Mobile WACh: Communication Empowering Patients and Health Care Workers

Submitted by Jennifer Unger (University of Washington) on January 18, 2018 - 4:23pm
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Proposal Status: Review Complete

Executive Summary

People want, need and deserve streamlined access to support for their health. Mobile WACh (Mobile Solutions for Women and Children's Health) is a unique open-source platform offering semi-automated bidirectional mobile messaging, connecting health care workers (HCWs) directly to patients via SMS, driven by patient characteristics, health data and clinic attendance. **As a result, HCWs are empowered to offer real-time tailored information and support to patients in low-resource settings.** The unique functionality of the Mobile WACh platform rests in the end user's (healthcare worker's) experience and ability to integrate mobile messaging into daily workflows and provide tailored, consistent, efficient health advice through individual and automated messages. (Figure 1) **Mobile WACh harnesses the benefits of *SMS messaging* by bringing vital health information to people where they are and expands its reach by engaging users with *SMS dialogue*- asking critical questions at crucial times in order to assess the needs, challenges and health of babies, mothers and HIV patients.** With appropriately timed and targeted messaging, patients are prompted to communicate concerns and questions in real-time through efficient bidirectional communication with trained HCWs which allows for swift connection to care and triage of potentially acute conditions (Figure 1). Mobile WACh also manages tracking of patients' clinical care to promote attendance and retention in care. **Current SMS systems provide information and visit reminders but our human centered design approach to a direct communication conduit between HCWs and patients optimizes patient support and work flow efficiencies.**

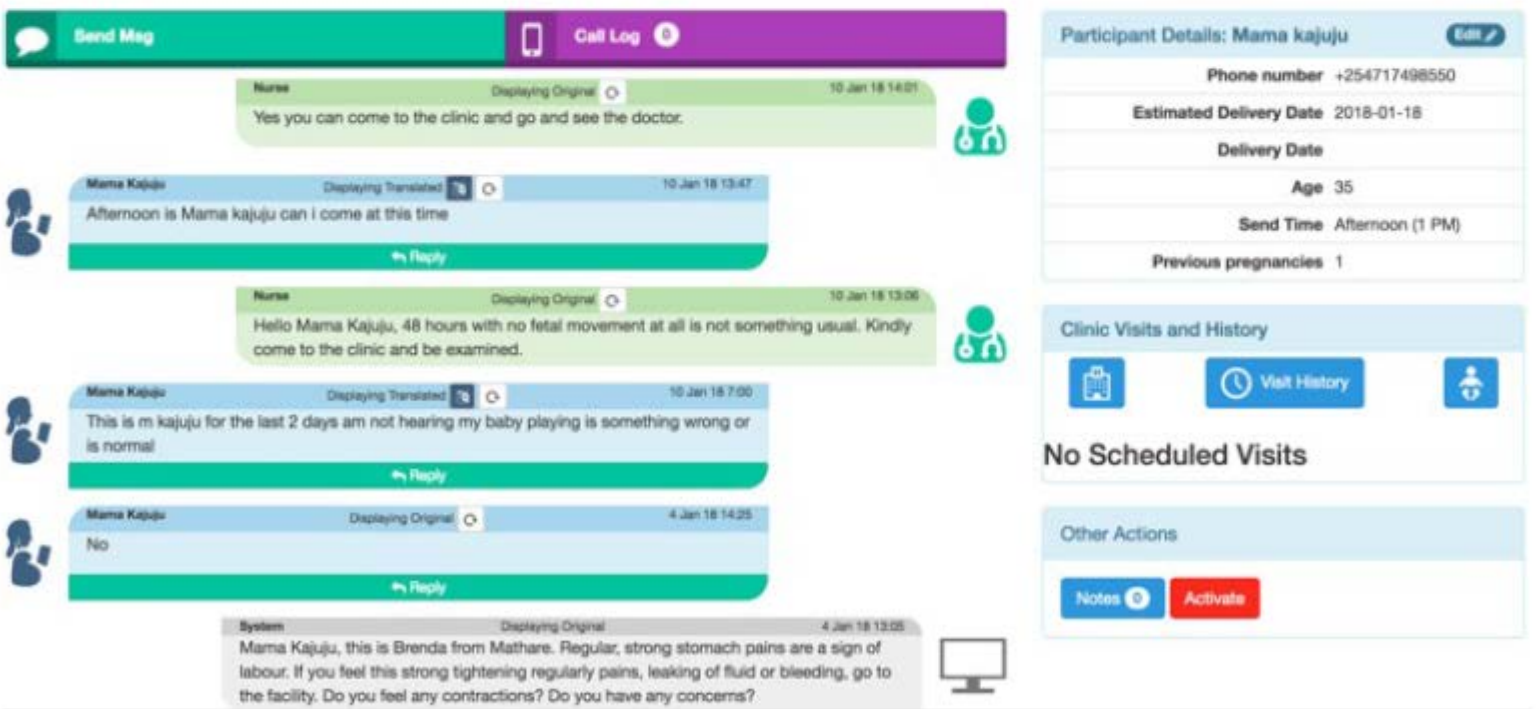


Figure 1: *Mobile WACh Communication Platform with triage of potential pregnancy complication*

Mobile WACh's platform and messaging have been used as a strategy to support patients in accessing proven interventions such as facility delivery, exclusive breastfeeding, family planning, antiretroviral therapy (ART), pre-exposure prophylaxis (PrEP), early identification of

neonatal and infant illnesses and peripartum depression care (Unger JMIR 2017, Ronen AIDS Care 2017, Drake Cont Clin Trials 2017, Unger BJOG in revisions 2018, Bhat Gen Hosp Psychiatry 2018). Development of Mobile WACh over the last 5 years has progressed through careful qualitative work with end users, clinical pilot studies, and randomized trials. With *Saving Lives at Birth* funding, we are working closely with the Kenyan Ministry of Health (MOH) and key stakeholders to further evaluate this intervention, develop a business plan and sustainability model, and closely integrate with the Kenyan Ministry of Health e/mHealth strategies and targets for maternal, newborn, and child health. Plans for deployment at the county level in Kenya are in development.

