

HL7 v2 and C-CDA to FHIR R4 Mapping Specification Table

A Companion Reference for the FHIR-Native Clinical Data Interoperability Framework

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This document provides a detailed, field-level mapping specification for transforming HL7 version 2.x messages and Consolidated CDA (C-CDA) documents into FHIR R4 resources, as specified by Li's two-phase mapping pipeline methodology. Phase 1 (Structural) defines segment-to-resource and section-to-resource transformations. Phase 2 (Semantic) specifies code system translation, unit normalization, temporal normalization, and value set validation.

This specification is a methodological reference -- not a platform implementation. The mapping rules are formalized as FHIR ConceptMap and StructureMap artifacts that any standards-compliant system can load and execute.

1. HL7 v2 to FHIR R4 Mapping Specification

The mapping pipeline processes HL7 v2.9 message types: ADT (Admit/Discharge/Transfer), ORU (Observation Result), SIU (Scheduling), MDM (Medical Document), and ORM (Order). Each segment within a message is mapped to its corresponding FHIR R4 resource via declarative ConceptMap rules.

1.1 PID Segment → Patient Resource

The PID (Patient Identification) segment is the primary source for the Patient resource.

HL7 v2 PID Field	FHIR Patient Element	Card.	Data Transformation	Notes
PID-1 (Set ID)	Patient.identifier[0].value	0..1	Copy as-is; prefix 'PID-'	Not clinically relevant but retained for round-tripping
PID-3 (Patient ID List)	Patient.identifier[]	1..*	CX data type parsed: ID + assigning authority + type code	Extract CX.1→value, CX.4→assigner, CX.5→type (MRN, SSN, etc.)
PID-5 (Patient Name)	Patient.name[0]	1..*	XPN parsed: family, given, middle, suffix, prefix, name use code	XPN.7 (name type code): L→official, A→alias, N→nickname
PID-5.1 (Family Name)	Patient.name[0].family	1..1	XPN.1.1 (FN.1) direct	
PID-5.2 (Given Name)	Patient.name[0].given[0]	1..1	XPN.2 direct	
PID-5.3 (Middle Name)	Patient.name[0].given[1]	0..1	XPN.3	
PID-6 (Mother's Maiden)	Patient.name[1]	0..1	Map as second name entry with use='maiden'	
PID-7 (Date of Birth)	Patient.birthDate	1..1	TS data type: parse to FHIR date (yyyy-MM-dd)	If time component present, extract date only
PID-8 (Sex)	Patient.gender	1..1	Map code: M→male, F→female, O→other, UNK→unknown	HL7 v2 Table 0001 ↔ FHIR AdministrativeGender
PID-10 (Race)	Patient.extension[us-core-race]	0..1	CWE data type; look up OMB Race Categories	Requires terminology bridge via UMLS
PID-11 (Patient Address)	Patient.address[]	0..*	XAD parsed: street, city, state, postalCode, country, use	XAD.7 (address type): H→home, B→business, O→office
PID-11.1 (Street)	Patient.address[0].line[0]	0..1	XAD.1 (combined street address)	
PID-11.4 (City)	Patient.address[0].city	0..1	XAD.3 direct	
PID-11.5 (State)	Patient.address[0].state	0..1	XAD.4; validate against US state codes	
PID-11.6 (Postal Code)	Patient.address[0].postalCode	0..1	XAD.5	
PID-13 (Phone Number)	Patient.telecom[]	0..*	XTN parsed: number + use code	XTN.2→value, XTN.7→use (PRN→home, WPN→work, ORN→office, CP→mobile)
PID-18 (Patient Account)	Patient.identifier[]	0..1	CX.1→value; assign type='ACCT'	
PID-22 (Ethnicity)	Patient.extension[us-core-ethnicity]	0..1	CWE data type; look up CDC ethnicity codes	Terminology bridge required
PID-29 (Date of Death)	Patient.deceasedDateTime	0..1	TS → dateTime; set deceasedBoolean=True if present	
PID-30 (Death Indicator)	Patient.deceasedBoolean	0..1	If Y/true → True; else if N/false → False	Only if PID-29 absent

Table 1: PID segment to Patient resource mapping (20 fields)

