

Digital Square Notice E0

Improving Shelf-Readiness by Sharing Patient Data Across Systems: OpenMRS, Mobile WACH, an SHR, and OpenHIE

*Preliminary Technical Application
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Two-Sentence Overview

Both OpenMRS and Mobile WACH are critical components in providing care to patients, and collect data at different points in the healthcare system that should be shared with each other through a Shared Health Record (SHR) to improve decision making and patient outcomes. This project aims to 1) build FHIR support and OpenHIM mediators to send and receive data from both OpenMRS and Mobile WACH with the SHR, 2) test the resulting code in the Instant OpenHIE project, and 3) disseminate code and OpenHIE implementation guides for the broader global goods community.

Executive Summary

Patient centered care (PCC) is defined as “providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions”, and was identified by the Institute of Medicine as a critical gap in achieving high quality healthcare and improving patient outcomes.¹ Evidence shows that a shift to PCC in the US significantly improved patient outcomes and reduced costs, but global health has yet to make this shift, partly due to information silos. Digital health tools can serve to support PCC, but just having tools that involve patients does not equal PCC. Those tools must also be properly integrated across the ecosystem, making information about patients’ evolving needs, preferences and contexts accessible and usable across the longitudinal record to inform shared decision making by providers and patients.

This proposal identifies a specific use case to improve shelf-readiness of digital health tooling that can better support the shift towards PCC in LMIC. Our use case builds upon a provider-centered EMR, a patient-centered technology (PCT), and the longitudinal shared health record (SHR) that integrates the data and informs the patients’ needs, preferences, and contexts. Our provider-

¹ Institute of Medicine (US) Committee on Quality of Health Care in America. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington DC: National Academies Press (US); 2001. <https://doi.org/10.17226/10027>

centered EMR, OpenMRS, is a high quality, open source platform used in over 5,500 health facilities in 64 countries, and is a founding block to the data needs across a health program. We will improve the OpenMRS interoperability capabilities by expanding the FHIR module to interact with a Shared Health Record using the OpenHIE architecture.

Our patient-centered technology, Mobile WACH, is a recognized digital health global good supporting patient centered care through bidirectional mobile messaging between clinic health care workers (HCW) and patient consumers. It is used for managing urgent, episodic, and chronic health conditions (e.g. MCH, mental health, HIV). Mobile WACH provides patients real-time personalized education, support, advice and referrals. Although Mobile WACH has successfully supported care within a siloed program, in order to be shelf-ready for maximally effective care and treatment in broader implementations, and to provide tailored support and guidance for patient decision-making about their health, Mobile WACH will need longitudinal data for a patient. In return, Mobile WACH collects critical patient-reported data, such as significant events, symptoms and concerns, that should be shared back to other care providers and the health record. We will improve the shelf-readiness of Mobile WACH by adding FHIR-support for interoperability with a Shared Health Record using the OpenHIE architecture.

The results contribute to a more complete longitudinal patient record that can be utilized within national implementations for improved continuity of care, and supports the shift towards PCC. Both products will also be able to be used by Instant OpenHIE for rapid deployment. The project includes leadership from University of Washington and Kenyatta National Hospital collaborating with OpenMRS, Mobile WACH, and OpenHIE communities; and leverages existing country-level projects in Haiti and Kenya to contribute to the requirements and ensure real-world applicability and implementability.

Consortium Team

The project team will be led by the Digital Initiatives Group (DIGI) at the International Training and Education Center for Health (I-TECH) at the University of Washington (UW). I-TECH is a Center within the UW Department of Global Health (DGH) that leads health systems strengthening initiatives in more than 20 countries.

