

# CommCare: Automated Quality Improvement To Strengthen Community-Based Health

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## Abstract

*Community Health Worker (CHW) programs have potential to improve the health of the millions living in extreme poverty by serving as a liaison between a household and the formal health system. Yet despite many attempts, CHW programs consistently fall short due to inconsistent care, lack of supervision and feedback, and high staff turnover. Quality Improvement (QI) tools have great potential to mitigate these shortcomings. We are evaluating the possibility of inserting QI tools into CHW practice through CommCare, a phone-based application. Each CHW is equipped with a low-cost phone running CommCare to help manage their day and report data in real time. By making checklists, decision support protocols, and reminders a part of CHWs' routines, we can reinforce the target behavior that a successful CHW program requires. CHWs using CommCare have reported a significant improvement in their management of pregnancies. Additionally, CommCare is paired with a set of supervisory tools to ensure regular feedback from health officers, though these tools have yet to be appropriately piloted.*

## Keywords:

mHealth, CHWs, quality improvement, supervision

## Introduction

The purpose of this study is to present a phone-based tool for promoting safe pregnancies at the community level. Called CommCare, the tool consists of a set of forms and protocols meant to support pregnant women before, during, and after delivery. The larger goal of CommCare is to promote community-based management of pregnancies in a real-time, empirical manner. This paper presents the theoretical basis for CommCare as well as its implementation by the Millennium Villages Project in the Mbola village cluster, Tanzania.

Despite significant gains in global health indicators in the past several decades, maternal health has remained stagnant. The failure to improve maternal health has implications for neonatal mortality as well, as 3.3 million babies are stillborn each year [1]. Most of these deaths have been attributed to poor service provision and lack of access. Yet the global health community does not lack guidelines for improving maternal health. There are largely agreed upon interventions

for every stage of maternal care – pregnancy, delivery, and postpartum – whose efficacy has already been proven [2]. Rather, there is a need to focus on practically implementing these interventions in a rigorous, data-driven way [3] [4].

Community health workers (CHWs) are often needed to implement these strategies effectively. Their efficacy in well structured maternal and child health programs has been shown in numerous studies, including one reporting 30-50% reductions in infant mortality [5]. However, CHW programs have been shown to be difficult to scale up while still maintaining effectiveness [6]. This has been ascribed to a number of factors, including inadequate training [7] and the lack of opportunities to reinforce CHW knowledge in the field [8]. Additionally, clearly delineated tasks [9] and adequate supervision [10] are necessary components of successful CHW programs.

In recent decades, tools and supervision under the umbrella term of Quality Improvement (QI) have received increased attention. These tools, often used in a clinical setting, have been shown to improve the standard of care provided by health workers. Though results of QI efforts have been mixed, they remain an important component of efforts to increase the effectiveness of healthcare [11] [12]. There is great potential for the application of these tools in community health [13]. However, such attempts to date have been few and far between.

Our goal is to build information systems to strengthen community-based approaches to maternal health. In this paper, we present a phone-based tool called CommCare that runs on relatively inexpensive phones that can be carried by the CHWs from visit to visit. CommCare maintains a small patient record on the phone of each pregnant woman under the care of the CHW. For each type of visit (registration, general follow-up, referral follow-up, end-of-pregnancy) CommCare integrates standard quality improvement tools such as checklists, reminders, and decision support to help reinforce standards of care by CHWs. By relaying visit data captured on the phone in real time to a central server, CommCare can enable supervision, other feedback loops, and reporting.

CommCare's pregnancy module is being piloted by a number of organizations in sub-Saharan Africa and worldwide. This paper presents its implementation by the Millennium Villages

Project (MVP) in Tanzania. The MVP Community Health program has been active in the Mbola village cluster located in the Tabora region since May 2006.

Our key findings are:

- CommCare is a potential vehicle for continuous, semi-automated quality improvement for CHW programs;
- CHWs reported a strong preference for the decision support feature of CommCare, believing that it standardized the care that they provided in house visits and assisted them in keeping track of pregnant women in their respective catchment areas;
- Supervisory tools are necessary to couch CommCare within a broader management system.

In the remainder of this paper we present background information to justify the need for quality improvement techniques, describe our system for automating this quality improvement, and conclude.

## The Need for Quality Improvement for CHWs

### Best practices for safe pregnancy

A great deal of literature exists on proven interventions to improve maternal health in developing countries. The World Health Organization (WHO) has published a number of recommendations for promoting safe pregnancies, both for the general population and women with severe diseases or complications [14]. These interventions are largely agreed upon, and include all stages of maternal care – during pregnancy, during childbirth, and postpartum.

