Scaling Mobile Community-Based Health Information Systems

TWO CASE STUDIES

Medic Mobile and Living Goods
Dimagi and mothers2mothers

March 2018

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MEASURE Evaluation

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March 2018

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Cover: A mother and child with a community worker, participating in the Living Goods mHealth project, in Kenya. Photo: Medic Mobile

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ABBREVIATIONS

ACT	artemisinin-based combination therapies
app	application
ART	antiretroviral treatment
CHP	community health promoter
CHW	community health worker
CMM	community mentor mother
FMM	facility mentor mother
iCCM	integrated community case management
IT	information technology
J&J	Johnson and Johnson
M&E	monitoring and evaluation
MEC	monitoring and evaluation coordinator
mHealth	mobile health
m2m	mothers2mothers
MOH	Ministry of Health
ORS	oral rehydration salts
SIM	subscriber identification module
SMS	short messaging service

INTRODUCTION

Stakeholders in the field of international health increasingly emphasize community health and community health information, and how they link with the larger health system. Governments and donors realize that as a result, they will need community health programs and the information they generate to reach key global policy goals, such as universal health coverage and the global 90-90-90 targets: by 2020 90% of all people living with HIV will know their status, 90% of all people diagnosed with HIV will receive antiretroviral treatment (ART), and 90% of those on ART will be virally suppressed) (Joint United Nations Programme on HIV/AIDS [UNAIDS], 2014). This effort aligns with the goals of the United States Agency of International Development (USAID) to prevent child and maternal deaths, combat infectious disease threats, control the HIV epidemic, and prevent and treat malaria. Community health workers (CHWs), who have been recognized for years in the international development community as the link or bridge between the formal health system and the communities they target, can help countries reach the goals set out in these policies.

Governments and implementing partners often rely on volunteer CHWs to collect program information on paper-based forms or registers. CHWs often refer to the paper-based forms as cumbersome or see them as bulky and susceptible to damage from rain or other factors (Damtew & Moges, 2013). Some programs note that these paper forms are not always filled out completely or received in a timely manner. Once the forms are submitted to the program and/or health post, a large amount of data either must be tallied and recorded on a monthly summary sheet or entered in a health management information system (HMIS). With the sheer number of paper-based forms submitted, often it is not manageable to manually enter the data in the HMIS by the reporting deadline. The result is a backlog of community data that may not get entered in the HMIS (Chewicha & Azim, 2013; Jeremie, Kaesie, Olayo, & Akinyi, 2014).

As access to low-cost technology has expanded, organizations and governments have equipped CHWs and community-based program staff with mobile devices to facilitate data collection. Mobile health (mHealth) tools provide solutions to some of the challenges associated with paper-based tools, including assisting case management by facilitating their work flow and improving the completeness, accuracy, and timeliness of data submission, while also reducing the load CHWs must carry.

Despite the introduction of mHealth tools in community-based programs almost two decades ago, to date few programs have managed to successfully scale and sustain mHealth solutions. Many documented small-scale digital health interventions exist, but the use of digital devices for health services has not achieved the promise suggested by the technology companies' high levels of market penetration (Wilson, Gertz, Arenth, & Salisbury, 2014). There are many possible reasons, including lack of resources, infrastructure to support the systems, and training (Wilson, et al., 2014).

Focusing on practical and replicable mHealth implementations, the USAID-funded MEASURE Evaluation conducted case studies of two mHealth projects that have moved beyond the pilot phase. These studies aim to provide insight into how two implementing partners worked with technology companies to implement mHealth solutions in order to improve case management and care coordination, and thus monitoring and evaluation (M&E) of their programs. Through these studies, MEASURE Evaluation shares lessons learned and best practices that others can draw upon when developing their own mHealth solutions.

The first case study highlights the partnership between Living Goods and Medic Mobile. The second case study features Dimagi and mothers2mothers.

CASE 1. LIVING GOODS UGANDA AND MEDIC MOBILE

BACKGROUND

Medic Mobile is a nonprofit technology company based in San Francisco, CA, founded in 2010 to support community health workers through deploying mobile and web-based solutions. It has worked with more than 20,000 health workers in 20 countries. Its goal is to help improve health in those communities hardest to reach through designing, building, and supporting open source software for health workers and health systems. Initially, Medic Mobile developed solutions that were subscriber identification module (SIM)- and short messaging system (SMS)-based. However, since 2015, it has expanded its portfolio to include Android apps for smart phones. Although Medic Mobile's in-house programmers configure the software for large customized projects, a preconfigured standard version of its toolkit is available free-of-charge for pregnancy, postnatal care, and immunization.

Medic Mobile's Android app links CHWs with clinical staff in facilities to improve the continuum of care. The application has the functionality, based on health area, to schedule appointments, remind CHWs to alert clinic staff about potential patient danger signs, notify clinic staff of missed appointments, track disease burden, and track CHWs' performance.

Living Goods is a nonprofit based in San Francisco, CA, that started in 2007 to implement a social entrepreneurial approach to healthcare in Uganda. Its community health promoters (CHPs) go door-to-door providing health education; registering pregnancies; diagnosing malaria, diarrheal disease, and pneumonia; and selling health products such as artemisinin-based combination therapies (ACT), oral rehydration salts (ORS), cook stoves, and fortified foods. CHPs generate income as a percentage of their sales revenue. Since 2007, Living Goods has expanded its programs to Kenya, Myanmar, and Zambia.

