



Using CDA to Build a World on FHIR

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Setting Context: CDA & FHIR

Designing a Roadmap: Two Approaches

- Transformation
- Division of Labor

Summary & Q/A Discussion

Polling by web: PollEv.com/cooltrain562

Polling by text: **cooltrain562 to 22333**

So, where you all dialing in from?

The word cloud displays numerous city names in different colors, including Atlanta, Tacoma, Wildwood, Island, Chile, India, Utica, Vestal, Austin, Binghamton, New York, Syracuse, Oneida, Ithaca, Diego, Orleans, Rhode, Massachusetts, Raleigh, Washington, Yonkers, Boston, Hyderabad, and Heath Connections.

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- Former Co-Chair Structured Documents Working Group
- Co-Editor, CDA Consolidation (C-CDA) and many other Implementation Guides
- Lead: C-CDA on FHIR project
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Our Structure

- Founded in 2005
- Completely Distributed
- Privately held, transitioning to Employee-owned (ESOP)
- Woman-Owned Small Business

Our Team

- Over 55 full-time staff
- Clinical, Public Health, Data, and Program Analysts, and Engineers
- Home offices across the US, Canada, and Australia



Our Mission

- Improve healthcare through health information
- Lead the industry through our consulting and volunteer practice

What We Do

- We develop and support the implementation of new standards for electronic clinical information sharing and reuse
- We help our clients use their data to support:
 - Continuity of care
 - Healthcare surveillance (public health, quality reporting)
 - Research
 - Policy and decision making

What is the HealtheConnections HIE?

Health information exchange (HIE) is the secure exchange of information across organizations and regions.
We provide the capability to electronically move clinical information among different health care information systems.

- In operation since 2010
- No-cost HIE services readily available
- Additional analytics and incentive program consulting & resources
- On-call support team



Improve Quality of Care



Lower Cost of Care

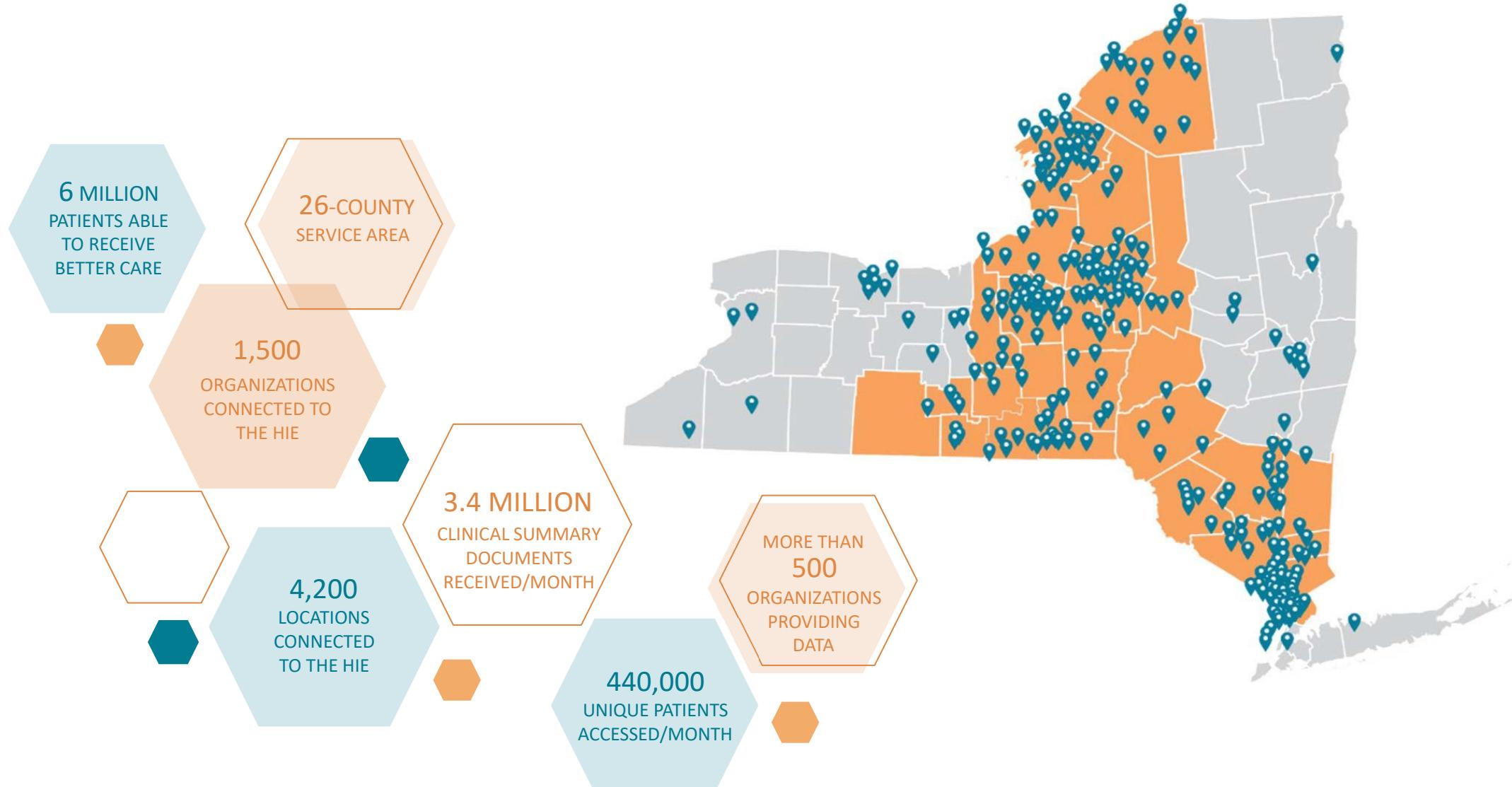


Improve Clinician Experience



Improve Patient Experience

Participants & Data Sources



HealtheConnections Services



Patient Lookup

Real-time patient records at the touch of a button



Image Exchange

Diagnostic-quality images via the portal, directly delivered to you, or can be downloaded into your PACS



