

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?



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- Co-Chair, HL7 FHIR Infrastructure Working Group
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- 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 HealthConnections 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

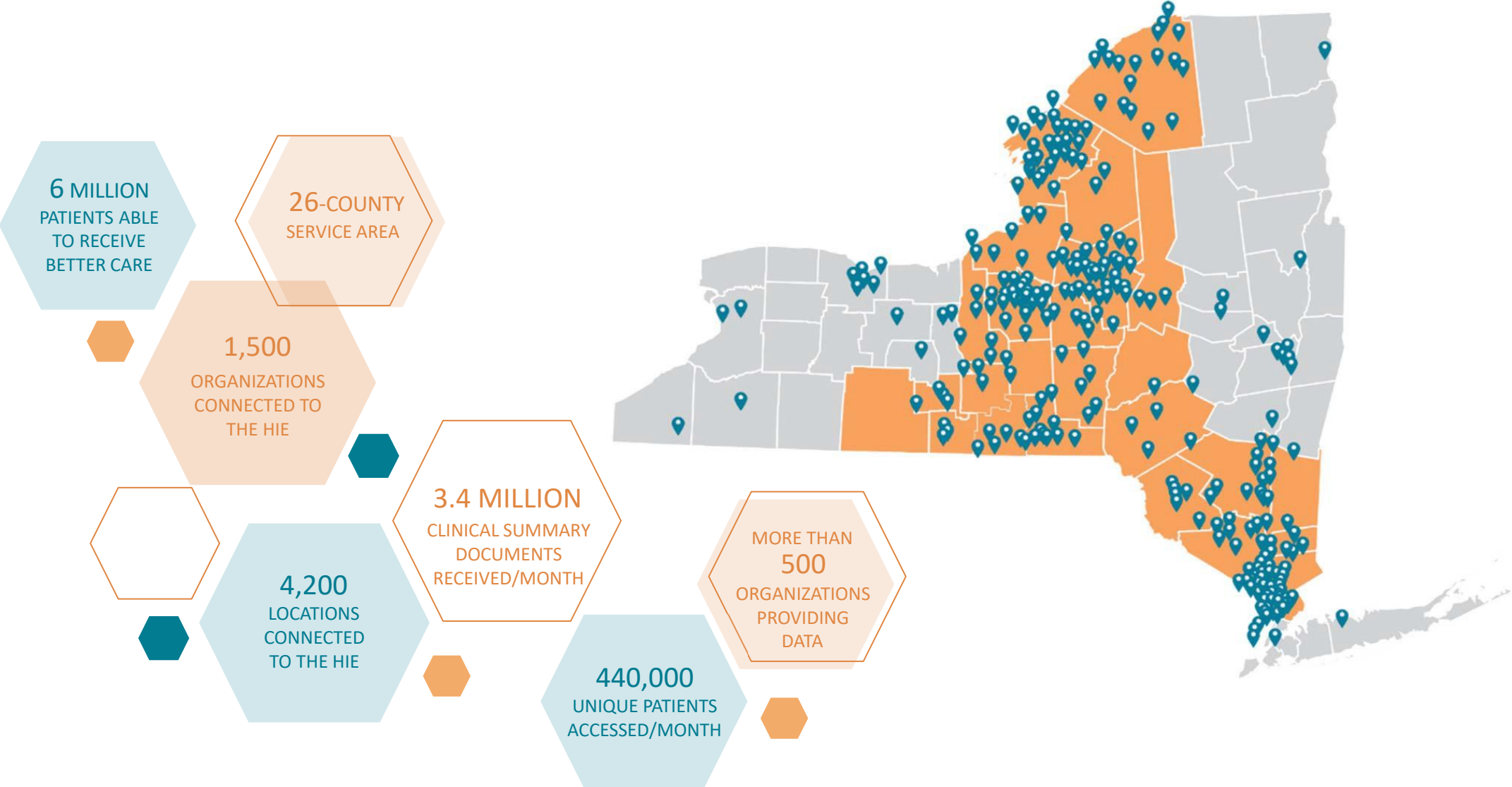


Improve Clinician Experience



Improve Patient Experience

Participants & Data Sources



HealthConnections 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.

