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Implementation of an HIV Case Based Surveillance Using Standards-Based Health Information Exchange in Rwanda

Dr. Tom Oluoch

Health Scientist

US CDC – Kigali, Rwanda

Rwanda: HIV Epidemiology

- Joint United Nations Programme on HIV and AIDS (UNAIDS) *Fast Track* goals recommend a 95-95-95 coverage in all sub-populations and age groups in order to end AIDS by 2030.
- Rwanda, located in Central Africa, has a population of 13m. In 2019 there were 216,000 HIV infected persons among whom 83.8% knew their status, with 97.5% of them were receiving ART and 90.1% virally suppressed (RPHIA-2019).
- National HIV prevalence is stable at 3% with significant variations in sub-populations; e.g. higher HIV prevalence among female sex workers (35.5%) and men who have sex with men (10%) in 2020.

Need for Case Surveillance

- With Rwanda achieving high coverage in HIV treatment, comes the challenge of monitoring individual level outcomes.
- WHO recommends the collection and use of patient-centered data across the HIV testing, care and treatment cascade leveraging a case surveillance (CBS) system.
- A sentinel event is a pre-defined key event for which data are collected, analyzed, and reported to a public health agency for action.
- Rwanda's sentinel events tracked using the CBS: *HIV diagnosis, recent infection status, ART regimen, immunological status and viral load, opportunistic infection, and outcome (on ART, stopped treatment, LTFU, transferred out and dead)*.

Why interoperable systems

- Rwanda currently uses inefficient and potentially error-prone paper-based and disjointed electronic systems for: 1) active case finding; and 2) routine case surveillance to track the HIV continuum of care at the individual level.
- The Rwanda Health Information Exchange System (RHIES), adapted from the OpenHIE architecture, includes an EMR, LIS, DHIS-2 Tracker, a Client Registry, Facility Registry and Shared Health Record.
- Deployed at 4 health facilities in Kigali City, HIE that is based on open standards support the generation of the complete dataset needed for routine HIV CBS in Government owned health facilities in a low-resourced setting.

The RHIES Architecture (1)

The RHIES Architecture (2)

- RHIES is a shared infrastructure that acts as a universal translator to make data sharing between systems possible.
- The RHIES Architecture has 3 components:
  - The centralized resources or component layer made up of registries (client, facility, provider, terminology), and an SHR.
  - The national health service bus or interoperability layer (IL) is a middleware which performs the orchestration of transactions between systems. The IL performs core functions such as authentication, routing, logging and audit.
  - The point of care applications layer consisting of various instances of an EMR, LIS, DHIS-2, and other systems

HIE Mediators

- Mediators (made up of transaction channels) are microservices that allow the processing of data so that they can be communicated from one interface to another.
- Two channels were used for the EMR-LIS integration:
  - *VLSM order:* channel used to submit a lab order to VLSM system
  - *VLSM find order:* channel used to retrieve lab results submitted from VLSM
- Three channels used were for the EMR-DHIS-2 integration:
  - *DHIS-2 enrollment:* channel used to create RCBS enrollment record in DHIS2
  - *DHIS-2 forms:* creates DHIS-2 events corresponding to RCBS forms in EMR
  - *DHIS-2 events:* adds data to created events in DHIS-2 from forms from EMR

Registries: Record Matching and Linkage

- The CR is implemented as a registry of all patients and their demographic data. A UPID generator (part of RHIES) assigns an ID prior to new registration.
- The data representation in Rwanda's CR follows the HL7 FHIR Person Resource. A local instance of the CR maintained at each health facility is routinely synchronized with the national Master Patient Index (MPI).
- The CR employs a basic search function using a deterministic matching algorithm.
- The FR is built on the DHIS-2 hierarchical structure. The FOSA ID uniquely identifies each facility and is part of the metadata that support the routing of data between systems.
- A SHR (a normalized subset of data from point of care systems) is in development

Code Sample:

Recording Sentinel Events for CBS

- Once a UPID is assigned and patient enrolled, the electronic CBS enrollment form (pre-populated with the demographic data) is generated. The VL request from the EMR uses the *"VLSM order"* channel and the test results are called from the LIS into the EMR using the *"VLSM find order"* channel.
- "DHIS-2 *Enrollment"* and *"DHIS-2 Events"* channels are used to trigger an enrollment on DHIS-2 and add events from the EMR to DHIS-2 Tracker, respectively.
- The data stored in DHIS-2 were reviewed for completeness and duplicates by generating a summary report and comparing to the summaries from the EMR. PowerBI for analysis and visualization.

Data Exchange Experience (1)

- Various components of the RHIES needed for RCBS data were implemented, tested and functional.

Scenario	Description	Action
1	Patient had an ID and the facility had Internet connectivity	Search was conducted on the CR/MPI and new ID assigned if patient is not found
2	Patient did not have an ID but the facility had Internet connectivity	Search was conducted on the CR/MPI using patient's demographics
3	Patient had an ID but the facility had no Internet connectivity	A temporary ID was issued, if not found on CR, until Internet connectivity was restored, and a search conducted on MPI
4	Patient had no ID and the facility had no Internet connectivity.	

Data Exchange Experience (2)

- An internal server error code 500 was encountered during the EMR-lab data exchange (due to a bug on the OpenMRS instance data sync storing null IDs). This was resolved on the EMR.
- The data exchanged in the RHIES provided a complete dataset for RCBS. The UPID generated by the CR, demographic and clinical data captured on the EMR and the VL results from the LIS.
- A 100% match on comparison of the sentinel events data on the EMR RCBS module and those transmitted to DHIS-2 after the errors displayed on the OpenHIM Admin Console were resolved.
- Data from DHIS-2 was successfully ingested into PowerBI for analysis and visualization.

Discussion

- Unique identification of patients remains a key challenge in many sub-Saharan African countries, as they do not have strong citizens registration systems
- We demonstrated that unique identifiers managed in a CR that is linked to multiple identifiers can support record matching and linkage in a complex data exchange ecosystem.
- The work described in this paper, once scaled up nationally, and interoperability optimization completed, could potentially save time currently spent generating RCBS data from paper-based and disjointed electronic systems.

Challenges

- For the EMR-DHIS-2 data exchange, the UPID generated by an algorithm implemented on the DHIS2 system was not compatible with the EMR due to expected null data attributes. We modified the DHIS-2 instance to accept the TRACNET_ID (HIV clinic ID) as an alternate identifier.
- Inadequate workforce capacity to conduct mapping of data elements to HL7 FHIR resources. This is being addressed through ongoing hackathons and training of the software developers.
- OpenHIM and EMR performance optimization are works in progress.

Conclusion

This was a successful demonstration of a standards-based HIE use to support HIV case surveillance in a low resource setting. Rigorous evaluation is needed to assess its effect on HIV treatment outcome monitoring and CBS processes once the RHIES is fully implemented, and interoperability optimization completed.

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