Query-Based Exchange

Access information in state and from national databases



myResults

Labs, rads, and reports easily accessed or delivered directly



myAlerts

Clinical alerts for hospital and ED admits, discharges, and transfers; additional capabilities with flexible filtering



Results Delivery

Labs, rads, and reports easily accessed or delivered directly



Direct Mail

HIPAA-compliant secure mail & national provider directory



myData

Series of dashboards that allows a user to better understand their patient profiles

Setting Context: CDA & FHIR

Will FHIR Finally Solve My Healthcare Interoperability Problems?

- No Magic. No silver bullets.
- A more enabling technology.
- Plenty of reasons to be excited.
- Still need to deal with
 - HIPAA
 - Agreements
 - Data Acquisition
 - Data Quality
 - Local Codes
 - Documents/text/etc.

FHIR is a powerful new tool, but healthcare interoperability will still be hard.

CDA: HL7's Clinical Document Architecture (R2: 2005)

- The backbone of electronic clinical record interoperability for the past decade
- Millions of documents changing hands each year
- CDA is the primary way that HealtheConnections receives data today.
- Existing value. Many solved problems.
- Yet CDA is a static document in a dynamic, increasingly interconnected ecosystem.
- A brute force “dump” of clinical data
- Repetitive, no building blocks
- Unique to healthcare, hard to learn

F – Fast (to design & to implement)

Relative – No technology can make integration as fast as we'd like

H – Health

That's why we're here

I – Interoperable

Ditto

R – Resources

Building blocks

The FHIR Manifesto

1. Focus on Implementers
2. Target support for common scenarios
3. Leverage cross-industry web technologies
4. Support human readability as base level of interoperability
5. Make content freely available
6. Support multiple paradigms & architectures
7. Demonstrate best practice governance



FHIR: HL7's Fast Healthcare Interoperability Resources (R4: 2019)

- New HL7 standard built from the ground up using modern approaches
 - Easier to get up to speed, enabling more developers to add value
- Exposes content as “resources” using either JSON or XML
- Can address the clinical document use case, but can do more than just documents
- FHIR has a built in REST API
 - Push, Pull, Read, Write, etc.
- Not just for clinical data. Can support administrative, financial, etc.
- Precise: Queries can be very granular
- An emerging standard: FHIR is not yet fully supported in EHRs
- Will be the dominant standard for years to come

Why not just stay with CDA?

- Where it works, we probably will... for now
- Not built using modern development tools and approaches
- Not everything is a document
- Sometimes you just need one piece of granular data

Why not just convert to FHIR?

- Existing infrastructure (document exchange, public health, and quality reporting)
- Some data is currently unavailable via the FHIR APIs of production EHRs
- Use it where it adds value.

Leverage our investment in CDA

Take advantage of FHIR

- New opportunities
- A roadmap to get there... Where is “there”?
 - A blended, heterogenous environment
 - Supporting growth and continuity
 - Expanding the usefulness of current information systems.
- We will describe the foundation for a path forward and our experience driving down that path, supporting care planning, public health, and information exchange.

Designing a Roadmap: Two Approaches

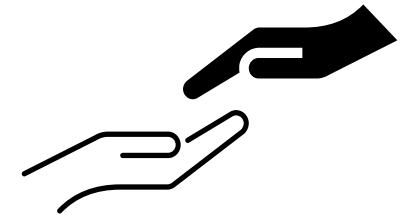
The Integrated Team: The Dual Implementation Guide

- Use CDA, Use FHIR
- Loss-less, bi-directional transforms for compatibility
- Transformation is key