As we create our roadmap for the institutionalization of this digital tool and envision its progress on the Global Goods Maturity Model, we recognize the critical need for significant investment in the platform's sustainability – of both technology and implementation. Our tool has been tested in multiple contexts, results in very high mobile messaging engagement (currently >80%) and is being rigorously evaluated for impact on health outcomes. Mobile WACh meets many of the functional requirements as defined by the WHO classification of Digital Solutions (WHO, Monitoring and Evaluating Digital Health Interventions, 2016): it has demonstrated feasibility, high end-user acceptability and adoption (both patients and HCWs), improved service utilization and trends for improved health outcomes. However, Mobile WACh requires investment for sustained success and development specifically for its software platform.

At the end of the Digital Square funding we envision a more sustainable, scalable architecture and readily deployable, easily adaptable instances of the Mobile WACh platform software and SMS data bank. This will include supporting significant new functionality that will remove technical barriers to use and enable an accessible, maintained and supported codebase with capability of responding to community demands for feature expansion. We view the platform and associated message banks as part of a larger digital communication ecosystem and we envision that external partners would be able to download, customize and deploy this technology and potentially integrate with other technology platforms, including electronic medical records (EMRs) and data collection tools (Figure 2).

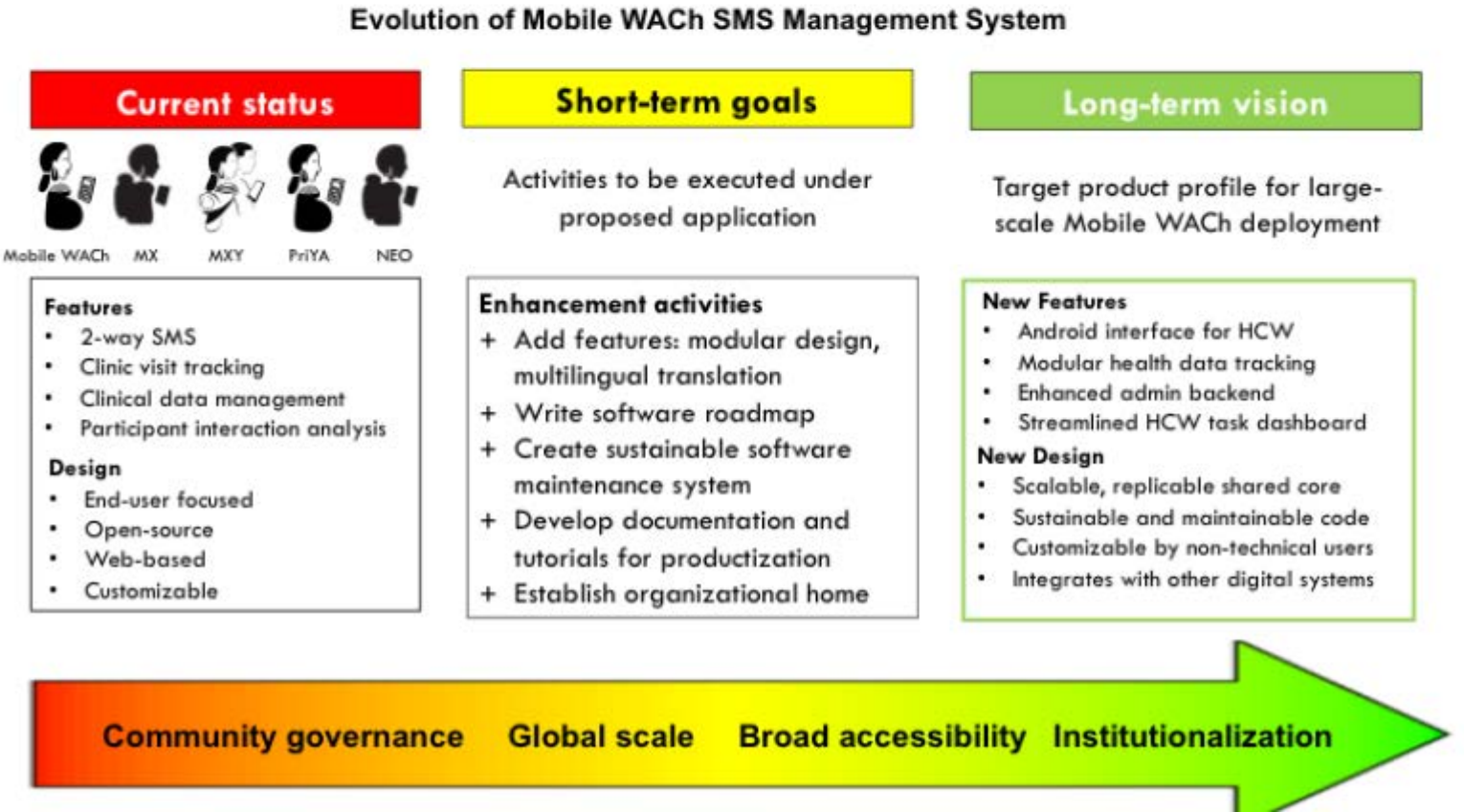


Figure 2: *Evolution of the Mobile WACh Tool to achieve Global Goods Maturity*

Consortium Team

This application will be led by Dr. Jennifer Unger (UW Global Health and OBGYN), Dr. Keshet Ronen (UW Global Health) and Dr. Brian DeRenzi (UCT Department of Computer Science and Dimagi) who bring more than 10 years of experience in designing, deploying and evaluating mobile technology tools to address challenges in global health. The team includes additional expertise in information and communication technology for development (ICTD) (Dr. Keshet Ronen, Trevor Perrier), epidemiology and clinical research (Dr. Ronen, Dr. Jillian Pintye and Dr. Alison Drake) with senior mentorship from Dr. John Kinuthia (UoN, Director of Research) and Dr. Grace John-Stewart (Director, Global WACh). The larger team includes experts from the University of Washington (UW) and University of Nairobi (UoN) Kenya Research and Training Center (KRTC) with over 3 decades of collaborative research and implementation experience as well as the UW Global Center of Integrated Health of Women, Adolescents, and Children (Global WACh), and the University of Cape Town (UCT) Centre for Information and Communication Technologies for Development (ICT4D) and the UW Department of Computer Science and Engineering (CSE) who have extensive expertise in building innovative mHealth platforms. The UW KRTC and Global WACh offer significant institutional capacity for this application to the *Digital Square funding for digital health global goods*. KRTC supports both trainees and investigators in the planning, implementation, analysis, and presentation of projects. Created in 2006, KRTC is comprised of 27 UW and Kenyan faculty, 18 US-based staff and ~80 Kenyan-based staff, and over 30 post-and pre-doc trainees. The faculty, appointed at US and Kenyan institutions including UW, Fred Hutchinson Cancer Research Center, University of Nairobi, Kenyatta National Hospital, Kenya Medical Research Institute, and the Kenya National AIDS and STI Control Programme (NASCOP), collectively work with ~$15 million annually in research and training funding. Established in 2011, the mission of Global WACh is to make scientific discoveries, cultivate leaders, and bridge disciplines to advance the tightly connected health and wellbeing of women, adolescents, and children. Global WACh has over 200 members and is home to over 23 research grants with an annual combined budget of over $6.8 million, housed in 3 UW sponsoring departments: Global Health, Pediatrics, and Obstetrics and Gynecology. ***The collaborative efforts of UW Global WACh and KRTC provide vision and experience in intervention development and implementation within large health systems, community engagement and capacity building with in-country implementers and health workers.***

