mHealth4Afrika - Supporting Primary Healthcare Delivery in Resource Constrained Environments

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Abstract
mHealth4Afrika is co-designing and validating a modular, multilingual, state of the art health information system to address primary healthcare requirements in resource constrained environments. This platform has been co-designed in partnership with Ministries of Health, district health officers, clinic managers and primary healthcare workers from urban, rural and deep rural clinics in Ethiopia, Kenya, Malawi and South Africa. This paper provides insights into the motivation for this work, the co-design process followed to develop and validate the mHealth4Afrika platform to date, ongoing research and lessons learnt to date. The expected outcome is a multi-country proof of concept that can be adapted to address the requirements of different national health systems. mHealth4Afrika has the potential to make a significant contribution to strengthening primary health delivery in resource constrained environments.

1. Introduction

1.1 Context

mHealth4Afrika is specifically focused on supporting achievement of Sustainable Development Goal 3 (SDG3) - Ensure healthy lives and promote well-being for all at all age. The SDG3 targets include: reduce global maternal mortality ratio to less then *70 per 100,000 live births*; end preventable deaths of newborns and children under 5 years of age; reduce premature mortality from non-communicable diseases through prevention and treatment by one third and end the epidemics of AIDs, tuberculosis, malaria and neglected tropical diseases by 2030 (Sustainable Development Goals, UN). While these are very ambitious targets when compared for example, to the average maternal mortality ratio in Sub-Saharan Africa (initial focus of mHealth4Afrika) in 2015 of *546 per 100,000 live births* (Cunningham et al, 2017), the objectives of mHealth4Afrika are well aligned with the SDG3 targets.

mHealth4Afrika intervention countries (Ethiopia, Kenya, Malawi, South Africa) have strong policy commitments in place to support healthcare delivery. They are focused on increasing access to healthcare including offering free access to maternal healthcare (antenatal and postnatal care), leveraging technology to increase the efficiency of primary healthcare delivery more efficiently and address shortfalls in experienced healthcare professionals in rural and deep rural areas where large populations are based (Cunningham et al, 2016; African Union Commission, 2014; Federal Democratic Republic of Ethiopia National Planning Commission, 2015; NESC, 2007; National Economic Council, 1998; National Planning Commission, South Africa, 2013).

In the context of supporting Universal Health Coverage, there is a growing awareness of the critical role technological innovation can play in supporting people-centred health services (Cunningham et al, 2018a, 2018b; WHO, 2016; European Commission, 2014). The current default data capture method in resource constrained urban, rural and deep rural health centres in Ethiopia, Kenya, Malawi and South Africa is paper-based registries (Cunningham et al, 2016; Cunningham et al, 2018b). The level of detail captured is constrained based on the physical nature of the registry. It can be challenging to create a comprehensive medical history for patients who have engaged with multiple services or attended different health facilities. Data can inadvertently be duplicated across different program registries. This can create significant problems for primary healthcare facilities, especially in cases of medical emergency (Cunningham et al, 2018a). All of these issues have a direct impact on the quality and continuity of care.

Electronic records can include personal health records, electronic medical records and electronic health records (Moster-Phipps et al, 2012). There is a move towards personal health records in developing countries where individuals take a more active role in their health care, leveraging a range of technological applications to monitor health conditions (e.g., fitness levels, diabetes, blood pressure, heart conditions) as well as interacting with professional healthcare providers. Electronic medical records (EMR) are digital versions of the paper-based registries within a specific health facility, while electronic health records (EHR) are patient-centred records that include past medical history, allergies, immunisations, radiology images, laboratory results, diagnoses and treatments (WHO, 2016). WHO highlights that electronic health records enhance patient diagnosis and treatment through access to accurate and timely patient data (WHO, 2016).

As part of the initial interaction with target intervention health centres identified by Ministries of Health, mHealth4Afrika identified that none of them had access to a complete electronic patient record system or electronic medical devices to record patient data at the point of care (Cunningham et al, 2018a). Based on identifying this gap, mHealth4Afrika has co-designed an integrated solution to address the health service delivery needs based on requirements in the initial partner countries (Ethiopia, Kenya, Malawi, South Africa). This solution is being validated by the intervention health centres.