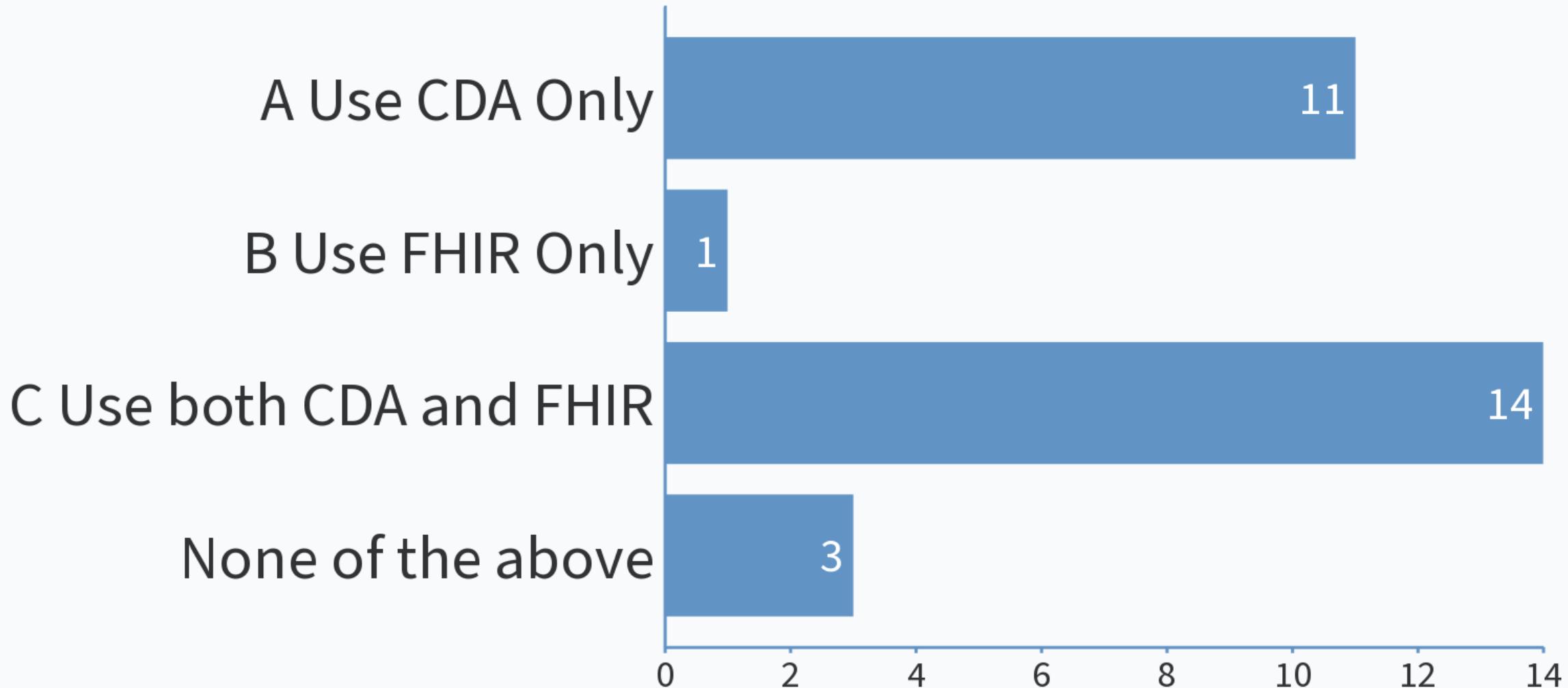


The Hand-off: CDA Documents, FHIR APIs

- Information remains in CDA
- FHIR API provides access, management
- Division of labor is key



Do you currently...



The Integrated Team

Dual IG Development and Transformation

When you have opportunity to build a new specification, consider going dual from the outset.

- Balance current vs. future exchange the needs
- Allow implementers to leverage existing CDA investments
- Allow new implementers to start using FHIR (streamlined syntax, APIs, etc.)
- Advantages, example: ONC High Impact Pilot (HIP) on Pharmacist Care Plan

Dual IG Example: Pharmacist Care Plan

- High-Impact Pilot issued through the Office of the National Coordinator for Health Information Technology (ONC-HIP)
- Purpose: Exchange pharmacy information in both CDA and FHIR
- Created dual CDA/FHIR IGs with lossless transforms between them.
- Original participation: 2 pharmacy management system vendors and a state health agency (CCNC), all CDA
- Pilot expansion: over 20 vendors, majority used FHIR, and the CCNC switched to FHIR.
- Each participant built according to own infrastructure

Dual IG Example: Pharmacist Care Plan (Details)

Project Objectives

Improve practice efficiency

- Eliminate duplication of effort by pharmacists
- Allow pharmacists to focus on high-risk patients
- Support greater patient engagement

Improve clinical quality

- Increase structured data capture
- Support shift to automated, electronic quality measurement

Support interoperable exchange

- Close a gap in current standard specifications
- Support sharing of structured data from patient interactions between providers, pharmacist and payers

Work Products

Three key tools placed into the public domain:

- CDA and FHIR® implementation guides (IGs) for PhCPs
- A library of bi-directional transformations converting PhCP FHIR to and from PhCP CDA
- PhCP FHIR and PhCP CDA training for implementers delivered in person and materials delivered to ONC

Dual IG Example: Pharmacist Care Plan (Findings)

Successful ONC High Impact Pilot

- Pilot Period: June 1 – August 31, 2017
- Vendor interest: grew from three initial adopters to 22 participating vendors
- ~4,000 messages received from 100+ pharmacies

Alignment efforts in IGs allowed for easy uptake in CDA or FHIR

| Month | # Shared | Participating Pharmacies |
|-----------|----------|--------------------------|
| June | 537 | 30 |
| July | 999 | 61 |
| August | 2308 | 53 |
| September | 2035 | 88 |
| October | 3837 | 102 |

Problem Statement

- New implementers prefer FHIR over CDA
 - CDA has a steeper learning curve than FHIR
 - CDA has no API; limited to a static document format
- Significant existing investment in CDA throughout healthcare IT
- How can we preserve existing investments while leveraging the advantages of FHIR and reducing the burden for new implementers?

