HSPC | the healthcare services platform consortium™

THE HEALTHCARE INNOVATION ECOSYSTEM

Modeling for Clinicians

Russ Leftwich, MD; Stan Huff, MD; Susan Matney PhD

"In attempting to arrive at the truth, I have applied everywhere for information, but in scarcely an instance have I been able to obtain hospital records fit for any purpose of comparison. If they could be obtained, they would enable us to decide many other questions…

They would show [subscribers] how their money was being spent [and] what amount of good was really being done with it…"

Florence Nightingale - Notes on a Hospital, 1873

Agenda

- Innovations in Achieving Interoperability - Russ Leftwich
- Overview of CIMI and Model Patterns -Stan Huff
- Modeling Use Case Exercise – Susan Matney

Innovations in Achieving Interoperability

Russ Leftwich, M.D.

CIMI and CIMI Logical Models

Stan Huff, M.D., FACMI, FHL7

Clinical Information Modeling Initiative (CIMI)

- The Clinical Information Modeling Initiative (CIMI) is an HL7 Work Group that is producing detailed clinical information models to enable interoperability of health care information systems
- CIMI was initiated during a “Fresh Look” session at an HL7 meeting in 2011
- CIMI models are free for use for all purposes
- See http://www.opencimi.org/ for more details

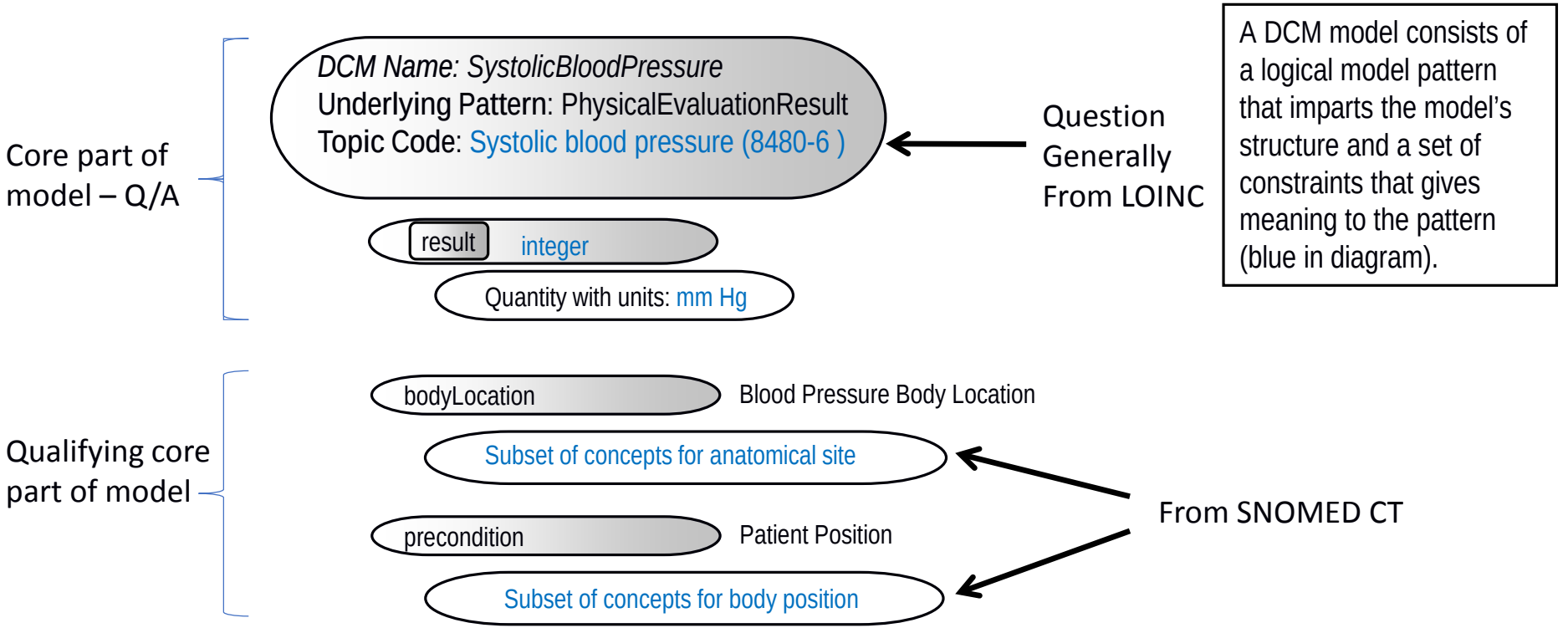
CIMI Goals

- Create a shared repository of detailed clinical information models
- Repository is open to everyone and models are licensed free for use at no cost
- Where the models:
  - Are based on a core reference model, including a set of base data types
  - Have formal bindings to standard coded terminologies

What is a Logical Model?

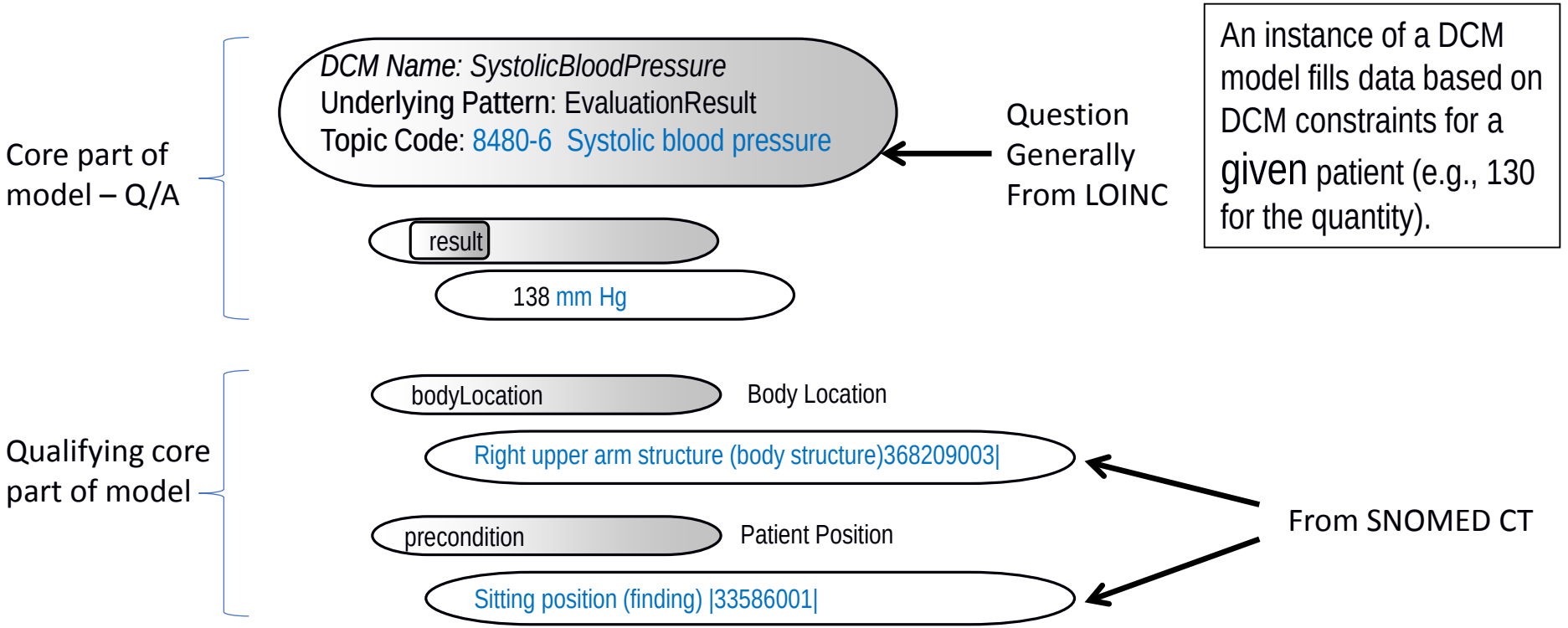
- Model of a specific healthcare domain
- Combines – standard terminology, structure and attribute specifications
- Expressed as data structures
- Independent of specific standard or technology
- Benefits:
  - Guarantees semantic interoperability
  - Facilitates avoidance of data redundancy
  - Facilitates data re-use and sharing
  - Decreases development and maintenance time and cost
  - Confirms a logical process model for data analysis