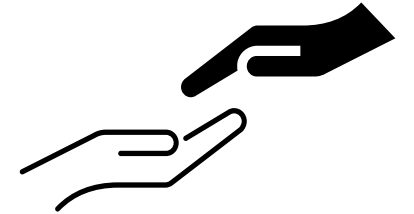
Designing a Roadmap: Two Approaches

The Integrated Team: The Dual Implementation Guide

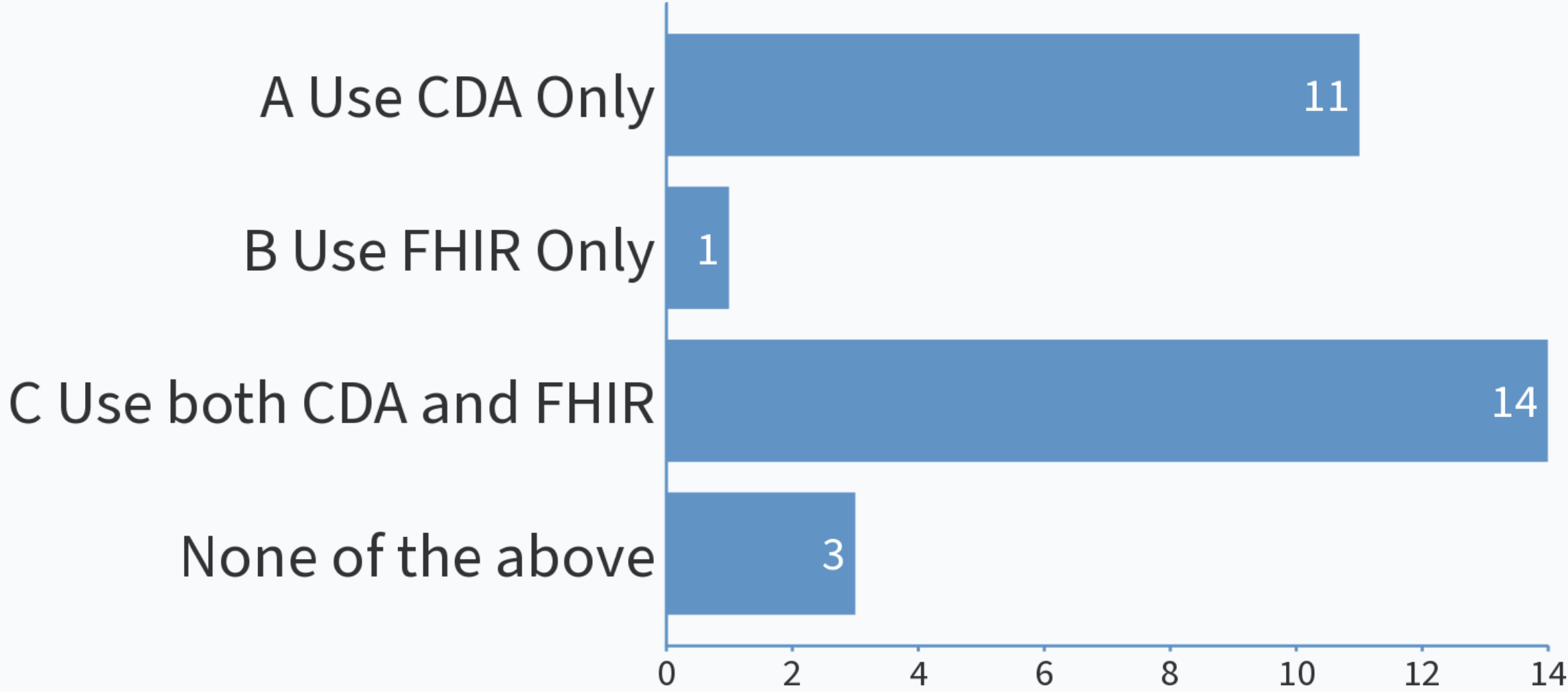
- Use CDA, Use FHIR
- Loss-less, bi-directional transforms for compatibility
- Transformation is key