1.2 mHealth4Afrika Objectives

mHealth4Afrika is co-designing and validating a modular, multilingual, state of the art health information system to address primary healthcare requirements in resource constrained environments. This platform has been co-designed in partnership with Ministries of Health, district health officers, clinic managers and health workers from urban, rural and deep rural environments in Ethiopia, Kenya, Malawi and South Africa since November 2015 (Cunningham et al, 2017; Cunningham et al, 2018a). It supports the adoption of technology at the point of care by integrating electronic medical record and electronic health record functionality with medical sensors and data visualisation tools to facilitate the interpretation and monitoring of patient results.

The overall objectives (Cunningham et al, 2017; Cunningham et al, 2018a) include to:

- research end-user requirements for rural and deep rural communities in developing country contexts;
- research and evaluate the challenges and potential benefits associated with co-designing a common multilingual patient record framework that integrates readings and clinical data from tablets and medical sensors used at the point of care;
- train healthcare workers in urban, rural and deep rural clinics on the coordinated, integrated use of medical sensors and electronic patient records to support more efficient, high quality healthcare delivery in resource constrained environments and

- pilot and validate an integrated solution addressing the health system requirements of primary healthcare clinics in Ethiopia, Kenya, Malawi and South Africa to assess usability, user acceptance and functional and interface related modifications required to facilitate wider adoption at national, regional and continental level.

mHealth4Afrika aims to provide both direct and indirect contributions to primary healthcare delivery at health centre level by supporting improvements in: (a) the quality and impact of primary healthcare delivery through timely capture of information, systematic storage of important data points in the patient electronic record, and improved follow up; (b) data quality (by reducing human error); (c) frequency of contact with a focus on prevention through adoption of state-of-the-art technologies at the point of care, (d) accuracy, quality and timeliness of monthly aggregate program indicators and (e) access to educational materials for clinic staff and patients to strengthen digital literacy and health skills and support preventative care (Cunningham et al, 2018a).

1.3 Insight into Intervention Health Centres

Traditionally validation of technological innovation has taken place in environments with access to good physical and electronic infrastructure, using a model clinic approach. mHealth4Afrika took a deliberate approach to engage with resource constrained intervention health facilities in semi-urban, rural and deep rural locations. The objective is to gain true insight into real environments where this platform could be adopted by healthcare professionals. The intervention clinics are based in Northern Ethiopia, Western Kenya, Southern Malawi and Eastern Cape in South Africa. They were agreed with the Ministries of Health and district health offices (Cunningham et al, 2018a).

In terms of infrastructure the semi-urban health centres and some of the rural health centres are connected to the electricity grid. However, some have only intermittent supply, particularly during the rainy season. Since initial interaction with the other clinics there have been some positive infrastructure developments in terms of being connected to the grid or installing solar infrastructure. Most of the health centres now have access to a 2G or 3G mobile signal. None of the initial participating health centres had a local area network, WiFi network or Internet access (Cunningham et al, 2017).

Historically, there has been limited use of technology to support healthcare delivery in participating intervention clinics (Cunningham et al, 2016). Prior to engaging with mHealth4Afrika, intervention clinics were not using electronic medical devices or an electronic system to record patient data at the point of care (Cunningham et al, 2017). Where computers had been installed they were typically used by the clinic manager for administrative issues including reporting, or used to capture a sub-set of data or monthly indicators related to a specific program (such as TB or HIV). None of the computers were networked and there was limited awareness that existing computers could be used for more than one purpose (Cunningham et al, 2016). Most health facility staff had not received any on the job formal computer literacy training. Some were self-taught or received limited training as part of their studies. Nurses in Bungoma Country (Kenya) and Eastern Cape (South Africa) indicated that they use their personal mobile phones to communicate with peers via WhatsApp Groups or search for clinical information the on the Internet (Cunningham et al, 2016). Based on findings captured during the needs assessment and baseline study, it was necessary to install basic electronic infrastructure and provide digital literacy training in intervention clinics and ensure that user interfaces were intuitive and easy to use (Cunningham et al, 2016; Cunningham et al, 2017).

Most health facilities provide a range of services including antenatal care, postnatal care, family planning, child under 5 programs (growth and nutrition, immunisation), tuberculosis, antiretroviral therapy (ART) and general out patient department (OPD). Some of the larger facilities also provide delivery and cervical cancer screening services.