Before birth, safe pregnancy practices largely involve monitoring women for risk factors and danger signs, as well as administering key tests and vaccinations [14]. These practices include: identifying high-risk factors; danger signs monitoring and referrals to clinic if needed; tetanus immunization; anemia prevention and control (iron and folic acid supplements); birth planning; syphilis testing; HIV/AIDS testing; intermittent preventative treatment (IPT) and insecticide treated nets (ITN) for malaria; de-worming medication; and counseling on safe pregnancy and newborn care.

Table 1: Target CHW Behavior

	First Visit	Follow Up	Referral	Post Partum
Frequency	Once, upon identification	Once/month if 1-7 months pregnant; Twice/month if 8-10 months pregnant	If referral is made, once every two days until referral is completed	Once, upon delivery or termination
Key Components	<ul style="list-style-type: none"> <li>•Identification of high-risk factors</li> <li>•Advice on HIV and Syphilis testing</li> </ul>	<ul style="list-style-type: none"> <li>•Check for danger signs</li> <li>•Promote safe antenatal practices (Tetanus immunization; Iron and folic acid supplements; Birth planning; Syphilis testing; HIV/AIDS testing; IPT and ITN for malaria; De-worming medication)</li> <li>•Counseling on safe pregnancy and newborn care</li> </ul>	<ul style="list-style-type: none"> <li>•Check if referred woman went to clinic and received treatment</li> <li>•Refer again if did not go or did not receive treatment</li> </ul>	<ul style="list-style-type: none"> <li>•Record circumstances of birth</li> <li>•Check for postpartum danger signs</li> <li>•Advise on future family planning</li> </ul>

Though these interventions must be supplemented by access to emergency care and skilled attendants at delivery [15], promotion of these practices has been shown to improve maternal and child health and minimize mortality.

### Target CHW Behavior

The goal of a community-based program promoting maternal health is to increase uptake of clinical services when needed, and educate pregnant women about healthy behavior both during and after pregnancy. Ideally, a CHW would promote these practices by identifying pregnant women, making regular follow-ups, making special referral related follow-ups, and following up with the woman after delivery. We present a summary of these practices in Table 1 below.

However, experience has shown that such behavior is difficult to translate into practice. Community health worker programs are often hampered by inconsistent care by different CHWs, inadequate follow-ups, and poor supervision by superiors [10]. As such, promotion of these practices is often unreliable, and many pregnant women fall through the cracks.

### Quality Improvement Mechanisms

Recently, the promotion of tools to improve the quality and consistency of care has gained traction amongst public health programs in developing countries [11]. Through a variety of mechanisms, these tools aim to standardize and monitor practice within an organization. Such tools can include preventing failure, identifying and mitigating mistakes, and redesigning a system to compensate for existing failures [16]. Three major areas these tools address are:

1. **Decision Support (DS):** These tools intend to guide health workers through key activities to ensure adherence to existing standards of care. These include visual algorithms, memory aids, constraints, and reminders;
2. **Inspection:** The CHWs are assigned many specific responsibilities by the target behavior described above. QI tools need to provide easy and fast methods for oversight by supervisors to ensure that these activities occur. Checklists, for example, provide DS to health workers while also allowing supervisors to understand which tasks are most

often omitted from key practices. Though not an end in itself, inspectability allows health organizations to understand the quality of care provided by CHWs and ensure more consistent performance;

3. **Improvement:** Projects must change to survive. The quality of care of offered by any fixed program will naturally decline as the context changes. Improving the quality of programs ultimately requires mechanisms to identify problems, propose solutions, and monitor whether a solution has the desired effect or not. Feedback mechanisms, involving regular communication between personnel and both their clients and supervisors, are a key component of any QI effort. By translating aggregated data into coordinated efforts to change the status quo, improvability can lead to significant gains in the quality of care provided by health workers.

Our goal is to automate these tools and techniques in a lightweight information system that CHWs can use during household visits.

## CommCare

### Overview

CommCare software is open source code that can run on a wide range of Java-enabled phones. It is an extension to the JavaROSA codebase (code.javarosa.org), which is being used to support many different mobile health and data collection applications in low-income countries [17]. The first CommCare module was deployed to support CHWs providing social support to HIV+ and other chronically ill patients in Tanzania, with subsequent modules developed for routine health promotion and for supporting orphans and vulnerable children [18].

Once registered, a CHW can login with a personal password to access their cases. Once logged in, a CHW can select from one of four options: New Case, Follow-up (routine), Follow-up (if a woman has been referred to the clinic), and Close (after the woman has given birth).