The UCT ICT4D Centre works with a number of communities across sub-Saharan Africa to co-design and co-develop appropriate uses of ICTs (e.g., mobile phones, Internet access) to achieve development goals. The Centre was founded in 2009 and has grown to include more than eight staff members across three faculties and houses 50 postgraduate students. The Centre serves as a focal point for researchers in Sub-Saharan Africa who create and deploy ICT in the region. The UW Department of Computer Science and Engineering (CSE) Computing for Development Division (C4D) brings to this proposal expertise in developing open-source sustainable service tools in a wide range of application domains including public health. ***The representatives from these departments have expertise in small and large-scale design and digital deployments and capacity building among in-country technology developers and health workers.***

Project Description

There is an increasing recognition of the effectiveness of bidirectional mobile messaging and its benefits over one-way push messages. As a result, there is demand for user friendly scalable bidirectional messaging systems. To date, 7 Mobile WACh projects have been deployed in Kenya and Seattle, Washington, supported by the Saving Lives at Birth Consortium (USAID), National Institutes of Health (NIH), DREAMS Innovation Challenge and Society for Family Planning (SFP) and at least 3 other projects in development. The success of these systems depends on their ability to integrate and alleviate rather than add to the work burden of HCWs and must be efficient and cost effective for the larger health care system. Our current tool is customized on a case-by-case basis with input from software developers and global health experts. Guided by the Global Goods Model, the goal of this application is to enable maturation of the Mobile WACh SMS Management System to a scalable, sustainable system with stable core and modifiable periphery, which can be efficiently accessed, customized and deployed by non-

technical users globally (Figure 2). This includes a central website, standardized training tools, and well-developed systems for consultative input. We propose to adapt our current architecture and project model to create a website where internal and external collaborators can access and rapidly deploy a modular version of Mobile WACh with options for different types of deployments including utilization of message banks and templates for message development.

In order to achieve these goals, Digital Square funding is needed to support:

1. Additional features to enable scaled deployments, including:

- Developing a generic shared modular codebase that can be customized to support different deployment use-cases of future projects outside our organization
- Development of standardized "messaging packs" building a larger automated SMS bank that can be customized for individual deployments
- Adding a "quick-reply" feature for HCWs to pull from a precompiled FAQ based on qualitative analysis of messaging from our 6 deployments
- Development of automatic identification of message topics and importance functionality based on natural language processing from our existing SMS data sets
- Development of an Android-based HCWs frontend to lower per-health facility costs and allow HCWs to manage incoming patient messages more efficiently
- Engagement tracking module that notifies HCWs of patients who need additional contact and follow-up.

