

DIGITAL SQUARE RFA #2020-019

Notice E1: Client Registries

TECHNICAL APPLICATION

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Prepared by: IntraHealth International

DUNS: 189705820 | TIN: 55-0825466

In partnership with:

Regenstrief Institute (an affiliate of Indiana University)

Ona

IntelliSOFT

Application Validity: 90 days

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Patient Registration and Identity Management Services for Health Information Exchanges

Two-Sentence Overview

IntraHealth's new Open Client Registry (OpenCR) represents a foundational global good supporting identity management needs in low resource countries using leading technologies, including the powerful ElasticSearch engine and the reference standards-based HAPI FHIR server. Building on its successful real-world pilot, IntraHealth and partners Regenstrief Institute (an affiliate of Indiana University), Ona, and IntelliSOFT seek to expand OpenCR into a robust, high-value global good and field test it with select ministries of health through a consortium that includes unparalleled international design and deployment expertise in client registry and identity management as well as leadership within the OpenHIE architecture and client registry communities.

High-Level Budget Summary

	Work Package 1	Work Package 2	Work Package 3	Work Package 4	Total Cost (USD)
Total Project Costs	\$266,669	\$126,051	\$24,929	\$181,953	\$599,601

Executive Summary

Accurate patient identification is an essential component of comprehensive digital health infrastructure and essential for ensuring safe patient care, retention of vulnerable populations, epidemic control, and support of population-level health. The use of unique identifiers and identity management is the basis of shared health records and together they enable better health outcomes and improve resource allocation, provide for more accurate monitoring and population health data, and support data for strategic decision making.

IntraHealth recently completed the development of an open source, standards-based prototypical client registry, [OpenCR](#), which was built to safely and uniquely identify patients who have demographic information stored in multiple health information systems. Leveraging IntelliSOFT's relationships with ministries of health (MOHs), Ona's understanding of the evolving security landscape, and Regenstrief's expertise developing client registries in high and low resource settings, the consortium proposes to rapidly expand the functionalities of OpenCR to meet the global community's unmet need for a standards-based, advanced, yet accessible, open source client registry to support longitudinal management of patient data across the health sector.

The initial use case driving development for OpenCR was developed to match and link records together under a single unique ID. With funding from Digital Square, the consortium team plans to complete the expansion of the OpenCR prototype into a broadly applicable global good across a wide variety of low resource settings and use cases to enable countries to track patient records across health information systems.

As a cornerstone of interoperability, OpenCR will help realize the vision of electronic health records (EHR) and health information exchanges (HIEs) to support scalable, safe, and effective care especially in low resource settings.

Consortium Team

IntraHealth International will lead the overall solution development process with consortium partners Regenstrief Institute (an affiliate of Indiana University), Ona, and IntelliSOFT.

IntraHealth is a global health NGO with a 40-year history in developing successful data tools and digital health applications for health workers and managers, including OpenCR, a prototypical open source, standards-based client registry. We develop solutions that are open source, data-driven, sustainable, and collaborative. As a pioneer in the field of health workforce informatics, we're committed to using technology, information, and analytical approaches to support the people at the center of our health systems. IntraHealth's experienced Digital Health team will lead rapid expansion of OpenCR to meet the community's unmet need: Luke Duncan has over 20 years of experience in software development, including leading the development of multiple data interoperability standards and reference designs. Richard Stanley, PhD, has 24 years of experience in information and communications technology. Finally, Dana Acciavatti has 19 years of experience strengthening health systems, including leading project management for IntraHealth's portfolio of digital health projects.

The Regenstrief Institute's Center for Biomedical Informatics, including the Global Health Informatics program, has 40 years of experience in the design, deployment, implementation and utilization of health information technology, with particular strength in supporting the use of standard terminology and standardized metadata, patient record-keeping systems, and standards-based health information exchange (HIE). Regenstrief is the creator of OpenMRS, an open-source electronic medical record system, and leader of the global OpenHIE community, which includes coordinating the OpenHIE Implementers Network, leading the OpenHIE Architecture Community and Review Board, and leading the Client Registry subcommunity. Regenstrief will support Work Package One with high-level solution design, will bring forth feedback from the OpenHIE community, and will contribute to Work Package Four. Regenstrief and Indiana University's key team members are Dr. Shaun Grannis (IU) and Jennifer Shivers (Regenstrief). Shaun Grannis, MD, MS, FAAFP, FACMI, FAMIA and an Indiana University faculty member, has contributed to ensuring patient identity in a wide range of settings, including overseeing the development of the architecture for Rwanda's first HIE client registry Jennifer Shivers, MFA, is a health information technology integration and process design specialist within the Regenstrief Institute with over 25 years of experience.

Established in early 2014, Ona (which means "to see" in KiSwahili) is a design and engineering social enterprise with offices in Burlington, Vermont, and Nairobi, Kenya whose mission is to help ensure equitable access to services to those who need them most. Ona builds technology that affords new opportunities for governments, international organizations, development organizations, and related actors to be increasingly collaborative, data-driven, and accountable to the people they serve. Ona is the lead technology partner for the open-source global good OpenSRP, currently deployed in more than 12 countries globally. Ona will contribute to Work Package One and deliver Work Package Three. Contributions will be led by Peter Lubelle-Doughtie, MS (CTO), Jason Rogena (Site Reliability Engineering Lead), Samuel Githengi (Senior Engineer), Emmanuel Tarus (Senior Engineer), and Craig Appl, MPH (Health Technical Lead).

IntelliSOFT Consulting Ltd. is a Kenyan-based company that has been implementing health information systems in East Africa since 2009. IntelliSOFT will use its national client registry and unique patient identifier experience in Tanzania and Kenya to undertake Work Package Two, leveraging its strong relationships with MOHs and their partners to ensure effective field testing of OpenCR. IntelliSOFT's contributions will be led by Steven Wanyee, an accomplished digital health expert with more than 18 years of experience implementing digital health solutions across Africa with support from Peter Anampiu, Kenneth Ochieng, and Susan Gath. Peter Anampiu is an experienced business analyst with over 10 years of experience, including implementing enterprise-level systems. Kenneth Ochieng is a senior software developer with over 10 years of experience developing large scale digital health solutions. Susan Gath is a certified Project Management Professional with more than 5 years of experience managing large digital health projects in East and Southern Africa.

Background

Comprehensive patient identity management is essential to realize the clinical and analytical promise of electronic health records (EHR) within a HIE. As the core function of a client registry, identity management is a foundation required for supporting key health activities for continuity of care, longitudinal records, case reporting, and for calculating accurate metrics. Yet identity management remains elusive for many reasons, including siloed points of care systems that lead to multiple identifiers; dynamic patient mobility across providers either out of practical necessity or due to social factors; and a gap in software that supports the required governance frameworks that balance the sharing of life-saving clinical information, confidentiality, and patient privacy.

The OpenHIE Community of Practice convenes and advocates for health information sharing and pursues the participation of open source client registry software products. The OpenHIE CR community identifies functional and workflow requirements for client registries based on modern, open standards. Using the OpenHIE Architecture Specification as a guiding framework, IntraHealth conducted a landscape analysis of current client registry software, noting gaps in products leveraging open source development processes and adherence to open standards. We also identified a gap in client registry solutions that support the required governance frameworks addressing the spectrum of trust levels between systems and the client registry in order to support privacy, IT security, and confidentiality.

IntraHealth developed OpenCR, a prototypical open source client registry, with funding from USAID, through MEASURE Evaluation. OpenCR was designed to help countries manage patient identity through the continuum of care by accurately identifying individuals with records across multiple information systems. Development was informed by stakeholders in Uganda, including the MOH and the Central Public Health Laboratory (CPHL), as well as technical teams at CDC and USAID. OpenCR was built to support epidemic control by deduplicating patients' lab test results for tracking outcomes over time and identifying those lost to follow up. To meet both the needs of Uganda's specific use case and ensure global applicability, the initial release of OpenCR already supports:

- 45 algorithm variations using the popular ElasticSearch engine and plugins. This includes support for deterministic and probabilistic matching.
- Record linkage and Registration as a Service by generating unique IDs with a non-destructive, auditable history of submissions.
- A modern UI to view and manage merges and overlays (incorrectly merged records), as well as audit matching decisions.
- Updated OpenMRS MPI Client Module to support OpenCR.
- Open standards, including the FHIR-based Mobile Patient Demographics Query (PDQm ITI-78) and Mobile Patient Identifier Cross-reference Query (PIXm ITI-83).

IntraHealth proposes to leverage and build upon this initial work to complete development of OpenCR as a flexible global good that fulfills the existing need within the OpenHIE architecture to track patient records across health information systems and embrace the real-world use cases of complex, fragmented systems and provide software support to governance in order to ensure patient privacy and confidentiality. The proposed activities for OpenCR will enable it to fulfill the critical roles of patient registration and identity management in realizing the digital transformation of health systems.

Digital Health Technologies

Architecture

OpenCR was developed to support an architectural pattern for national scale and is scalable to production environments of any size. OpenCR is not one application, rather it is a set of applications that work together to serve point-of-service systems, like EMRs, health financing platforms, and labs.

The OpenCR architecture includes the OpenCR Service, the API for managing queries, routing traffic to the components, and a UI to view and break matches between records and view matching histories; the HAPI FHIR Server, the reference FHIR server in Java; and ElasticSearch, a powerful search engine that is highly performant. HAPI FHIR Server additionally requires Postgres, a popular and powerful SQL database. The architecture initially supports OpenHIM for authentication, authorization, and auditing.

OpenHIE Architecture

As a patient identity management platform, OpenCR will meet or exceed requirements established by the OpenHIE Architecture workflows and functional requirements for a Client Registry. A comparison of OpenCR to the OpenHIE Architecture Specification 3.0 reveals that OpenCR fully meets three of the four required workflows and five of the 10 functional requirements and recommendations. The proposed activities described in the proposal will finalize compliance with all workflow and functional requirements of the OpenHIE Specification.

Standards

OpenCR fully meets two of the three core standards in IHE for client registries. The consortium members, through open collaboration in the OpenHIE community of practice, will implement the third core standard through this proposal:

- The Patient Demographics Query for Mobile (PDQm) Profile: PDQm defines a lightweight interface for patient demographics. (This is already supported in OpenCR.)
- The Patient Identifier Cross-reference for Mobile (PIXm) Profile: PIXm exists for supporting querying of patient identifiers from diverse systems and is designed for mobile platforms and browsers. (This is already supported in OpenCR.)
- The Patient Master Identity Registry (PMIR) Profile: PMIR supports managing patient master identities and for clients to subscribe to future changes. Implementation will include the Mobile Patient Identity Feed (ITI-93) and Subscribe to Patient Updates (ITI-94). (This is to be implemented in OpenCR.)

Use Cases and User Stories

Identity Management Maturity Model

A client registry is foundational to improving health outcomes, lowering costs, and increasing efficiency. We propose a maturity model for identity management based on existing maturity models. The Identity Management Maturity Model in the attached Appendix 1 illustrates the move from the siloed and peer-to-peer (integrated) maturity level to the interoperable maturity level with regard to the value-add for public health, and the added capabilities and responsibilities associated with the level.