The Digital Initiatives Group at I-TECH (DIGI), University of Washington (UW) is composed of health informatics experts, digital health developers and implementers, data scientists, and digital health training specialists. DIGI faculty and staff lead multiple global goods communities of practice, have led national implementations of OpenMRS in multiple countries; and have extensive experience developing and implementing national eHealth architectures, including those leveraging the OpenHIE architecture and reference applications. In December 2018, I-TECH launched the Digital Initiatives Group at I-TECH (DIGI), a global health informatics center within I-TECH and the UW DGH, under the leadership of faculty members Nancy Puttkammer and Jan Flowers. The DIGI team brings together experienced I-TECH informatics experts and staff with a broad range of expertise in setting global health informatics standards and leading global goods communities and products at the domain level, as well as, applying those in real-world settings in LMIC in a sustainable, scalable, replicable manner. In addition to the core team members, our center collaborates and harnesses expertise from faculty, staff, and students from the UW's Schools and Departments including Health Sciences, Computer Science and Engineering, Bioengineering, Information Sciences, Business and others.

Related to this proposal, DIGI faculty and team members are leaders in the global goods communities at large, founding and actively leading the OpenHIE LIS Community of Practice; as

well as, serving on the Board of Directors and in strategic leadership roles for both the OpenMRS and OpenELIS communities. Since 2009, DIGI staff have led multiple national-level OpenMRS engineering, implementation, and interoperability projects, including in Kenya (KenyaEMR), Haiti (iSantePlus), Mozambique (eSaude), and Vietnam (eClinica). DIGI has been lead interoperability architects for Haiti, Kenya, Cote d'Ivoire, Mozambique, and Vietnam health programs. DIGI is the steward of OpenELIS Global development and national implementations in Haiti and Cote d'Ivoire since 2009 and 2010 respectively, in more than 75 national public health reference labs as well as in large-volume clinical laboratories. With funding from Digital Square Notice C and in coordination with existing country-level projects in Haiti, DIGI established standards-based integration between OpenMRS and OpenELIS using FHIR, supporting the identification of gaps in the FHIR profiles and implementation guides for LMIC use, and led and published the OpenHIE LIS-EMR architectural specification with the OpenHIE LIS Community of Practice.

The Mobile WACH team is a multidisciplinary collaboration between researchers at UW and Kenyatta National Hospital (KNH) in Kenya. The team includes obstetrician-gynecologists and pediatricians at UW and KNH, nurses at KNH, and epidemiologists and digital health researchers at UW. Since 2012, the team has developed and implemented 7 projects using Mobile WACH to support maternal-child, HIV and reproductive health in Kenya, including 5 randomized controlled trials. Drs. Unger and Kinuthia are obstetrician-gynecologists, physician researchers, who led the platform's original development. Their perspectives as clinicians who provide care in diverse healthcare systems (Dr. Kinuthia in Kenya and Dr. Unger in the US), and as digital health researchers will ensure that the proposed project develops tools with clinical utility. Dr. Ronen is a digital health researcher with expertise in development, implementation and evaluation of digital health interventions in Kenya, including Mobile WACH. Dr. Ronen's experience working closely with software developers and translating research and implementation priorities into software decisions will ensure the proposed project develops tools that meet stakeholder needs. Mobile WACH was originally developed in collaboration with researchers in the UW Department of Computer Science and Engineering, employing human-centered design principles to develop a platform that integrated into healthcare worker workflow. With each implementation of the platform, iterative changes have been made in collaboration with software developers, to facilitate rapid deployment of new instances and improve the platform's scalability.

Background or Problem Statement

Despite being a mature product and global good, there is still a need to address a standards-based approach to connecting OpenMRS to a national repository of longitudinal data. Mobile WACH has focused on flipping the paradigm of healthcare in LMIC by moving towards a more direct to beneficiary, patient-centered approach for patient consumers; but remains an information silo in interoperable architectures. Providers using OpenMRS and HCWs supporting remote care in Mobile WACH would both highly benefit from access to the others' data from a more complete longitudinal medical record for improving decision making and moving towards PCC to improve patient outcomes.