Dual FHIR/CDA Implementation Guides with bi-directional transforms

- Support a transitional roadmap for those with CDA in production
- Support an integrated architecture for exchange, supporting both CDA and FHIR

Different levels of abstraction

- FHIR is more concrete than CDA (e.g., representation for allergies)
- A single FHIR resource often maps to multiple CDA templates and entry relationships

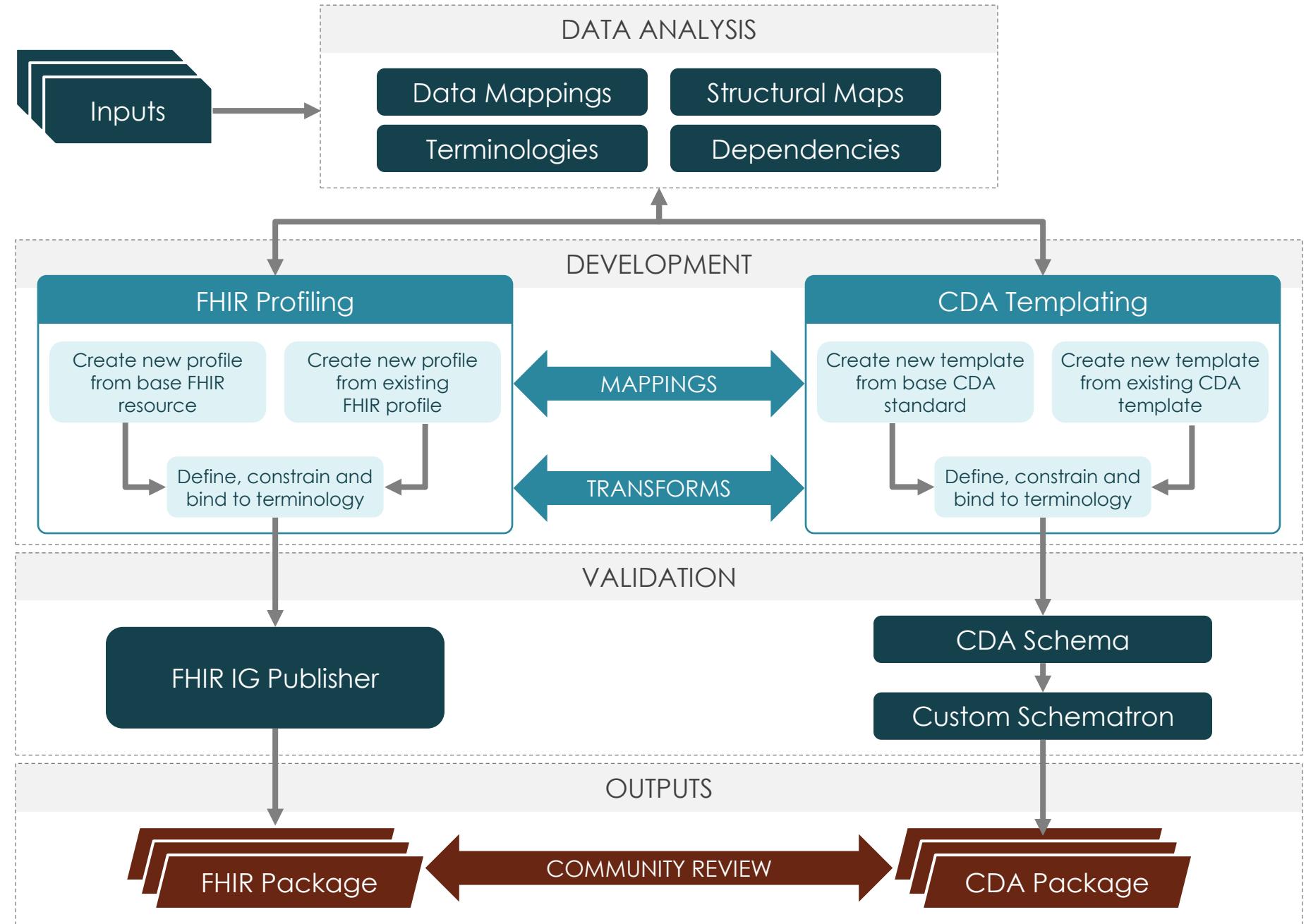
Datatypes

- FHIR uses common datatypes (e.g., W3C) with wide support in programming languages
- CDA datatypes often require custom parsing, which causes difficulty during transformation

Nesting vs. Referencing

- CDA documents are highly nested and have limited support for referencing, thus duplicate information is often copied in multiple places
- FHIR resources are created once then referenced everywhere

Concurrent CDA & FHIR IG Development



Client Use Case & Business Logic

Sample Data/Data Entry Forms

- Client use of existing templates, profiles, vocabularies, etc.

Requirements documents, spreadsheets, etc.

Surgical Site Infection (SSI)

Page 1 of 4

| | |
|--|-----------------------------------|
| *required for saving | **required for completion |
| Facility ID: | Event #: |
| *Patient ID: | Social Security #: |
| Secondary ID: | Medicare #: |
| Patient Name, Last: | First: |
| *Gender: F M Other | Middle: |
| Ethnicity (Specify): | *Date of Birth: |
| *Event Type: SSI | Race (Specify): |
| *NHSN Procedure Code: | *Date of Event: |
| *Date of Procedure: | ICD-10-PCS or CPT Procedure Code: |
| *MDRO Infection Surveillance: | *Outpatient Procedure: Yes No |
| <input type="checkbox"/> Yes, this infection's pathogen & location are in-plan for Infection Surveillance in the MDRO/CDI Module <input type="checkbox"/> No, this infection's pathogen & location are not in-plan for Infection Surveillance in the MDRO/CDI Module | |
| *Date Admitted to Facility: | Location: |
| Event Details | |
| *Specific Event: <input type="checkbox"/> Superficial Incisional Primary (SIP) <input type="checkbox"/> Superficial Incisional Secondary (SIS) <input type="checkbox"/> Organ/Space (specify site): | |
| <input type="checkbox"/> Deep Incisional Primary (DIP) <input type="checkbox"/> Deep Incisional Secondary (DIS) | |