What is a Detailed Clinical Model (DCM)?



A DCM model consists of a logical model pattern that imparts the model's structure and a set of constraints that gives meaning to the pattern (blue in diagram).

What is an Instance of a DCM?



The way it might work …

Name: Jane Doe Sex: F DOB: 4 Nov 1952

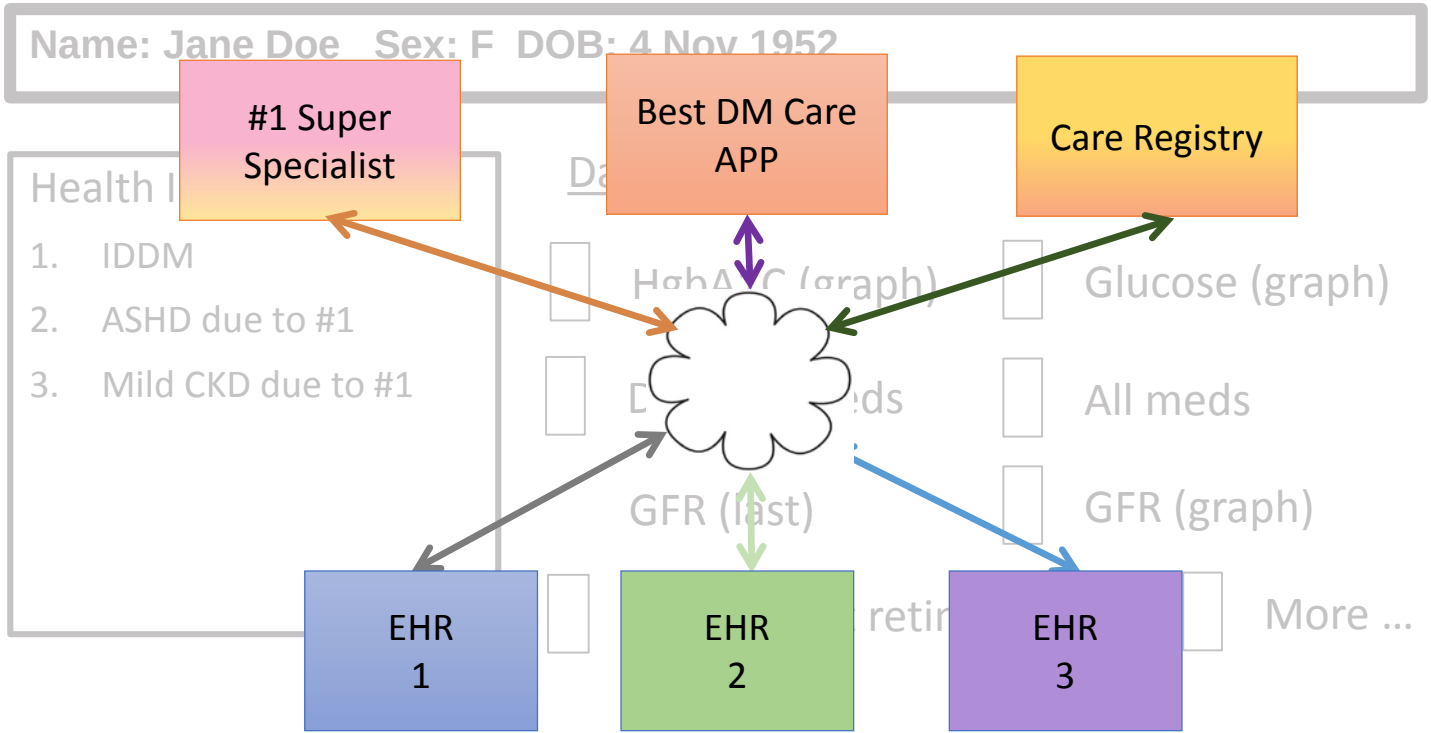
Health Issues

1. IDDM
2. ASHD due to #1
3. Mild CKD due to #1

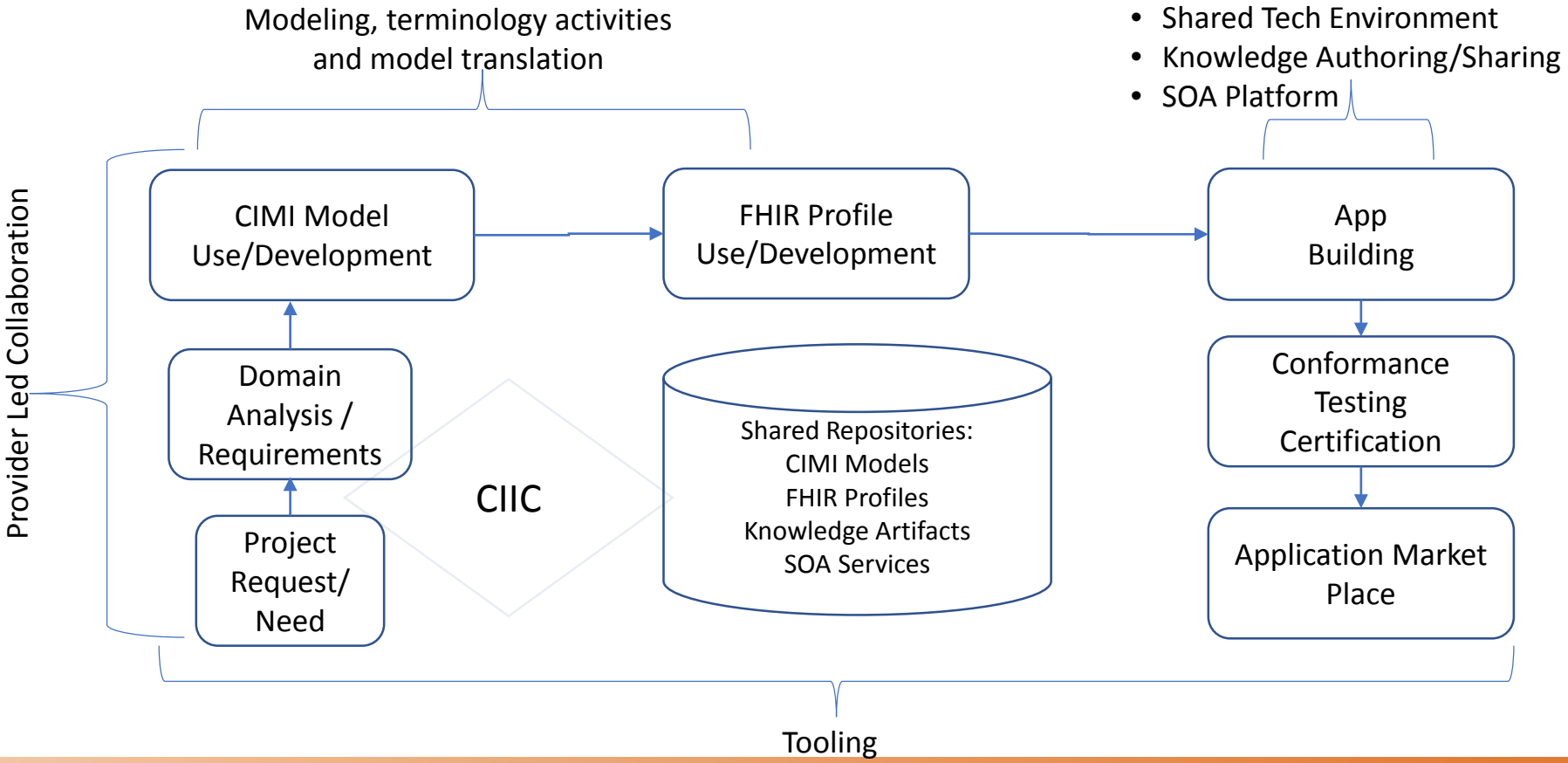
Data to report

- ■ HgbA1C (graph)
- ■ Glucose (graph)
- ■ Diabetic meds
- □ All meds
- □ GFR (last)
- ■ GFR (graph)
- ■ Date of last retinal exam
- □ More …