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

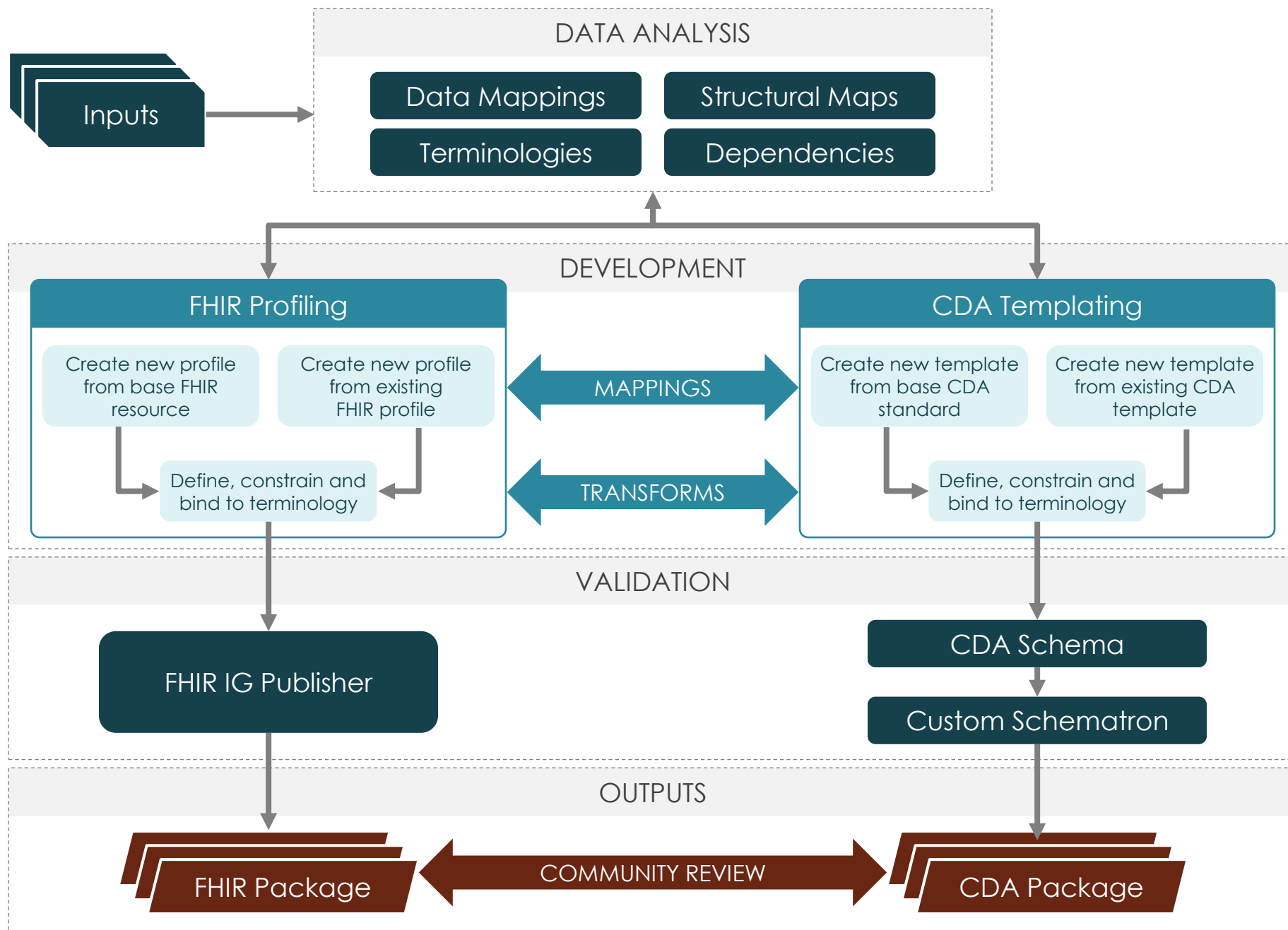
Datatypes

- 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: Middle:
*Gender: F M Other	*Date of Birth:
Ethnicity (Specify):	Race (Specify):
*Event Type: SSI	*Date of Event:
*NHSN Procedure Code:	ICD-10-PCS or CPT Procedure Code:
*Date of Procedure:	*Outpatient Procedure: Yes No
*MDRO Infection Surveillance:	
<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"/> Deep Incisional Primary (DIP)
<input type="checkbox"/> Superficial Incisional Secondary (SIS)	<input type="checkbox"/> Deep Incisional Secondary (DIS)
<input type="checkbox"/> Organ/Space (specify site): _____	

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
	Description of code	NHSN Definition of Data Element	CDA Template	CDA OID	CDA Xpath	FHIR Profile Name	FHIR Element Path
1							
2	Title/Event Type= Laboratory-identified MDRO or CDI Event for	Required. The client-assigned facility ID number will be auto-entered by the system.					
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					
	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					
17							
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							
2	Title/Event Type= Laboratory-identified MDRO or CDI Event for	Required. The client-assigned facility ID number will be auto-entered by the system.					Required
3	Facility ID	Required: Facility OID. Unique OID provided by facility.					Required
4	Resident ID	Required. Enter the alphanumeric resident ID. This is the resident identifier					Required
	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					Required