Software Requirements Specification

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DATA ANALYSIS

Data Mappings

Structural Maps

Terminologies

Dependencies

Data Analysis

Work with the client to understand their business case
Organize client requirements per data element

- Data labels/descriptions
- Cardinalities
- Required terminologies

Identify incomplete and ambiguous requirements

Identify dependencies

| B | C | G | H | J | L | M |
|---------------------|---|---|----------------|-----------------|-------------------|-------------------|
| | NHSN Definition of Data Element | CDA Template | CDA OID | CDA Xpath | FHIR Profile Name | FHIR Element Path |
| 1 | Title/Event Type= Laboratory-identified | Required. The client-assigned facility ID number will be auto-entered by the system. | | | | |
| 2 | MDRO or CDI Event for | | | | | |
| 3 | Facility ID | Required: Facility OID. Unique OID provided by facility. | | | | |
| 4 | Resident ID | Required. Enter the alphanumeric resident ID. This is the resident identifier | | | | |
| 17 | Date first admitted to facility | Required. The date of first admission is defined as the date the resident first entered the facility. This date remains the same even if the resident leaves the facility (for example, transfers to another facility) for short periods of time. | | | | |
| 19 | Event Details | | | | | |
| 20 | Date specimen collected | | | | | |
| B | C | N | O | P | Q | R |
| Description of code | NHSN Definition of Data Element | Standard Code Type (SNOMED, LOINC, cdcNHSN) | Standard Codes | Vocab value set | Value Set OID | Business Rule |
| 1 | Title/Event Type= Laboratory-identified | Required. The client-assigned facility ID number will be auto-entered by the system. | | | | |
| 2 | MDRO or CDI Event for | | | | | |
| 3 | Facility ID | Required: Facility OID. Unique OID provided by facility. | | | | |
| 4 | Resident ID | Required. Enter the alphanumeric resident ID. This is the resident identifier | | | | |
| 17 | Date first admitted to facility | Required. The date of first admission is defined as the date the resident first entered the facility. This date remains the same even if the resident leaves the facility (for example, transfers to another facility) for short periods of time. | | | | |
| 19 | Event Details | | | | | |
| 20 | Date specimen collected | Required. Date the specimen was collected for this Event | | | | |

FHIR <-> CDA Mappings



Refine high level analysis to detailed mappings

Capture sufficient detail to build profiles and write transforms

CDA Header to Composition or DocumentReference are key mappings, allow for management, search, and retrieval

| A Data Elements | D Cardinality | E FHIR Mapping | F CDA Mapping in Sample | G FHIR to CDA | H CDA to FHIR |
|-------------------------|---|--|---|------------------|------------------|
| 1 RxNumber | 1..* | MedicationDispense.identifier MedicationDispense.whenHandedOver | substanceAdministration.id substanceAdministration.entryRelationship.supply.effectiveTime | X | X |
| 84 Fill Date | 1..1 | MedicationDispense.medicationCodeableConcept.coding[1] | substanceAdministration.entryRelationship.supply.product.manufacturedProduct.manufacturedMaterial.code | | X |
| 85 RX Norm code | 0..1 | MedicationDispense.medicationCodeableConcept.coding[2] | substanceAdministration.entryRelationship.supply.product.manufacturedProduct.manufacturedMaterial.code.translation | X | X |
| 86 | | | substanceAdministration.entryRelationship.supply.product.manufacturedProduct.manufacturedMaterial.code.originalText | X | X |
| A Data Elements | I Value Sets | J Value Set OID | K Description | L | M |
| 90 QuantityUnit | This doseQuantity SHOULD contain zero or one [0..1] @unit, which SHALL be selected from ValueSet UnitsOfMeasureCaseSensitive urn:oid:2.16.840.1.113883.1.11.12839 DYNAMIC | 2.16.840.1.113883.1.11.12839 | | | |
| 91 Days Supply | NA | | | | |
| 92 Prescription Status | There is a required Value Set in C-CDA for the Prescription Status that should be used. | NA | | | |
| 93 Pharmacy Name | SHALL be selected from ValueSet ActStatus urn:oid:2.16.840.1.113883.1.11.159331 DYNAMIC | HI7 MedicationPrescriptionStatus | active, on hold, completed, entered in error, stopped, superseded | | |
| 94 Pharmacy Number | N/A | N/A | Pharmacy store name | | |
| 95 Pharmacy Number Code | | N/A | store number for multi-pharmacy ownership | | |
| | | | Pharmacy NPI number | | |

Profiling/Templating

Create new template from base **FHIR resource or CDA standard**

Create new template from existing **FHIR profile or CDA template**

Define, constrain and bind to terminology

Development

Search template/profile repositories

- Published through standards publishing bodies
- Tooling (Trifolia, Trifolia on FHIR, etc.)