2. Capacity for in-country development:

- Thorough documentation and revised road-mapping of the existing system for external users
- In-country Hackathons to engage South Africa and Seattle-based developers with in-country-developers and make progress on identified bugs and the roadmap
- Support for in-country project development to enable capacity building on real-world deployments and capacity build for research of other use cases

3. An organizational home for the open source digital Mobile WACh tool, including:

- A website, as well as user and developer communication tools (e.g., a Discourse forum and Slack channels), and an issue tracker
- Infrastructure to develop regular releases and builds of the software with integrated testing
- Stand-alone virtual machine reference setup (e.g., using Docker) to standardize development and deployment environments
- A set of tutorials illustrating common deployment scenarios
- A set of realistic test data and ready-made demos to illustrate unique features and recommended deployment configurations of the system

User Stories

Individual patients (current)

- A **pregnant woman** experiences decreased fetal movement and is unsure about returning to clinic so she sends an SMS through the Mobile WACh system and is counseled to present for an ultrasound where they **diagnose a fetal demise**. The nurse is able to provide support throughout this process. (Figure 1)

· A **postpartum adolescent** experiences irregular bleeding and weight loss after a contraceptive injection. She lives a large distance from clinic and has not disclosed the **family planning** to her partner or family. She sends an SMS and is reassured that this is an expected side effect but is given parameters to return to clinic. (Figure 3)

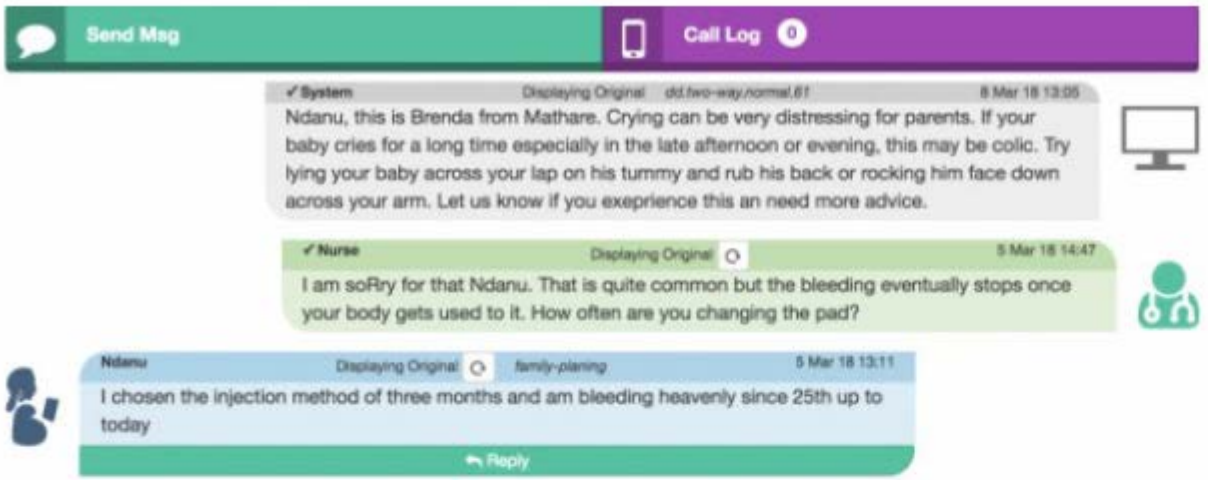


Figure 3: *Use of the Mobile WACh tool to receive advice on family planning and avoid unecessary clinic visits.*

· A **neonate** experiences diarrhea and the mother, whose partner is working in another location, wonders if the infant needs to be seen by a doctor. The mother sends an SMS and the nurse is able to triage the neonate and determine he needs to present to **clinic for evaluation**. (Figure 4)

Figure 4: *Use of the Mobile WACh tool to identify a sick infant and advise a necessary evaluation.*

· A **young adolescent** receives pre-exposure prophylaxis (PrEP) from her clinic provider but when she returns home she experiences nausea and is worried the pills are damaging. She sends an SMS to the PrEP nurse and is given strategies to **improve her side effects and**

adherence.

Individual patients (future/ potential)

- Adolescents without access to sexual and reproductive health (SRH) services have a confidential conduit to receive personalized counseling and support

- Families with growth restricted infants needing to monitor infant growth progress are able to avoid lengthy and expensive trips to clinic while receiving support to care for and monitor their fragile infant

- Patients with chronic medical conditions (Hypertension, Diabetes, Depression) requiring long-term surveillance but not clinic attendance for every check-in or medication change are able to communicate challenges (and successes) without expending personal and system time for a full visit.

Health Care Workers (current)

- An **antenatal care nurse** is unable to track the women who are supposed to attend ANC on any given day and those who have not come in for care. Phone calls to follow up with patients are unsustainable given time and documentation requirements. With Mobile WACh's visit tracking the nurse has daily, weekly and monthly retention lists and can report back on attendance.

- **Postpartum nurses** have little time to counsel women about family planning and almost none to address personal concerns, values or challenges. Mobile WACh educates and collects data from women to target efficient counseling.

Health Care Workers (future/potential)

- **A community health worker (CHW)** needs to assess neonates for signs of severe illness but is only able to cover the entire geographic area every 2-3 weeks which delays evaluation of neonates during the most critical time. She is able to automatize SMS to a large group and triage the most critical infants and determine a visit strategy.