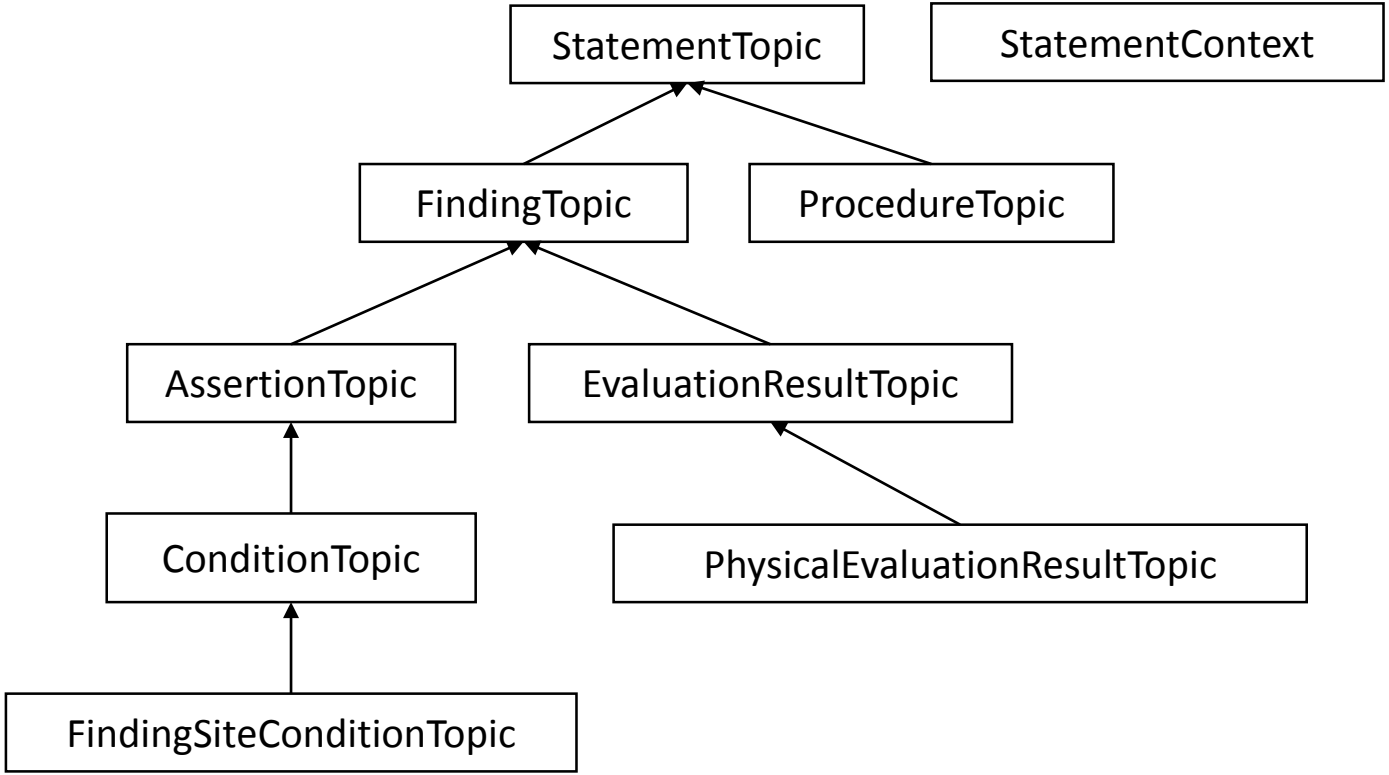
The way it might work …



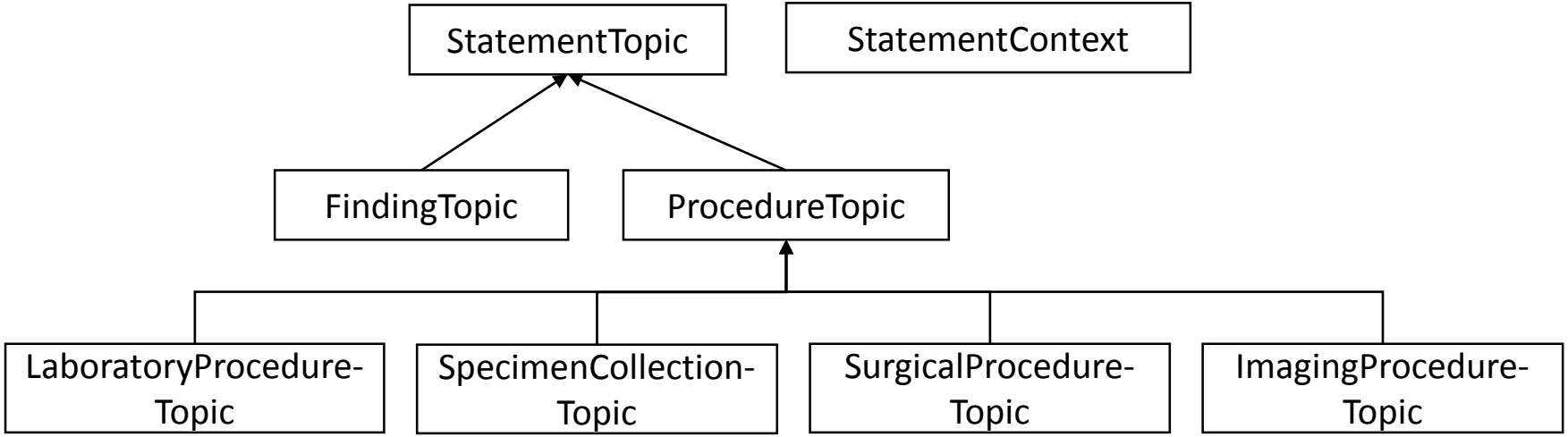
So…how do we get there?
HSPC Deliverables



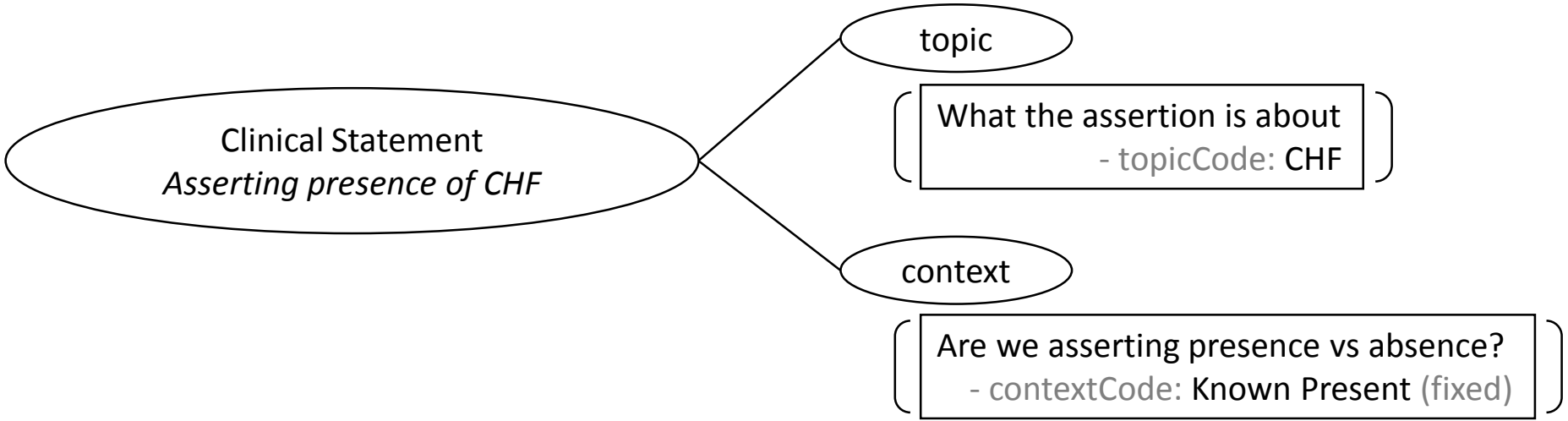
CIMI Hierarchy



CIMI Hierarchy



CHF Clinical Statement



Condition Pattern

ConditionTopic

topicCode : Concept [1..1]
description : PlainText [0..1]
multimedia : Multimedia [0..*]
interpretation : Concept [0..*]
severity : Concept [0..1]
clinicalCourse : Concept [0..1]
episodicity : Concept [0..1]
diseasePhase : Concept [0..1]
associatedSignAndSymptom : Concept [0..*]
periodicity : Concept [0..*]
alleviatingFactor : Concept [0..*]
exacerbatingFactor : Concept [0..*]
clinicalStatus : Concept [0..1]
causedBy : CausedByEntityAssociation [0..1]
associatedEntityNOS : EntityAssociationNOS [0..1]
dueTo : DueTo [0..*]
before : TemporallyBefore [0..*]
after : TemporallyAfter [0..*]
…

A code representing what's being asserted ("rash", "auto accident", "hypertrophy", etc…)
Concepts from SNOMED CT "Clinical Finding" hierarchy

A code indicating whether the assertion indicates presence of the finding or absence of the finding.

PresenceContext

contextCode : Concept [1..1]
status : Concept [0..1]
dateAsserted : TemporalValue [0..1]
verificationStatus : Concept [0..1]
certainty : Concept [0..1]
dateOfOnset : TemporalValue [0..1]
ageAtOnset : Quantity [0..1]