Create new template/profile

- Based on base CDA/FHIR specification
- Based on existing template/profile

Update definitions and constraints

Bind to Terminology



Trifolia-on-FHIR

- End to end implementation guide creation tool
- Includes profiling and terminology support
- Web based
- Open source
- Integrated with the FHIR IG Publisher

Forge

- Full featured profile editor
- Windows Desktop tool

Simplifier

- Web based implementation guide creation/assembly tool
- Upload profiles with Forge



FHIR <-> CDA Transforms

Develop transforms:

- Between CDA and FHIR
- Between FHIR versions (i.e., STU3 <-> R4) if needed

Create sample files:

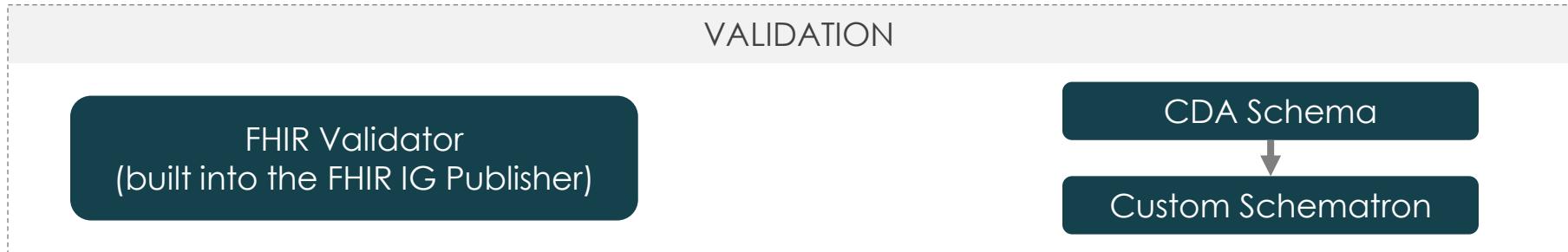
- Create valid CDA and FHIR examples
- Cover as many profiles/templates as possible (including dependencies)
- Will serve as inputs for testing transforms
- Include as examples in the IG

Test transforms:

- Against sample files
- At a Connectathon or during pilots
- Transform development and testing iteratively feeds back to mapping stage

```

<xsl:template
  match="
    cda:organizer[cda:templateId[
      @root = '2.16.840.1.113883.10.20.22.4.1'
      or @root = '2.16.840.1.113883.10.20.22.4.26'
      or @root = '2.16.840.1.113883.10.20.22.4.66'
    ]]>
    <xsl:variable name="category">
      <xsl:choose>
        <xsl:when test="cda:templateId[@root = '2.16.840.1.113883.10.20.22.4.1']">
          laboratory</xsl:when>
        <xsl:when test="cda:templateId[@root = '2.16.840.1.113883.10.20.22.4.26']">
          vital-signs</xsl:when>
        <xsl:when test="cda:templateId[@root = '2.16.840.1.113883.10.20.22.4.66']">
          activity</xsl:when>
        </xsl:choose>
      </xsl:variable>
      <Observation>
        <xsl:call-template name="add-meta"/>
        <xsl:apply-templates select="cda:id"/>
        <status value="final"/>
        <category>
          <coding>
            <system value="http://hl7.org/fhir/observation-category"/>
            <code value="{$category}"/>
          </coding>
        </category>
        <xsl:apply-templates select="cda:code">
          <xsl:with-param name="elementName">code</xsl:with-param>
        </xsl:apply-templates>
        <xsl:call-template name="subject-reference"/>
        <xsl:if test="cda:effectiveTime/@value">
          <effectiveDateTime>
            <xsl:attribute name="value">
  
```



Templates AND profiles will be validated against:

- Asserted base standard
- Asserted templates/profiles
- Asserted additional:
 - Constraints
 - Extensions

- Dual FHIR/CDA IGs paired with bi-directional transforms preserves CDA investment for existing implementers while reducing costs for new implementers
- There are significant challenges developing dual IGs and transforms, including different levels of abstraction, datatype mismatches, and the different design approaches of the standards (referencing vs. nesting)
- None of these challenges are show-stoppers, especially if you scope your IGs and transforms to well-understood use cases

The Team Hand Off

Using FHIR to Leverage your CDAs: A Division of Labor

Rationale

- HIEs exchange millions of CDA documents today
- Incrementally adopt FHIR starting with the RESTful API vs. SOAP-based alternatives
- Over time, add native FHIR documents and other collections of resources to exchanges

A Mixed Model

- Map CDA header content to the FHIR DocumentReference resources
- Payload is still CDA today
- Over time, payload can move to FHIR as well
- Example: IHE MHD