Ministry of Health (future/ potential)

- A county level health administrator receives prompt notification of only about 60% of live births in her county. Through Mobile WACh, she receives birth outcome and severe adverse event notifications from 90% of women within a week.

Program Implementers (current)

- A large NGO deploying PrEP in Kenya experiences a retention rate of 0.4% at 6 months but has little to no information about why young women do not return for medication or counseling. With Mobile WACh they can privately communicate with women about their experience with PrEP at home and improve understanding about implementation.

Program Implementers (future/potential)

- A large NGO deploying PrEP in South Africa has a small budget for IT support and wishes to independently use the mobile WACh system to improve patient monitoring and support. They download and deploy Mobile WACh and integrate it with the EMR system in use at their clinics.

Researchers

- A pediatric research group focused on the effects of HIV exposure on infant growth and development requires frequent communication

and data transfer from patients. The burden of presenting to clinic is relieved with 2-way SMS and retention tracking.

Use Cases

Currently the Mobile WACh platform is deployed in 8 sites in Kenya and has been used in 7 individual implementations to support mainly maternal, child and reproductive health and HIV care in Kenya. The provider focused two-way messaging interface and patient tracking capabilities have allowed for significant impact within these communities including the ability to ***use the platform to triage and counsel on potential medical conditions in a timely manner, give advice on simple medical concerns and provide support to patients experiencing challenges during the reproductive continuum.*** The system is poised to reach large numbers of women with many flexible capabilities including different languages and diverse conditions (pregnancy, postpartum, infant death, HIV).

With investment from Digital Square, new collaborators (technology experts, global researchers, program implementers) and the existing consortium, we anticipate the following example use cases will be possible with achievement of our milestones (Figure 5)

- Application of the semi-automated two-way messaging and patient tracking Mobile WACh platform to other medical or social contexts.
- Large scale deployment across multiple countries in which SMS is a dominant communication modality.
- The ability of patients to transfer participation from clinic to clinic or to be referred to another facility.
- Capability of messaging platform to interface with other electronic medical records (EMR) systems.
- An implementer or researcher is able to remotely access, download and deploy the Mobile WACh platform and messaging.

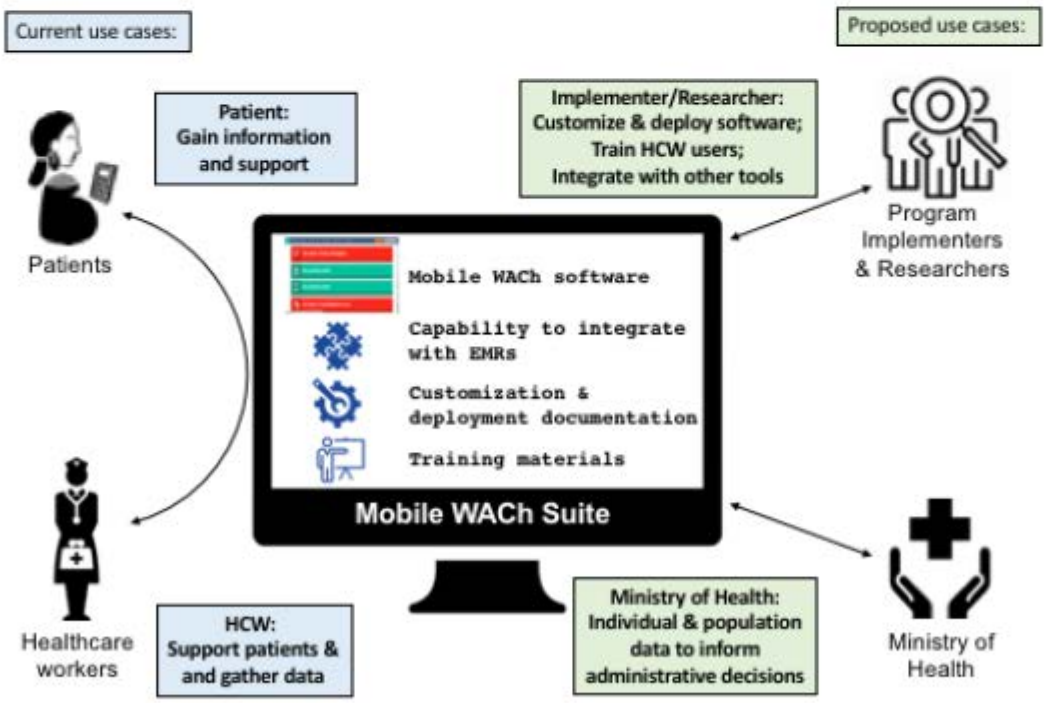


Figure 5: *Mobile WACh potential use cases*

Current status of the Mobile WACh Technology

The Mobile WACh SMS Management System (Figure 6) is an open-source cloud-based software that manages bidirectional semi-automated SMS messaging between HCWs and patients. The current system is deploying two-way messaging to over 3000 women and providers in 8 clinics.