dateAbated : TemporalValue [0..1]
hasAbated : Concept [0..*]
presentOnAdmission : Concept [0..*]

Condition Exercise
"Chronic Hypertension"

* Only new constraints are shown in diagrams

ConditionTopic

topicCode : Concept [1..1]
description : PlainText [0..1]
multimedia : Multimedia [0..*]
interpretation : Concept [0..*]
severity : Concept [0..1]
clinicalCourse : Concept [0..1]
episodicity : Concept [0..1]
diseasePhase : Concept [0..1]
associatedSignAndSymptom : Concept [0..*]
periodicity : Concept [0..*]
alleviatingFactor : Concept [0..*]
exacerbatingFactor : Concept [0..*]
clinicalStatus : Concept [0..1]
causedBy : CausedByEntityAssociation [0..1]
associatedEntityNOS : EntityAssociationNOS [0..1]
dueTo : DueTo [0..*]
before : TemporallyBefore [0..*]
after : TemporallyAfter [0..*]
…

Hypertensive disorder, systemic arterial (disorder)|38341003 → topicCode

"Chronic Hypertension Model" → description

Chronic (qualifier value)|90734009 → clinicalCourse

Known Present (Qualifier value) |410515003 → contextCode

PresenceContext

contextCode : Concept [1..1]
status : Concept [0..1]
dateAsserted : TemporalValue [0..1]
verificationStatus : Concept [0..1]
certainty : Concept [0..1]
dateOfOnset : TemporalValue [0..1]
ageAtOnset : Quantity [0..1]
dateAbated : TemporalValue [0..1]
hasAbated : Concept [0..*]
presentOnAdmission : Concept [0..*]