Once one of these options has been selected, CommCare guides the CHW through that particular type of visit, asking questions and dispensing advice for both the CHW and the pregnant woman. Upon completion of the visit, the CHW has the option to send their completed form immediately or at a later time. If a referral has been made during the follow-up visit, the referral will be stored on the phone until a referral form is filled out specifying that the woman went to the clinic and received care.

Each of these four options is used at different intervals, some occurring only once (registration, close), some occurring monthly (follow-up), and some occurring only if circumstances require (referral). Once a new case is registered, the woman is visited by a CHW for both regularly scheduled follow ups and visits specific to clinic referrals. The registered case remains active until a close form is filled out, after which the case is considered complete.

After each visit, CommCare submits the data collected during that visit to our central server, CommCare HQ. The data is submitted over the cellular network using GPRS, which is

vastly less expensive than text messaging per data unit in Tanzania. When connectivity is not available, forms are saved on the phone and submitted later.

### Decision Support

Each of CommCare’s pregnancy forms contains QI tools specific to each visit. Each of these four forms contains a pre-defined algorithm of care that guides the CHW through the various tasks outlined in the Target Behavior of Figure 1. Constraints are also placed on each question response, in case the CHW inputs information that does not reasonably correspond to the question asked. Each form contains additional DS tools specific to each visit.

1. **Registration:** This initial visit contains a series of questions to assist the CHW in identifying factors for complications at birth. If the woman is identified as high-risk based on her responses to a series of questions, CommCare will prompt the CHW to advise the woman to seek specific counseling and care. The specific criteria that constitute a high-risk pregnancy are based on guidelines set by the Tanzanian Ministry of Health.

2. **Follow-up:** This visit, occurring monthly, consists of three parts. The first provides memory aids to CHWs on symptoms for common danger signs that would necessitate a referral; if any of these are present, the woman is referred to the clinic. The second involves a checklist of healthy pregnancy actions that is maintained throughout the pregnancy (see Figure 1), updated during each visit with the goal of accomplishing all before birth. Finally, the visit ends with a series of “trivia” questions about safe pregnancy, birth, and postpartum behavior. CommCare provides memory aids for the CHW to educate the woman on each question.
3. **Referral:** If a woman is referred to the clinic, the CHW follows up after two days to see if she has sought medical attention. CommCare provides reminders to the CHW after two days have passed, to ensure that each case receives an appropriate follow-up. This form functions as a way to consistently keep track of referred women, as well as a way to collect data on why a woman does or does not visit a clinic.
4. **Close:** Taking place after birth, this form collects data on the circumstances of the delivery or termination. It also asks questions about future plans for family planning methods and newborn care.

### Inspection

We strive to make the system useful to the CHW even if no

Figure 1: Safe Pregnancy Checklist

data were submitted, but having the data submitted to CommCareHQ opens up a tremendous number of opportunities. Any program manager with the appropriate access level can login and get data on the details of CHW behavior at any time, along with a daily report indicating how many forms each CHW has submitted for the last 7 days. Additionally, HQ produces a Safe Pregnancy Monitoring Report, presenting actionable items on a real-time basis (see Figure 2).

MVP Safe Pregnancy Monitoring Report					
<b>Open Referrals</b>					
Mother Name	Name of CHW	Months Pregnant	Danger Signs	Date Referred	Last Referral Visit by CHW
xxxx	xxxx	5	fever: yes, unusual stomach pain: yes, headache/blurred vision: yes	22-Jul-09	30-Jul-09
<b>Women 7-10 Months Pregnant</b>					
Mother Name	Name of CHW	Months Pregnant	Days Since Last Seen	High Risk Factors	Incomplete Checklist Items
xxxx	xxxx	8	20	<18 years	Finished tetanus immunization
<b>Women Needing Followup</b>					
Mother Name	Name of CHW	Months Pregnant	Days Since Last Seen	High Risk Factors	Incomplete Checklist Items
xxxx	xxxx	4	41	>35 years, >5 pregnancies	Tested for blood pressure [BP], Tested for hemoglobin [HB]

Figure 2: Sample Safe Pregnancy Monitoring Report

The components of the Safe Pregnancy Monitoring Report focus on items that CHWs and their supervisors can use to monitor the state of pregnancies in their catchment areas: i) Women who have been referred to the clinic but have not yet received care; ii) Women expecting to deliver soon (7-10 months pregnant); and iii) Women who have not received a routine follow-up visit in the recent past (30 days if 1-6 months pregnant, 15 days if 7-10 months pregnant). By placing emphasis on items that directly affect the health of existing pregnancies, this report aids supervisors in ensuring that a certain baseline of care is provided by CHWs.