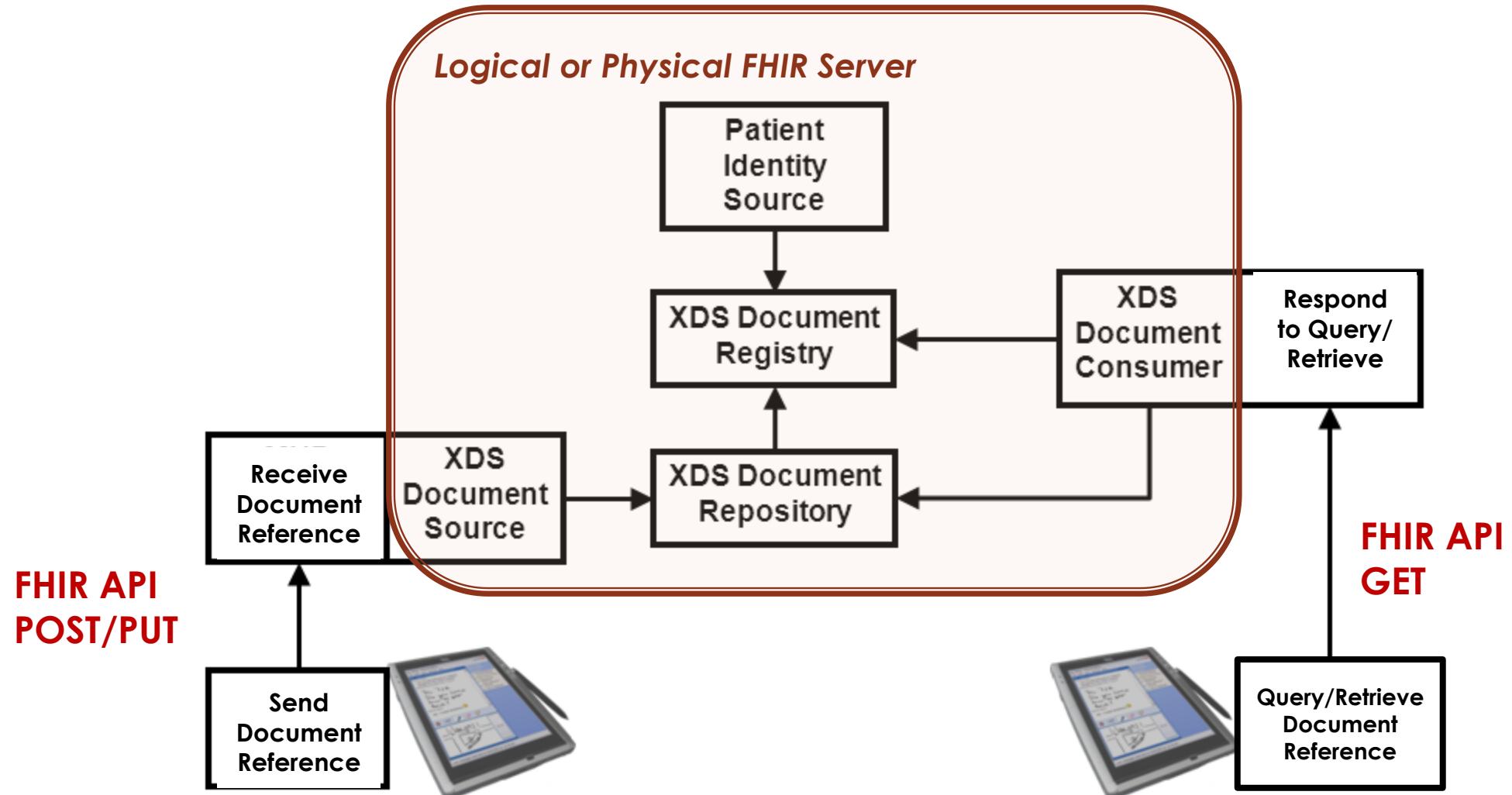
IHE Cross Enterprise Document Sharing (XDS)

- Primary HIE exchange mechanism for CDA documents in the US
- Allows any kind of document as content so can be CDA, FHIR, PDF...
- SOAP-based API

IHE Mobile access to Health Documents (MHD)

- FHIR façade for XDS
- Uses DocumentReference and FHIR RESTful APIs
- If using XDS, can bolt on MHD to provide RESTful access to documents
- If not using XDS, can still use DocumentReference and a native FHIR server

Hand Off Example: IHE MHD Diagram



Hand Off Example: Exchange CDA Documents with a FHIR REST API

1. Take a CDA document
2. Extract enough header data to create a DocumentReference resource
3. Associate the CDA doc with the DocumentReference (embedded or by reference)
4. POST the DocumentReference as the MHD Document Consumer
5. CDA doc is now available through the HIE via FHIR or XDS queries.