We propose to build interoperability between OpenMRS, Mobile WACH, and a Shared Health Record, using the OpenHIE architecture and FHIR standards. For the purpose of this project, the Shared Health Record will also serve as a patient index, but may not do so in real-world

applications where another designated software serves as that source of truth for the patient index. In addition, we will show the improved shelf-readiness by testing the products as part of the Instant OpenHIE project. We will work with applicable global goods communities in all phases of the work, and collaborate with our real-world implementations of these tools to ensure appropriate requirements are specified to meet the needs of users and that final products are accepted as meeting the specified requirements.

Digital Health Technologies

OpenMRS is the most widely used open-source electronic medical record (EMR) system globally. The OpenMRS platform is a generic platform for developing electronic medical record (EMR) system implementations. It is designed to collect and manage patient-centric longitudinal medical data. The platform consists of a database, an abstraction layer between code and the database (i.e., Hibernate, a tool to map between Java objects and a database), a Java-based service layer, and a web services (a bespoke REST interface and a standard FHIR interface). The data model is heavily influenced by the HL7 reference information model and uses a central concept dictionary to define the data it contains. As a result, the system is very flexible – not focused on a specific vertical use case – and can be adapted for any patient-centric health solution. The platform is also designed to be modular, making it extremely extensible by allowing customizations to be added or removed to meet local needs. Multiple APIs are available, supporting interoperability. Proven interoperability already exists between multiple systems, and, in fact, OpenMRS has been proven to support case based reporting using the OpenHIE architecture.

MobileWACH is a semi-automated platform that connects patients with healthcare workers by SMS messaging. The platform automatically sends patients a pre-composed curriculum of scheduled messages (1-way “push” messaging) based on their medical condition or health status. Patients may send messages to the system at any time to be answered by a live HCW, leading to personalized dialogue (2-way messaging). The platform has been tailored to deliver SMS curricula targeting multiple health behaviors and evaluated in 2 completed randomized controlled trials (RCTs) with pregnant and postpartum women in Kenya as well as a large demonstration project among adolescent and young women (AGYW). The trials found that interactive Mobile WACH SMS led to extension of exclusive breastfeeding and higher contraception use. The demonstration project led to an increase in PrEP use and retention in care for AGYW. Building on these studies, 3 additional RCTs are ongoing, evaluating the impact of Mobile WACH on antiretroviral treatment adherence in women living with HIV, neonatal health, and at-home mid-upper arm circumference measurement of children by their caregivers for early detection of malnutrition

Use Cases and User Stories

As a **patient**, I would like to:

- know that when I receive care, my medical history is available to the provider that I am seeing for care at any time

- know that when using a patient centered service that provides care and support outside of the traditional clinic facility and programs, my preferences, values, and relevant data will be available for use by my traditional providers when I utilize their services.
- know that all of my medical record information will be available to any care provider I include as part of my whole medical home so that I receive the best possible care based on my specific situation and history.
- communicate remotely with my healthcare provider team

As a **clinical provider in a routine care program**, I would like to:

- be able to share the patient data I have collected from visits with other programs that the patient may be having clinical encounters with, such as an MCH clinic program or visits with community health workers.
- be able to view the clinical and other information collected during visits my patient had with other providers before receiving care with me, or between visits I've had with her at the clinic - such as with a community health worker.
- be able to know what relevant concerns have been communicated with nurses and CHWs between visits, such as side effects of prescriptions, or concerns about fetal movements, etc.
- be able to see if my patient has had prescriptions filled by other providers or community health workers between visits to my clinic

As a **an antenatal care nurse**, I would like to:

- be able to review a woman's longitudinal medical record for pertinent information from her routine visits to inform my decision making.
- be able to communicate with patients remotely and have that be part of their patient data.

As a **postpartum nurse**, I would like to:

- be able to review a woman's longitudinal medical record for pertinent information from her routine visits to inform my decision making.
- be able to tailor educational materials more effectively with information from the full patient longitudinal medical record.

As a **community health worker**, I would like to:

- be able to review a patient's longitudinal medical record to inform my visit with that patient
- know that the tailored content within the tool I'm using is based on the patient's full medical context, not just the limited set of clinical information I've gathered from my visits
- share the medical data that I have collected on a patient with the longitudinal medical record so that others can use that clinical data if that patient goes to a clinic for care

As a **program manager**, I would like to be able to:

- utilize data from longitudinal medical records to determine if patients are receiving care according to best clinical practice, are lost to follow up, or have transferred care between clinics, services, or programs.