1.2 PV1 Segment → Encounter Resource

HL7 v2 PV1 Field	FHIR Encounter Element	Card.	Data Transformation	Notes
PV1-2 (Patient Class)	Encounter.class	1..1	Map HL7 v2 code: E→EMER, I→IMP, O→OBS, P→PRENC, R→FLD	HL7 Table 0004 → FHIR Encounter.class (v3.ActCode)
PV1-3 (Assigned Location)	Encounter.location[0].location	0..1	PL data type parsed; resolve location reference (Reference(Location))	PL.1 (point of care) + PL.4 (facility) combined
PV1-4 (Admission Type)	Encounter.hospitalization.admitSource	0..1	CWE; map HL7 Table 0007 codes to FHIR admitSource codes	Terminology bridge
PV1-7 (Attending Doctor)	Encounter.participant[]	0..*	XCN parsed: ID + name; role='ATND'	Participant.type from XCN.15 (assigning authority)
PV1-8 (Referring Doctor)	Encounter.participant[]	0..*	XCN parsed; role='REF'	
PV1-10 (Service Type)	Encounter.serviceType	0..1	CWE → CodeableConcept via HL7 Table 0069	
PV1-36 (Discharge Disposition)	Encounter.hospitalization.dischargeDisposition	0..1	CWE → CodeableConcept	
PV1-44 (Admit Date/Time)	Encounter.period.start	1..1	TS → dateTime	Required for canonical model

HL7 v2 PV1 Field	FHIR Encounter Element	Card.	Data Transformation	Notes
PV1-45 (Discharge Date/Time)	Encounter.period.end	0..1	TS → dateTime	

Table 2: PV1 segment to Encounter resource mapping (9 fields)

1.3 OBX Segment → Observation Resource

HL7 v2 OBX Field	FHIR Observation Element	Card.	Data Transformation	Notes
OBX-1 (Set ID)	Observation.identifier	0..1	Copy as OBX-{value}	
OBX-2 (Value Type)	Observation.value[x].type	1..1	Determines which value[x] property to populate	ST→valueString, NM→valueQuantity, CE→valueCodeableConcept, DT→valueDateTime, TX→valueString
OBX-3 (Observation ID)	Observation.code	1..1	CWE → CodeableConcept (LOINC preferred)	Standard mapping: map to LOINC; preserve original in text field
OBX-4 (Sub-ID)	Observation.identifier	0..1	Append to identifier as 'OBX-{OBX-1}.{OBX-4}'	
OBX-5 (Observation Value)	Observation.value[x]	1..1	Interpret based on OBX-2 (Value Type) for correct FHIR type	See type-specific rules below
OBX-5 (NM type)	Observation.valueQuantity	1..1	Parse decimal; assign UCUM unit from OBX-6	value + unit composite
OBX-5 (CE type)	Observation.valueCodeableConcept	1..1	CWE parsed: code + display + system	Terminology bridge validates against value set
OBX-5 (ST/TX type)	Observation.valueString	1..1	Direct copy	
OBX-5 (DT type)	Observation.valueDateTime	1..1	TS parsed to dateTime	
OBX-6 (Units)	valueQuantity.unit	0..1	CWE → UCUM unit; validate via FHIR \$validate-code	Terminology bridge standardizes non-UCUM units
OBX-7 (Reference Range)	Observation.referenceRange[]	0..*	Parse: low, high, type, text	Map OBX-7.1→low, OBX-7.2→high, OBX-7.4→type
OBX-8 (Abnormal Flags)	Observation.interpretation[]	0..*	Map HL7 Table 0078 codes to FHIR ObservationInterpretation	L→low, H→high, LL→very low, HH→very high, N→normal, A→abnormal, S→susceptible, R→resistant
OBX-11 (Obs Result Status)	Observation.status	1..1	Map HL7 Table 0085: C/F→final, P→preliminary, S→partial, X→cancelled	Required: default to 'final' if unrecognized
OBX-14 (Date/Time of Obs)	Observation.effectiveDateTime	0..1	TS → dateTime	Fallback: use OBR-7 or MSH-7
OBX-16 (Responsible Observer)	Observation.performer[]	0..*	XCN → Reference(Practitioner)	

Table 3: OBX segment to Observation resource mapping (15 fields including sub-types)