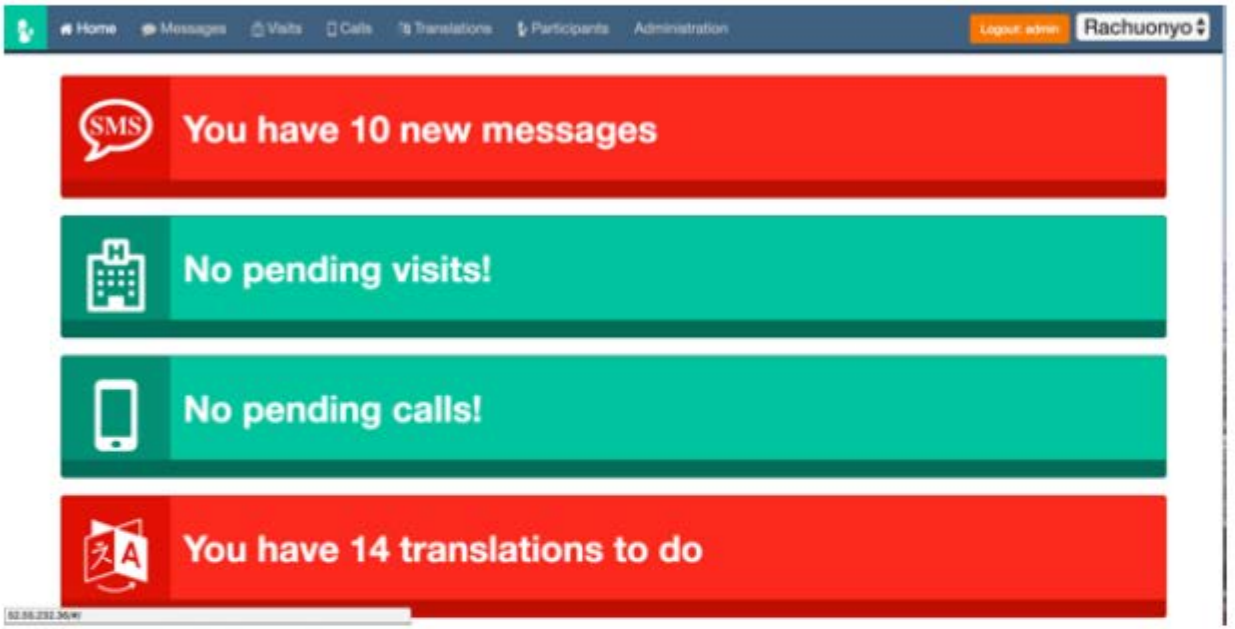
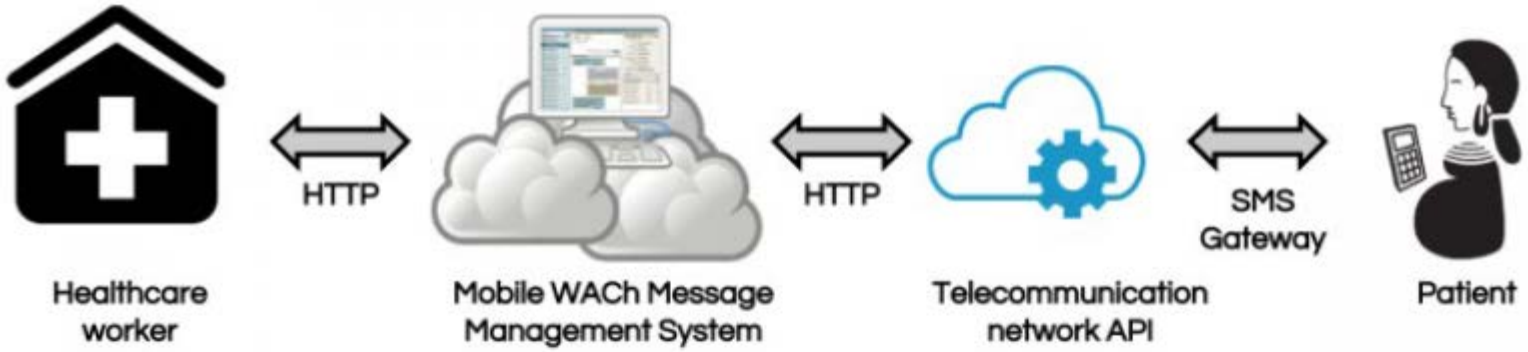


Figure 6: *Mobile WACh Tool dashboard*

The Mobile WACh system is designed with a flexible modular architecture to support multiple user interfaces, multiple backend SMS providers, and incremental scale. The current system consists of two main components: a Django-powered backend running in the cloud and an Angular-based front-end currently accessed via an in-facility internet-connected laptop computer. Using the front-end website nurses read and respond to messages as well as manage basic health metrics and clinic visits for each patient.

The communication between the front-end and back-end systems follows a RESTful API for accessing and updating patient messages and details. This standard architecture provides an abstraction for the front-end interface, allowing us to develop alternate front-end modalities targeting larger scale or different requirements, e.g., a progressive web app with service workers to support offline user or a mobile application on Android to support use on tablet or phone.

Additionally, the backend communicates with the messaging platform through an abstracted SMS transport layer. (Figure 7) This allows us to easily add support for additional mobile network operators or third-party SMS APIs. Existing deployments of Mobile WACh connect to an SMS toll-free shortcode which allows patients to receive and send SMS with any mobile phone at no charge.



The system manages and integrates display of incoming and outgoing messages, including:

1. **Scheduled automated outgoing messages.** These are sent by the system based on a message bank, uploaded via a .csv file (see supplementary material for a sample message bank). Sending of automated messages is managed using cron jobs, with reference to pre-defined events specific to the application, for example delivery date for pregnant women, PrEP initiation date for HIV prevention, or appointment date for appointment reminders. All messages end in a direct question to encourage engagement with the system.
2. **Incoming unstructured participant SMS.** These messages can be received in any language(frequently including SMS shorthand and slang).
3. **Manual responses to participant messages** sent by the HCW. These are entered directly into the messaging interface as free text in any language.