Objectives and Activities

Work Package 1: Expand FHIR Module for OpenMRS for interoperability with Mobile WACH through a Shared Health Record

OpenMRS has developed an early version of a FHIR module to address FHIR-based interoperability with a small set of specific use cases. The FHIR module is governed and managed by an OpenMRS community squad that includes several engineering and implementation teams, external engineering contributors, and both interoperability and FHIR experts. Our team will continue to participate in this squad, spearheading this initiative as part of the overall FHIR module strategic roadmap with that squad.

To properly build the exchange with the Shared Health Record, we will need to engage additional contributors and collaborators with this FHIR squad. Our team will recruit interested members of the OpenHIE SHR subcommunity to participate as stakeholders, providing input into the requirements from the SHR perspective. Our team will also leverage our existing OpenMRS and FHIR module implementation in Haiti to engage country-level members from those projects to provide real-world experience and input into the requirements to ensure the end product can be feasibly implemented in a real-world setting. Lastly, we will include members of the Mobile WACH community to provide domain expertise into the requirements.

In this work package, we propose working with the FHIR squad to prioritize the expansion of the FHIR module to include the specified resources and pathways for exchanging critical patient medical record information with a shared health record as part of a national health information ecosystem, with the intention that we will utilize this work to exchange data with the Mobile WACH system.

As part of shelf-readiness, OpenMRS FHIR interoperability must be well tested to create trust in the use of the product in a production environment, particularly when adding to a standards-based HIE, such as Instant OpenHIE. We will work with the OpenHIE team throughout the project to design a testing strategy for inclusion of this exchange architecture in the Instant OpenHIE product.

Our team proposes the following objectives and activities:

Objective 1.1: Develop FHIR-based interoperability for OpenMRS to exchange a standards-based patient summary

Activity 1.1.1: Develop requirements and specification for the OpenMRS-SHR exchange in collaboration with OpenMRS FHIR Squad, OpenHIE SHR subcommunity, Mobile WACH; and members from the Haiti implementation of OpenMRS.

Activity 1.1.2: Expand FHIR Module to include OpenMRS-SHR API: Based upon the HL7 FHIR International Patient Summary, map appropriate FHIR resources to the OpenMRS data model and develop the workflow.

Activity 1.1.3: OpenHIM mediators for OpenMRS-SHR exchange: Develop appropriate mediators for processing the exchange transaction between OpenMRS and the SHR.

Activity 1.1.4: Document the FHIR module additions

Objective 1.2: Test and document the OpenMRS patient summary exchange with OpenHIE

Activity 1.2.1: Document testing with Instant OpenHIE: Collaborate with the Instant OpenHIE team to design systematic testing for adding OpenMRS to the Instant OpenHIE project, specifically for exchanging a patient clinical summary.

Activity 1.2.2: OpenHIE architecture workflow specification for EMR-SHR: Provide input into the OpenHIE EMR-SHR workflow for the next publication of the specification.

Work package 2: Build Mobile WACH FHIR Support for Shared Health Record Interoperability

To date, Mobile WACH has not addressed the need for interoperability with other health systems. However, with critical clinical data being collected by this system in patient centered programs that provide care outside of the traditional clinical setting (such as with MCH nurses and community health workers), it is paramount that this system be able to receive a patient's longitudinal record from traditional visits, as well as, share clinical data back to the patient's full longitudinal record. As such, our team proposes to conduct activities that increase shelf-readiness through the addition of a FHIR-based API for exchanging data within a national health information architecture.

Although the community for the Mobile WACH specific system is still emerging, our team will actively recruit and engage similar system stewards and implementers to collaborate on requirements for this type of exchange. Such systems could include Commcare, Medic Mobile, and such. Our team will do the initial groundwork to determine which systems may have similar requirements, and create a small forum to collaborate during the project. Conducting the project this way will improve the possibility of the work serving as an example workflow for that can be contributed towards the overall OpenHIE architecture specification, and for a broader set of systems to adopt.