In Uganda, Living Goods currently has 17 branches, which support 1,700 CHPs in providing health services in the communities in which they live. The CHPs tend to be 25 to 50 years of age and have a working knowledge of the English language and math. CHP supervisors work out of the branches, from which they provide in-service training to CHPs, manage commodities to be distributed to CHPs, and plan supervisory field visits.

The Living Goods entrepreneurial model lends itself to a data-driven approach, because staff must track the distribution of commodities and incentivize the performance of the CHPs. From top to bottom, individual, supervisor, branch, and program performance is monitored through data collected in the Living Goods mobile system, which are displayed on dashboards to support decision making at all levels.

The Path to an Integrated mHealth Application

Living Goods is a not-for-profit organization that provides products designed to fight poverty and disease in low- and middle-income countries. Its community health information system originally consisted of three separate register books—for household registration, those under the age of five years, and pregnant women—that CHPs carried with them for their household visits. The CHPs considered the registers "hectic" and quite bulky; also, CHPs could not use them to plan their visits or know if they were achieving their performance targets. CHPs would occasionally lose some of the paper forms or the forms would get wet and be ruined, which weakened overall data quality. Because these three separate registers contained so much data, tallying them monthly was difficult; therefore, CHPs would not produce regular reports, so their supervisors would simply tally the data they received and generally not use them for decision making. Also, the Living Goods district branches considered the paper-based system expensive, because they constantly had to make copies of the registers for the CHPs and themselves.

To begin addressing these paper-based system issues, Living Goods decided to digitize the registers using resources available in-house. The organization created three separate mobile applications (apps) based on the paper registers. Living Goods soon learned that CHPs would use only one app during a household visit, because they thought it was too much effort to open all three, again resulting in an incomplete data set. The in-house system also could not track supervisor or CHP performance—a significant part of the Living Goods program.

In 2015, the chief executive officers of Living Goods and representatives of Medic Mobile—a nonprofit company specializing in mHealth—met in San Francisco, CA, and began discussions about developing an integrated Android-based app for the Living Goods program. The meeting and eventual partnership resulted from the decision by Living Goods that the organization needed an external technology company to support the process to aggressively scale its mHealth tools. At the time of their initial meetings, Medic Mobile was working on developing new software for Android phones. Living Goods realized it could benefit from the new software for its integrated mobile app. Medic Mobile had the technical capabilities to integrate the three apps, the processes for understanding workflows and where technology could complement and support these workflows, and the expertise to build the performance management dashboards.

Designing the Integrated mHealth Application

The first task under the new partnership was for Medic Mobile to develop a management dashboard with the three current apps while they continued discussions on how best to consolidate those apps into one integrated care app with built-in performance dashboards.

Medic Mobile had received unrestricted funding, which allowed it to conduct significant research and development throughout the process of developing the new Living Goods app. Unrestricted funding allowed Medic Mobile to try innovative approaches to the app and gave the company space to make mistakes and learn from them.

Using its people-centered approach, Medic Mobile staff spent several weeks with Living Goods staff, both at the Living Goods office and at the community level, to understand the workflows, how staff perform their jobs, potential pain points, communication channels, and the infrastructure needed to support an mHealth solution. Medic Mobile equates its people-centered design approach to conducting a rapid ethnography based on the amount of qualitative data collected to help design an mHealth solution.

Through this design process, program managers and designers can determine where technology can support staff to do their jobs more efficiently. The company uses the information gathered to develop user stories and map project workflows, allowing them to develop forms, data fields, and job aids and share them with the software development team to build the app.

> "This [human-centered design] really gets at who does what, [and] when and why certain actions happen, and others do not."
>
> —Designer, Medic Mobile Kenya

When designing the Living Goods app, the Medic Mobile team tried to ensure it could do as much as possible to limit the amount of data that the CHPs needed to enter directly. To do so, the team programmed validations for data elements, skip logic, and streamlined program workflows. For example, when CHPs need to enter data in the app, the team tried to make it as simple as possible, by limiting drop-down menus and using only free text for names.

The team developed the app with offline functionality to address CHP needs; some CHPs work in areas with low to no connectivity but still need to use the app during household visits. The app syncs the information collected offline with the cloud server as soon as the CHP gets to a location with connectivity. CHPs have access to all their client information locally through their phones, so they can access it even in areas where connectivity is poor. Because some of this information is sensitive, the phones and the app are password-protected, with each CHP having unique passwords. The data sent to the server from the phones also are encrypted for security reasons.

Once the Medic Mobile team developed the prototype of the mHealth app, they tested it with a small group of CHPs to see if it met program needs. The designers then worked with program staff to tweak the app based on the CHPs' feedback. After revising the prototype, Medic Mobile put in place an iterative process with quarterly, monthly, and biweekly goals for app features to be pushed out to Living Goods users. Having an adaptable platform was key to the success of the app; new features have been introduced every month since the launch.