The maturity levels are based on the ability to share information and associated responsibilities for governance:

- **Siloed systems** are isolated implementations where there is little to no sharing of information. This is common in low-resources settings where many projects have historically created systems for their use case without coordination. The lack of information exchange makes them inefficient in both the clinical sense and with regard to business allocations. There is more potential for errors and lost opportunities for holistic clinical care.
- **Peer-to-peer (integrated) systems** are a common solution to increase the business value-add of peer-to-peer systems. Often this means custom systems integration but without standards. While the solutions may perform their roles, the exchange of information is tightly coupled (integration not interoperability). Peer-to-peer systems are difficult to scale to other systems as they are custom solutions.
- **Interoperable systems** employ standards-based exchanges. Solutions based on them, like shared health records, solve double-counting. This maturity level has the least potential for clinical errors. However, by being the most flexible and powerful, this maturity level requires the highest responsibility for governance, IT security, and privacy. This means managing a broad spectrum of trust levels with participating systems.

The maturity model informs the user stories for feature development. Countries at different levels of maturity will benefit from the Client Registry and as their maturity levels will be different the functionality will be flexible enough to adapt to different capabilities of systems and governance.

Client Registry Functional User Stories

The maturity model described above identifies the increased data analysis and functionalities provided by robust identity management, which are commensurate with additional accountability and responsibilities.

This thinking frames the user stories for feature development, which focus on those who are directly using the software, rather than patients who receive business value-add but are not directly interacting with the system software.

Table 1 below summarizes both the existing features in OpenCR and proposed software requirements to meet the business needs, organized by functional user. Though OpenCR can support any FHIR store of patient demographic data, the user stories below use an EMR for explanation. Building on the first iteration of OpenCR, the following functional roles (actors) and responsibilities are enabled with this proposal:

- **Facility-based Data Entry Clerks (Point-of-care [POC] systems users)** will continue to register patients and update demographic information in their systems; client demographic data can automatically be sent to OpenCR.
- **POC system developers** will be able to receive subscriptions of patient updates to their systems. This is especially necessary when a particular system is indicated to be the source of truth.
- **MOH Matching reviewers and administrators** will be able to use a user interface for configuring decision rules and linking, merging and/or breaking matches, and will be able to manage the bulk import of records.
- **MOH Systems administrators** will be able to set the full spectrum of trust levels with the submitting systems, configure robust authentication and authorization using an open source platform, and provide easy demos and training using Instant OpenHIE.

Table 1: Overview of User Stories and Features

Functional User Roles (As a...)	Responsibilities (I need to...)	Existing Features	Proposed Features
POC systems users	Be able to securely send standards-based patient information to the CR to obtain a unique identifier in the background. Update patient demographic information.	Provides unique identifier from Client Registry. Update patient demographic information in Client Registry.	None.
POC system developers	Add Client Registry integration into POS systems. Subscribe to updates from other systems.	PDQm & PIXm standards for submitting patient information. OpenMRS module to help with integration.	PMIR standard for source systems to subscribe to change events (pub-sub) of demographic information.
MOH Matching reviewer and administrator	Set up and test decision rules, and view and break matches. Load patients directly, manage merges.	JSON configuration file to set up decision rules. UI for viewing and breaking matches.	UI for configuring decision rules. Bulk import of Patient Identity records. UI for Manage merging records.
MOH Systems administrator	Provide accounts to manually adjudicate records. Ensure privacy, and IT security across the full spectrum of levels of trust for systems, nodes, and users.	Node authentication. Simple user authentication. OpenHIM as optional auditing and auth{z n} provider.	Set the full spectrum of trust levels with the submitting system. Robust auth{z n} platform. Easy demos and training using Instant OpenHIE

Objectives and Activities

Work package 1: Modifications to design and functionality of OpenCR

Objective 1.1: To meet the needs of additional use cases, IntraHealth will grow capabilities within the OpenHIE Community, facilitate uptake, and provide a platform that grows with the needs of the users.

Activity 1.1.1: Support additional IHE profile actors and transactions beyond existing support for PIXm and PDQm, including PMIR - Patient Identity Manager, Mobile Patient Identity Feed (ITI-93) and Subscribe to Patient Updates (ITI-94)

Activity 1.1.2: Include easy, configurable entity matching UI and decision rule management.

Activity 1.1.3: Support merging and golden record management for reviewing, accepting, and rejecting changes.

Activity 1.1.4: Support bulk matching options to include the ability to bulk import and export patients.

Activity 1.1.5: Support attribute management, including the ability to start from a default patient resource and then modify it to add common extensions.

Objective 1.2: Ona will provide a robust, flexible, easy-to-manage authentication and authorization system for enhanced security and auditing.

Activity 1.2.1: Integrate a proven open source authorization and authentication platform to provide enterprise-scale, easy-to-manage authentication and authorization for accessing and updating OpenCR.

Activity 1.2.2: Develop robust roles in the authorization platform that support the transactions defined in objective 1.1 and ensure that they are reflected in OpenCR.

Activity 1.2.3: Integrate OpenCR with an open source robust, centralized logging system that provides logging of all transactions that took place in the authorization system and OpenCR.

Objective 1.3: IntraHealth and consortium members will undertake iterative design and software development with key global stakeholders and user groups.

Activity 1.3.1: Participate in OpenHIE Client Registry Community to solicit feedback on design, features and issues.

Activity 1.3.2: Maintain a publicly available GitHub issue tracker so users are able to create tickets and issues on a transparent platform.

Activity 1.3.3: Incorporate features and feedback from Ministries of Health (work package 2) and iterate based upon feature requests.

Work package 2: Validate Modifications with MOHs

Objective 2.1: IntelliSOFT will focus on field testing OpenCR with one to two select ministries of health, including gathering requirements and validating use cases with governments grappling with the issue of identity management to ensure that the product is both accessible and functional in low resource settings. Planned countries for collaboration include Kenya and Liberia.

Activity 2.1.1: Facilitate community engagement and country-level field testing of OpenCR with select MOHs to validate use cases, functionality, and usefulness.

Activity 2.1.2: Test the OpenMRS MPI Client Module.

Activity 2.1.3: Explore the use of OpenCR in cross-border contexts, such as shared governance of a system between two sovereign governments and how to manage patient identities when data sets differ between countries.

Activity 2.1.4: Validate the Instant OpenHIE demo and testing platform for OpenCR with potential users.

Work Package 2 was designed to enable this component to continue even if travel is not feasible due to the COVID-19 pandemic. If travel is not possible, the IntelliSOFT will leverage its existing presence in Kenya to conduct field testing with the Kenyan MOH, and field testing with additional ministries such as Liberia will occur once travel restrictions are lifted.

Work package 3: OpenCR Shared Health Record (SHR) Gap Analysis

Objective 3.1: Ona will investigate, document, and develop a software roadmap for using OpenCR's existing FHIR resources to support a shared health record. OpenCR's technology stack supports the core workflows of storing FHIR documents with minimal additional investment. This objective focuses on comparing the existing capabilities against the Shared Health Record architecture features and functions.

Activity 3.1.1: Develop a gap analysis that documents OpenCR's current features against the OpenHIE Shared Health Record capabilities and workflows as defined in the OpenHIE Specification Release 2.0 and defines a software development roadmap.

Activity 3.1.2: Present the gap analysis from Activity 3.1.1 to the OpenHIE Shared Health Record community working group

Work package 4: Testing, DevOps, Packaging, and Documentation

Objective 4.1: IntraHealth and Regenstrief will create a testing framework, document proposed enhancements to OpenCR, building upon the [comprehensive documentation](#) we developed for OpenCR's first release. These activities will facilitate long term sustainability and wider adoption.

Activity 4.1.1: Build a repeatable testing framework, indicators, reporting and coverage, including conformance testing in line with the OpenHIE Testing Framework and Architecture Specification.

Activity 4.1.2: Document work developed under Work Packages One and Two.

Activity 4.1.3: Make enhancements to the OpenCR User Guide and Developer Guide.

Activity 4.1.4: Conduct DevOps and packaging e.g. (Ansible, Docker, Kubernetes). Includes associated requirements for the Instant OpenHIE platform and presentation to the DevOps Subcommunity.

Activity 4.1.5: Create packaging and continuous integration and continuous delivery (CI/CD) processes.

Activity 4.1.6: Create a website that includes a hosted demo site with realistic but fake data for individuals to acquaint themselves with the functionalities of a CR and how to use a limited set of algorithms.

Dependencies: Work Package One is the core development of expansions and modifications to the design and functionality of OpenCR. Work Packages Two, Three, and Four build upon the iterations in Work Package One and enable consultation with stakeholders to ensure that the features are based on the needs of potential implementers. There are no interdependencies between the packages other than dependence on the core deliverables in Work Package One.

Community Feedback

The development of OpenCR was heavily influenced by the expertise shared on monthly OpenHIE Client Registry Subcommunity calls where progress would continue under this award, and additional adhoc feedback will be requested from the Shared Health Record and DevOps subcommunities. The consortium will also present and review the broader OpenHIE community at upcoming events, including the virtual 2020 OpenHIE Community Meeting.

With regard to soliciting input from country stakeholders, the consortium has defined a dedicated work package (WP2) to encompass those activities to ensure there is critical input on the project.

Schedule

The following is a high-level work plan.

Activity	Team Location	Month								
		1	2	3	4	5	6	7	8	9
WP1, Objective 1.1, Activity 1.1.1	IntraHealth, US	x	x	x						
WP1, Objective 1.1, Activity 1.1.2	IntraHealth, US	x	x	x						
WP1, Objective 1.1, Activity 1.1.3	IntraHealth, US	x	x	x						
WP1, Objective 1.1, Activity 1.1.4	IntraHealth, US				x	x	x			
WP1, Objective 1.1, Activity 1.1.5	IntraHealth, US				x	x	x			
WP1, Objective 1.2: Activity 1.2.1	Ona, US				x	x	x			
WP1, Objective 1.2, Activity 1.2.2	Ona, US				x	x	x			
WP1, Objective 1.2, Activity 1.2.3	Ona, US				x	x	x			
WP1, Objective 1.3, Activity 1.3.1	All, US				x	x	x	x	x	x
WP1, Objective 1.3, Activity 1.3.2	IntraHealth, US				x	x	x	x	x	x
WP1, Objective 1.3, Activity 1.3.3	IntraHealth, US				x	x	x	x	x	x
WP2, Objective 2.1, Activity 2.1.1	IntelliSOFT, TBD	x	x	x						
WP2, Objective 2.1, Activity 2.1.2	IntelliSOFT, TBD	x	x	x						
WP2, Objective 2.1, Activity 2.1.3	IntelliSOFT, TBD						x	x	x	x

WP2, Objective 2.1, Activity 2.1.4	IntelliSOFT, TBD						X	X	X	X
WP3, Objective 3.1, Activity 3.1.1	Ona, US			X	X	X				
WP3, Objective 3.1, Activity 3.1.2	Ona, US			X	X	X				
WP4, Objective 4.1, Activity 4.1.1	IntraHealth, Regenstrief, US	X	X	X	X	X	X	X	X	X
WP4, Objective 4.1, Activity 4.1.2	IntraHealth, Regenstrief, US	X	X	X	X	X	X	X	X	X
WP4, Objective 4.1, Activity 4.1.3	IntraHealth, Regenstrief, US	X	X	X	X	X	X	X	X	X
WP4, Objective 4.1, Activity 4.1.4	IntraHealth, Regenstrief, US	X	X	X	X	X	X	X	X	X
WP4, Objective 4.1, Activity 4.1.5	IntraHealth, Regenstrief, US	X	X	X	X	X	X	X	X	X
WP4, Objective 4.1, Activity 4.1.6	IntraHealth, Regenstrief, US	X	X	X	X	X	X	X	X	X