Condition with Finding Site

FindingSiteConditionTopic

topicCode : Concept [1..1]
description : PlainText [0..1]
multimedia : Multimedia [0..*]
interpretation : Concept [0..*]
severity : Concept [0..1]
clinicalCourse : Concept [0..1]
episodicity : Concept [0..1]
diseasePhase : Concept [0..1]
associatedSignAndSymptom : Concept [0..*]
periodicity : Concept [0..*]
alleviatingFactor : Concept [0..*]
exacerbatingFactor : Concept [0..*]
clinicalStatus : Concept [0..1]
causedBy : CausedByEntityAssociation [0..1]
associatedEntityNOS : EntityAssociationNOS [0..1]
dueTo : DueTo [0..*]
before : TemporallyBefor
after : TemporallyAfter [
…

Body location added to Condition Pattern

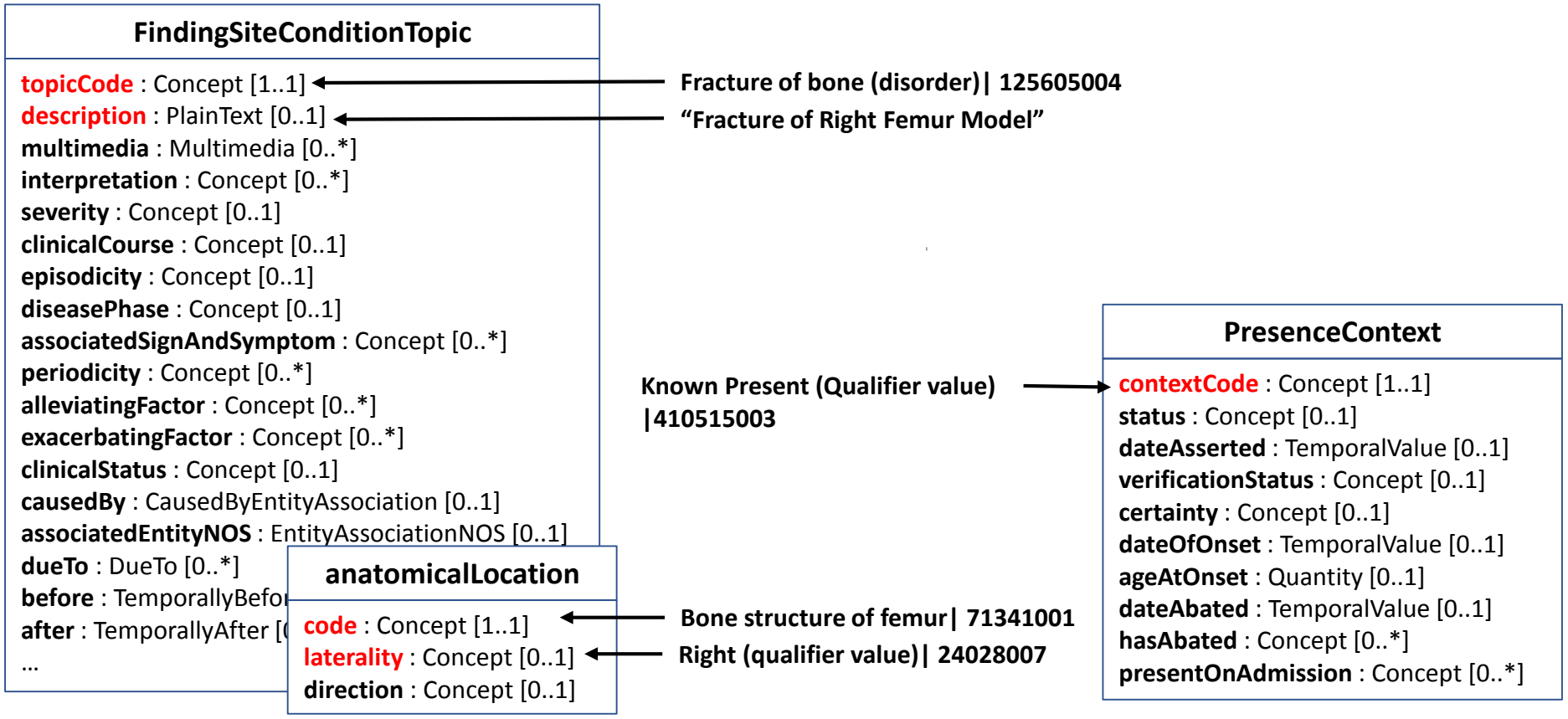
anatomicalLocation ← **Anatomical location class**

code : Concept [1..1] ← **Body Location**
laterality : Concept [0..1] ← **Body Side**
direction : Concept [0..1] ← **Body Location Qualifier**