The web-based HCW interface is used to manage the incoming message queue and review all previous messages in a view emulating the conversation style of smartphone messaging apps (Figure 8). In addition to summarizing message dialogue with patients, the HCW front-end contains the following features to enhance message management and workflow:

- Every incoming message **must be replied to or actively dismissed by the HCW**, to ensure no participant messages are missed.
- The interface enables **translation of messages and toggling between the languages** displayed for each message, to support HCW understanding and quality control in multilingual settings. This is also important for making SMS shorthand easier to read when reviewing past messages.
- **Patient clinical information** is stored and displayed in the same interface as the message management so that message responses are informed by the patient's current medical context. This context is manually updated through the interface as new information is learned (e.g. a delivery, starting family planning, etc.). In the future we hope to bridge this context to existing EMRs if a facility is using one.
- Tracking of scheduled and attended patient visits (Figure 8). This provides additional context for messaging and enables scheduling of

automated visit reminder messages based on upcoming visits.

- Documentation of patient phone calls in addition to SMS (Figure 8). Phone calls to participants can be scheduled to follow up after important events (e.g. delivery), as yearly check-ins, or to follow up on multiple SMS delivery failures.
- System home page that summarizes system status and highlights pending tasks, such as new incoming messages, translations and visits to verify (Figure 6). The home page was designed to facilitate HCW workflow. Sections with pending action items appear in red and indicate the number of tasks left to do. This dashboard helps ensure that messages are not left unattended for long periods of time.

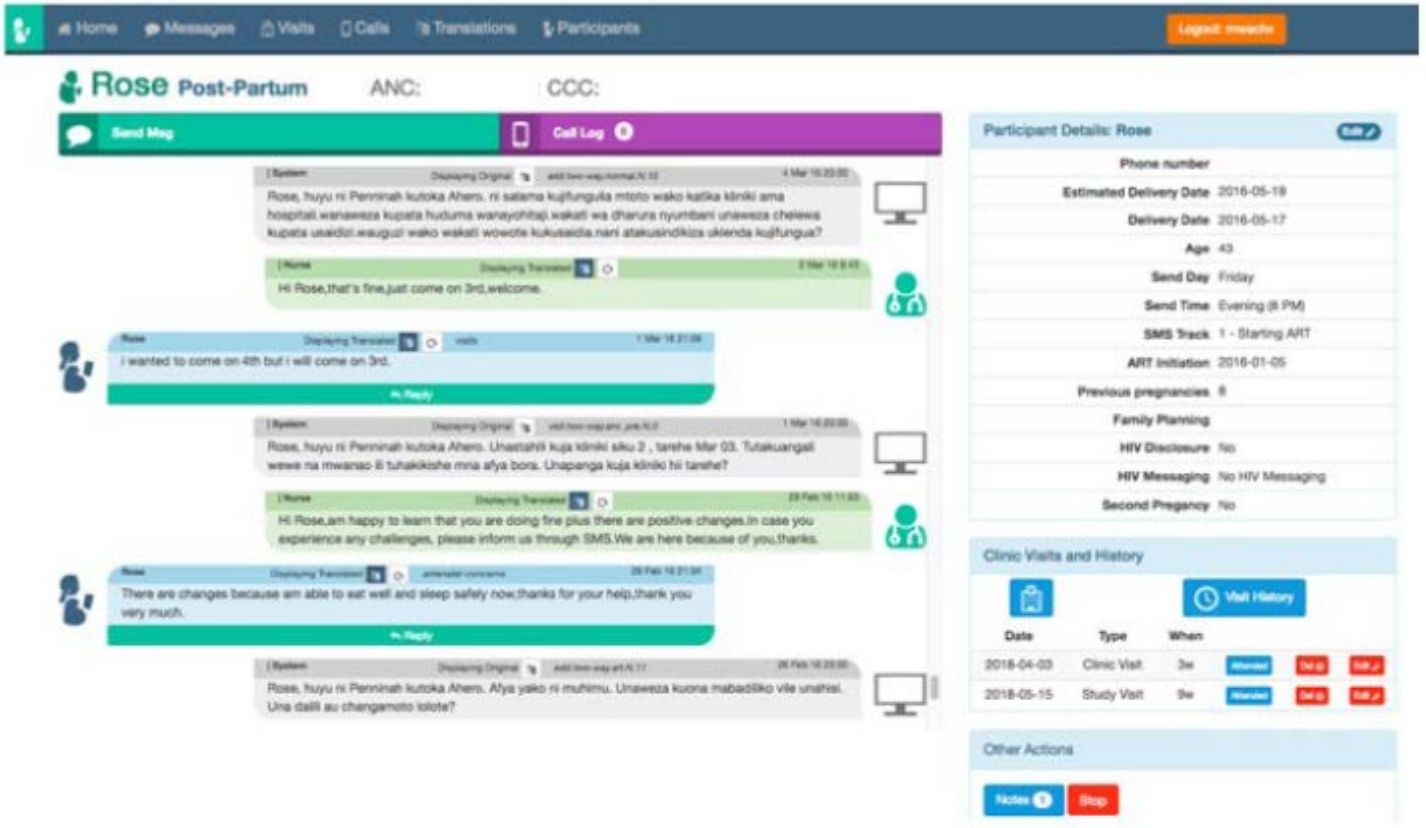


Figure 8: *Mobile WACh Communication Platform patient page*

Proposed activities to improve the reach and sustainability of the Mobile WACh Technology through the Global Goods Maturity Model

Global Utility

Source Code Accessibility

While the source code for Mobile WACh is currently hosted on GitHub and licensed with the very permissive Apache License, additional work can be done to increase the accessibility of the code. Specifically, it needs to be refactored to develop a generic shared modular codebase that can be customized and scaled to support different deployment use-cases of future projects outside our organization.