While Medic Mobile was working on the app design and architecture, Living Goods was deciding which phone to use. It tested several Android-based smart phones in the environment in which CHPs would be working, and looked at Internet bandwidth, battery life, and the ability to process the app functions. Based on these factors, Living Goods decided to go with a Tecno phone, which it bought in bulk for US$70 per phone.

To increase the CHPs' perceived value of the phone, Living Goods decided to have each CHP contribute the Uganda shilling equivalent of US$8 toward the phone. CHPs receive an initial loan for the phone, which they pay off through sales of health products. According to Living Goods, approximately 80 percent of the CHPs pay back the loan. Living Goods also provides CHPs with 100 megabytes (MB) of data each month, at approximately US$1.50 per CHP. The data package is locked for use only with the Living Goods app, so CHPs can use the data only with the app; most of them use only about 40 percent of the 100 MB. Currently, Living Goods is negotiating with MTN, a mobile telecommunications company, to pay only for the data used. CHPs buy their own airtime to make calls.

Implementation of the mHealth Application

Once the app was ready for release to staff, Living Goods put in place an intensive training program. CHP supervisors received training on how to use the app and interpret and use the information generated in the performance dashboards as part of their pre-posting training. Supervisors also learned how to troubleshoot basic technical issues that might arise with the phone or app. Because it was the first time using a smart phone for many CHPs, Living Goods held a four-day training on how to use the phones and app. Initially thinking the four-day training would be sufficient, with a follow-up refresher several months later, Living Goods soon learned that the CHPs needed more regular training on the app and included this training as part of the agenda for the monthly CHP meetings.

> "Learning the phones at the beginning wasn't easy, as we did not know touch screens, but now it is easy, and we can show clients what we are doing."
>
> —Living Goods Uganda CHP

Another element of implementation was hiring regional information technology (IT) staff. These staff regularly visit the branch offices to support the supervisors and CHPs and attend all monthly meetings to service and update the phones. Besides hiring IT staff, Living Goods ensures that each branch has a trained Android focal person who can troubleshoot basic issues, such as manually starting a data upload when an upload times out.

Because data are entered directly in the mobile device and synced with the server whenever Internet coverage is available (the app requires only EDGE technology), reporting rates have improved: most CHPs now submit their data on time. All the branches have Wi-Fi, so they can also sync their data at the branch when they come to collect supplies or attend monthly meetings. According to one Living Goods branch manager, CHPs no longer waste time trying to calculate the numbers at the end of the month, as they had to do with paper-based forms; the app now does it for them.

Because Living Goods now receives timely information, it can produce weekly reports on three key indicators: number of pregnancies registered, number of those under the age of five years assessed and diagnosed, and number of those under the age of one year assessed and diagnosed. It can also produce monthly reports that include these indicators, as well as the number of households registered and the number of newborns and sick children followed up. Branch managers can access this information from their dashboards and use it for their monthly meetings with CHPs. Living Goods also uses sales data from its point-of-sale system to compare with the health information and check data quality. For example, the organization can compare the number of malaria rapid tests sold against the number of tests conducted. In this example, if the number of tests conducted is higher than tests sold, Living Goods may need to increase supervision of the CHPs, to ensure that protocol is being followed and data are being recorded correctly.

> The CHPs interviewed said that when using paper, they would forget which clients they had seen during the month and what occurred during a visit. Therefore, the app's ability to track what occurs during a visit and generate a task list is helpful.

CHPs also now use the data they collect during household visits for planning. It took Living Goods a substantial amount of time to train CHPs to use the information in the app to make decisions, but most now embrace it as a valuable tool for their jobs. One Living Goods CHP said, "[The] phone is my doctor." Based on the information a CHP enters during household visits (for example, pregnancy, a positive test for malaria, or referral to a health facility), the app generates a daily task list. If a child tests positive for malaria, two days later the task list in the app will remind the CHP to follow up with the child. Using paper-based forms, they had no means to plan their day strategically or prioritize clients, unless they made notes to

themselves; therefore, they tended to visit households in an ad hoc manner. CHPs also have a dashboard in the app that tells them how well they are performing against their monthly targets, allowing the CHPs to monitor their own performance and make improvements if needed. CHP supervisors have ready access to this performance information based on the data entered and can plan their supervisory visits and monthly meetings accordingly. Before the app was available, supervisors would randomly choose which CHPs to visit during the month. Now, they note whether certain CHPs are behind in reaching their targets and follow up to address any issues.

In addition to checking sales against health data, Living Goods has established two other quality control checks. One uses automated geographic positioning system coding to record the locations where CHPs conduct assessments. Living Goods can then determine whether the CHPs are visiting clients and recording data at the correct locations. The other quality control check is implemented by the quality control team, which works with six districts each month to contact 5 percent of the households visited to verify whether the services in the database match those that the household says it received.

Way Forward: Sustainability for the mHealth Application

Through their strategic partnership, Living Goods and Medic Mobile are working toward an aggressive scale-up of CHP use of the app. Living Goods wants to increase the number of CHPs supported through its programs significantly by 2021. Living Goods has been open with Medic Mobile about its scaling plans and strategy, by sharing its annual and five-year plans, so the two organizations can work together to develop appropriate solutions to reach the 2021 goal.