Deliverables

Deliverable	Month Due
WP1, Objective 1.1, Activity 1.1.1: Additional IHE profile actors and transactions supported	M3
WP1, Objective 1.1, Activity 1.1.2: Easy, configurable entity matching UI and decision rule management included	M3
WP1, Objective 1.1, Activity 1.1.3: Merging and golden record management for reviewing, accepting, and rejecting changes supported	M3
WP1, Objective 1.1, Activity 1.1.4: Bulk matching options to include the ability to bulk import and export patients supported	M6
WP1, Objective 1.1, Activity 1.1.5: Attribute management, including the ability to start from a default patient resource and then modify it supported	M6
WP1, Objective 1.2, Activity 1.2.1: A proven open source authorization and authentication platform integrated	M6
WP1, Objective 1.2, Activity 1.2.2: Robust roles developed in the authorization platform that support the transactions defined in objective 1.1	M6
WP1, Objective 1.2, Activity 1.2.3: OpenCR integrated with an open source robust, centralized logging system that provides logging of all transactions.	M6
WP1, Objective 1.3, Activity 1.3.1: Feedback solicited from OpenHIE Client Registry Community on design, features and issues.	M9

WP1, Objective 1.3, Activity 1.3.2: Publicly available GitHub issue tracker maintained on GitHub so users are able to create tickets and issues on a transparent platform.	M9
WP1, Objective 1.3, Activity 1.3.3: Features and feedback from MOHs incorporated (per work package 2) through iterative process	M9
WP2, Objective 2.1, Activity 2.1.1: Community engagement and country-level field testing of OpenCR conducted with select MOHs	M3
WP2, Objective 2.1, Activity 2.1.2: Tested OpenMRS MPI Client Module	M3
WP2, Objective 2.1, Activity 2.1.3: Report on the applicability of OpenCR in cross-border contexts	M9
WP2, Objective 2.1, Activity 2.1.4: Validation of the Instant OpenHIE demo and testing platform for OpenCR with potential users.	M9
WP3, Objective 3.1, Activity 3.1.1: Gap analysis that documents OpenCR's current features against the OpenHIE Shared Health Record	M5
WP3, Objective 3.1, Activity 3.1.2: Presentation of gap analysis from Activity 3.1.1 to the OpenHIE Shared Health Record community working group	M5
WP4, Objective 4.1, Activity 4.1.1: Repeatable testing framework, indicators, reporting and coverage built	M9
WP4, Objective 4.1, Activity 4.1.2: Documentation of work developed under Work Packages One and Two.	M9
WP4, Objective 4.1, Activity 4.1.3: Complete OpenCR User Guide and Developer Guide	M9
WP4, Objective 4.1, Activity 4.1.4: DevOps and packaging for the Instant OpenHIE platform.	M9
WP4, Objective 4.1, Activity 4.1.5: Packaging and creation of continuous integration and continuous delivery (CI/CD) processes.	M9
WP4, Objective 4.1, Activity 4.1.6: A hosted demo site with realistic but fake data.	M9

Global Good Maturity Model Assessment

Linked below is a completed Global Good Maturity Model Self-Assessment

Global Good Maturity



Assessment link

https://docs.google.com/spreadsheets/d/1Mv_IS8OCbQ3395lgrCRZXLMolg2T5Kw8zKlphz7q-rU/edit?usp=sharing

ANNEX 1 - KEY PERSONNEL RESUMES

Luke Duncan

Digital Health Assistant Director

SUMMARY OF RELEVANT EXPERIENCE

Luke Duncan has more than 20 years of professional experience in developing software by using open source technology and programming languages such as JavaScript/Node.JS, PHP, Java, Perl, PL/SQL, and JSP. He is an expert in Oracle, My SQL, PostgreSQL, and Informix databases as well as XML, XSL, HTML5, and CSS. He is a member of the Integrating the Health Enterprise (IHE) Information Technology Infrastructure (ITI) committee and has authored profiles using HL7's Fast Healthcare Interoperability Resources (FHIR). He has also worked with Vue.JS, AngularJS, React, Elasticsearch, Kibana, Python, Go, Ruby, and MongoDB. Over the past twelve years, Mr. Duncan led the design and development of the iHRIS suite of software, including its implementation in Uganda, Rwanda, and Tanzania. He also provided technical support to country developers working with iHRIS in customizing the system and maintained public access to all source codes on launchpad.net. Prior to joining IntraHealth, Mr. Duncan was a systems programmer at Infosystems Technology Inc. where he worked with systems and applications administrators to develop and maintain tools to monitor their systems. He also developed and maintained the company's control center website and led the development of tools to help track infected systems.

INTERNATIONAL EXPERIENCE Botswana, Democratic Republic of the Congo, Ethiopia, Ghana, Guatemala, India, Kenya, Namibia, Nigeria, Pakistan, Rwanda, Senegal, Swaziland, Tanzania/Zanzibar, Uganda

PROFESSIONAL EXPERIENCE

Assistant Director, Digital Health, IntraHealth International

May 2017 - Present

Chapel Hill, North Carolina

Manages a team of developers to support iHRIS and other software products. Works with Integrating the Health Enterprise (IHE) on international standards supporting our work: mCSD, CSD, and mACM. Designs and develops the iHRIS software using open source technologies, including iHRIS Manage, iHRIS Qualify, iHRIS Train, and iHRIS Plan. Interacts with iHRIS users and department representatives to ensure product development meets stated functional requirements, system design, standards, and data integrity. Builds web-driven software using Node.JS, MongoDB, PHP, MySQL, and Apache. Supports in country developers working with the iHRIS suite of software with customizations and maintenance. Maintains public access to all source code on launchpad.net or GitHub.

Senior Systems Developer, IntraHealth International

January 2006 – May 2017

Chapel Hill, North Carolina

Designed and developed the iHRIS software using open source technologies including iHRIS Manage, iHRIS Qualify, and iHRIS Plan. Interacted with iHRIS users and department representatives to ensure product development meets stated functional requirements, system

design, standards, and data integrity. Implemented and installed HRIS software in Uganda, Rwanda, and Tanzania. Built web-driven software using PHP, MySQL, and Apache. Managed software contributions from a team of developers based on feature requests from technical leaders and in country requests. Supported in country developers working with the iHRIS suite of software with customizations and maintenance. Maintained public access to all source code on launchpad.net.

Systems Programmer, Infosystems Technology Inc.,

2001 –2005

Chapel Hill, North Carolina

Maintained and developed the Control Center website and tools: <http://control-center.unc.edu/>, Cujo, and Service Monitor. Worked with systems and applications administrators to develop and maintain tools to monitor their systems, recognize recurring problems in the monitoring infrastructure, and initiate corrective action. Worked with departmental representatives to resolve, implement, and sign-off approved user requests. Worked with Control Center administrators to build tools for monitoring the campus network and systems and maintain documentation of Control Center policies and procedures. Worked with other groups on campus such as OASIS, Telecom, and the IT Response Center to develop and maintain custom tools.

Chief Technologist, Catalogue.com

1997 –2000

Chapel Hill, North Carolina

Developed and maintained e-commerce and dynamic web sites using Perl, ASP, PHP, and Server-Side JavaScript with an Informix database back end. Developed and maintained administrative web applications to manage dynamic web sites. Assisted with system administration duties. Managed team of developers working with Java and JSP. Identified potential threats and vulnerabilities, assessed the risks of these to the organization, and implemented appropriate corrective or preventative action.

Lead Programmer, Ventana Communications Group

1994 –1997

Research Triangle Park, North Carolina

Provided the underlying system platform programming support on which applications are developed and deployed. Developed and maintained website for informational purposes and an online sales catalogue. Managed rewrite of e-commerce site using Netscape Enterprise server and Server-Side JavaScript. Investigated, designed, and implemented new features for the Oracle database server environment, develop OM Policies and other monitoring components, and assist monitoring specialists in the application support areas in doing the same. Responsible for system administration and backups of Solaris servers and applications. Converted published books to HTML for reading from CD and having online updates.

SELECT PUBLICATIONS

Abdoulaye Diedhiou, Kate E Gilroy, Carie Muntifering Cox, Luke Duncan, Djimadoum Koumtingue, Sara Pacqué-Margolis, Alfredo Fort, Dykki Settle and Rebecca Bailey. Successful mLearning Pilot in Senegal: Delivering Family Planning Refresher Training Using Interactive Voice Response and SMS, *Global Health: Science and Practice*, 2015

- Duncan L. Official Netscape Server-Side JavaScript for Database Applications, Ventana Communications Group, 1997.
- Duncan L, Alan Wyke. The Perl 5 Programmer's Reference, Ventana Communications Group, 1997.
- Duncan L, Sean Michaels. Official Netscape Technologies Developer's Guide: All Platforms Ventana Communications Group, 1997.
- Duncan L, Sean Michaels. Official Netscape ONE Book: Create Integrated, Platform-Independent Web Applications. Ventana Communications Group, 1997.
- Duncan L, Gareth Branwyn, Sean Carton, Tom Lichty, Shannon Turlington, et al. Internet Roadside Attractions: Sites, Sounds, and Scenes along the Information Superhighway. Ventana Communications Group, 1995.

Richard Stanley, PhD, MSc

Senior Technical Advisor, Digital Health

SUMMARY OF RELEVANT EXPERIENCE

Dr. Richard Stanley manages product development for data science, analytics, and interoperability to support the digital transformation of health systems. He has worked in technical leadership roles across 30 countries over the course of his 24-year career. As the global lead for real-time information systems at UNICEF and innovation lead in Afghanistan, he led the first pilot for RapidPro, an easy-to-use tool to create text messaging-based applications. He is proficient in Python and Stata and has a background as a Unix systems administrator. Richard has a PhD in Politics from the University of Oxford and has conducted quantitative research on the impacts of climate change and conflict on child survival. He was a Fulbright Fellow in Sierra Leone and National Science Foundation Graduate Research Fellow.

EDUCATION

Doctor of Philosophy, Politics, University of Oxford, Oxford, UK, 2013

Master of Science, African Studies, University of Oxford, Oxford, UK, 2006

Bachelor of Arts, Political Science, University of California, Berkeley, CA, 2005

INTERNATIONAL EXPERIENCE

Afghanistan, Ghana, Sierra Leone, South Sudan, Sudan, Uganda

PROFESSIONAL EXPERIENCE

Senior Technical Advisor, IntraHealth International

May 2017 - Present

Washington, DC

Digital health product management and global technical leadership, including international health interoperability efforts for the OpenHIE community of practice, and for the iHRIS community. Create data science analytics, services and training for USG-funded projects and for internal staff. Support critical projects for persons living with HIV in Tanzania, volunteer community health workers in Uganda, and the health workforce management in Kenya.