Most of the intervention health centres in Ethiopia, Kenya and Malawi support large catchment areas (populations of 25,000 to 50,000) with constrained staffing. As is normal outside hospitals, none of the intervention health centres have doctors on staff. Clinic managers are typically either a clinical officer (three year diploma in clinical medicine) or a degree nurse. Other clinical staff are either degree or diploma nurses. Larger facilities may also have a pharmacy or laboratory technician on staff (Cunningham et al, 2016). Health Information Technicians in Ethiopia have a diploma in health informatics and are responsible for preparing clinic level monthly aggregate program indicators to be sent to the district health office. All clinics have community-based healthcare workers (Health Extension Workers in Ethiopia, Community Healthcare Workers in Kenya and South Africa, Health Surveillance Assistants in Malawi). In some countries, they may have a certificate. Most have limited formal training and are supervised by clinic nurses (Cunningham et al, 2016).

1.4 Paper Focus

This paper shares insight into the co-design process followed to date to develop and validate the mHealth4Afrika platform. Section 2 describes the methodology applied, while Section 3 provides insights into activities to date and ongoing research. Section 4 presents conclusions and lessons learnt.

2. Methodology

mHealth4Afrika is applying an experimental research strategy, carrying out "*an empirical investigation under controlled conditions designed to examine the properties of, and relationship between, specific factors*" (Denscombe, 2010).

mHealth4Afrika has a number of research threads:

a) researching end-user requirements – to inform data sets for programs, workflow and initial functional requirements in the four beneficiary countries;
b) researching medical sensors appropriate for use in participating health centres;
c) researching the minimum technological infrastructure and minimal level of digital literacy required to effectively use the platform;
d) technical development of a platform based on the requirements identified; and
e) validating the platform to assess usability, user acceptance and any modifications required to support wider adoption for primary healthcare service delivery.

Qualitative data collection (incorporating a mix of semi-structured interviews and focus groups) and ethnographic observations have been used during the needs requirements and base line study (November 2015 - January 2016, 40 informants from 19 health centres in the four intervention countries), alpha validation (November - December 2016, 49 participants from 14 health clinics in the intervention countries) and validation of the first iteration of the beta platform (November - December 2017, 36 participants from 11 health clinics in the intervention countries) (Cunningham et al, 2016; Cunningham et al, 2017; Cunningham et al, 2018). Intensity sampling was the most appropriate approach based on the use of purposive sampling techniques (Creswell, 2007; Collins et al, 2007).

Desk research, analysis of World Health Organisation standards, national protocols and qualitative data collection were used to determine the breadth of data sets across the four beneficiary countries and workflow required for specific programs and to research those medical sensors deemed most appropriate based on the requirements of the health centres and the readings prioritised during the needs requirements study.

Design science research techniques are applied for the technical development whereby the problem is identified, artefact requirements defined, and the artefact is designed, developed, demonstrated and evaluated (Johannesson et al, 2012). The regular platform iterations are implemented using an agile development process. This supports regular interaction with policy makers, district and clinic managers and healthcare workers as part of the co-design process to validate the current iteration and prioritise functionality and data sets for subsequent iteration(s) (Cunningham et al, 2018a).

mHealth4Afrika secured the necessary ethical approval required in each country (Cunningham et al, 2016; Cunningham et al, 2017; Cunningham et al, 2018a; Cunningham et al, 2018b). There are no risks to participants based on their contribution to this study, which is voluntary. Participants are all adults and either nursing school or university graduates. They are generally fluent in English, and no vulnerable people were targeted. As highlighted earlier, the intervention clinics/health centres are identified by the Ministries of Health and district health offices. This study is taking place at a mix of semi-urban, rural and deep rural health centres in the Amhara Region, Northwest Ethiopia, Bungoma County, Western Kenya, Zomba and Machinga Districts, Southern Malawi and Eastern Cape, South Africa. Clinic management signed an Informed Consent form during Q4 2015 agreeing that data collected throughout the project duration could be used for the purposes of research, informing policy and associated publications. To ensure anonymity, each transcript per health facility was allocated a unique numerical code. With the consent of participants, interviews were audio recorded to facilitate creating transcripts to complement field notes taken during interviews, which were analysed leveraging Creswell's Data Analysis Spiral (Creswell, 2007).