The Ministry of Health (MOH) in Uganda has begun recognizing private-sector integrated community case management (iCCM) programs as partners, allowing Living Goods to establish a partnership with it. At the MOH's request, Living Goods currently submits data to the government on paper, because several facilities in Uganda do not have computers. The Living Goods Kenya program is conducting tests to make its system interoperable with Kenya's DHIS 2 national health information reporting system, so the data can be submitted to it directly. Eventually, Living Goods plans to do this in Uganda, as well. Through its partnership with the MOH, Living Goods has been able to second CHPs to facilities for training on diagnosis and treatment of diarrheal disease, malaria, and pneumonia.

Lessons Learned and Recommendations

Through the process of maintaining paper-based registers, digitizing them, and then developing an integrated system, Living Goods has learned that translating a paper tool or register directly to a digital tool is not always possible. A detailed understanding of actual workflows and how the end users perform their tasks is needed to design an effective digital system for community health programs. This understanding enables a shift from simply digitizing M&E and case management tools to incorporating human-centered design processes, in order to learn about workflows and client interactions and to consider how best to integrate care. If care is organized by individual forms that are not reviewed in conjunction with one another, opportunities to provide holistic care can be missed. Through human-centered design, programs can find ways to support CHPs to work more effectively while still collecting the data elements needed for M&E reporting.

By developing decision support tools within the app, Living Goods has been able to support task shifting for some of the key assessment and treatment tasks from facilities to CHPs. For example, CHPs can conduct rapid malaria tests, dispense ACT for malaria, and provide ORS for diarrheal disease—as outlined in the World Health Organization's iCCM protocol. mHealth solutions must move beyond data collection tools alone to more decision support tools for CHWs to provide timely, high-quality care for certain illnesses, so more programs can task-shift to frontline workers.

> "I do not feel that we have an informatics component of our program, as the mobile application is so embedded within the program that it would not function without it."
>
> — Uganda Country Director, Living Goods

Implementing partners need to understand what drives the costs of developing and implementing an mHealth solution. Both Medic Mobile and Living Goods had substantial unrestricted funds, which allowed them to innovate and avoid pressure to get everything right the first time. Not all partners have access to such funds, so they need to look at costs when considering developing an mHealth app. There were significant upfront costs for Medic Mobile to develop new software for the Living Goods app, and the investment in the first few branches that received the app was quite high. However, because the software was replicable, it benefited from economies of scale as it was rolled out to more sites. Initially, Living Goods thought procurement of phones and data would consume a significant portion of its recurring budget; in fact, training costs and human resources were the most significant recurring costs.

Along the path toward development of the current app, it became apparent that an mHealth solution could not be a siloed activity within a program. It needs to be integrated in the program and in the organization, so that adequate resources can be channeled to it. Rather than treating mHealth programs as add-ons to be supported by separate funding streams, organizations would do well to see these interventions as integrated tools that make core programs more scalable and effective.

CASE 2. DIMAGI AND MOTHERS2MOTHERS SOUTH AFRICA

BACKGROUND

Dimagi is a B-Corporation* based in Cambridge, MA, and founded in 2002 to provide mobile tools to frontline health workers in low-resource settings. Dimagi's open-source mobile data-collection platform, CommCare, enables the development of custom mobile apps to collect information, support complex workflows, and provide data for real-time decision making. Through a range of product levels, users can opt for a do-it-yourself approach or contract Dimagi's services for prototyping, designing, testing, deploying, and training mobile systems.

Implementation and capacity-strengthening services leverage Dimagi's experience with more than 500 organizations in more than 60 countries to implement cost-effective, sustainable, and scalable mobile data management systems. Dimagi's approach provides organizations and users with several tools to build applications ("CommCare HQ"), understand the financial resources required to sustain an mHealth solution ("Total Cost of Ownership Model"), and assess current systems for developing roadmaps and sustainability plans ("Maturity Model").

m2m is a global nonprofit organization based in Cape Town, South Africa, with programs in Kenya, Lesotho, Malawi, Mozambique, South Africa, Swaziland, Uganda, and Zambia. m2m works with mothers to improve reproductive, maternal, newborn, child, and adolescent health. m2m's Mentor Mother Model seeks to empower mothers living with HIV by providing education and employment and presenting them as role models to help other women, children, and families access essential services and medical care. m2m incorporates facility-to-community-based services, by deploying "mentor mothers" at health facilities and in communities to provide integrated services. This integrated service platform supports facility-community linkages to promote retention in care and treatment and ensure a continuum of care. To improve the quality of services at the facility and community level, m2m introduced two mobile applications for the following purposes:

- **Digital tracking of client appointments at the facility level and subsequent management of client follow-up.** Facility-based mentor mothers use this electronic client appointment diary app as an appointment tracking tool to remind them when clients are due for an appointment. It prompts the mentor mothers to actively follow up with clients who miss a scheduled appointment.
- **Assistance to community-based mentor mothers to provide good-quality family-based services at the household level and strengthen bidirectional linkages between the facility and community.** Community-based mentor mothers use this app to guide them in scheduling home visits, remind them to provide appropriate education and support based on client outcomes, and prompt them to follow up on open referrals and completion of the referral loop.

*A B-Corporation is a for-profit company "certified by the nonprofit B Lab to meet rigorous standards of social and environmental performance, accountability, and transparency" (https://www.bcorporation.net/what-are-b-corps).