Digital Health Interventions

There are a number of new features this funding would support that have already been identified that would increase the deployability and scalability of the system, including a FAQ for fast responses, automatic language identification and prioritization, an Android-based frontend, and a tracking module to ensure that patients needing additional follow-up are identified.

- Adding a quick-reply feature for HCWs to pull from a precompiled FAQ based on qualitative analysis of messaging from our six deployments would support scaling the application by reducing the amount of time required per message. Currently, we see that many participant questions or concerns can be answered with only slight modifications to messages HCWs have already sent. Streamlining this process with a library of common responses will reduce the amount of time spent on processing and answering generic questions and allow clinic staff to focus on the more urgent cases.
- The development of automatic identification of message language, topics and importance, based on natural language processing (NLP) from our existing SMS data sets, will allow us to triage and direct messages to targeted HCWs for response. The unstructured text of incoming messages in multiple languages means that existing English-centric NLP toolkits cannot be used for automatically filter messages. We have a growing corpus of both HCW and participant messages on which we can train NLP classification algorithms.
- An Android-based frontend for HCWs, to replace or augment the current web-front end, will lower the barrier to access and the cost of supporting additional workers. Moving from a laptop-based HCW system to an Android-based SMS management system lowers the costs associated with scaling the Mobile WACh platform and will enables HCWs to manage incoming patient messages more efficiently.
- Engagement tracking module that notifies HCWs of patients who need additional contact and follow-up. This module will use SMS delivery reports from the SMS gateway if available as well as the frequency of replies from individual patients. Automating the process of re-engaging with patients will make the Mobile WACh platform more reactive since currently clinic staff only follow up to patients send messages into the system.

Community Support

Developer, Contributor and Implementer Community Engagement

Our international team will allow us to setup and engage with developers from across the world to help existing organizations use the Mobile WACh platform, as well as build tools that connect Mobile WACh to the larger mHealth ecosystem. We envision a number of initiatives to support this, including:

- In-country Hackathons to engage South Africa- and Seattle-based developers with in-country-developers and make progress on identified bugs and the software roadmap.
- Support for in-country project development to enable capacity building on real-world deployments and capacity build for research of other use cases.

Community Governance

- A website, as well as user and developer communication tools (e.g., a Discourse forum and Slack channels), and an issue tracker.
- Infrastructure to develop regular releases and builds of the software with integrated testing.

Software Maturity

Software roadmap

- Thorough documentation and revised road-mapping of the existing system for external users.
- Design road map for potential integration into partner EMR.

User documentation

- Development of standardized "messaging packs" building a larger automated SMS bank that can be customized for individual deployments.
- Stand-alone virtual machine reference setup (e.g., using Docker) to standardize development and deployment environments.
- A set of tutorials and training materials illustrating common deployment scenarios.
- A set of realistic test data and ready-made demos to illustrate unique features and recommended deployment configurations of the system.

Community Feedback

In the past 6 years of the Mobile WACh development we have solicited and received feedback through scientific presentations at both health care and technology conferences (CHI, DEV, ICT4D, Global Digital Health Forum, FIGO, CROI, IAS), through technical working groups (TWGs) and in meetings with the Ministry of Health and other implementing partners on the ground. In addition, **we have utilized both internal and external evaluations regarding the utility and future of our technology.** Throughout the past year we have met with technology consultants (ITECH, Caktus), performed a ***technology platform assessment*** (Cory Zue), created a ***Mobile WACh business plan*** and presented in multiple forums to ensure we understand the current state of the mHealth field and our role within it. We recognize the need for robust, resilient, rigorously evaluated technologies and aim to ensure we are contributing both scientifically and through direct health impact with our system. As such, we believe that Mobile WACh, and its patient centered, provider-facing two-way messaging approach continues to have potential for scalability and large impact.

We will seek feedback from the broader digital health community through several channels:

- Participation in the Digital Square peer review and potential mentoring process.
- Engaging Ministries of Health e/mHealth leadership and technical working groups (TWG).
- Public sharing of Mobile WACh achievements (and potential failures) through digital community forums.
- Documentation of all code and roadmaps publically on Github.
- Continued engagement with mentors and other implementing partners who have achieved more mature products.
- Presentations and workshops at annual conferences such as the ICT4D conference and the Global Digital Health Forum.
- In-country Hackathons to engage a spectrum of partners, developers, mentors and mentees.

A self-assessment on the Global Good Maturity Model

Please seen attached file name "Mobile WACh_Digital Health Software Global Good Maturity Model- v1.1_MW"

Workplan, Project Deliverables & Timeline

Please seen attached file name "GANTT_Mobile WACh_DigitalSquare"

Supporting Documents:
Global Good Maturity Assessment
Workplan, Project Deliverables & Timeline
Sample SMS Message Bank
Budget Narrative