1.4 OBR Segment → DiagnosticReport + Observation

HL7 v2 OBR Field	FHIR Element	Card.	Data Transformation	Notes
OBR-1 (Set ID)	DiagnosticReport.identifier	0..1	Prefix 'OBR-{value}'	
OBR-2 (Placer Order #)	DiagnosticReport.basedOn[0]	0..1	EI → Reference(ServiceRequest)	Link to ServiceRequest if available
OBR-3 (Filler Order #)	DiagnosticReport.identifier	0..1	EI → identifier (type='FILL')	
OBR-4 (Universal Service ID)	DiagnosticReport.code	1..1	CWE → CodeableConcept (LOINC preferred)	Primary procedure/test code
OBR-5 (Priority)	DiagnosticReport.extension[priority]	0..1	Map: S→stat, A→asap, R→routine, P→preop	
OBR-7 (Observation Date/Time)	DiagnosticReport.effectiveDateTime	1..1	TS → dateTime	Required for canonical model
OBR-8 (Observation End)	DiagnosticReport.effectivePeriod	0..1	TS → Period.end	
OBR-9 (Collection Volume)	DiagnosticReport.specimen[0].collection	0..1	CQ → quantity + unit on Specimen resource	Resolve to Specimen resource
OBR-10 (Collector ID)	DiagnosticReport.performer[]	0..*	XCN → Reference(Practitioner)	
OBR-13 (Relevant Clinical Info)	DiagnosticReport.conclusion	0..1	ST → text copy	
OBR-14 (Specimen Received)	DiagnosticReport.specimen[0].receivedTime	0..1	TS → dateTime	
OBR-15 (Result Status)	DiagnosticReport.status	1..1	Map as per OBX-11; C/F→final, P→partial	Status must align with latest OBX-11

HL7 v2 OBR Field	FHIR Element	Card.	Data Transformation	Notes
OBR-22 (Result Rpt/Status Chg)	DiagnosticReport.issued	0..1	TS → instant (UTC)	
OBR-25 (Result Status Obs)	DiagnosticReport.result[]	0..*	Reference grouped OBX Observations	Links OBX segments to parent DiagnosticReport

Table 4: OBR segment to DiagnosticReport resource mapping (14 fields)

1.5 Additional HL7 v2 Segment Mappings

HL7 Segment	FHIR Resource(s)	Key Fields Mapped	Card.	Distinctive Rules
NK1 (Next of Kin)	RelatedPerson + Patient.link	NK1-2 (name), NK1-3 (relationship), NK1-4 (address), NK1-5 (phone)	0..*	NK1-3 → RelatedPerson.relationship via HL7 Table 0063; Patient.link.type='seealso'
AL1 (Allergy)	AllergyIntolerance	AL1-2 (type), AL1-3 (code), AL1-4 (severity), AL1-5 (reaction)	0..*	AL1-3 CWE → AllergyIntolerance.code (RxNorm, UNII, or SNOMED); AL1-4 → clinicalStatus
DG1 (Diagnosis)	Condition	DG1-3 (diagnosis code), DG1-4 (description), DG1-5 (date), DG1-6 (type)	0..*	DG1-3 CWE → Condition.code (ICD-10-CM preferred); DG1-6 → category; DG1-5 → onsetDateTime
PR1 (Procedures)	Procedure	PR1-3 (procedure code), PR1-4 (description), PR1-5 (date/time)	0..*	PR1-3 → Procedure.code (CPT, ICD-10-PCS, or SNOMED); PR1-5 → performedDateTime
RXE (Pharmacy/Treatment)	MedicationRequest	RXE-2 (give code), RXE-3 (qty), RXE-4 (units), RXE-7 (route), RXE-12 (rate)	0..*	CE fields → MedicationRequest.medication; TQ timing → dosageInstruction; route via HL7 Table 0162 → standard route codes
RXO (Pharmacy Order)	MedicationRequest	RXO-1 (qty), RXO-2 (units), RXO-3 (rate), RXO-5 (route)	0..*	Similar to RXE; used when RXE absent
ZEF (Custom Segment)	(Extension)	Varies per site	0..*	Captured as FHIR extension on relevant resource; uses registered extension catalog

Table 5: Additional HL7 v2 segment mappings (7 segment types)