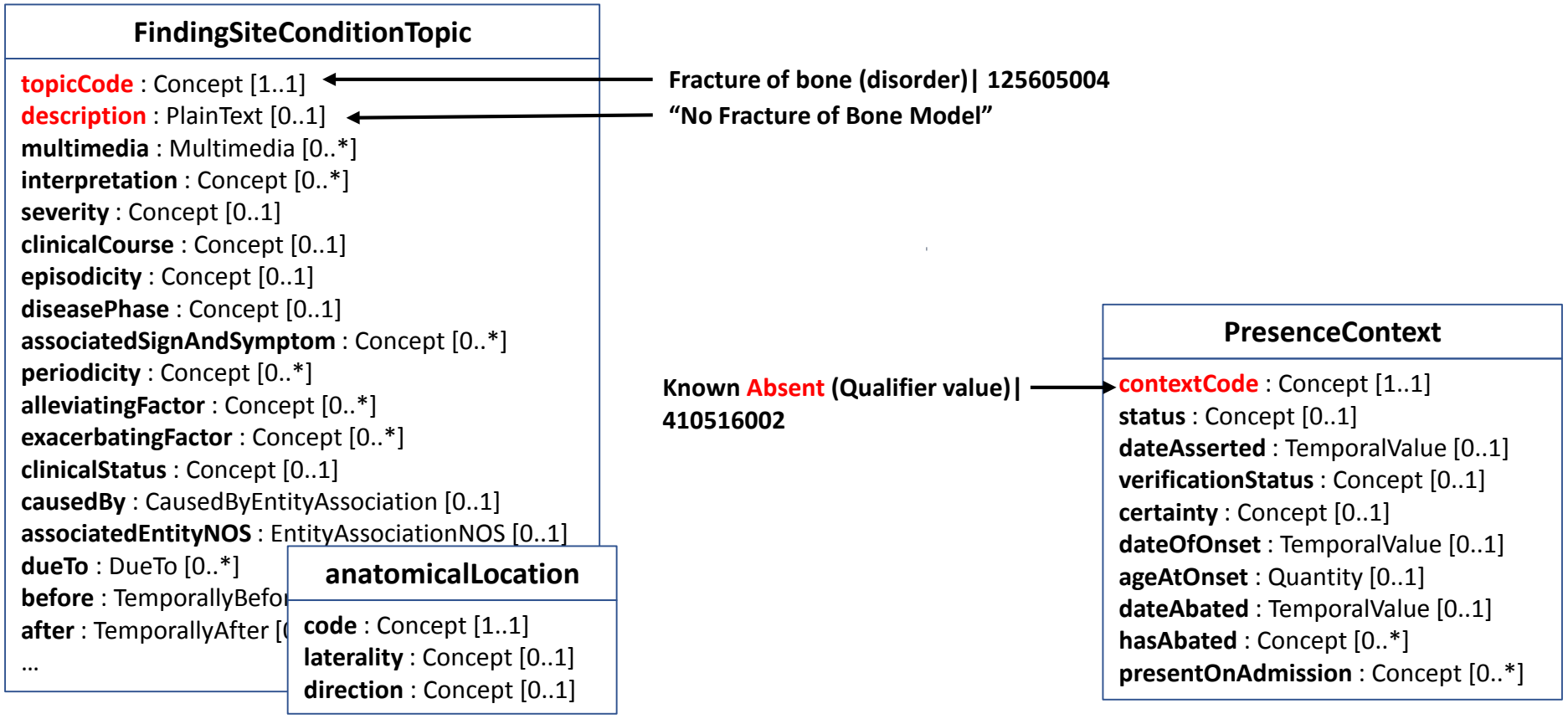
PresenceContext

contextCode : Concept [1..1]
status : Concept [0..1]
dateAsserted : TemporalValue [0..1]
verificationStatus : Concept [0..1]
certainty : Concept [0..1]
dateOfOnset : TemporalValue [0..1]
ageAtOnset : Quantity [0..1]
dateAbated : TemporalValue [0..1]
hasAbated : Concept [0..*]
presentOnAdmission : Concept [0..*]

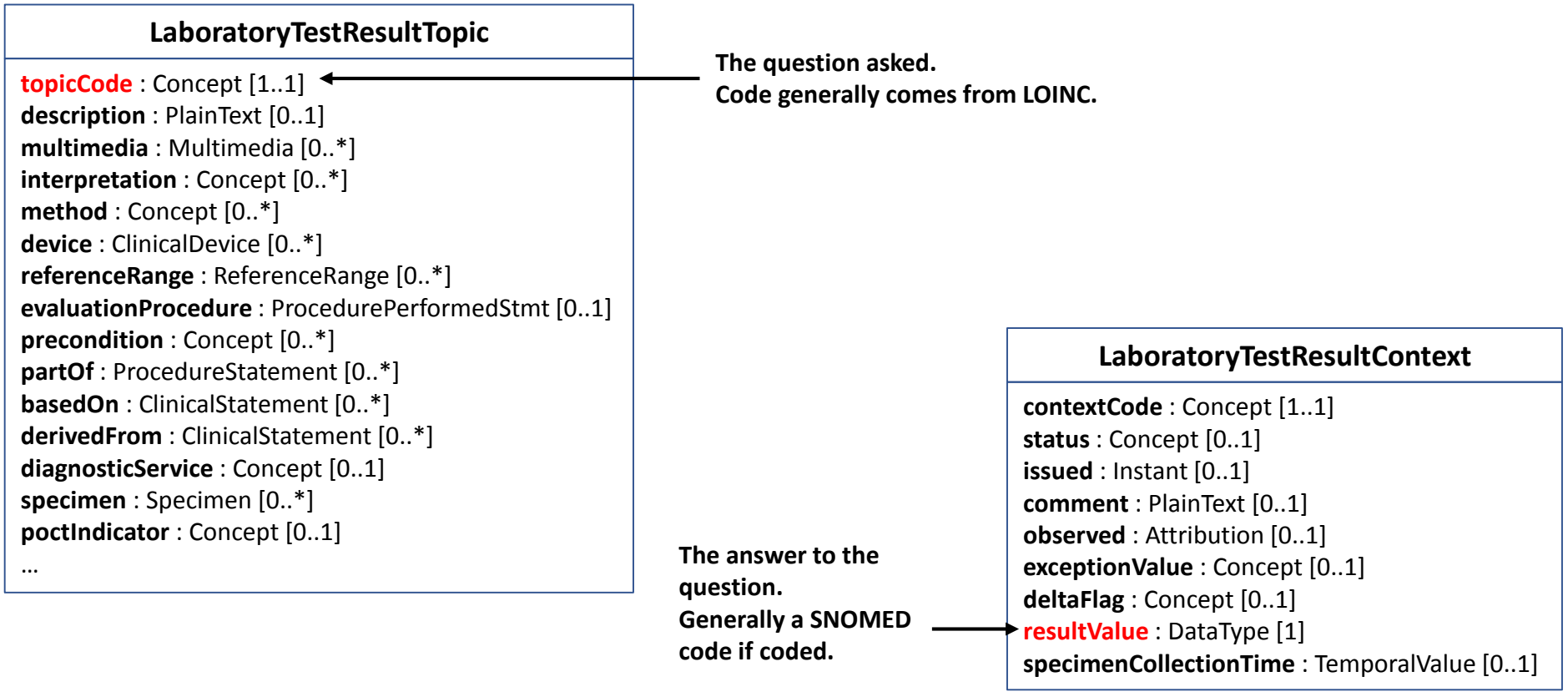
Condition Exercise
"Fractured Right Femur"



Condition Exercise
"No Bone Fractures"