3. mHealth4Afrika Activities to Date

3.1 Determining End User Requirements and Designing Programs

As part of the co-design methodology, an extensive consultation was undertaken with key stakeholders at national level in Ethiopia, Malawi, Kenya and South Africa between October 2015 and January 2016 to inform the needs requirements and carry out a base line study. Leveraging a mix of semi-structured interviews, focus groups and analysis of national protocols, an analysis of the patient record system, user interface, sensor, linguistic, work flow, privacy and infrastructure requirements was undertaken to inform the development of the alpha version of the mHealthAfrika platform. The needs assessment analysed end user profiles, usability and user experience requirements, health data elements to be captured, and the overall clinical workflows and reporting requirements related to maternal healthcare delivery (Cunningham et al, 2017).

The baseline study (Cunningham et al, 2016) examined the overall health centre environment to determine how best to integrate the platform into day-to-day operations and healthcare workers’ work practices. It also took account of previous exposure to and use of technology to determine the potential impact of the adoption of the mHealth4Afrika platform on the working life of healthcare workers and clinics in different settings. It provided valuable insights into human resource capacity, practical and technical challenges, and both equipment and infrastructure related deficits. It also identified constraints and digital literacy and platform training requirements of healthcare workers to be considered during the co-design of the mHealth4Afrika platform.

One of the aims of mHealth4Afrika is to design a multi-country proof of concept based on the needs of four beneficiary countries, that can be adapted to address the requirements of different national health systems in other intervention countries. Based on these requirements, it is necessary that the programs incorporate both mandatory data sets required under national protocols as well as additional data healthcare professionals wish to capture as part of holistic monitoring of a patient's well being.

The initial use case / program focus was on Antenatal Care including Medical History, as this is a free service in beneficiary countries with a large data set and complex workflow (Cunningham et al, 2018a). A detailed analysis was undertaken of the standard paper-based registries for the four countries to create a super set of data elements. These were then grouped into relevant program stages and sections (General Examination, Systemic Examination, Screening, Immunisations and Supplements) to support a useful workflow. The mandatory data sets identified were compared with the WHO Essential Interventions for Maternal, newborn and child health (Cunningham et al, 2017). This analysis identified significant additions required beyond the WHO Essential Interventions, which were incorporated into the program design of the alpha prototype. This significantly expanded the datasets to be collected, to create the necessary basic superset of data points required to validate the mHealth4Afrika alpha prototype. The alpha validation was very productive, validating data sets and workflow and identifying additional data sets to include in the first beta iteration (Cunningham et al, 2017).

The programs configured for Beta v1 extended maternal health to cover Antenatal Care, Delivery and Postnatal Care and the initial Child Under 5 Program structure. The initial data points in the Child Under 5 program were based on analysis of mandatory national data sets from child health booklets in the four countries addressing growth and nutrition, immunisations, vitamin A and deworming. The initial data sets were positively validated during the beta v1 validation, with the data sets extended to include childhood illnesses (including cough, fever, diarrhoea, measles, ear problems, sore throat and anaemia). The program structure and workflow was adjusted based on feedback received for inclusion in beta v2.

Based on interdependent programs to facilitate holistic monitoring of the patient's well being, programs prioritised for inclusion in beta v3 included Family Planning, Cervical Cancer Screening, Tuberculosis (TB), Antiretroviral therapy (ART) and General Out Patient Department (OPD) consultations. There was extensive interaction with healthcare staff in the intervention health centres while designing these programs.

3.2 Introducing Medical Sensors at the Point of Care

Medical sensors are primarily used in referral hospitals in the beneficiary countries. Blood pressure readings in a health centre are typically taken using a traditional arm blood pressure cuff. As part of the needs requirements, the health centres were asked to prioritise sensor readings that would be beneficial to take at the point of care. The sensors prioritised by the health centres in the four countries included: blood pressure sensor (Sphygmomanometer); pulse and oxygen in blood sensor (SPO2); Glucometer sensor; Body temperature sensor (thermometer), haemoglobin and fetoscope (Foetal activity including pulse rate). Based on agreeing the readings and environmental factors to be considered, IIMC engaged with a number of European, American and Chinese sensor manufacturers focused on Sp02, blood pressure, body temperature, glucose and weight during December 2016 - February 2017. The objective was to identify CE approved sensors at different price points that would be appropriate for use in semi-urban, rural and deep rural clinic environments. Sensor manufacturers short listed for validation purposes included Hemocue (Sweden), Nonin (US) and Visiomed (France).