The Path to an mHealth Active Client Follow-Up Tracker and Client Case Management Tools

A nonprofit organization, mothers2mothers (m2m) seeks to improve reproductive, maternal, newborn, and child health using a peer-to-peer approach, by employing HIV-positive mothers as frontline health workers. Originally, it maintained several client management tools (notebooks, logbooks, and active client follow-up registers) with information about active clients, services received, and appointment dates.

The facility mentor mothers (FMMs), who support clients at facilities, would use notebooks to capture services provided to each client and the supervisors would transfer the information to logbooks each day. The FMMs would also record details of clients who missed appointments in a separate register: the active client follow-up register. The paper-based system was cumbersome and took the FMMs a significant amount of time to find clients in the logbooks, which inhibited their ability to do their work efficiently. Later, m2m rolled out a paper-based client appointment diary, which was maintained at the health facility. Clients' priority appointments were recorded in the diary and missed appointments were tracked and followed up by telephone and through home visits. The diary system improved on the old logbook and the active client follow-up register, because restructuring information in the daily diary format allowed peer mentors to see readily when clients had missed appointments and follow up with them more efficiently and effectively. The electronic client appointment diary was developed to further improve this process.

The community mentor mothers (CMMs), who support clients at the household level but are linked to a facility, would capture information about the household visit in a "community family folder," which guided the CMMs as they provided client services at the household level. Each household enrolled by a CMM had such a family folder, which documented all services provided to every family member. CMMs reported that the family folder had so many client information fields that they did not always complete the entire tool; moreover, they would forget which clients they had referred to the facility and with whom they needed to follow up.

In 2009, m2m started its digital health journey with several pilot mHealth projects. The flagship application (implemented in 2012) was an mHealth app designed to improve the tracking of mother-baby pairs. It was launched at 30 sites but had issues that caused it to be underutilized. The app did not provide offline functionality, which was critical, given m2m work in sub-Saharan African communities, so its users needed network connectivity. This created backlogs in registering clients on the app, and in keeping client records updated. Mentor mothers could not see whether they had missed clients on a given day or if the clients had not shown up for their appointments. Also, the platform did not allow them to link antenatal and postnatal care records, limiting m2m's ability to do longitudinal tracking. This app was eventually phased out.

After initial attempts to implement mHealth failed, m2m decided instead to strengthen its paper-based system by introducing a paper client appointment diary, a daily planner that replaced the active client follow-up register. But in 2014, m2m revitalized its digital health efforts, by bringing in an external partner to review its past attempts and determine how the application of digital health in the context of program implementation could be improved. The review helped m2m understand that its earlier digital health initiatives had been driven by technologists rather than program staff, resulting in a lack of understanding of how the technology should best be implemented to support high-quality program implementation. The review also found that when systems were provided in-kind, they were often designed to suit external priorities rather than m2m's internal needs. Finally, the review showed that m2m lacked the in-country or in-house capacity to absorb or institutionalize the technology, once implemented.

On the strength of these findings, m2m hired an external group, Health Enabled, to help it develop a new digital health strategy that would identify program priorities aligned to m2m's vision and strategic plan. Ultimately, m2m envisioned integrating digital health in its peer approach and program implementation to improve overall retention of clients in care in the m2m program, as well as improve client outcomes, through a client case management tool that would also serve as the primary data source for routine M&E.

Using funding from Johnson and Johnson (J&J), in 2015, m2m was ready to start developing a new mHealth application to support the mentor mothers' tracking of client appointments and active client follow-up/defaulter tracing. Learning from previous digital health interventions, m2m sought an experienced technology partner that could help design a system to manage client follow-up aligned with and informed by programmatic priorities and implementation realities. When choosing a partner for the app development, rather than signing on another technology vendor, m2m sought an organization that fully understood its facility and community health operating context. It selected Dimagi, a social enterprise that delivers open-source software technology suitable for low-resource settings and underserved communities. Dimagi's expertise, which combines technology, program management, and community health, allowed it to work with m2m to develop a meaningful app that would benefit both the program and the mentor mothers, focusing first on the program's facility component. Using additional funding from J&J in 2016, and from the United States Agency for International Development, m2m continued its work with Dimagi to develop a community client case-management app.

Designing the mHealth Applications

Dimagi used its CommCare platform to develop both m2m apps. First it developed App 1, the electronic client appointment diary app, and then App 2, the community client management app. App 1 tracks clients' appointments through an electronic appointment schedule; notifies FMMs about clients who are due for an appointment or have missed one; and flags those clients for active follow-up, thereby enhancing retention in care of clients on ART and along the prevention of mother-to-child transmission cascade. During the initial development stage, Dimagi deployed a program manager and technical lead to work with the m2m team to understand the m2m program, including walking through its current forms and indicators, and observing mentor mother workflows and their interactions with clients. Based on this initial scoping, Dimagi developed an application workflow and then a Version 0 in CommCare. Once it had developed Version 0, Dimagi demonstrated it to m2m program and M&E staff, made changes based on their feedback, and then demonstrated it to the FMMs to obtain their input.