Web Application Developer, Freelance

August 2016 – February 2017

London, UK; Kensington, Maryland

Built prototype software products for undervalued problem domains, including an Amazon Alexa skill for medication reminders as part of a larger effort to enable safer living for seniors and others with limitations due to illness or disability. Created a chatbot that finds the latest journal articles and preprints to promote scientific research. Prototyped solutions to overcome slow networks and to make it easier to deploy web applications in legacy data centers. Contributed data science expertise to an open data platform for civic engagement.

Global Product Manager, Senior Technology Specialist, UNICEF*May 2015 – April 2016**Kampala, Uganda*

Owned the global roadmap, strategy, execution, and growth of real-time information systems. Provided high-level technical product support for youth engagement (U-Report), polio eradication, digital health, education, and child protection. Grew mobile application adoption for government interventions in more than 30 countries, with over 200 million sent messages. Supported launches in Brazil, China, India, Thailand, Pakistan, and a dozen African countries, a \$3 million program. Ensured agile project management with globally distributed vendors to deliver features including Android-based data collection, and channels for voice, USSD, and Facebook Messenger integration. Built the capacity of in-country stakeholders on how to forge partnerships with regulatory authorities and mobile network operators. Drove the development of the Kolibri platform for offline learning in refugee camps.

Innovation Lead and Program Manager, UNICEF*April 2013 – April 2015**Kabul, Afghanistan*

Led innovation for UNICEF programs in health systems strengthening, polio, and education. Launched the first mobile application initiatives in conflict areas to reach out-of-school children and improve polio campaigns. Conducted and contracted the first global pilot for RapidPro, an easy-to-use tool to create text messaging-based applications. Designed the technical architectures, trained government and technical staff, and managed mobile network operator contracts.

Director of Research and Innovation, Forcier Consulting*December 2012 – April 2013**Juba, South Sudan*

Managed the production of high quality research and rapid data analytics for monitoring and evaluations in Somalia, South Sudan, Uganda, Egypt, and Sudan. Directed the first national survey in South Sudan enumerated with smartphones. Supervised 19 field staff and mentored early career researchers. Managed the relationship with the national statistical authority. Authored evaluation reports, grant proposals, and rapid data analytics.

Field Research Manager, Institute for Development Studies*February 2011 – July 2011**Khartoum, Sudan*

Managed a Darfur-wide household survey of nutritional status, exposure to conflict and gender-based violence, migration, and livelihoods. Supervised 50 field staff in conflict areas across Darfur. Coordinated with stakeholders including ECHO, FAO, WFP, and UNICEF.

Data Analyst and Statistician, Freelance*May 2008 – June 2013**South Sudan, Sudan, Liberia, Sierra Leone, UK*

Statistical, monitoring and evaluation, and data consultant. Highlights:

- War Child, Sudan: Designed a randomized controlled trial for a digital education project for displaced persons.
- Population Council, South Sudan: Created analytics for a DFID-funded policy planning and decision support tool.

- Norwegian People's Aid, South Sudan: Supervised the data entry and created analytics for a UNHCR/UNFPA survey on gender-based violence and conflict. Managed 15 data entry staff.
- WHO Barcelona Office for Health Systems Strengthening: Devised methodologies for tracking out-of-pocket spending on healthcare and published articles.
- Department of Economics, University of Oxford: Statistical analysis on conflict, trade, and foreign aid.
- UN Country Team, Sierra Leone: Researched the impact of rising fuel prices on poverty reduction and led authorship of a report for FAO/WFP.

Fulbright Fellow, US Department of State

February 2008 – November 2008 Freetown, Sierra Leone

Field research in public health about the impacts of foreign aid and the civil war on the health system and health outcomes. Analyzed raw census data and all available household surveys (DHS and MICS). Revised mortality rate and nutritional status estimations given seasonality.

Unix Systems Administrator, Identity Engines

July 2006 – October 2006 Mountain View, California

Provided Unix systems administration support for a defunct security startup. Created multi-platform (UNIX and Windows) solutions for enterprise network integration. Upgraded infrastructure for engineering teams.

Software QA Engineer and Unix Systems Administrator, Freelance

February 2001 – January 2006 Berkeley, California

Engineering and Unix systems administration in the high technology sector. Highlights:

- UC Berkeley: Programmed Perl and shell utilities to maximize network and storage resources.
- LSI Logic: Wrote a comprehensive testing harness in Perl and shell scripts for company products.
- Hitachi Global Storage Technologies: Created and conducted the full spectrum of tests for fiber optic products.

GIS Applications Specialist, Centre for Remote Sensing and GIS

October 2004 – January 2005 Legon, Ghana

Volunteer GIS analyst for a research institution. Designed the telecommunications architecture for a monitoring system for all development activities in Ghana. Wrote a grant proposal for Buduburam Liberian refugee settlement for water and sanitation issues.

Unix Systems Administrator, Sun Microsystems

May 1996 – January 2001 Cupertino, California

Provided enterprise IT support for the Java engineering division and built capacity across the company in advanced systems administration. Maintained an environment with 1,900 clients and servers. Trained Solaris system administrators across North America.

SELECT PUBLICATIONS

Adhvaryu, Achyuta, Prashant Bharadwaj, James Fenske, Anant Nyshadham, and Richard Stanley, 2016. Dust and Death: Evidence from the West African Harmattan. Working paper. Oxford: Center for the Study of African Economics.

Stanley, Richard, 2013. Micro-macro paradoxes: The effects of conflict and aid on child survival. PhD diss., University of Oxford.

Markova, Nora and Richard Stanley, 2011. Behind the estimates of out-of-pocket spending on health in the former Soviet Union. Copenhagen: WHO Regional Office for Europe.

Stanley, Richard, 2010. Supporting democratic institutions and clean and peaceful elections. Working paper. Oxford: Center for the Study of African Economics.

Stanley, Richard, Enitor Briggs, Suhrid Patel, and Lansana Woneh, 2008. The severe impact of the food crisis: A situational assessment of the food crisis in Sierra Leone. WFP and FAO.

Stanley, Richard, 2007. Why are civil wars in Africa more difficult for governments to win? A quantitative study of civil war outcomes. World Bank.

Dana Acciavatti

Senior Portfolio Manager, Digital Health

SUMMARY OF RELEVANT EXPERIENCE

Dana Acciavatti has 18 years of experience strengthening systems that support health workers globally and currently manages IntraHealth's portfolio of digital health activities and provides leadership across the Digital Health team. Ms. Acciavatti played a strategic role in the development of the iHRIS Foundation, and she leads community engagement efforts to ensure user input into the future development of the software and to support the growth of the global iHRIS community. She has guided country implementations of iHRIS at national and district levels and managed the core development of other digital health products such as the Facility Match solution, a facility reconciliation tool. She led the project team implementing a digital registry of community health workers in Uganda, resulting in the first comprehensive view of the community health workforce and services they are providing in that country. Ms. Acciavatti brings a unique combination of technical expertise and superior project management skills and provides strong leadership in program design, contract management, implementation, and reporting for digital health interventions.

EDUCATION

Bachelor of Arts, Women's Studies, Communications, University of North Carolina, Chapel Hill, NC, USA, 2000

INTERNATIONAL EXPERIENCE

Barbados, Dominican Republic, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Peru, Rwanda, South Africa, Switzerland, Tanzania, Uganda

PROFESSIONAL EXPERIENCE

Senior Portfolio Manager, Digital Health, IntraHealth International

November 2015 – Present

Chapel Hill, NC, USA

Responsible for managing IntraHealth's portfolio of digital health projects and activities. Provides leadership and guidance to the digital health team, including strategic growth and business development. Implemented a digital registry for community health workers in Uganda for workforce planning, management, and decision-making. Developed the iHRIS Foundation to manage continued growth of the global iHRIS community and open-source software suite. Establishes and maintains project plans, budgets, and tracking systems.

Program Manager, CapacityPlus, IntraHealth International

September 2009 – November 2015

Chapel Hill, NC, USA

Senior member of the CapacityPlus program management team responsible for overall project operations and assigned field support programs. Managed and provided technical oversight to Human Resources for Health (HRH) programs globally and at the country level. Provided portfolio management support to Informatics Team. Independently led OVC funded field activities in Malawi and Nigeria (budgets of \$900,000 and \$1,538,231) focused on building the capacity of the social service workforce, including HRIS strengthening. Conducted a situational analysis of training programs for para-social workers in Nigeria, Tanzania, and Ethiopia.

Coordinated a mapping of the child protection systems in six states in Nigeria. Served on the Project Leadership Team, engaging in high level problem solving and strategic direction. Managed project start-up and close-out, including opening and closing field offices.

Program Manager, The Capacity Project, IntraHealth International

December 2007 – September 2009 Chapel Hill, NC, USA

Provided management oversight for the global, \$250 million USAID Capacity Project activities, including monitoring staffing plans, budgets, and timelines to achieve project results. Responsible for the project's five-year \$26.6 million core funded portfolio across more than 25 countries and eight partner organizations. As a member of the Project Leadership Team, provided input and guidance in problem-solving, strategies for responding to the donor, and budget decisions. Supervised 5 operations staff and ensured deliverables were met and that individual components were on track. Ensured IntraHealth compliance with USAID deliverables and planned expenditures.

Program Officer, IntraHealth International

December 2005 – December 2007 Chapel Hill, NC, USA

Developed and monitored program budgets. Trained staff in programmatic, organizational, and donor financial requirements and monitored program activities for compliance. Managed procurement and developed and monitored sub awards. Organized and oversaw management of large domestic and international conferences. Coordinated logistics for large-scale project meetings and events. Supervised staff and developed project management and operations systems and processes.

Program Associate, IntraHealth International

October 2004 – December 2005 Chapel Hill, NC, USA

Developed and revised budgets for Capacity Project technical activities, coordinated budgets from multiple partners, monitored and tracked expenditures, and advised on spending. Supervised project operations staff. Managed subcontracts and subgrants and ensured compliance with organizational and USAID policies and procedures. Coordinated logistics for large scale project events, staff meetings, and international workshops. Prepared, edited, and disseminated project reports and documents, including subcontracts, subagreements, purchase orders, and memoranda of understanding. Assisted with project start-up activities, including setting up management systems and templates. Assisted leadership team with information collection, data entry and analysis, and follow up.

Office Manager, IntraHealth International

June 2001 – October 2004 Chapel Hill, NC, USA

Developed operating procedures and systems for office services unit, supervised staff.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. DO NOT EXCEED FIVE PAGES.