17							
19	Event Details						
20	Date specimen collected	Required. Date the specimen was collected for this Event					Required



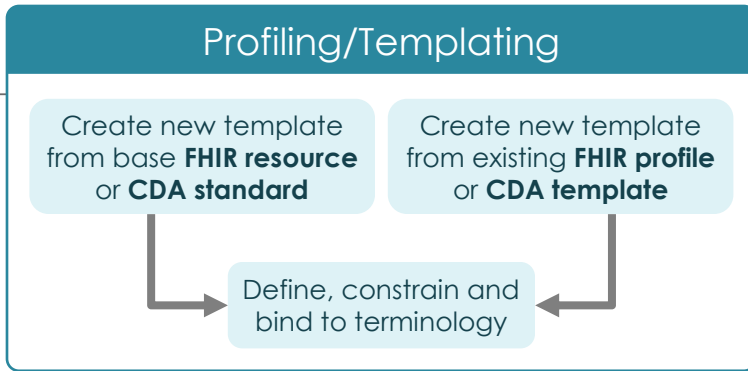
FHIR <-> CDA Mappings

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	D	E	F	G	H
	Data Elements	Cardinality	FHIR Mapping	CDA Mapping in Sample	FHIR to CDA	CDA to FHIR
1				substanceAdministration.id	X	X
84	RxNumber	1..*	MedicationDispense.identifier	substanceAdministration.entryRelationship.supply.effectiveTime	X	X
85	Fill Date	1..*	MedicationDispense.whenHandedOver	substanceAdministration.entryRelationship.supply.product.manufacturedProduct.manufacturedMaterial.code		X
	RX Norm code	1..1	MedicationDispense.medicableConcept.coding[1]	substanceAdministration.entryRelationship.supply.product.manufacturedProduct.manufacturedMaterial.code.translation	X	X
PG		0..1	MedicationDispense.medicableConcept.coding[2]	substanceAdministration.entryRelationship.supply.product.manufacturedProduct.manufacturedMaterial.code.originalText	X	X
	Data Elements	Value Sets	Value Set OID	Description		
1	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			
90	Days Supply	NA	NA			
91	Prescription Status	There is a required Value Set in C-CDA for the Prescription Status that should be used.				
92	Pharmacy Name	SHALL be selected from ValueSet ActStatus urn:oid:2.16.840.1.113883.1.11.159331 DYNAMIC	H17 MedicationPrescriptionStatus	active, on hold, completed, entered in error, stopped, superseded		
93	Pharmacy Number	N/A	N/A			Pharmacy store name
94	Pharmacy Number Code	N/A	N/A			store number for multi-pharmacy ownership
95						Pharmacy NPI number