App 2's development process was like that of App 1, but slightly more complex. App 2 supports community client case management; health education on reproductive, maternal, newborn, and child health; early childhood development, HIV and linkages/referrals to facility-based clinical care; and other high-priority services. Dimagi needed to develop algorithms that would pull up questions for the CMMs to ask their clients, based on what had occurred in previous visits and in response to the clients' current health needs and the support services available. It also needed to remind CMMs about referrals and to follow up with those they had referred. The volume of cases stored on the devices placed a heavy burden on memory and slowed down the app's performance. Dimagi had just developed a new feature to search all cases and case claims, which would push cases to the cloud if they were inactive for 90 days, removing the information from the mentor mothers' devices. The case claim feature would help m2m avoid duplicating information on clients who accessed services from more than one m2m facility.

m2m wanted the mentor mothers to be able to search for clients on the cloud server, to determine whether someone really was a new client or simply had moved from another location. Dimagi also created linkages from App 2 to App 1, so an FMM could send a request to a CMM to follow up with a client who had missed an appointment. The CMM could then send the FMM feedback about the visit

with the client. CommCare generates unique patient identifiers used to link clients between facility and community programs. This identifier is assigned per household and mother and can be used to track patient trends over time.

CommCare's offline functionality allows FMMs to work without connectivity and then upload the data at the end of the day, when they are done seeing clients, and for CMMs to do so when they are back at a facility and can connect there to the Internet. The app time-stamps when a form has been completed rather than when it has been uploaded, so that an accurate record can be kept and so that a supervisor can see how many clients a mentor mother has seen in a given day.

According to m2m's deputy director for research and strategic information, m2m decided to strengthen the organizational capacity for hands-on day-to-day supportive supervision to mentor mothers using App1, for an initial start-up period of three months of post-training and roll out App 1 in all six countries where it worked at the time of implementation. m2m staff saw no reason not to do so, because all the countries had strong programs. Because each country had its own set of requirements, Dimagi adapted the app to fit the specific context before rolling it out.

Dimagi helped m2m select and test the appropriate hardware to run the mobile application. m2m decided to purchase the SmartPoynt phone, which is manufactured in South Africa and runs on the Android operating system. When m2m expanded mHealth to the community level, it decided to use tablets, because mentor mothers needed to enter a large amount of information and eventually will provide multimedia education messages and videos during visits. In South Africa, the CMMs requested phones rather than tablets for security reasons, so m2m purchased Samsung mobile phones. m2m purchased all devices and pays for all airtime required for the devices to be connected to the network, currently set at one gigabyte of data per month. For m2m's South Africa program, the cost is roughly US$1,700 per month for the data for 244 users using App1 and App2 in South Africa in 86 health facilities and three communities.

Implementing the mHealth Applications

Dimagi tested App 1 with monitoring and evaluation coordinators (MECs) first, and then in the six m2m countries for two weeks, before rolling it out more widely. For App 2, once Dimagi tested and refined the prototype, it conducted a pilot in Western Cape, South Africa to inform the final strategy for system rollout. To train the mentor mothers on the apps, Dimagi facilitated a four-day training-of-trainers event, and m2m then cascaded it down to the mentor mothers. Part of the training focused on digital literacy for mentor mothers, including how to use the phone and typing exercises, while also helping them understand how the app functions. After the first round of training on App1, they brought in short-term research assistants to work with the program managers for a period of up to three months, to provide robust supportive supervision to the mentor mothers in using the app. This greatly improved digital health literacy and spurred the mentor mothers to familiarize themselves with the app and its use more rapidly. In a few sites where the research assistants hired were not involved early enough in the App1 training, there were gaps in technical knowledge, which affected supervision. Going forward, mentor mothers will have two in-service trainings per year, including refreshers on the app.

After the first users began to use the tools, Dimagi recommended that m2m let the app stabilize with this smaller group of users for a few months and then scale it up to other users. Following the initial pilot, m2m, with financial support from Comic Relief and the United Kingdom Department for International Development, rolled out App 1 to 179 m2m facilities in six countries. With support from J&J, m2m rolled out App 2 at five sites in South Africa, seven sites in Swaziland, and six in Lesotho. A key question in this rollout was how to train mentor mothers to manage client interaction while using the apps. Because the Mentor Mother Model is built on the relationship with clients, it was important that the

technology not impede that relationship. During the pilot, the need for practical training scenarios to help mentor mothers better understand the app's use and anticipate real-life situations became apparent. Robust post-training follow-up and frequent on-site support for the CMMs were also needed.

Depending on the project, Dimagi staff try to transition from direct project support four to eight weeks after a contract ends. To support this process, they try to ensure that the organization can troubleshoot problems that arise, by building in-house capacity. Dimagi encouraged building the capacity of at least one staff member within m2m, an mHealth coordinator, on how to program CommCare software to make changes as needed and develop new functionality. This capacity building allows for sustainability within the organization once the Dimagi contract ends. m2m also brought the MECs up to speed on the new technology, because they are located in-country and could troubleshoot some issues more readily.