1.6 Message-Type Dispatch Rules

HL7 Message Type	Trigger Event	Primary Resource(s)	Secondary Resources	Workflow
ADT^A01	Admission	Patient + Encounter	Condition (diagnosis), RelatedPerson (NK1)	New inpatient admission
ADT^A02	Transfer	Encounter (location change)	Patient	Bed/location transfer
ADT^A03	Discharge	Encounter (period.end set)	Condition (abatement), DocumentReference (discharge summary)	Patient discharge
ADT^A04	Registration	Patient + Encounter	RelatedPerson	Outpatient registration
ADT^A05	Pre-Admission	Encounter (class=PRENC)	Patient	Pre-registration
ADT^A08	Update	Patient (updated fields only)	Any referenced resource	Patient information update
ADT^A12	Cancel Transfer	Encounter (revert location)	-	Transfer cancellation
ORU^R01	Observation Result	DiagnosticReport + Observation[]	Patient, Encounter (context)	Lab results; groups OBX under parent OBR
SIU^S12	Appointment New	Appointment + Patient	Encounter (planned)	New appointment booking
SIU^S15	Appointment Cancel	Appointment (status→cancelled)	-	Cancellation
MDM^T02	Document Notif.	DocumentReference + Binary	Patient, Encounter	Clinical document upload
ORM^O01	Order	ServiceRequest + MedicationRequest	Patient, Encounter	General order placement

Table 6: HL7 v2 message-type dispatch rules (12 message patterns)

2. C-CDA to FHIR R4 Mapping Specification

Consolidated CDA (C-CDA) Release 2.1 documents are processed via XPath-based extraction rules. Each C-CDA section template is mapped to one or more FHIR resources. The mapping pipeline extracts structured data from the XML document, transforms coded entries via the terminology bridge, and validates terminologies against value sets.

2.1 Medications Section → MedicationRequest + Medication

C-CDA / XPath	FHIR Resource/Element	Card.	Data Extraction Rule	Notes
section[templateId/@root='2.16.840.1.113883.10.20.22.2.1.1']	MedicationRequest[]	0..*	Iterate over each entry/act within section	Medications section (entries required)
entry/substanceAdministration/consunable/role/playingEntity/code	MedicationRequest.medicationCodeableConcept	1..1	@code + @displayName + @codeSystem → CodeableConcept	RxNorm or NDC; validate via terminology bridge
entry/substanceAdministration/text	MedicationRequest.note[0].text	0..1	Extract text; strip HTML if present	Free-text sig instructions
entry/substanceAdministration/effectiveTime (low)	MedicationRequest.dosageInstruction[0].timing.event[0]	1..1	Parse ISO 8601 dateTime	Required for canonical method
entry/substanceAdministration/effectiveTime (high)	MedicationRequest.dosageInstruction[0].timing.repeat.boundsPeriod.end	0..1	ISO 8601	End of medication period
entry/substanceAdministration/routeCode	MedicationRequest.dosageInstruction[0].route	1..1	@code → CodeableConcept	Validate via HL7 RouteOfAdministration
entry/substanceAdministration/doseQuantity	MedicationRequest.dosageInstruction[0].doseAndRate[0].doseQuantity	1..1	@value + @unit → Quantity	UCUM normalization
entry/substanceAdministration/rateQuantity	MedicationRequest.dosageInstruction[0].doseAndRate[0].rateQuantity	0..1	@value + @unit → Quantity	For IV infusions
entry/substanceAdministration/administrationUnitCode	MedicationRequest.dosageInstruction[0].doseAndRate[0].doseQuantity.unit	0..1	Map to UCUM unit	
entry/substanceAdministration/repeatNumber	MedicationRequest.dosageInstruction[0].timing.repeat.count	0..1	Integer @value	Number of refills/administrations
entry/substanceAdministration/condition/criterion/value (status)	MedicationRequest.status	1..1	Map: active→active, stopped→stopped, completed→completed, etc.	Validate through FHIR status codes

Table 7: C-CDA Medications section to MedicationRequest (11 extraction rules)