NAME: Grannis, Shaun

eRA COMMONS USER NAME (credential, e.g., agency login): sgrannis

POSITION TITLE: Professor of Family Medicine

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	END DATE MM/YYYY	FIELD OF STUDY
Massachusetts Institute of Technology, Boston, Massachusetts	BS	05/1991	Aeronautical and Astronautical Engineering
Harvard University, Boston, Massachusetts	OTH	08/1991	Medical School Prerequisites
Michigan State University, East Lansing, Michigan	MD	05/1997	Medicine
Indiana University, Indianapolis, Indiana	MS	06/2003	Clinical Research and Medical Informatics

A. Personal Statement

After receiving an Aerospace Engineering degree from MIT, and undergoing post-doctoral training in Medical Informatics and Clinical Research at Regenstrief Institute and Indiana University School of Medicine, I joined Indiana University in 2001. Since then I have become a close collaborator with national and international public health stakeholders to advance the technical infrastructure and data-sharing capabilities. I served as a member of World Health Organization (WHO) Collaborating Center for the Design, Application, and Research of Medical Information Systems, where I provided consultancy on issues related to health information system identity management; and implementing automated patient record matching strategies. I currently serve as Chief Architect for OpenHIE, a global health collaborative supporting eHealth planning and implementation needs for developing countries. I've built and studied automated regional electronic laboratory reporting systems that demonstrate substantial increases in the electronic capture rates for diseases of public health significance when compared to traditional, manual, paper-based procedures, despite substantial data quality challenges. I oversee the evaluation of operational standards-based laboratory data interfaces between public health clinical laboratories and an electronic clinical messaging application used by both public health officials and clinicians. This system adjudicates more than 50 million real-time clinical transactions from hundreds of data sources yearly to assess their report-ability to public health. As co-chair of the U.S. Health Information Technology Standards Panel (HITSP) Population Health technical work group, I helped lead development of technical interoperability specifications for nationally recognized public health IT use cases. I received the American Medical Informatics Association's (AMIA) Martin Epstein Award for advancing the body of medical informatics knowledge through novel record linkage methods; I've provided expert testimony before the DHHS National Committee for Vital and Health Statistics (NCVHS) regarding national patient identity management policy; I have worked with the World Health Organization, UNAIDS, and the CDC as a subject matter expert developing new approaches, policies, and procedures for identity management and I have received AHRQ R01 funding to develop methodological improvements for real-world patient matching systems. My recent research focuses on developing and testing large-scale HIE-based solutions in support of population health and public health informatics; integrating clinical and social determinants of health (SDH) to identify at-risk patients in need of SDH services, which include nutrition counseling, financial planning, and medical-legal partnership assistance; developing and testing novel patient matching methods; and leveraging machine learning-based models to improve discovery and decision support in a variety of contexts. The following publications highlight my recent AI and data analytics work:

1. **Grannis SJ**, Xu H, Vest JR, Kasthurirathne S, Bo N, Moscovitch B, Torkzadeh R, Rising J. Evaluating the effect of data standardization and validation on patient matching accuracy. J Am Med Inform Assoc. 2019 May 1;26(5):447-456. PubMed PMID: [30848796](#).
2. Kasthurirathne SN, Dexter G, **Grannis SJ**. An Adversarial Approach to Enable Re-Use of Machine Learning Models and Collaborative Research Efforts Using Synthetic Unstructured Free-Text Medical Data. Stud Health Technol Inform. 2019 Aug 21;264:1510-1511. PubMed PMID: [31438206](#).
3. Kasthurirathne SN, Vest JR, Menachemi N, Halverson PK, **Grannis SJ**. Assessing the capacity of social determinants of health data to augment predictive models identifying patients in need of wraparound social services. J Am Med Inform Assoc. 2018 Jan 1;25(1):47-53. PubMed PMID: [29177457](#).
4. Li X, Xu H, Shen C, **Grannis S**. Automated linkage of patient records from disparate sources. Stat Methods Med Res. 2018 Jan;27(1):172-184. PubMed PMID: [28034172](#).

B. Positions and Honors

Positions and Employment

1997 - 2000	Resident, Mid-Michigan Family Practice Residency Program, Midland, MI
2001 - 2004	Clinical Lecturer, Indiana University, Department of Family Medicine, Indianapolis, IN
2001 - 2004	NLM Informatics Fellow, Regenstrief Institute Medical Informatics, Indianapolis, IN
2004 -	Research Scientist, Regenstrief Institute, Inc., Indianapolis, IN
2004 - 2011	Asst. Professor, Indiana University, Department of Family Medicine, Indianapolis, IN
2011 - 2019	Assoc. Professor, Indiana University, Department of Family Medicine, Indianapolis, IN
2015 - 2016	Assoc. Director, Regenstrief Institute, Inc., Center for Biomedical Informatics, Indianapolis, IN
2016 - 2017	Interim Director, Regenstrief Institute, Inc., Center for Biomedical Informatics, Indianapolis, IN
2017 - 2019	Director, Regenstrief Institute, Inc., Center for Biomedical Informatics, Indianapolis, IN
2018 - 2019	Clem McDonald Investigator in Biomedical Informatics, Indiana University School of Medicine, Indianapolis, IN
2019 -	Professor of Family Medicine, Indiana University, Dept. of Family Medicine, Indianapolis, IN
2019 -	Vice President of Data & Analytics, Regenstrief Institute, Inc., Indianapolis, IN

Other Experience and Professional Memberships

1997 -	Member, American Academy of Family Practice
1999 -	Member, American Medical Informatics Association
2000 -	Diplomat, American Board of Family Practice
2008 -	Fellow, American Academy of Family Practice
2011 -	Member, Institute of Medicine Study Committee, Integrating Primary Care and Public Health
2011 -	Member, Indiana Health Information Technology (IHIT) Board
2012 -	Fellow, American College of Medical Informatics (ACMI)
2019 -	Fellow, Applied Informatics Recognition Program, American Medical Informatics Association

Honors

2002	1st Place, Student Paper Competition, 2002 AMIA Fall Symposium
2002	The Martin Epstein Award, AMIA
2007	The eHI Blueprint Award for Improving Population Health, eHealth Initiative
2011	Distinguished Paper Award, AMIA Fall Symposium
2011	Outstanding Research Article in Biosurveillance, International Society for Disease Surveillance
2012	Best of AMIA in Public Health Informatics Award, AMIA Fall Symposium
2013	Research Frontiers Trailblazer Award, IUPUI
2015	Showalter Scholar, Showalter Trust Committee, I.U. School of Medicine

C. Contribution to Science

1. My research in probabilistic record linkage demonstrated that the information characteristics of routinely collected patient demographics yielded a sufficiently accurate deterministic matching algorithm to support unsupervised record linkage within an operational health information exchange. Further, my team demonstrated that unsupervised methods for parameterizing matching models yielded sufficiently accurate linkage supporting operational health information exchange. We also described an ensemble method for improving string nearness comparisons.
 - a. Daggy JK, Xu H, Hui SL, Gamache RE, **Grannis SJ**. A practical approach for incorporating dependence among fields in probabilistic record linkage. BMC Med Inform Decis Mak. 2013 Aug 30;13:97. PubMed PMID: [24001000](#); PubMed Central PMCID: [PMC3766252](#).
 - b. **Grannis SJ**, Overhage JM, Hui S, McDonald CJ. Analysis of a probabilistic record linkage technique without human review. AMIA Annu Symp Proc. 2003;PubMed PMID: [14728174](#); PubMed Central PMCID: [PMC1479910](#).
 - c. **Grannis SJ**, Overhage JM, McDonald C. Real world performance of approximate string comparators for use in patient matching. Stud Health Technol Inform. 2004;107(Pt 1):43-7. PubMed PMID: [15360771](#).
2. Latent class maximum likelihood estimator models for record linkage are commonly applied in healthcare settings. These class of models often assume conditional independence for agreement among corresponding fields. This assumption and practice is often invalid. For example, agreement on first name and gender are correlated. I led our record linkage laboratory in the exploration of methods for both improving models for record linkage. We tested several approaches for accommodating correlation among matching variables. Subsequently, we demonstrated that Gaussian random effects models and log linear models with interaction terms improve record linkage classification accuracy over traditional models that assume conditional independence. Traditional widely used latent class maximum likelihood estimator models for record linkage do not incorporate term frequency information. We developed an information-theoretic empirical modification to a commonly used record linkage model that incorporated term frequency. We demonstrated that models incorporating term frequency-based weight modifications exhibit greater specificity.
 - a. Daggy J, Xu H, Hui S, **Grannis S**. Evaluating latent class models with conditional dependence in record linkage. Stat Med. 2014 Oct 30;33(24):4250-65. PubMed PMID: [24935712](#).
 - b. Zhu VJ, Overhage MJ, Egg J, Downs SM, **Grannis SJ**. An empiric modification to the probabilistic record linkage algorithm using frequency-based weight scaling. J Am Med Inform Assoc. 2009 Sep-Oct;16(5):738-45. PubMed PMID: [19567789](#); PubMed Central PMCID: [PMC2744724](#).
 - c. **Grannis SJ**, Overhage JM, McDonald C. Real world performance of approximate string comparators for use in patient matching. Stud Health Technol Inform. 2004;107(Pt 1):43-7. PubMed PMID: [15360771](#).
3. Another significant thread to my research focuses on health information exchange [HIE]. This field explores technologies, policies, architectures, and economic models that enable the effective and efficient integration and sharing of health data. Given that health care data is increasingly generated across many diverse systems, methods for aggregating, managing and sharing these data are needed. Few successful, sustainable approaches have been identified. I have developed, implemented and studied novel approaches for aggregating and sharing large volumes of data to support a variety of healthcare, population health, and research purposes. Public health surveillance, automated case detection, regional broadcast alerting, and disease outbreak detection all represent novel uses of health information exchange frameworks. Additionally, I constructed methods to identify patients who are high utilizers of Emergency Department services. Identifying these patients may result in lower costs by diverting high utilizers to other more cost-effective venues. Similarly, we identified individuals with multiple public reportable conditions that frequently move among health care organizations and identified factors that suggest greater movement. My more than 10 year's work with the Indiana Network for Patient Care, the nation's largest and oldest HIE, led to opportunities to serve in advisory capacity with organizations such as Indiana Health Information Technology Board of Directors, Nationwide Health Information Network, the Regenstrief Institute/World Health Organization collaborating center for medical informatics. Due in part to my work in

this area, in 2012 I was nominated and subsequently elected as a Fellow of the American College of Medical Informatics (ACMI) during my first year of eligibility – an uncommon event.

