas and accelerate knowledge exchange between CHWs and higher levels in the health system. As a result, the project should consider scaling up the SMS network and replicating this experience in other districts in Malawi, especially in areas where cell phones are already available among CHWs.

The project should also consider developing a limited number of new features to improve the use of the network in the existing project area. For example, automated responses could be developed for frequently asked questions by CHWs. This approach has been used successfully elsewhere (Blynn & Aubuchon, 2009). The objective would be to simplify the response turnaround for simple, common queries so that supervisors could devote more time responding to more complicated questions via SMS.

In addition, the project should consider developing automated surveys that can be administered via SMS for ongoing monitoring and evaluation of the project using simple yes/no and multiple choice questions. Likewise, health workers and the health centers could use the SMS network to send monthly report forms to the district levels.

SMS monitoring systems are increasingly used to streamline reporting processes and improve data quality with positive results (Vital Wave Consulting, 2009).

Finally, one of the main challenges of this study was developing technically sound indicators at a time when measuring mHealth is still a new area and there are few, if any, standard, tested knowledge management indicators in the literature. As a result, this was a process of trial and error. A second challenge we faced was effectively linking SMS use to quality of care. The project originally chose to use number of client visits and number of client referrals as quality of care indicators. However, because CHWs in Malawi do not have any required targets for client visits, it is difficult to identify an optimum number that reflects quality of care. CHWs are responsible for anywhere between 5 and 15 villages, depending on the population distribution. Likewise, client referrals is not an adequate quality measure because this reflects client and community needs at any given moment, which may have nothing to do with CHWs having a phone. We may want to see a reduction in referrals over time because the SMS system enables CHWs to handle more cases on their own rather than having to refer.

Given the challenges in identifying measures of quality related to SMS use, in the future it is important to consider how the SMS system affects the inputs into quality of care (e.g., stockouts and quick resolution of problems), because these may be better indicators of quality. We also suggest working with the district level to identify health service indicators, such as contraceptive use, that could better reflect the influence of the SMS network on the quality of care. In addition, more extensive qualitative data can be collected to provide rich narratives on how CHWs use the SMS system to improve their care.

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