Hand Off Example: Exchange CDA Documents with a FHIR REST API

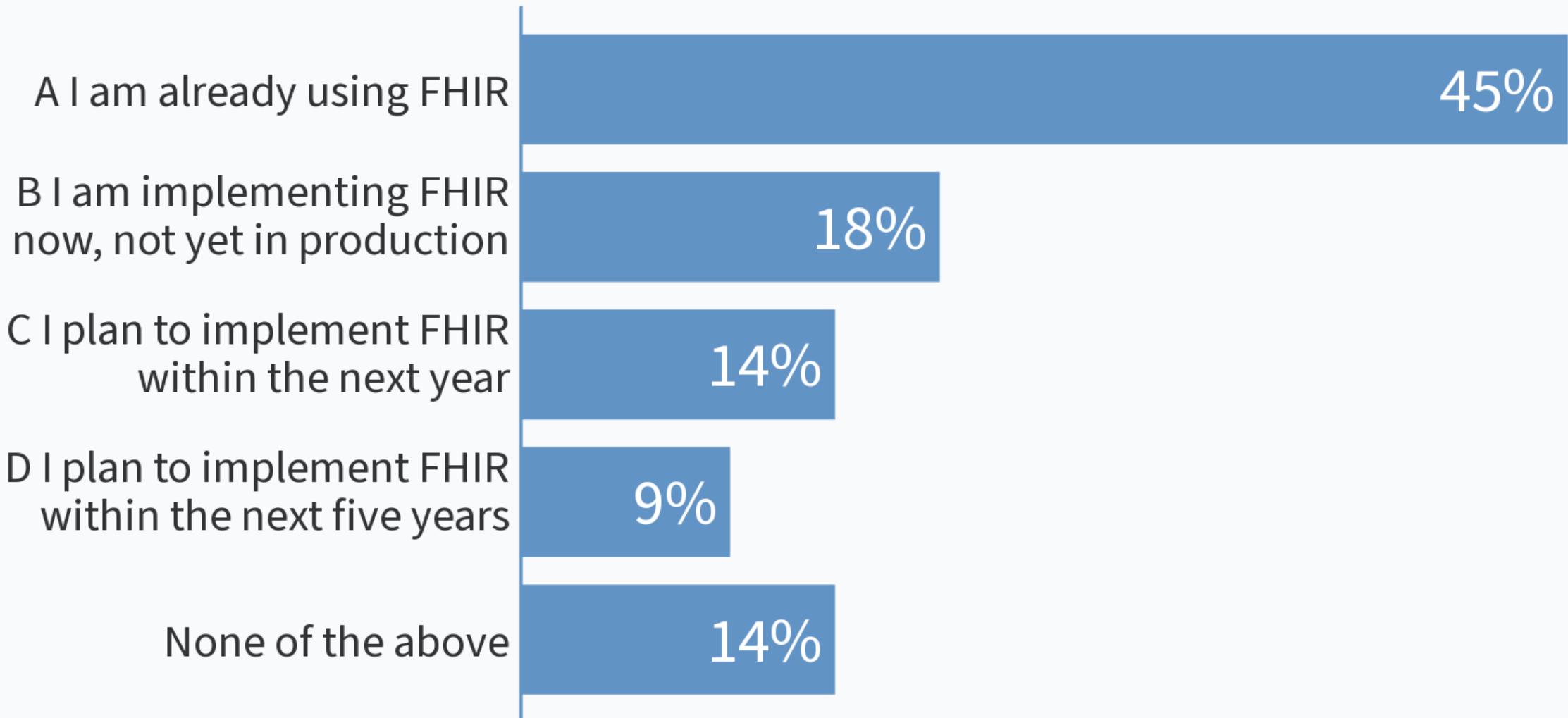
```
<ClinicalDocument xmlns="urn:hl7-org:v3" >  
<id extension="TT988" root="2.16.840.1.113883.19.5 99999.1"/>  
<code code="52521-2" codeSystem="2.16.840.1.113883.6.1" displayName="Overall Plan of Care/Advance Care Directives"/>  
<title>Pharmacist Care Plan</title>  
<effectiveTime value="201308151030-0800"/>  
<confidentialityCode code="N" codeSystem="2.16.840.1.113883.5.25" codeSystemName="Confidentiality" displayName="normal"/>  
<languageCode code="en-US"/>  
<recordTarget/>  
...  
</ClinicalDocument>
```

| Name | Flags | Card. | Type |
|-------------------|-------|-------|--|
| DocumentReference | TU | | DomainResource |
| masterIdentifier | Σ | 0..1 | Identifier |
| identifier | Σ | 0..* | Identifier |
| status | ?! Σ | 1..1 | code |
| docStatus | Σ | 0..1 | code |
| type | Σ | 0..1 | CodeableConcept |
| category | Σ | 0..* | CodeableConcept |
| subject | Σ | 0..1 | Reference(Patient Practitioner Group Device) |
| date | Σ | 0..1 | instant |

Two Standards for Clinical Information: CDA & FHIR

What's on Your Roadmap?

FHIR Plans



- **OxygenXML Developer:** https://www.oxygenxml.com/xml_developer.html
- **Pharmacist Care Plan (PhCP) Public Transforms:** lantanagroup/PhCP-Public-Transforms.github.com
- **IHE XDS:** [https://wiki.ihe.net/index.php/Cross-Enterprise Document Sharing](https://wiki.ihe.net/index.php/Cross-Enterprise_Document_Sharing)
- **IHE MHD:** [https://wiki.ihe.net/index.php/Mobile access to Health Documents \(MHD\)](https://wiki.ihe.net/index.php/Mobile_access_to_Health_Documents_(MHD))
- **PhCP Igs**
 - FHIR: <http://hl7.org/fhir/us/phcp/>
 - CDA:
http://www.hl7.org/implement/standards/product_brief.cfm?product_id=561
- **Dental FHIR IG (draft):** <http://www.hl7.org/fhir/us/dental-data-exchange/>

Please use the Q&A box

Or drop us a note:

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& Thanks to you all for the opportunity to speak with you today!

Acronyms

| | | | |
|----------------|---|-------------|---|
| API | application program interface | HIP | High Impact Pilot |
| C-CDA | Consolidated CDA | HL7 | Health Level Seven International |
| CCNC | Community Care of North Carolina, Inc. | IG | implementation guide |
| CDA | Clinical Document Architecture | IHE | Integrating the Healthcare Enterprise |
| EDI | electronic data interchange | MHD | Mobile access to Health Documents |
| EHR | electronic health record | NHSN | National Healthcare Safety Network |
| eICR | electronic Initial Case Report | ONC | Office of the National Coordinator for Health Information Technology |
| ESOP | Employee stock ownership | QRDA | Quality Reporting Document Architecture |
| FHIR | Fast Healthcare Interoperability Resources | REST | representational state transfer architecture |
| FML | FHIR Mapping Language | SOAP | Simple Object Access Protocol |
| H&P | History and Physical | V3 | HL7 Version 3 messaging standard |
| HIE | health information exchange | XSD | Cross Enterprise Document Sharing |