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

The screenshot displays a FHIR tool interface. On the left, a table lists various templates with their IDs and constraints. On the right, a detailed configuration panel for template 31027 is shown, including fields for 'code', 'Data Type', 'Branch/Slice', 'Binding Type', 'Value Conf.', 'Value Set', 'Binding Date', and 'Dynamics'. A note at the bottom of the panel states: 'This playingEntity SHALL contain exactly one [1..1] code, which SHALL be selected from ValueSet NHSNSpecimenTypeCode urn:oid:2.16.840.1.114222.4.11.3249 DYNAMIC (CONF:4417-31027)'.

ID	Name	Quantity	Min	Max	Constraint	Cardinality	Class
31025	participantRole	No	No	SHALL	MAY	1..1	ParticipantRole
31034	@classCode	No	No	SHALL	MAY	1..1	NullFlavor
	realmCode						RoleClassRoot
	typeld					0..*	CS
	templeld					0..1	typeld
	id					0..*	II
	code					0..1	CE
	addr					0..*	AD
	telecom					0..*	TEL
	playingDevice					0..1	Device
	playingEntity					1..1	PlayingEntity
	@nullFlavor					0..1	NullFlavor
	@classCode					0..1	EntityClassRoot
	@determinerCode					0..1	EntityDeterminer
	realmCode					0..*	CS
	typeld					0..1	typeld
	templeld					0..*	II
31027	code	No	No	SHALL	MAY	1..1	CE
	quantity					0..*	PQ
	name					0..*	PN
	sdtc:birthTime					0..1	TS
	desc					0..1	ED
	scopingEntity					0..1	Entity
	entryRelationship					0..*	EntryRelationship

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

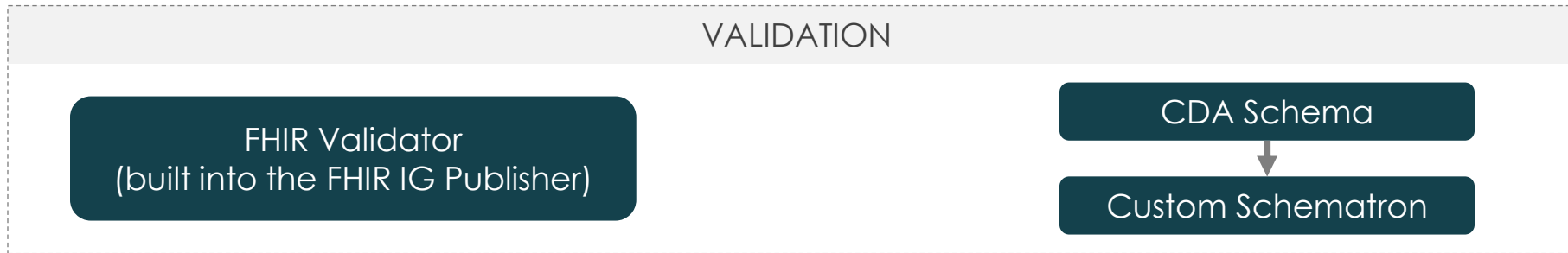
Create sample files:

- 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

Putting your CDA Content behind a FHIR API

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

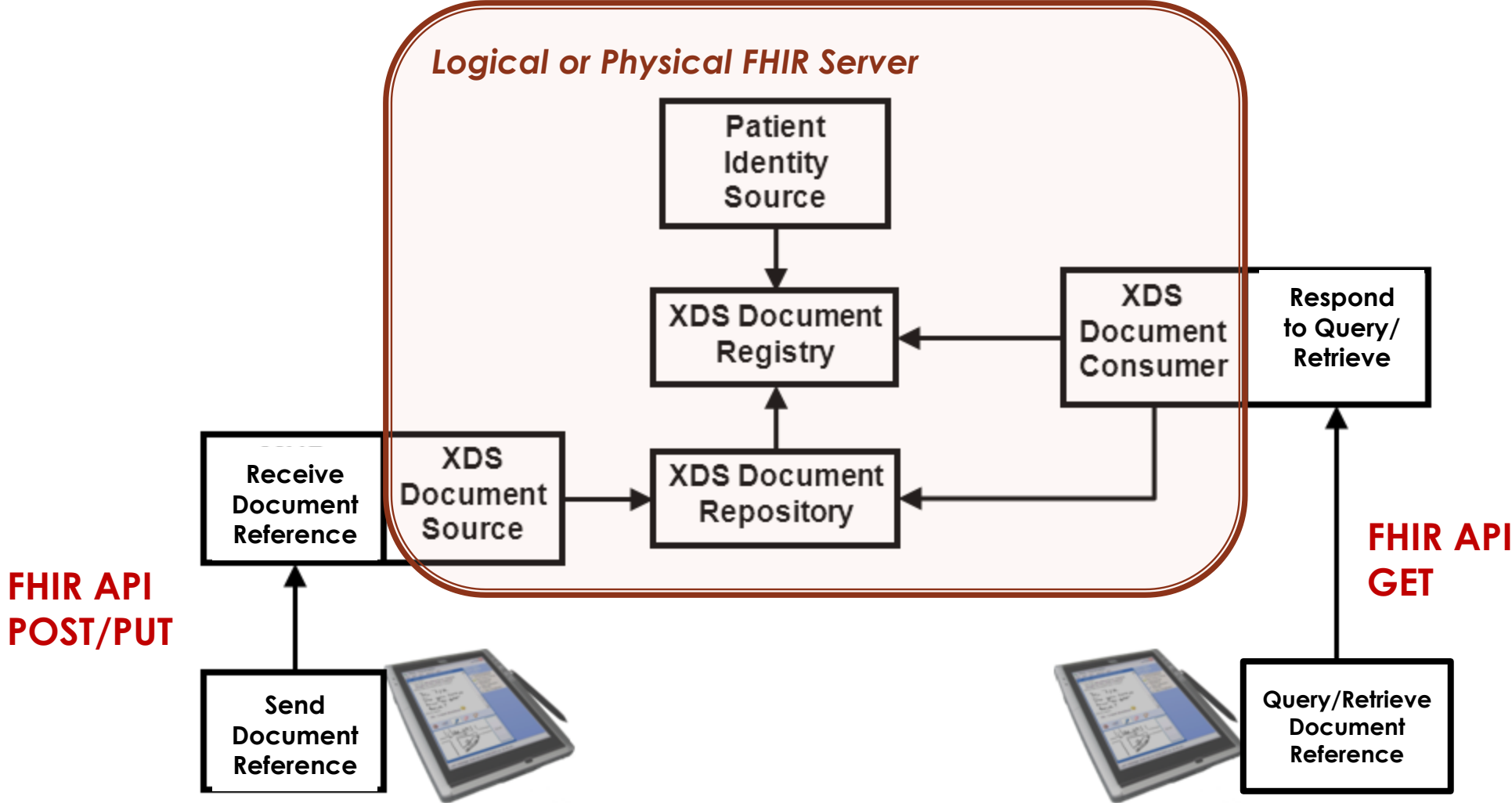
IHE Cross Enterprise Document Sharing (XDS)