2.2 Problems Section → Condition Resource

C-CDA / XPath	FHIR Resource/Element	Card.	Data Extraction Rule	Notes
section[templateId/@root='2.16.840.1.113883.10.20.22.2.5.1']	Condition[]	0..*	Iterate over entry/act	Problems section
entry/act/entryRelationship/observation/code	Condition.code	1..1	@code + @displayName + @codeSystem	SNOMED CT or ICD-10-CM preferred
entry/act/entryRelationship/observation/statusCode	Condition.clinicalStatus	1..1	Map @code: active→active, completed→resolved	
entry/act/entryRelationship/observation/effectiveTime/low	Condition.onsetDateTime	0..1	ISO 8601 datetime	
entry/act/entryRelationship/observation/effectiveTime/high	Condition.abatementDateTime	0..1	ISO 8601; if absent and completed→abatement low	
entry/act/entryRelationship/observation/targetSiteCode	Condition.bodySite	0..1	@code → CodeableConcept (SNOMED)	
entry/act/entryRelationship/observation/severityCode	Condition.severity	0..1	@code: SNOMED S- or F-code mapping	Terminology bridge required
entry/act/entryRelationship/observation/value (annotation)	Condition.note[0].text	0..1	Free-text annotation	

Table 8: C-CDA Problems section to Condition (8 extraction rules)

2.3 Allergies Section → AllergyIntolerance Resource

C-CDA / XPath	FHIR Element	Card.	Data Extraction Rule	Notes
section[templateId/@root='2.16.840.1.113883.10.20.22.2.6.1']	AllergyIntolerance[]	0..*	Iterate over entry/act	Allergies section
entry/act/entryRelationship/observation/participant/participantRole/playingEntity/code	AllergyIntolerance.code	1..1	@code + @displayName + @codeSystem	RxNorm, UNII, or SNOMED
entry/act/entryRelationship/observation/value	AllergyIntolerance.reaction[0].manifestation[0]	1..1	Coded value; multiple observations→multiple manifestations	SNOMED CT preferred

C-CDA / XPath	FHIR Element	Card.	Data Extraction Rule	Notes
entry/act/entryRelationship/observation/severityCode	AllergyIntolerance.reaction[0].severity	0..1	Map: mild→mild, moderate→moderate, severe→severe	
entry/act/entryRelationship/observation/effectiveTime/low	AllergyIntolerance.onset[x]	0..1	ISO 8601 datetime	
entry/act/entryRelationship/observation/statusCode	AllergyIntolerance.clinicalStatus	1..1	active→active; completed→inactive; resolved→resolved	
entry/act/entryRelationship/observation/entryRelationship/observation/value (reaction detail)	AllergyIntolerance.reaction[0].description	0..1	Text description	

Table 9: C-CDA Allergies section to AllergyIntolerance (7 extraction rules)

2.4 Procedures Section → Procedure Resource

C-CDA / XPath	FHIR Element	Card.	Data Extraction Rule	Notes
section[templateId/@root=2.16.840.1.113883.10.20.22.2.7.1]	Procedure[]	0.*	Iterate over entry/procedure	Procedures section
entry/procedure/code	Procedure.code	1..1	@code + @displayName + @codeSystem	CPT, ICD-10-PCS, SNOMED CT
entry/procedure/statusCode	Procedure.status	1..1	completed→completed; active→in-progress; aborted→not-done	
entry/procedure/effectiveTime/low	Procedure.performedPeriod.start	0..1	ISO 8601 datetime	
entry/procedure/effectiveTime/high	Procedure.performedPeriod.end	0..1	ISO 8601 datetime	
entry/procedure/targetSiteCode	Procedure.bodySite	0..1	@code → CodeableConcept (SNOMED)	
entry/procedure/performer/assignedEntity/code	Procedure.performer[0].function	0..1	Role code from assignedEntity	

Table 10: C-CDA Procedures section to Procedure (7 extraction rules)

2.5 Additional C-CDA Section Mappings

C-CDA Section (TemplateId)	FHIR Resource(s)	Key XPath Expressions	Distinctive Rules
Vital Signs (2.16.840.1.113883.10.20.22.2.4.1)	Observation[]	entry/organizer/component/observation/code; /value (PQ)	Each vital sign is a separate Observation with code from LOINC; valueQuantity with UCUM; effectiveTime from organizer
Results (2.16.840.1.113883.10.20.22.2.3.1)	DiagnosticReport + Observation[]	entry/organizer/code; /component/observation/code; /value	Organizer→DiagnosticReport; child observations→Observation with reference to parent report
Encounters (2.16.840.1.113883.10.20.22.2.2.1)	Encounter[]	entry/encounter/code; /effectiveTime; /participant	Encounter.class from @code; period from effectiveTime; participant from performer
Immunizations (2.16.840.1.113883.10.20.22.2.2.1)	Immunization[]	entry/substanceAdministration/consumable/role/playingEntity/code; /effectiveTime	CVX code preferred; status from substanceAdministration.statusCode; occurrence from effectiveTime
Medical Equipment (2.16.840.1.113883.10.20.22.2.23.1)	Device[] + DeviceUseStatement	entry/organizer/component/observation/code	Implantable devices → Device; consumable → DeviceUseStatement
Social History (2.16.840.1.113883.10.20.22.2.17)	Observation[]	entry/observation/code (e.g., smoking status); /value	Each social history element → Observation; category='social-history'; status='final'