- a. Biondich PG, **Grannis SJ**. The Indiana network for patient care: an integrated clinical information system informed by over thirty years of experience. J Public Health Manag Pract. 2004 Nov;Suppl:S81-6. PubMed PMID: [15643364](#).
 - b. Mwogi TS, Biondich PG, **Grannis SJ**. An Evaluation of Two Methods for Generating Synthetic HL7 Segments Reflecting Real-World Health Information Exchange Transactions. AMIA Annu Symp Proc. 2014;2014:1855-63. PubMed PMID: [25954458](#); PubMed Central PMCID: [PMC4419874](#).
 - c. Revere D, Dixon BE, Hills R, Williams JL, **Grannis SJ**. Leveraging health information exchange to improve population health reporting processes: lessons in using a collaborative-participatory design process. EGEMS (Wash DC). 2014;2(3):1082. PubMed PMID: [25848615](#); PubMed Central PMCID: [PMC4371487](#).
4. A distinct but related thread to my work focuses on public health informatics (PHI), an emerging sub-field in biomedical informatics focusing on methods to improve management of, and knowledge discovery within, population level health data, syndromic surveillance and notifiable condition detection. Biomedical informatics methods that have been demonstrated in patient-level/patient centric settings are being applied and extended to cohorts of patients/populations. I've led one of the nation's first initiatives to develop, deploy, and evaluate a statewide real-time public health surveillance system in conjunction with the Indiana State Department of Health, which received a national recognition for its effectiveness, and use to quickly identify public health outbreaks and identify clusters or abnormally high rates in reported disease conditions from hospitals and local health departments throughout the state. In addition to serving public health, this system has served as one of my primary public health informatics laboratories. I've developed automated approaches to detecting cases reportable to public health across large regions, and I've constructed and evaluated methods for seamlessly delivering just in time public health alerts to physicians. Through an Indiana Center of Excellence in Public Health Informatics that I founded, we have evaluated and operationalized real-time linkages between (a) the Social Assets and Vulnerability Indicators (SAVI) community database maintained by the Polis Center and (b) the Indiana Network for Patient Care's massive clinical data repository. Using this unparalleled resource, we've enabled effective and efficient exploration of health determinants by studying the interactions between community factors, observational clinical data, and population health outcomes.
- a. Vest JR, Harle CA, Schleyer T, Dixon BE, **Grannis SJ**, Halverson PK, Menachemi N. Getting from here to there: health IT needs for population health. Am J Manag Care. 2016 Dec;22(12):827-829. PubMed PMID: [27982666](#).
 - b. Dixon BE, Siegel JA, Oemig TV, **Grannis SJ**. Electronic health information quality challenges and interventions to improve public health surveillance data and practice. Public Health Rep. 2013 Nov-Dec;128(6):546-53. PubMed PMID: [24179266](#); PubMed Central PMCID: [PMC3804098](#).
 - c. Gichoya J, Gamache RE, Vreeman DJ, Dixon BE, Finnell JT, **Grannis S**. An evaluation of the rates of repeat notifiable disease reporting and patient crossover using a health information exchange-based automated electronic laboratory reporting system. AMIA Annu Symp Proc. 2012;2012:1229-36. PubMed PMID: [23304400](#); PubMed Central PMCID: [PMC3540527](#).
 - d. **Grannis SJ**, Biondich PG, Mamlin BW, Wilson G, Jones L, Overhage JM. How disease surveillance systems can serve as practical building blocks for a health information infrastructure: the Indiana experience. AMIA Annu Symp Proc. 2005;PubMed PMID: [16779047](#); PubMed Central PMCID: [PMC1560724](#).

Complete List of Published Work in My Bibliography:

<https://www.ncbi.nlm.nih.gov/myncbi/shaun.grannis.1/bibliography/48095122/public/>

D. Additional Information: Research Support and/or Scholastic Performance

Ongoing Research Support

UL1TR002529, NIH - NCATS

Shekhar (PI)

05/18/18-04/30/23

Indiana Clinical and Translational Sciences Institute

Role: Co-Investigator

Technical Application | Digital Square Notice E1 | Patient Registration and Identity Management Services for HIEs 24

T15LM012502, NIH: National Library of Medicine Dixon/Schleyer (PI) 07/01/17-06/30/22
 The Indiana Training Program in Public & Population Health Informatics
 Role: Mentor

R01HS023808, AHRQ Grannis (PI) 07/01/17-04/30/22
 Enhancing Patient Matching in Support of Operational Health Information Exchange
 Role: PI

ME-2018C1-11287/FY19.989.001 Ong (PI) 03/01/19-02/29/22
 PCORI through University of Colorado Denver
 Incremental Privacy-Preserving Record Linkage (iPPRL) to Reduce Barriers to Data Sharing and Improve Data Quality
 Role: Co-Investigator, Site PI

IU23-887-04, Trustees of Indiana University Shekhar (PI) 09/01/16-08/31/21
 Precision Health Initiative (PHI) Grand Challenge
 Role: KP

ME-2017C1-6425, PCORI Grannis (PI) 01/01/18-12/31/21
 Advancing Privacy Preserving Record Linkage Methods in the Context of Real-World Data Networks and Health Information Exchange
 Role: PI

G-30834, California HealthCare Foundation Grannis (PI) 03/06/20-02/28/21
 California Health Care Foundation Data Exchange Program - Evaluation of Referential Matching
 Role: PI

IU Grand Challenge - Addictions Initiative Embi (PI) 01/01/18-12/01/20
 The Trustees of Indiana University
 The Indiana Addictions Data Commons (IADC)
 Role: Co-Investigator

U2GGH001531, DHHS-CDC through Biondich (Site PI) 04/01/15-09/29/20
 CARDNO Emerging Markets USA, Ltd., and Regenstrief Institute, Inc.
 CDC's Public-Private Partnerships in the U.S. President's Emergency Plan for AIDS Relief (PEPFAR)
 Role: Co-Investigator

32818 Agmt 5/15/19/60053303 IU Kho (PI) 05/15/19-08/14/20
 PEW Charitable Trusts through Northwestern University
 Demographic Data Availability and Standardization for Patient Matching
 Role: Co-Investigator, Site PI

Completed Research Support

U58DP005400, DHHS-CDC through Durbin (PI) 09/30/14-09/29/19
 University of Kentucky
 Enhancing Cancer Registries for Early Case Capture
 Role: Co-Investigator

HHSF223201750065A, FDA through Quintiles Biondich (Site PI) 09/25/17-10/24/18
 IMS Government Solutions
 Center for Biologics Evaluation and Research (CBER), Biologics Effectiveness and Safety Initiative (BEST),
 Develop New, Innovative Methods for Automation of Blood Product Adverse Event Reporting
 Role: Co-Investigator

PEW30381, PEW Charitable Trusts Grannis (PI) 06/08/17-09/30/18
 Evaluating the impact of data standardization and normalization on matching effectiveness
 Role: PI

CRAIG APPL, MPH

cappl@ona.io

SUMMARY STATEMENT

- Craig Appl, MPH, is the mHealth Technical Lead for Ona Systems Inc. As the mHealth technical Lead, he provides technical leadership for the overall design, development, and implementation of the mHealth platforms managed by Ona systems across multiple country programs and awards.
- Mr. Appl works closely with the global OpenSRP teams and partners on the design, development and implementation of OpenSRP and other systems. He has a wealth of experience in field implementation, solution architecture and project management.
- Prior to his work at Ona, Craig was the Senior Technical Advisor for Health Information Systems at I-TECH where he designed and lead a team that implemented the national scale OpenHIE platform and iSantéPlus clinic application. His experience ranges from managing global software development teams to small scale implementations in Nepal and Uganda. He has an MPH from Johns Hopkins University with a certificate in Public Health Informatics.

PROFESSIONAL EXPERIENCE

Ona

January 2018 - Present

mHealth Technical Lead

- Providing technical oversight, management and strategic leadership related to the development and maintenance of Ona's mHealth technologies.
- Translating functional requirements across projects to technical requirements for OpenSRP and related platforms.
- Managing the technical roadmap for numerous platforms and working with the engineering teams to ensure their success
- Integrating, communicating and building the global OpenSRP technology community

International Training and Education Center for Health (I-TECH) Center, University of Washington

(UW), Department of Global Health, Seattle, WA,

September 2016 – January 2018

Senior Technical Advisor for Health Informatics

- Planned, developed, supported and delivered a nationwide transition from the legacy iSanté clinic EMR to iSantéPlus (OpenMRS) in Haiti.
- In partnership with SolDevelo and I-TECH Haiti, developed core integrations on the OpenMRS platform that were globally functional including, integration with a local and national fingerprint server, integration with OpenHIE, integration with Mirth for automated retries when the internet becomes available.
- Planned, developed and implemented OpenHIE in Haiti to support the exchange of information from each iSantéPlus clinic to other clinics and stakeholders.
- Defined requirements, developed and implemented a national laboratory order and result exchange with multiple national and regional laboratories in Haiti using IHE profiles.
- Managed multiple development teams and contracts in Haiti and Poland.
- Planned, architected and piloted an electronic immunisation system (Kenya Immunisation Platform) in Kenya using OpenSRP

- Defined patient record interoperability standards in both Kenya and Haiti to ensure patient records are available at all levels of the health ecosystem, including automatic retries when internet becomes available at the point of service
- Liaise with local and government officials in both Kenya and Haiti to support ministry of health and CDC initiatives.
- Developed online content related to Health Information Systems in conjunction with the UW Department of Global Health E-Learning program.
- Supported national health information system strategic planning in partnership with the CDC and Guyana Ministry of Public Health.
- Developed technical proposals, supported grant development and provided deep technical expertise across I-TECH's global portfolio.

Grameen Foundation US, Seattle, Washington June 2015 – September 2016 Lead Technical Program Manager

- Proactively managed the full development pipeline from defining end user requirements, scoping technical needs, managing distributed software development teams, delivering the solution and supporting field implementations.
- Defined the MOTECH program and product strategy within the global health field, which required an assessment of functions, limitations, challenges and opportunities when connecting deployed technologies in the field. This resulted in shifting MOTECH from a developer platform to an end user configurable platform.
- Advised donors, partners and other stakeholders on technical strategies, architectures and applicability of open source technologies to solve real world problems in field implementations.
- Supported in country capacity building for field deployments in Nepal and Mozambique, ensuring the continued use of the MOTECH platform by local team members.
- Wrote detailed grant proposals and participated in co-creation groups with other organizations who aim to support point of service interoperability.
- Championed the use of interoperable health information systems including identifying appropriate point-to-point (API) and standards based connections.
- Engaged with the OpenHIE implementer community to provide an implementers perspective when connecting the point of service to high level infrastructure systems.
- Scoped, developed and delivered robust connections to CommCare, ODK, Ona.io, KoboToolbox, OpenMRS/Bahmni, RapidPro, OpenLMIS, DHIS2 and numerous reporting systems.
- Connected individuals from the diverse disciplines of computer science, IT services, subject matter experts, logisticians and behavior change experts.
- Actively managed vendor contracts in the US, Poland and India, ensured the appropriate level of support, performed due diligence and provided actionable feedback across multiple cultures.

Deerwalk Institute of Technology Kathmandu, Nepal
Adjunct Professor

June 2014 – April 2015

- Created and executed a project management curriculum that spans four years to supplement the BSc in Computer Science and Information Technology curriculum taught at DWIT.
- Mentored the Information Technology club that is responsible for the IT infrastructure of the school. This team is actively developed networking services for the student body including a file sharing system and 24 PC computer lab.
- Taught project management an average of 10 teaching hours per week.

- Helped individual students improve entrepreneurial ideas in my office hours (5 hours per week).

Deerwalk Inc. Kathmandu, Nepal

June 2014 – April 2015

Data Analyst

- Analyzed the time differences of big data analytical processes with MSSQL, Hadoop and R.
- Manipulated 40+GB of customer data to prepare it to be entered into a Hadoop environment.
- Evaluated Amazon Web Services solutions to identify the best scalable environment to process big data with R including EC2 clustering, S3 and Elastic Map Reduce.
- Gained experience with data manipulation using R's data frames, data.table package, ff and fbase packages.