mHealth4Afrika intervention clinics have access to an oximeter (SpO2, pulse), glucometer (sugar levels), blood pressure, contactless thermometer, weighing scales and the HemoCue Hb 201 (haemoglobin). mHealth4Afrika has developed a custom Android application to support the transfer of sensor readings from BLE CE approved devices to populate the electronic patient record using proprietary standards. This Android application is integrated with the mHealth4Afrika database via a Web API and Oauth2 API to authenticate the user, retrieve up to-date patient records from the mHealth4Afrika database, search for the patient, capture the sensor reading from Bluetooth Low Energy sensors, associate sensor readings with a specific patient and transfer the data using the secure Health Level 7 Fast Healthcare Interoperability Resources (FHIR)® data communication standard to the electronic patient record (Cunningham et al, 2018a). The readings are visualised and compared with similar readings from previous program visits within the mHealth4Afrika platform to facilitate comparative monitoring of the patient's condition.

The research is focused on determining: a) user acceptance to use medical sensors at the point of care; b) if this supports preventive care through quicker identification of non-communicable diseases (such as diabetes and hypertension); c) if sensors can facilitate adoption of triage and d) if comparative visualisation of the readings captured across visits support better holistic monitoring of the patient's overall well-being.

3.3 Infrastructure and Training

As outlined previously the initial intervention clinics did not have existing computer technology to validate the mHealth4Afrika platform during pilot phases. As part of the needs requirement, the basic hardware required was identified: laptop to be used as server for storage and retrieval of the patient records; tablets to be used for data collection and search at the point of care, and WiFi router to support data exchange between the devices used at the point of care and the server hosting the database.

While traditionally desktop computers are installed in health facilities, mHealth4Afrika decided to provide a high specification laptop because of the impact of intermittent electricity,. Some of the more recent intervention clinics in Kenya have some existing infrastructure in place (server, LAN, thin clients). This will allow us to compare findings and test the impact of the platform being hosted on a different technical configuration.

The SSIT IST-Africa SIGHT secured a Projects Grant from the IEEE Humanitarian Activities Committee (HAC) to procure necessary equipment (touch screen laptops, 10-inch tablets, routers and back up drives) for the initial intervention health centres in Ethiopia, Malawi and Kenya. This grant also supported the procurement of solar systems for several health centres in Malawi and one health centre in Ethiopia, which are currently not connected to the public grid (Cunningham et al, 2016).

While setting up the technical infrastructure in the health centres, digital literacy training was undertaken with clinical staff around their clinical responsibilities. Undertaken both on a one-on-one basis and in small groups, this training focused on how to use the devices (laptops, tablets) provided and becoming familiar using a computer keyboard as well as a touch screen. Bluetooth keyboards were provided with the tablets. Valuable lessons were learnt during the initial digital literacy training, which informed how we approach digital literacy training with new intervention health centres, to encourage self-directed learning while staff are not working. To use a health information system, clinical staff must be trained to type sufficiently confidently and quickly that they have the option to collect patient data in real time during a consultation (Cunningham et al, 2018a).

Following basic digital literacy training, application training was provided, both in small groups and on a one-on-one basis as required. Initially clinical staff requested an electronic application training manual with one printed hard copy per facility as a back up to the face-to-face training. We have found through experience that supplementing such manuals with a series of short videos focused on different functionality sets and programs, is very well received by staff. Tool Tips are also included within the program data collection forms to support online learning (Cunningham et al, 2018b).

3.4 mHealth4Afrika Platform Iterations

mHealth4Afrika is applying an agile development process. This supports regular interaction with policy makers, district and clinic managers and healthcare workers as part of the co-design process to validate the current iteration and prioritise functionality and data sets to be added to subsequent iteration(s) (Cunningham et al, 2018a).

During Q4 2016, the alpha prototype focused on a use case focused around antenatal care. This facilitated validation of a common workflow to register patients, set up healthcare worker access rights, manage patients and capture and retrieve medical data associated with medical history, obstetric history and ANC1 stages (Cunningham et al, 2017). Based on feedback received during the alpha validation, the first beta iteration ncluded a more comprehensive functional set, refined user interface, extended program for maternal health (antenatal care, delivery, postnatal care), first iteration of the Child under 5 Program and integration of sensor readings in the electronic patient record.