When using the devices, mentor mothers have different channels of technical support. The first source of support is through the MECs. The MECs serve as a mini-help desk, from which mentor mothers or supervisors can request support by SMS or a phone call. Issues generally can be addressed remotely. However, if an issue is systemic within the CommCare application, it must be escalated to the mHealth coordinator based at m2m's head office. A WhatsApp group is available for the mentor mothers, MECs, and the mHealth coordinator where they can ask questions if they encounter issues. District managers who manage sites play a pivotal role, because they are a main channel of communication between the mentor mothers and the MECs. In some countries, they have been capacitated by the MEC on how to troubleshoot most basic issues related to the apps, either in person or by phone.

Privacy and security concerns around using the app are addressed by password-protecting it and encrypting the data when they are sent to the cloud. CMMs take an extra step to ensure data privacy, by logging out of the app after each home visit as they walk to the next home. The app will log them out automatically after two hours of nonuse. With these measures in place, if the device is stolen, an unauthorized person would not be able to log into the app. Mentor mothers said there are similar concerns about paper, except that there is no way to protect paper records if they are stolen or lost. In South Africa, mentor mothers also return the devices to the health facility each day, where they are stored securely, rather than carrying them home; this practice adds another level of security.

> "Before, if their bag was stolen with the paper tools, they would lose their info. Now, with the phones, they don't lose the info, as it goes to the cloud once it is synced and it is safe there."
>
> —A South African CMM

Data quality was considered at the beginning and during development of the application. Dimagi helps partners map possible areas for data quality issues within the tools and forms, and then develops appropriate data validations within the system. Thereafter, m2m is responsible for checking data quality, unless something within the application could be causing the issue. m2m's head office conducts monthly and quarterly reviews of the data from the six country offices. These offices conduct periodic site visits for data quality checks and semiannual data quality assessments. At country level, the program managers conduct biweekly or monthly supportive supervision visits, to provide quality assurance and quality improvement support. As part of this, the program managers triangulate records between App1 and the paper-based form (the "master client card"), to ensure that all new clients enrolled are being tracked using App1 and that clients who miss appointments are diligently followed up. App 2 no longer has a paper-based form associated with it, but some data can be checked against the master client card and facility records, especially for clients who have been documented as facility-community clients.

Initially, CMMs expressed concern about using the phone in front of their clients, but nevertheless introduced it to their clients and showed them what they were doing. Now, clients see the phone as a safe

place to store their information. Mentor mothers stress that confidentiality is enhanced when they use the phones and show their clients how data are password-protected. Several FMMs still like to use the paper master client card during a client's first visit, because they feel that the phone limits their interaction; they say they are more comfortable using the phone with the client during follow-up visits. m2m realizes the need to incorporate all client services documented on the master client card into App1 to make it a more comprehensive client management tool and avoid the challenges that come with mentor mothers having to use both paper-based tools and App1.

In contrast with the limitations of the paper-based system, m2m now has access to real-time data and can perform periodic checks across all countries to regularly monitor key indicators, such as client volumes, client retention, and clients lost to follow-up. With the app, m2m can check these indicators daily or weekly, whereas before, it checked them only monthly or quarterly. In light of this development, m2m is better able to troubleshoot issues and conduct quality assurance and performance management.

Before implementing the digital system, site coordinators were responsible for tabulating and analyzing data that were submitted monthly. The app eliminated the need for manual tabulation, but there was still a need to keep the site coordinators engaged in the review process and to use findings for supervision of mentor mothers. In South Africa, the country office is training supervisors to use mentor mothers' daily activity reports to target sites that need supervision and drill down to the causes of underperformance. One mentor mother said she likes the app, because her supervisor can see how well she performed.

The Way Forward: Sustainability for the mHealth Applications

Adding features to the apps will depend on programmatic need; m2m does not want to add anything that does not facilitate such need. The current apps have facilitated the organization's ability to improve client management and enhance data use in program implementation. Further mHealth developments will be determined by the program's operating environment and ongoing program developments.

m2m was cognizant of the cost implications of scaling up digital health; yet, during budgeting, the organization never considered reducing the costs related to digital health implementation as an option to reduce overall cost. For example, rather than sacrifice training for the mentor mothers or reduce the amount of support provided to them, m2m preferred to reduce the scale of the digital health implementation, by decreasing the number of sites. In this way, m2m made a commitment to build mentor mothers' capacity to use the apps successfully rather than sacrifice that capacity building in order to expand the program to additional sites using the digital health platform. Dimagi emphasizes that an organization should not scale up until the end users are using the phone correctly instead of the paper forms.

Moving forward, m2m hopes to expand its partnership with MomConnect, a program through the South African National Department of Health that sends prenatal care messages to pregnant women. Already, once clients are registered through CommCare, they can be enrolled in MomConnect automatically, should they opt in. Patient data from m2m's system are sent directly to the MomConnect platform (implemented by Praekelt) following patient consent.

According to a project manager at Dimagi, community health workers need to think of the phones as something with which they can fully engage around all of the services they are offering, so m2m needed a holistic tool to support mentor mothers in their work. When you don't do this, the new app does not tend to go over well.

Lessons Learned and Recommendations

From the onset of its decision to implement digital health, M&E and program staff at m2m recognized the need for a high level of buy-in for the initiative, both by leaders in the m2m headquarters and in the

countries where m2m operates. After some internal awareness building within the organization about the value of digital health, this vision was aligned with leadership, leading to organizational buy-in regarding digital health as key to the future of their programs—a position that was supported by an enabling donor environment

Apart from high-level buy-in, another key to m2m's success was having mHealth champions with a clear vision of how mHealth would improve not only M&E but also service delivery. The champions were supported by high-level leadership, which provided resources and freedom to experiment. Another key to success was having an mHealth coordinator within m2m to support issues with the software and help develop some new functionality.