- 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>

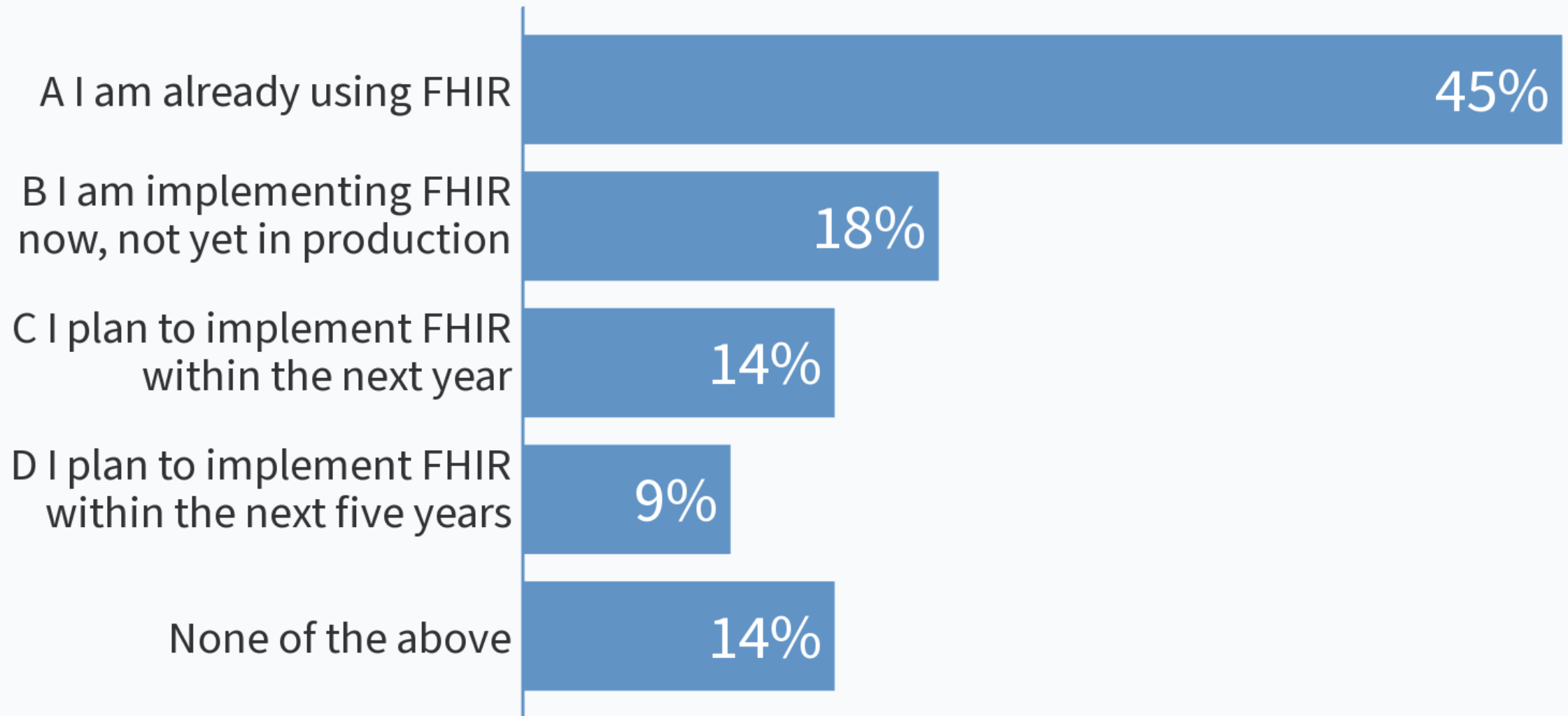
```

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:** [lantaganagroup/PhCP-Public-Transforms \(github.com\)](https://github.com/lantanagroup/PhCP-Public-Transforms)
- **IHE XDS:** 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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- dlee@healthconnections.org
- www.HealthConnections.org



& 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