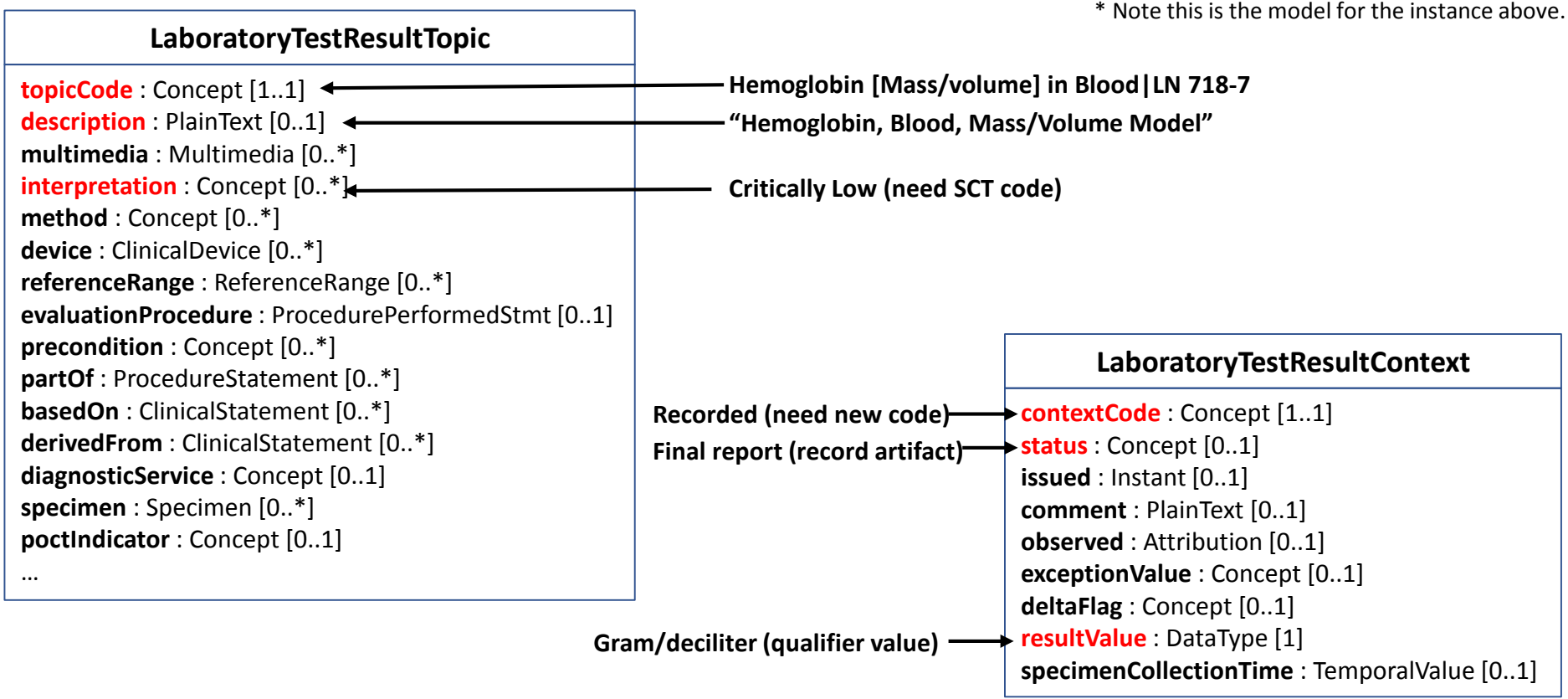


LaboratoryTestResult
An example EvaluationResult pattern



Lab Evaluation Result Exercise
"Blood Hemoglobin of 6.1 g/dl is Critically Low"

* Note this is the model for the instance above.



Evaluation Result Exercise
"Patient's skin turgor decreased"

* Only new constraints are shown in diagrams

PhysicalEvaluationResultTopic

topicCode : Concept [1..1] ← **Skin Turgor| LNC 39109-4**
description : PlainText [0..1] ← **"Skin Turgor Model"**
multimedia : Multimedia [0..*]
interpretation : Concept [0..*]
method : Concept [0..*]
device : ClinicalDevice [0..*]
referenceRange : ReferenceRange [0..*]
evaluationProcedure : ProcedurePerformedStmt [0..1]
precondition : Concept [0..*]
partOf : ProcedureStatement [0..*]
basedOn : ClinicalStatement [0..*]
derivedFrom : ClinicalStatement [0..*]
diagnosticService : Concept [0..1]
poctIndicator : Concept [0..1]
…

EvaluationResultContext

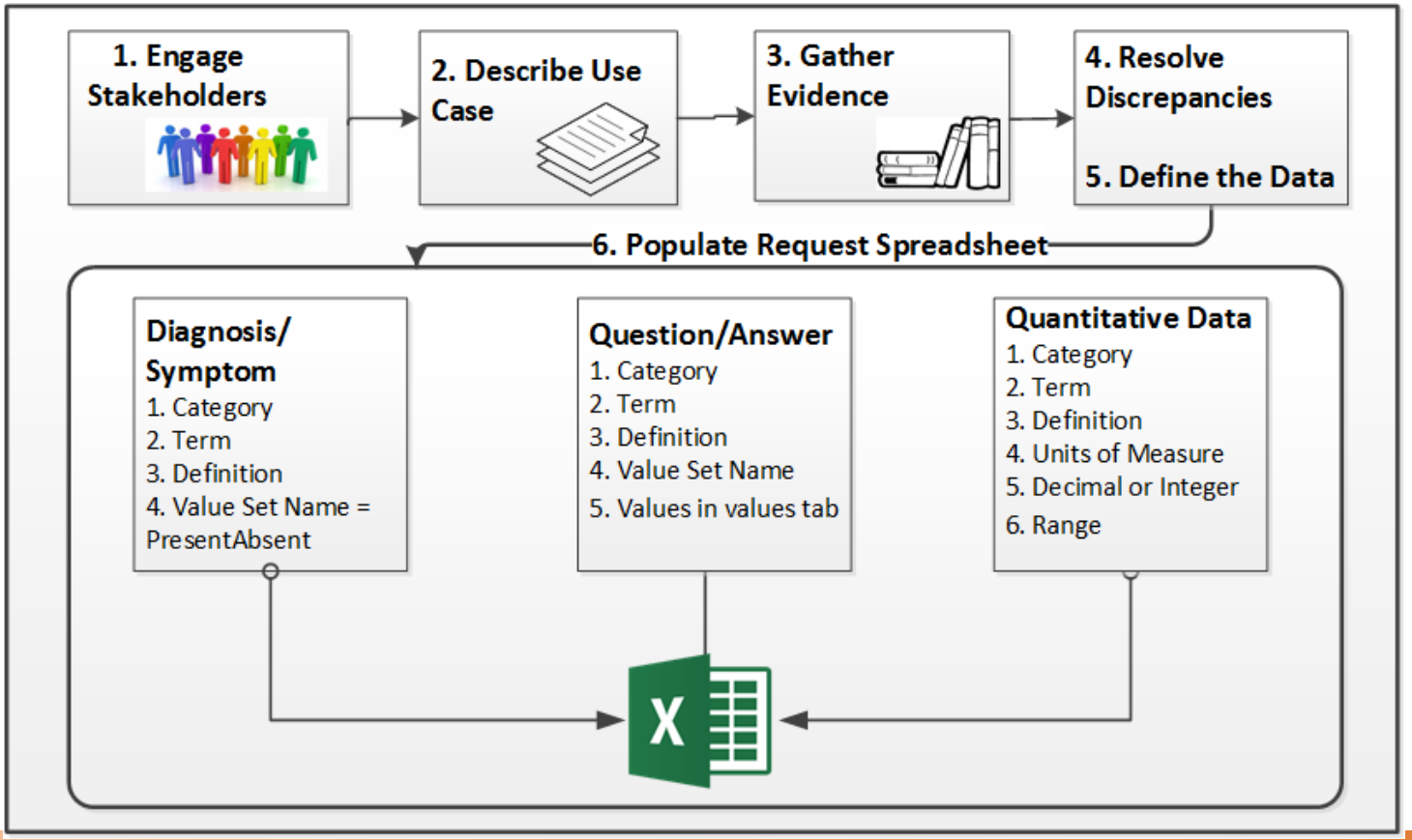
contextCode : Concept [1..1]
status : Concept [0..1]
issued : Instant [0..1]
comment : PlainText [0..1]
observed : Attribution [0..1]
exceptionValue : Concept [0..1]
deltaFlag : Concept [0..1]
resultValue : DataType [1]