Friends of Maiti Nepal Kathmandu, Nepal

July 2013 – June 2015

IT Projects Manager

- Assisted in the development, pretesting and implementation of multiple data collection tools.
- Created the first open source human trafficking concept dictionary that allows organizations to share a common definition of trafficking related data ([SurvivorMIS](#))
- Digitized a paper based system by implementing OpenMRS to track rehabilitation outcomes and standardize workflows.
- Proposed, scoped and implemented a missing person system in CommCare that reduced a paper based process from one week to a matter of minutes.
- Deployed 43 CommCare handsets across 15 field offices, 12 surveillance posts and 16 outreach workers that allowed for the collection and retrieval of missing person information across the country.
 - Ensured compliance with local laws and regulations when collecting survivor information.
- Designed and implemented capacity building and quality improvement activities internally at Maiti Nepal.
- Provided guidance and discovered system constraints that addressed the ethical challenges when collecting information on survivors and missing persons.
- Actively interacted with numerous levels of team members (from the executive to the frontline worker) to ensure my projects continually progressed and were supported by the team.

JHU Global mHealth Initiative Baltimore, Maryland

December 2012 – June 2013

Public Health Informatician

- Documented the flow of information and core business of Maiti Nepal, an organization that combats sex trafficking of girls across Nepal.
- Identified literature and conducted literature reviews to support the project.
- Created and reported use cases, swim lane charts and other visual aids which clearly describe the movement of clients and girls through Maiti Nepal's service offerings.
- Identified and documented areas of improvement at the organizational level that could immediately streamline business processes and use information to improve the efficiency of the organization.
- Reported my findings to my academic advisor, and the executive officers of Maiti Nepal and Friends of Maiti Nepal.
- Managed data processing of collected data. Transformed, cleaned and analyzed the entire Management Information System (300,000 rows in a SQL database), ultimately suggesting technical solutions that could improve the depth and breadth of the system which translated into a full time position at Friends of Maiti Nepal for implementation of the recommendations.

Defense Threat Reduction Agency Fort Belvoir, Virginia

March 2009 – March 2012 Budget

Analyst

- Identified and improved financial team business processes and inefficiencies with available technical solutions.
- Created numerous algorithms and solutions using MS Excel, MS Access, SharePoint and Visual Basic programming that reduced contractor costs, input time and government manpower to accomplish standardized business processes.
- As a team leader, created training materials and trained team members in new business processes as the government transitioned from legacy accounting systems to the DAI.
- Supported and participated in programmatic reviews with senior management and external partners who were responsible for the appropriate allocation of resources of our organization.
- Interacted with financial managers in numerous government agencies, universities and businesses to ensure the funding was being spent as forecasted.

Integrated Data Services Fort Belvoir, Virginia

April 2008 – March 2009

Business Analyst

- Participated in focus group efforts to conduct data quality assessments to determine the health and quality of data in the core financial system and data coming from feeder systems into the core system, which collectively mapped workflows and data definitions as well as timelines, deadline dates, and the necessary resources required to accurately improve the automated software system.
- Scoped functional and technical requirements for the CCaR project management system and managed their development from idea to customer implementation.
- Created step-by-step training manuals and taught monthly user-centered functional system courses.

Hope Clinic Lukuli Kampala Uganda

September 2007 – February 2008

Clinic Administrator

- Front line manager of clinic operations for a non-profit organization with 17 team members.
- Managed employees, daily accounting and community programs organized through the clinic.
- Ensured the onsite dispensary was accurately managed and stocked to meet patient demands.
- Planned, procured and tracked commodities for the clinic including program specific commodities.
- Helped secure a grant from the US Embassy Small Grants Department that sustained the clinic's HIV community programs.

Reach Out Mbuya Kampala, Uganda

June 2006 – August 2007

International Volunteer

- Lead organization wide restructure of approximately 125 staff including personnel allocation, records management, and Information Technology procurement.
- Assisted in determining methodologies for collecting information and standardization of data for two research studies:
 - “The Effects of Food Aid on HIV-Infected Patients in Kampala, Uganda” by Matthew Burkey, Johns Hopkins University
 - “Validation of the new WHO Diagnostic Algorithm for Pulmonary Tuberculosis in HIV prevalent settings” by Dr. Janine Thoullass, Department of Medicine, Makerere University, Uganda
- Supervised, managed and reported monthly World Food Programme food subsistence distribution program to 1000+ recipients.

- Compiled and edited correspondence for quarterly donor reports that consolidated information from multiple input sources.

EDUCATION

- 2013- MPH (Public Health Informatics); Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD
- 2006- BS in Economics; George Mason University, Fairfax, VA

STEVEN WANYEE - CURRICULUM VITAE

Proposed Position: Project Lead

Name of Firm: IntelliSOFT Consulting Limited

Name of Staff: Steven Wanyee Macharia

Profession: Digital Health Specialist

Date of Birth: 13th October 1973

Years with Firm: Ten (10)

Nationality: Kenyan

Membership in Professional Societies and Communities of Practice:

- Founder and Secretary General, Kenya Health Informatics Association (KeHIA)
- Secretary, Health Informatics in Africa (HELINA)
- Board Member, OpenMRS Inc.
- Member of Bahmni Governance Committee
- Board Member, Safaricom Health Advisory Committee

Key Responsibilities:

- Provide strategic, technical and administrative leadership to the project.
- Liaison with client and stakeholders to ensure alignment of expectations and consistent acceptable project performance.

Key Qualifications:

- The staff member has a masters degree in information systems with a focus in digital health systems. He also possesses extensive training in digital health/health informatics both academically and professionally. He graduated from University of Liverpool in 2007. Prior to that, he trained for 1 academic year (9 months) at the University of Washington in health information administration and health informatics.
- He led the team at I-TECH, University of Washington that built KenyaEMR in conjunction and under the leadership of the Ministry of Health in Kenya. This was from 2007 to 2012
- He has been involved with the OpenMRS global Community of Practice for the last 12 years, founded the OpenMRS Kenya Community of Practice in 2013 and was elected to serve on the OpenMRS Inc. Board of Directors in 2019 for a term of 2 years.
- He is also a key player at the global digital health level participating in Working Groups at the Health Data Collaboratives, and working with other technical teams at WHO, USAID and other organisations on various digital health areas fro research, development of normative guidelines to digital health interventions. He has been doing this for the last 10 years.

Education:

- PhD Student at University of Amsterdam, Medical Informatics
 - University of Liverpool, Masters degree in Information Systems with a focus on digital health systems, graduated in 2007.
 - University of Washington, 9 months course in health information administration and health informatics and graduated in 2005.
 - Karolinska Institutet, Department of Medical Epidemiology and Biostatistics, completed a 6 months fellowship in bioinformatics in 2007 leading to the development and publishing a software utility tool in Bioconductor (<http://master.bioconductor.org/>)
 - North Seattle Community College, Associated degree in applied information systems and technology development, graduating in 2004.
 - University of Nairobi, Diploma in Computing Information Systems, 2001.
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Employment Record:

- IntelliSOFT Consulting Limited, Founder and Director of Digital Health Solutions, Research and Innovation, 2011 - to date.
 - International Technical Education Center for Health (I-TECH) at University of Washington, Implementation and Interoperability Manager, 2007 - 2008 and 2010 - 2012.
 - ICFI, Technical Adviser (Health Information Systems) seconded to the USAID funded Afya Info project, 2009 - 2010
 - AED (now under FHI360), Monitoring and Evaluation Adviser on a USAID funded Small Grants Strengthening Program, 2006 - 2007.
 - University of Nairobi, AIDS Care and Treatment Services (ACTS) Project, Monitoring and Evaluation Adviser, 2005 - 2006
-

Consulting History and other relevant experience

- Supporting development of the Digital REACH Initiative (DHI) through a consultant by BroadReach as part of the USAID funded Regional Action through Data project.
- Supporting actualization of the Digital REACH Initiative through past and current contractual work with FHI360 through the Cross Border Health Integrated Partnerships Project (CB-HIPP) to implement the Cross Border Digital Health Solution.
- Assessment of digital health landscape in Somalia contracted by the World Bank.
- Technical assistance to develop the Digital Health Applied Leadership Program contracted by the WHO.
- Technical assistance to develop the National Health Client Registry for Ministry of Health, Community Development, Gender, Elderly and Children

- Assessment of the status of countries within the East Africa region to implement interoperability solutions using the HIS Maturity Model developed through the Digital Health and Interoperability Working Group

ANNEX 2 - PAST PERFORMANCE INFORMATION

1. Award Number: #AID-OAA-L14-00004, Monitoring and Evaluation to Access and Use Results (MEASURE) Evaluation Phase IV Project
2. Agency or Entity Providing the Funding: USAID
<p>3. Description of the Program: With funding from the USAID MEASURE Evaluation Project and technical direction from CDC and PEPFAR, IntraHealth developed Open Client Registry (OpenCR) in 2020, a prototypical open source and standards-based client registry. OpenCR was designed in response to a frequent problem in health information systems: point of service (POS) systems, such as lab systems and electronic medical record (EMR) systems, are often not interoperable with one another. This makes it difficult to track patients as they move between facilities to seek care, and to identify patients that are lost to follow up. Additionally, patients often have multiple duplicate records within the same POS system, such as multiple diagnostic results that the system does not recognize as belonging to the same patient. OpenCR was designed to uniquely identify individuals who have records in multiple information systems to help countries track patients through the continuum of care. OpenCR offers the ability to assign and look up patients using unique identifiers, allow connections from diverse POS systems using the FHIR standard, and configure decision rules around patient matching.</p> <p>The initial release of OpenCR was designed for a use case in Uganda to support epidemic control by facilitating the deduplication of patients' lab test results for tracking outcomes over time and identifying those lost to follow up. Development was informed by stakeholders in Uganda, including the Ministry of Health (MOH) and the Central Public Health Laboratory (CPHL), as well as technical teams at CDC and USAID. The initial release of OpenCR supports:</p> <ul style="list-style-type: none"> • 45 algorithm variations using the popular Elasticsearch engine and plugins. This includes support for deterministic or probabilistic matching. • Record linkage and Registration as a Service through the generation of unique IDs with a non-destructive, auditable history of submissions. • A modern UI to view, break, revert breaks, and audit matching decisions. • Updated OpenMRS MPI Client Module to support OpenCR. • Open standards, including the FHIR-based Mobile Patient Demographics Query (PDQm ITI-78) and Mobile Patient Identifier Cross-reference Query (PIXm ITI-83). <p>With funding from Digital Square, IntraHealth proposes to expand OpenCR into a broadly applicable global good across a wide variety of low-resource settings and use cases to enable countries to track patient records across health information systems.</p>
4. Period of Performance: August 15, 2019 – April 30, 2020
5. Dollar Value: \$390,723
6. Type of Award: Cooperative Agreement/Subagreement
<p>7. Contact Information, Including Name, Job Title, Mailing Address, Phone Numbers, and Email Address Dr. James Thomas, Project Director, 123 West Franklin Street, Building C, CB#8120, University of North Carolina, Chapel Hill, NC 27516, measure_subs@unc.edu</p>

Regenstrief Institute - Indiana University

1. Award Number: PEW Master 988 – Project 30381
2. Agency or Entity Providing the Funding: PEW Charitable Trusts
3. Description of the Program: <p>Dr. Grannis' team used four (4) separate databases curated from the Indiana Network for Patient Care Health Information Exchange (Databases) to evaluate how standardizing demographic data elements can improve the percent by which records for the same patient are able to be linked across electronic health records (EHRs) used in different healthcare institutions (Patient Matching Rates) and to reduce both false positives – where records were incorrectly matched, and false negatives—where records were not matched, but should have been matched.</p> <p>Additional overview of the project is available through publication, including the following March 2019 publication in JAMIA, https://doi.org/10.1093/jamia/ocy191, entitled, "<i>Evaluating the effect of data standardization and validation on patient matching accuracy.</i>"</p>
4. Period of Performance: 06/08/17 – 09/30/18
5. Dollar Value: \$127,506
6. Type of Award: Contract
7. Contact Information, Including Name, Job Title, Mailing Address, Phone Numbers, and Email Address: <p>James G. McMillan Senior Vice President, General Counsel and Corporate Secretary The PEW Charitable Trusts 901 E. Street NW, 10th Floor Washington, DC 20004</p>