To properly build the exchange with the Shared Health Record, we will need to engage additional contributors and collaborators from the OpenHIE SHR subcommunity to participate as stakeholders, providing input into the requirements from the SHR perspective. Our team will also leverage our existing Mobile WACH implementations in Kenya to engage country-level members to provide real-world experience and input into the requirements to ensure the end product can be feasibly implemented in a real-world setting.

As part of shelf-readiness, interoperability must be well tested to create trust in the use of the product in a production environment, particularly when adding to a standards-based HIE, such as Instant OpenHIE. We will work with the OpenHIE team throughout the project to design a testing strategy for inclusion of this exchange architecture in the Instant OpenHIE product.

Our team proposes the following activities:

Objective 2.1 Develop FHIR-based interoperability for MobileWACH to exchange a standards-based patient summary

Activity 2.1.1: Develop requirements and specification for the Mobile WACH-SHR exchange in collaboration with Mobile WACH implementers, OpenHIE SHR subcommunity, and similar systems stewards and implementers.

Activity 2.1.2: Mobile WACH release with FHIR support for SHR exchange: Leveraging our team's experience in developing FHIR APIs for other global goods, our team will utilize HAPI FHIR libraries to include a new API for the Mobile WACH product to exchange an HL7 FHIR international patient summary.

Activity 2.1.3: Create OpenHIM mediators for Mobile WACH-SHR exchange: Develop appropriate mediators for processing the exchange transaction between OpenMRS and the SHR.

Activity 2.1.4: Document Mobile WACH FHIR API

Objective 2.2 Test the MobileWACH patient summary exchange with OpenHIE

Activity 2.2.1: Document testing with Instant OpenHIE: Collaborate with the Instant OpenHIE team to design systematic testing for adding OpenMRS to the Instant OpenHIE project, specifically for exchanging a patient clinical summary.

Community Feedback

This consortium expects to collaborate closely with the OpenMRS and OpenHIE communities of practice, and will actively engage other global good partners interested in developing FHIR-based interoperability with a Shared Health Record. In addition, this consortium will work closely with the HL7 FHIR working groups to ensure gaps for use of FHIR in LMIC are identified and taken into consideration.

For Workstream 1, the project team will work most closely with the OpenMRS Community. The OpenMRS Community has multiple pathways for engaging with the various cadres of community members. The OpenMRS FHIR Squad will be the prime engagement for this particular project, but other groups and specific members, such as the Technical Advisory Committee (TAC) and the Director of Product will be engaged for specific strategic discussions and decision-making input. We will join the FHIR squad each week in planning for sprints, providing updates on the work, and testing the product. The team will also work with Instant OpenHIE project members to align towards use of OpenMRS-SHR interoperability within that tool, and to conduct testing with Instant OpenHIE.

For Workstream 2, the project team will work closely with Mobile WACH researchers and other CHW global goods developers and implementers to define the requirements for sharing data from and to Mobile WACH. These workflows will serve as an example for the development of an exchange architecture specification for CHW and PCT tools exchanging with SHRs. In addition, the team will work with the Instant OpenHIE project members to align towards use of OpenMRS-SHR interoperability within that tool.

Schedule

The following is a high-level work plan:

Activity	Team Location	Months								
		1	2	3	4	5	6	7	8	9
Work Package 1: Expand FHIR Module for OpenMRS for interoperability with Mobile WACH through a Shared Health Record										
Objective 1.1: Develop FHIR-based interoperability for OpenMRS to exchange a standards-based patient summary										
Activity 1.1.1: Develop requirements and specification for the OpenMRS-SHR exchange in collaboration with OpenMRS FHIR Squad, OpenHIE SHR subcommunity, Mobile WACH; and members from the Haiti implementation of OpenMRS.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote	X	X	X						
Activity 1.1.2: Expand FHIR Module to include OpenMRS-SHR API: Based upon the HL7 FHIR International Patient Summary, map appropriate FHIR resources to the OpenMRS data model and develop the workflow.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote			X	X	X	X			
Activity 1.1.3: OpenHIM mediators for OpenMRS-SHR exchange: Develop appropriate mediators for processing the exchange transaction between OpenMRS and the SHR.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote					X	X			
Activity 1.1.4: Document the FHIR module additions	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote			X	X	X	X	X	X	X
Objective 1.2: Test and document the OpenMRS patient summary exchange with OpenHIE										
Activity 1.2.1: Document testing with Instant OpenHIE: Collaborate with the Instant OpenHIE team to design systematic testing for adding OpenMRS to the Instant OpenHIE project, specifically for exchanging a patient clinical summary.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote				X	X	X	X	X	X
Activity 1.2.2: OpenHIE architecture workflow specification for EMR-SHR: Provide input into the OpenHIE EMR-SHR workflow for the next publication of the specification.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote				X					
Work package 2: Build Mobile WACH FHIR Support for Shared Health Record Interoperability										
Objective 2.1 Develop FHIR-based interoperability for MobileWACH to exchange a standards-based patient summary										
Activity 2.1.1: Develop requirements and specification for the Mobile WACH-SHR exchange in collaboration with Mobile WACH implementers, OpenHIE SHR subcommunity, and similar systems stewards and implementers.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote		X	X						

Activity	Team Location	Months								
		1	2	3	4	5	6	7	8	9
Activity 2.1.2: Mobile WACH release with FHIR support for SHR exchange: Leveraging our team’s experience in developing FHIR APIs for other global goods, our team will utilize HAPI FHIR libraries to include a new API for the Mobile WACH product to exchange an HL7 FHIR international patient summary.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote			X	X	X				
Activity 2.1.3: Create OpenHIM mediators for Mobile WACH-SHR exchange: Develop appropriate mediators for processing the exchange transaction between OpenMRS and the SHR.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote				X	X				
Activity 2.1.4: Document Mobile WACH FHIR API	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote				X	X	X	X	X	X
Objective 2.2 Test the MobileWACH patient summary exchange with OpenHIE										
Activity 2.2.1: Document testing with Instant OpenHIE: Collaborate with the Instant OpenHIE team to design systematic testing for adding OpenMRS to the Instant OpenHIE project, specifically for exchanging a patient clinical summary.	DIGI, Seattle, WA; MobileWACH, Seattle, WA, Kenya; others remote				X	X	X	X	X	X

Deliverables

Deliverable	Month/Quarter Due
Work Package 1	
Activity 1.1.1 OpenMRS-SHR Specification Document	M3
Activity 1.1.2 Link to Expanded FHIR Module Release	M6
Activity 1.1.3 Link to OpenHIM mediator repository	M7
Activity 1.1.4 FHIR Module Additions Documentation	M9

Deliverable	Month/Quarter Due
Activity 1.2.1 OpenMRS-SHR Test Documentation	M9
Activity 1.2.2 OpenMRS FHIR Module Release Documentation	M9
Work Package 2	
Activity 2.1.1 MobileWACH-SHR Specification Document	M3
Activity 2.1.2 Link to Mobile WACH Release	M6
Activity 2.1.3 Link to OpenHIM mediator repository	M7
Activity 2.1.4 MobileWACH Release Documentation	M9
Activity 2.2.1 MobileWACH-SHR Test Documentation	M9

Global Good Maturity Model Assessment

MobileWACH Global Good Maturity Model Assessment:

<https://docs.google.com/spreadsheets/d/1W-FzwYLMp4YQtgcHpwd977eJv4dImJKCt16g8LasdX8/edit?usp=sharing>

OpenMRS Global Good Maturity Model Assessment:

https://docs.google.com/spreadsheets/d/1vz_C95KPh8CxBFgWIsAz84k5xDi6iyMXGMFN6a83t0A/edit?usp=sharing