More elaborate versions of this report include information on recent deliveries, to assist managers in assessing the location of recent deliveries and the health of new mothers and infants.

### Improvement

Though this component is still under development, HQ has the potential to analyze data in various ways, by representing various indicators in terms of long-term trends. For example, CommCare's Close Form prompts the CHW to ask where each woman delivered and, if she delivered at home, why she chose to do so. Aggregate data on these questions can assist decision makers in targeting specific barriers to seeking care, be they financial, logistical, or distrust of the health sector. Other aggregate data allows health officials to target their improvement efforts in a more evidence-based way.

## Results

### Overview of CHW Program

CommCare was piloted with a group of five CHWs working for the Millennium Villages Project (MVP) in Tabora region, Tanzania. MVP's CHW program currently focuses on promoting hygienic practices and managing malaria. These CHWs do not currently dispense medications besides Coartem for malaria, but do refer people to the health facility when serious health problems are detected.

Currently, health staff responsible for each village's clinic and community health program monitor CHW practice. However, there is little documentation of CHW activities outside of malaria. As such, there is a need for a greater exchange of data between the clinic and CHWs, to ensure that referrals are successfully completed and key patient data is kept consistent.

MVP is currently planning to expand the role of the CHW to include maternal and child health, monitoring for priority diseases, and accurate recording of causes of death within the community. Give this changing context, CommCare is well placed to explore the training benefits of a mobile phone-based decision support system.

### Pilot Implementation

The CommCare module was developed over the course of four months, involving weekly meetings with five CHWs. These meetings were participatory in nature, including discussions on the best way to manage safe pregnancies in the community, focus groups on design and interface issues, and observed household visits as CHWs used CommCare in their community.

The structure and content of the pregnancy module was developed onsite, with few design decisions made beforehand. This was an important component in generating ownership of the module, as well as to ensure that CommCare was well suited for the CHW's working conditions.

Trainings were split between explaining the technical aspects of using CommCare and the structure and purpose of the pregnancy module. The most common technical difficulty reported by CHWs involved resubmitting forms that did not initially send due to network problems. That aside, CHWs were very receptive to CommCare and were able to use it comfortably after only a few training sessions.

As shown in Table 2, the five CHWs registered 60 pregnant women during the four-month period. By coincidence, they also conducted a total of 60 follow-ups, but some women got zero followups and others got more than one. The 30 "completed referrals" refers to referrals made in which the CHW later confirmed that the woman visited the clinic and received care. During this time, we collected data on 25 pregnancies that ended (in birth or otherwise) during the four months.

Table 1: Pilot submission data

Submission type	# Submissions (4 months)
Registration	60
Follow-ups	60

Completed referrals	30
Closed cases	25

## Findings

Though more rigorous study is needed, anecdotal evidence and focus groups suggest that CHWs greatly benefited from the DS component of CommCare. CHWs reported longer and more comprehensive household visits, more consistent follow-up of existing pregnancies, and more active identification and registration of pregnancies in their catchment areas. Additionally, CHWs reported that they had never actively followed pregnancies until after delivery, and monitored each woman's health throughout their pregnancy.

Though CommCare HQ's Safe Pregnancy Monitoring Report is currently functioning, there were several months during which it had not yet been integrated into the community health system. We were thus able to monitor the effects of supervision within the CHW program by comparing submission rates before and after the implementer's departure.

Our experience has closely mirrored existing literature on supervision, suggesting that decision support without supervision is not adequate to ensure a well-functioning community health worker program. A significant drop in the number of CHW submissions followed the implementer's departure. Though it is unclear whether this decrease was caused by technical problems or lack of encouragement, the point remains that a broader supervisory structure is a necessary component of any well-functioning CHW program, regardless of the existence of automated QI tools.

## Conclusion

This paper presents an overview of a mobile phone-based tool aimed to maintain the standard care provided by CHWs. Advancements in QI techniques in recent decades present new opportunities for CHWs to serve as a central component of health systems, particularly in low-resource settings.

Though initial results from pilots of CommCare have been positive, there is a need for a more rigorous assessment of the tool's strengths and weaknesses. Additionally, a clearer understanding of which supervisory tools are most beneficial to health officers is necessary. As attention is increasingly placed on managing information in a usable way, CommCare has great potential to improve the quality and consistency of community-based healthcare.

## Acknowledgments

The authors would like to thank the staff of MVP Tanzania under the leadership of Gerson Nyadzi, the CommCare team, and the Community Health Workers of Ilolangu village.

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