Ona

1. Award Number: Various
2. Agency or Entity Providing the Funding: CHAI
<p>3. Description of the Program: As part of the Digital Solutions for Malaria Elimination (DSME) community of practice, Ona partnered with Akros to develop Reveal (https://revealprecision.com). Based on the open source global goods product, OpenSRP, Reveal is a next generation geospatial health service planning and delivery tracking tool. The initial health domain in which Reveal is being used is Malaria.</p> <p>Reveal focuses on delivering precision service delivery that supports data collection workflows related to malaria response. Interventions include the planning, tasking and map-based tracking of malaria control tasks, that case workers perform in the field. Examples of these interventions include, indoor residual spraying (IRS), the distribution of long lasting insecticide treated nets, mass drug administration, proactive case detection, reactive case detection, and community engagement and awareness events.</p> <p>Reveal builds on 4 years of experience where partners Akros and Ona jointly developed and implemented <i>mSpray</i> - a project focussed on indoor residual spraying (IRS) in Zambia. The app helps health workers track and manage malaria control activities such as bednet distribution, focus investigations, community education events and IRS. In the last year Ona has led the technical development and roll-out of Reveal to 5 countries: Eswatini, Namibia, Nigeria, Thailand, and Zambia.</p> <p>Each intervention requires a distinct set of workflows that can be broadly categorized as planning, field delivery and analysis activities. These workflows are embedded in the App and a task list for each group of workers is then set up in the app - based on the priority for that country and specific community, for a specific time range. When opening the app, a case worker can then see a map of the community / catchment area, all locations that need to be visited, and a colour-coded view of activities that have already been performed. Structures that need to be visited in order to perform the expected task - i.e. visit these houses to perform indoor residual spraying - are colour coded in the App. A case worker can then click on that structure on their App and record tasks performed at that structure. They can also report problems or challenges that prevented them from performing the desired task.</p> <p>The project is notable as an example of a true Public Private Partnership where various governmental, donor, technical and implementation partners have come together to collaborate on this technically complex solution in Malaria prevention and control. It therefore illustrates Ona's capabilities to successfully manage multiple stakeholders - whilst designing and developing the tool. The Reveal project included integrating multiple open source systems, building HL7 FHIR standards, and improving security and role based access controls for new workflows that hadn't been implemented before. Reveal utilizes HL7 FHIR organizations, practitioners, practitionerRoles, plans, tasks, and locations in a unique way to support public health workflows for frontline workers and is able to be integrated with the HAPI FHIR system. Reveal has successfully been adapted to support the local country context and malaria control priorities, in five different countries.</p>
4. Period of Performance: 2018 to date
5. Dollar Value: \$895,000

6. Type of Award: Project-based funding. We have received funding directly from CHAI for some parts of Reveal, and for others we have been subcontracted through our partner in Zambia, Akros.

7. Contact Information, Including Name, Job Title, Mailing Address, Phone Numbers, and Email Address

Anne Liu, Senior Technical Advisor, Clinton Health Access Initiative (CHAI),
aliu@clintonhealthaccess.org, +1.646.770.6997

IntelliSOFT

1. Award Number: Subcontract under AID623L1400001
2. Agency or Entity Providing the Funding: USAID
3. Description of the Program: <p>IntelliSOFT has been contracted by FHI 360 under The Cross-Border Health Integrated Partnership Project (CB-HIPP) to design, customize and deploy technology to strengthen the cross-border health system through the Cross-border Health Unit (CBHU) model to enable continuous and real-time generation and sharing of health information between health facilities and support the continuum of care for HIV, TB, FP/RH and MNCH for mobile cross-border populations.</p> <p>CB-HIPP is designed to extend quality integrated health services in strategic border areas and other transport corridor sites in East, Central and Southern Africa. The project aims at interconnection of health facilities and health systems to enable applicable data sharing across selected border facilities (within and across borders) in the cross-border areas and enhancing linkage with local, national and regional data warehouses including DHIS2 and other EMRS in use in the selected facilities. IntelliSOFT's work under CB-HIPP has focused on several border regions between Kenya and Uganda.</p>
4. Period of Performance: January 2020 to August 2020
5. Dollar Value: \$68,000
6. Type of Award: Subcontract
7. Contact Information, Including Name, Job Title, Mailing Address, Phone Numbers, and Email Address <p>Dorothy Muroki, Chief of Party, Cross-Border Health Integrated Partnership Project (CB-HIPP), FHI 330, dmuroki@fhi360.org</p>

Appendix 1: Identity Management Maturity Model

A client registry is foundational to improving health outcomes, lowering costs, and increasing efficiency. We propose a maturity model for identity management based on existing maturity models. Table 1, Identity Management Maturity Model, illustrates the move from the siloed and peer-to-peer maturity level to the interoperable maturity levels with regard to the value-add for public health, the added capabilities and accountabilities. The maturity model frames the user stories for feature development.

The maturity levels¹ are based on the ability to share information and associated responsibilities for governance:

- **Siloed systems** are isolated implementations where there is little to no sharing of information. This is common in low-resources settings where many projects have historically created systems for their use case without coordination. The lack of information exchange makes them inefficient in both the clinical sense and with regard to business allocations. There is more potential for errors and lost opportunities for holistic clinical care. An example of siloed systems are multiple EMRs that are not connected to one another.
- **Peer-to-peer (integrated) systems** are a common solution to increase the business value-add of peer-to-peer systems. Often this means custom systems integration but without standards. While the solutions may perform their roles, the exchange of information is tightly coupled (integration not interoperability). Peer-to-peer systems are difficult to scale to other systems as they are custom solutions. An example of peer-to-peer (integration) is when an EMR is connected to a lab diagnosis system.
- **Interoperable systems** employ standards-based exchanges. Solutions based on them, like shared health records, solve double-counting. This maturity level has the least potential for clinical errors. However, by being the most flexible and powerful, this maturity level requires the highest responsibility for governance, IT security, and privacy. This means managing a broad spectrum of trust levels with participating systems.

Across the maturity model, there are critical implications for clinical care and other health outcomes for different actors:

- For patient and registration actors, the demographic patient information is updated at the point-of-care (POC). This results in duplicate and out-of-date patient demographic information. At the interoperable maturity level the demographic information may be linked to other records of the same patient information and may be distributed to other systems (if it's the source of truth or golden record).
- For clinicians at the siloed maturity level, they may only view patient demographic and clinical information in their system, and those that they are peering with if at the peer-to-peer level. But with a unique identifier and a separate process to create a shared health record, the clinician has the possibility to view the continuity of care of participating systems and thus the patient may receive more holistic care with less possibility for error as clinicians have more information about patient needs.
- Point-of-care (POC) system administrators assign their own identifiers. This fragmentation is overcome with record linkage at the interoperable maturity level. Any source ID designations are accepted and unaltered in the Client Registry, but they are also linked by the Client Registry to a unique identifier which links back to the originating system. This allows maximum flexibility and security where source data systems may not be trusted, so they may only update fields in their own records but still participate in the system and use unique identifiers provided by the Client Registry.
- Contact tracers in the siloed and peer-to-peer maturity models rely on information that may be different at each POC, while at the interoperable maturity level they may use linked records to use alternative addresses.
- At the interoperable maturity level and with shared health record, case-based surveillance officers may eliminate double-counting and create time-series (longitudinal) analysis to support

¹ The maturity levels are adapted from the Federated Vision for a Facility Registry, Digital Square.

surveillance from at any level of granularity, from the patient-level and up to administrative and international boundaries.

- Similarly, at the interoperable maturity level and with a shared health record, reporting actors may eliminate double-counting in reporting, and may be more agile in their timeliness and responsiveness to shifting reporting requirements; indicators can be aggregated up from any level and cross-tabulated on the fly through attributes like age, gender, and condition.
- At the interoperable maturity level, there are substantial requirements for and capacities with regard to governance. Management actors must be able to audit and tune the system along the full spectrum of levels of trust for systems, nodes, and users. With attention to best practices in health information systems only the absolute necessary data may be shared or linked, under a rigid governance process to ensure privacy.

Table 1: Maturity Model for Identity Management

Business Roles (Actors)	Maturity Level		
	Siloed: Isolated, inefficient, more potential for errors and lost opportunities for holistic clinical care. Difficult to share health information. Low levels of governance.	Peer-to-peer (Integrated): Greater data sharing through custom systems integration but without standards. Difficult to scale to other systems. Some governance.	Interoperable: Standards-based exchange. Less double-counting. Least potential for clinical errors. Most flexible and powerful. Highest responsibility for governance.
Patient	Provides demographic information to Registration Clerk but has no view of his/her/their own data. Depending on the siloed system, the patient may have access to their data.	Provides demographic information to Registration Clerk but has no view of his/her/their own data. Depending on the siloed system, the patient may have access to their data.	Provides demographic information to the Registration Clerk; updated demographic information is stored and potentially available as clinical information stored in a SHR.
Registration Clerk	Updates information at each point-of-care.	Updates information at each point-of-care.	Updates information at each point-of-care and those records are linked together by the Client Registry.
Clinician	May view patient data in the clinical EMR. Data may be captured on paper and entered into EMR at the end of the day or week for reporting purposes. Diagnoses are often added using a manual process.	Only views patient data captured by the clinical EMR or other system. Diagnoses may be electronically added.	Record linkages can be used in a separate process to create a shared health record. The clinician has the possibility to view a patient's health history through access to a shared health record created by participating systems.
Point of Care (POC) system administrator	Assigns local system IDs based on functionality of the local system, absent coordination.	Assigns IDs based on functionality of the local system, absent coordination.	Any ID designations accepted as records are designated with their source ID, while source records are also linked through a Client Registry Unique ID (CRUID) within the client registry.
Community contact tracer	Uses information limited to that captured in local POC to trace patients.	Uses information limited to that captured in local POC to trace patients.	Uses additional patient data stored in linked records, such as alternative addresses, to enhance patient tracing.

Case-based surveillance officer	POS may assist in identifying cases to report, but reporting will be manual	POS may assist in identifying cases to report, but reporting can be manual or electronic.	Provides a foundation for duplicate reporting to be addressed.
M&E Specialist	Aggregates indicators and metrics for their system. Often manual process or done in Excel.	Aggregates indicators and metrics for their system. Often manual process or done in Excel.	Provides a foundation for duplicate counting to be addressed.
System and governance owners	Limited view into siloes. Governance of confidentiality and privacy is not auditable except in-person at each POC.	Limited view into siloes. Governance of confidentiality and privacy is not auditable except in-person at each POC.	Greatest responsibility for managing confidentiality, privacy, and IT security. Must manage the full spectrum of levels of trust for systems, nodes, and users.