Partnerships were also critical to the success of m2m's approach to revamping its digital health strategy. From the beginning, an enabling donor such as J&J helped m2m to understand past challenges and strategize for the future. J&J's support was foundational to the development of the apps, by allowing the program and organization to evolve as the implementation evolved and letting the organization experiment with solutions and accept the possibility of failure. As mHealth has become a strategic part of m2m's program, the organization now includes a digital health component in all funding proposals, to ensure optimal client management systems and improved M&E. m2m also learned the importance of having a strong, continuous relationship with the technology company, because as the project evolves, so will the apps that support it.

According to m2m's deputy director for research and strategic information, mHealth takes a large initial investment and then becomes cost-effective. If you invest the effort, there is quite a lot of gain.

As with all programs, adequately anticipating costs is essential to sustaining an mHealth program. m2m stresses the importance of having an in-depth understanding of the running costs required to maintain the program. It is inherently easier to budget for design and start-up costs, but maintenance costs are often overlooked, such as managing the back end, making upgrades, and replacing devices. As for hardware, m2m advises programs to have a realistic expectation of how long devices should be expected to last and consider sources of new funding to replace them. Dimagi also emphasized the potential hidden costs in the amount of time necessary for programming the many iterations required.

A key point is that a successful mHealth program should go beyond simple data collection to include job aids and decision support tools. One outcome of a successful digital health program that m2m has had to embrace is that improving the data available might reveal potential flaws in a system. For example, through the m2m apps, facilities now have a more accurate picture of which clients are lost to follow-up, so they can be brought back for services. A facility must be able to handle an increase in the number of clients as a result of this information being more readily available.

Finally, m2m credits the success of the apps in ensuring that technology enhances the mentor mothers program and does what it needs to do. For the apps to serve the program well, the organization must engage in a significant amount of consultation with the in-country teams and end users to understand how they do their work and how technology can help. A successful mHealth program uses a bottom-up approach to determine what information is needed to support clients and performance. An app needs to be beneficial and make sense to staff at the community or facility levels, because they will use it on a day-to-day basis. For m2m, the client/mentor mother interaction and the relationship they forge is key to the program's success. Any mobile application must enhance that interaction, rather than detract from it.

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APPENDIX 1. IMPLEMENTATION

To identify mHealth solutions that have been successfully scaled up and sustained beyond the pilot stage, MEASURE Evaluation conducted a scan of mHealth implementations for case management and decision support that also included data collection for M&E. The scan identified projects, partners, applications, and technology companies that developed applications for HIV, maternal and child health, and Ebola. The scan revealed several technology organizations with significant experience working with different organizations to implement mHealth solutions across health areas and regions. For the case study selection, the informatics companies with a large breadth of experience were targeted, because they provided a wide range of insights into best practices. MEASURE Evaluation worked directly with the informatics companies to select an implementing partner or project for the case studies. Its final selections were the Medic Mobile partnership with Living Goods Uganda and the Dimagi partnership with m2m South Africa.

In February and March 2017, MEASURE Evaluation staff traveled to the program offices both of the implementing organizations and the technology companies to conduct informant interviews. The Medic Mobile and Living Goods Uganda case interviews took place February 16–24, 2017, in Nairobi, Kenya, and Kampala, Uganda. The Dimagi and m2m South Africa interviews took place March 9–17, 2017, in Cape Town, South Africa. Informant interviews were conducted with the following people:

Technology company staff

- Senior managers
- Finance staff
- Project managers
- Designers
- Software developers

Implementing partners

- Senior management
- Finance staff
- M&E staff
- Technical program advisors
- Information technology staff
- Branch and facility staff, including supervisors and CHWs
- CHWs

MEASURE Evaluation developed a questionnaire for the organizations and staff involved in designing and implementing the mHealth solutions—informatics companies, the headquarters staff of implementing partners, the subnational office/facility/community-based organization staff of implementing partners, and CHWs. The questionnaire asked the key informants questions based on their roles. MEASURE Evaluation adapted the questionnaire from the mHealth Assessment and Planning for

Scale toolkit, published in 2015 by the World Health Organization.[1] The interview questions were framed around the following topic areas:

- Groundwork and system design
- Partnerships
- Technology and architecture
- Finance and costing
- Reporting, M&E, and decision making
- Operations
- Sustainability

Discussions with the informatics companies and implementing partners focused on the keys to scale-up success and dealing with challenges. Overall, the informant interviews aimed to answer the following questions:

- What considerations for scale were incorporated during the design and planning stages?
- What training was provided to the users on how to use the system?
- What partnerships are in place to help with sustainability and scaling?
- What was used to inform the decision of whether to scale up the program?
- Are there potential cost savings or efficiencies that could be realized by scaling up the system?
- What are the key lessons learned and best practices in taking a community health information system to scale?

[1] http://www.who.int/reproductivehealth/topics/mhealth/maps-toolkit/en/

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