The validation of Beta v1 was undertaken over a longer time period during Q4 2017, with some of the health centres using the platform on a day-to-day basis for several weeks prior to the formal validation. They found the Beta v1 functionality to be comprehensive and intuitive, facilitating setting up system users, assigning access rights, managing clinic appointments, searching and retrieving patient electronic health records, viewing a patient overview page with visualisation of vital sign readings over the different ANC visits, capturing and retrieving patient data related to different visits and capturing vital sign readings using medical sensors (Cunningham et al, 2018a). The revised program structure was appreciated, with a number of participants noting that grouping data into sections provided a de-facto high level check list nurses could use while undertaking a consultation. They indicated that while using the paper-based registries, clinicians and nurses mostly take summaries during consultations that may not be sufficiently methodical or complete due to lack of time. They noted that providing such a checklist would help avoid missing capturing necessary details (Cunningham et al, 2018a).

During the pre-beta validation in June 2017 and the Beta v1 validation (November - December 2017) it became clear that the health centres require a health information system that allows a patient to be registered once and then enrolled in multiple programs over a period of time depending on changes in health conditions. This informed a re-architecture of Beta v2, while v1 was being validated (Cunningham et al, 2018a).

Beta v3, which is now being validated with the health centres, includes a significantly refined user interface, additional clinic related functionality to support management of healthcare workers as system users, additional patient and appointments and patient related functionality supporting access to a range of interdependent programs, appointments, risk factors, visualisation of program specific readings and reports to assist in monitoring the patient's condition (Cunningham et al, 2018b).

4. Conclusions and Lessons Learnt

This paper provides insights into the co-design process followed to design programs, develop and validate the mHealth4Afrika platform on a cross border basis to date.

4.1 Lessons Learnt

Importance of Active Engagement with End Users

Too often in the past eHealth/mHealth projects have primarily been technology push. To meet the overall goal of mHealth4Afrika it is necessary to take a User-centered Design, Collaborative Open Innovation based approach (Cunningham et al, 2016). A combination of the co-design and agile development process has been very beneficial to inform different iterations and facilitate active engagement. The objective was to ensure the platform meets the day-to-day requirements of the health centres in terms of usability, functionality and programs. The importance of interventions taking account of information needs at different stages in the continuum of care is well documented in literature (e.g. Bhutta et al, 2010; Cooper, 2013; Kerber et al, 2007; Obasola et al, 2015).

Importance of Being Reactive

A co-design approach also requires the research team to be responsive to feedback received and willing to make necessary modifications to reflect user requirements. mHealth4Afrika's initial focus was on addressing maternal and newborn healthcare delivery. However, during the pre-beta validation and Beta v1 validation the health centres indicated that while they appreciated the comprehensive programs being developed, they needed a platform that supported a range of interdependent programs to facilitate holistic monitoring of a patient's well being (Cunningham et al, 2018a). Family planning and cervical cancer screening were seen to be natural extensions of maternal health. TB and ART programs were prioritised based on the number of clients who may initially visit the health centre for antenatal care and subsequently be enrolled in these programs. The functionality required to support single enrolment and adding multiple programs required a re-architecture of the platform. While it required reallocation of resources to prioritise this technical work and program design, the net result is that the platform is more useful to the health centres. It is important to be willing to reallocate project resources to have the best overall impact.

Value to Taking a Cross-Border Approach

While it was considered ambitious for mHealth4Afrika to take a cross border approach and to target non-conventional validation sites, this has been very valuable. Designing programs that address the requirements of four national protocols has helped identify common aspects that may be beneficial to other health centres in monitoring patient's conditions, while still addressing country specific requirements. Developing a health information system that simply replicates a paper-based registry often designed a long time ago is short sighted. The amount of data that can be captured in a paper-based registry is restricted by the size of the registries and the prioritisation of data sets based on best practice at a point in time. The program design in mHealth4Afrika provides the ability to capture all mandatory data sets as well as capturing additional data for more complicated cases. We leverage conditional rendering / skip logic to facilitate additional information to be collected based on responses to prioritised questions. When all the programs have been fully validated in the beneficiary countries, we welcome the opportunity to also validate them with countries that did not participate in the initial co-design to get inputs on usability, functionality and program designs.

4.2 Ongoing Research

Functionality prioritised for inclusion in Beta v4 includes automatic counting of aggregated monthly program indicators and SMS notifications for patient appointments. Research is ongoing on integration of medical sensor readings from across all programs.

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