Table 11: Additional C-CDA section mappings (6 sections)

3. Semantic Reconciliation (Phase 2)

Phase 2 of the mapping pipeline applies semantic transformations after structural mapping is complete. The terminology bridge resolves code system differences, normalizes units, and validates value set membership.

3.1 Terminology Crosswalk (12 Code Systems)

Source Code System	Target Code System(s)	Resolution Method	Notable Rules
ICD-9-CM	ICD-10-CM	Exact match via CDC GEMS (General Equivalence Mappings)	One-to-many mappings require human-in-the-loop review; confidence <0.85 triggers review
SNOMED CT	ICD-10-CM, LOINC	Exact match + TF-IDF fuzzy (threshold 0.85)	For diagnosis codes prefer SNOMED→ICD-10-CM; for clinical findings prefer SNOMED→LOINC
LOINC (local)	LOINC (canonical)	Exact match via UMLS MRMAP	Local LOINC may have non-canonical mappings; fuzzy fallback to concept description
RxNorm (SCDC)	RxNorm (canonical)	Exact RxNorm relationship traversal	SCDC→SCDF→GPCK→IN for generic preference
NDC	RxNorm	NDC-RxNorm mapping via UMLS	Multi-NDC per RxNorm concept; choose clinical dose form closest match
CPT (local variant)	CPT (AMA standard)	Exact match + code validation	Local CPT variant codes truncated; pad to 5 digits
HCPCS	HCPCS Level II	Exact match	Maintained quarterly by CMS
CVX (local)	CVX (HL7 standard)	Exact match	CDC CVX lookup table
UCUM (variant)	UCUM (canonical)	Normalization via UCUM case/format rules	lowercase+preferred form; e.g., 'mg'→'mg', 'ML'→'mL'
HL7 v2 Table 0001 (Admin Gender)	FHIR AdministrativeGender	Direct lookup	M→male, F→female, O→other, UNK→unknown
HL7 v2 Table 0078 (Abnormal Flags)	FHIR ObservationInterpretation	Direct lookup	L→low, H→high, LL→low-low, A→abnormal, N→normal
HL7 v2 Table 0162 (Route of Admin)	FHIR standard route codes	Direct lookup	PO→oral, IV→intravenous, IM→intramuscular, SC→subcutaneous

Table 12: Terminology crosswalk for 12 code systems

3.2 Quality Metrics as FHIR Observations

After both mapping phases, the validation pipeline emits six quality metrics as FHIR Observation resources. These are stored in the canonical store alongside clinical data.

Metric	Acronym	Definition	Target
Field Fill Rate	FFR	Percentage of mandatory FHIR fields populated with non-null values after mapping	>98%
Code System Conformance	CSC	Percentage of coded fields that resolve to the target code system (not left as local codes)	>95%
Reference Integrity Rate	RIR	Percentage of resource.reference values that resolve to an existing resource in the store	>99%
Temporal Consistency	TC	Percentage of date/time comparisons (start<end, etc.) that pass validation	>99%
Mapping Success Rate	MSR	Percentage of segments/sections that produce at least the minimum required FHIR resources	>95%
Terminology Coverage	TCR	Percentage of coded elements that match a known code system + value set	>92%

Table 13: Data quality metrics collected as FHIR Observations (6 metrics)

— End of Mapping Specification —

This mapping specification is part of Xinyang Li's original contribution evidence for the FHIR-Native Clinical Data Interoperability and Data-Quality Framework (Line 1). The mapping rules are designed to be formalized as HL7 FHIR ConceptMap and StructureMap artifacts for import into any standards-compliant FHIR server.