Decreased skin turgor (finding)|SCT 425244000 → **resultValue**

Model Request Process and Exercise

Susan Matney, PhD, RNC-OB, FAAN, FACMI

DCM Request Process



DCM Creation Process

- Develop User Stories and Workflows
- Domain Experts Submit Content Request
- Review the Questions and Answers in the Spreadsheet
- Align Questions with CIMI Patterns
  - Hypertension = assertion
  - Systolic Blood Pressure = EvaluationResults
  - Educate about Hypertension = Procedure
- Model DCM
- Encode with Standard Terminologies

How to Model

- Identify entity – collections of similar objects
  - Assertions
  - Observations
  - Procedures
- Identify attributes
  - Topic
  - Qualifiers
- Map to the patterns

Hands-On Exercise

- Identify
  - The pattern to use
    - Condition
    - Evaluation Result
      - DataType
      - Unit of Measure if Needed
      - Coded Results
  - Review the attributes in the pattern and align with the item to map

Exercise Use Case

Joe is a 24 year-old male paraplegic admitted to an inpatient unit from his home with a Right Lower Lobe Pneumonia. He is confined to a wheelchair and requires two-person assist with movement. His oxygen saturation by pulse ox is 88% on room air. The evaluation of his vitals show a oral temperature of 101F. His skin is clammy.

Step 1 Identify Patterns: Conditions

Joe is a 24 year-old male paraplegic admitted to an inpatient unit from his home with a Right Lower Lobe Pneumonia. He is confined to a wheelchair and requires two-person assist with movement. His oxygen saturation by pulse ox is 88% on room air. The evaluation of his vitals show a oral temperature of 101F. His skin is clammy.

Paraplegia

RLL Pneumonia

Fever

Condition Exercise "Paraplegia"

* Only new constraints are shown in diagrams

ConditionTopic

topicCode : Concept [1..1]
description : PlainText [0..1]
multimedia : Multimedia [0..*]
interpretation : Concept [0..*]
severity : Concept [0..1]
clinicalCourse : Concept [0..1]
episodicity : Concept [0..1]
diseasePhase : Concept [0..1]
associatedSignAndSymptom : Concept [0..*]
periodicity : Concept [0..*]
alleviatingFactor : Concept [0..*]
exacerbatingFactor : Concept [0..*]
clinicalStatus : Concept [0..1]
causedBy : CausedByEntityAssociation [0..1]
associatedEntityNOS : EntityAssociationNOS [0..1]
dueTo : DueTo [0..*]
before : TemporallyBefore [0..*]
after : TemporallyAfter [0..*]
…

Paraplegia (disorder)| SCT 60389000

"Paraplegia Model"

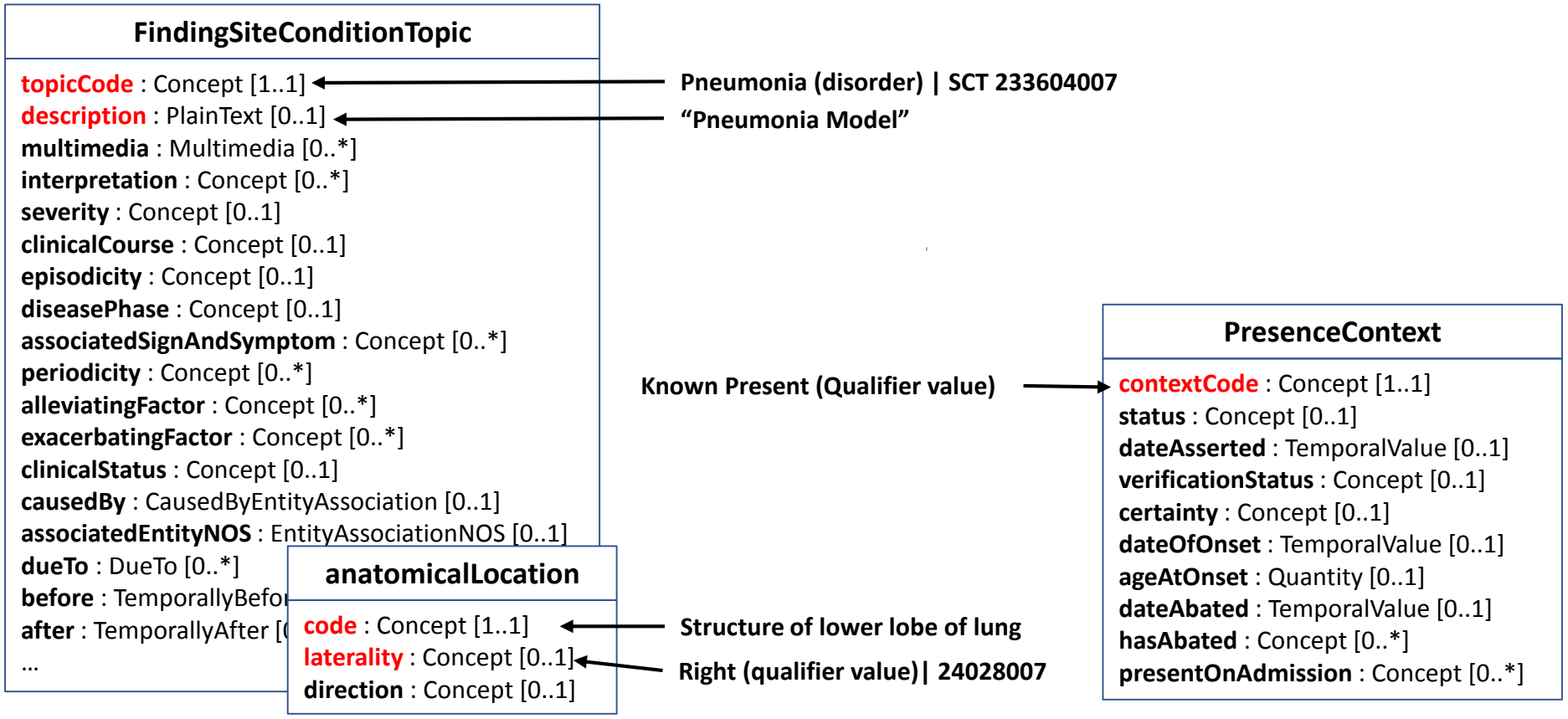
Known Present (Qualifier value) |90734009

Date of onset (observable entity)| 298059007

PresenceContext

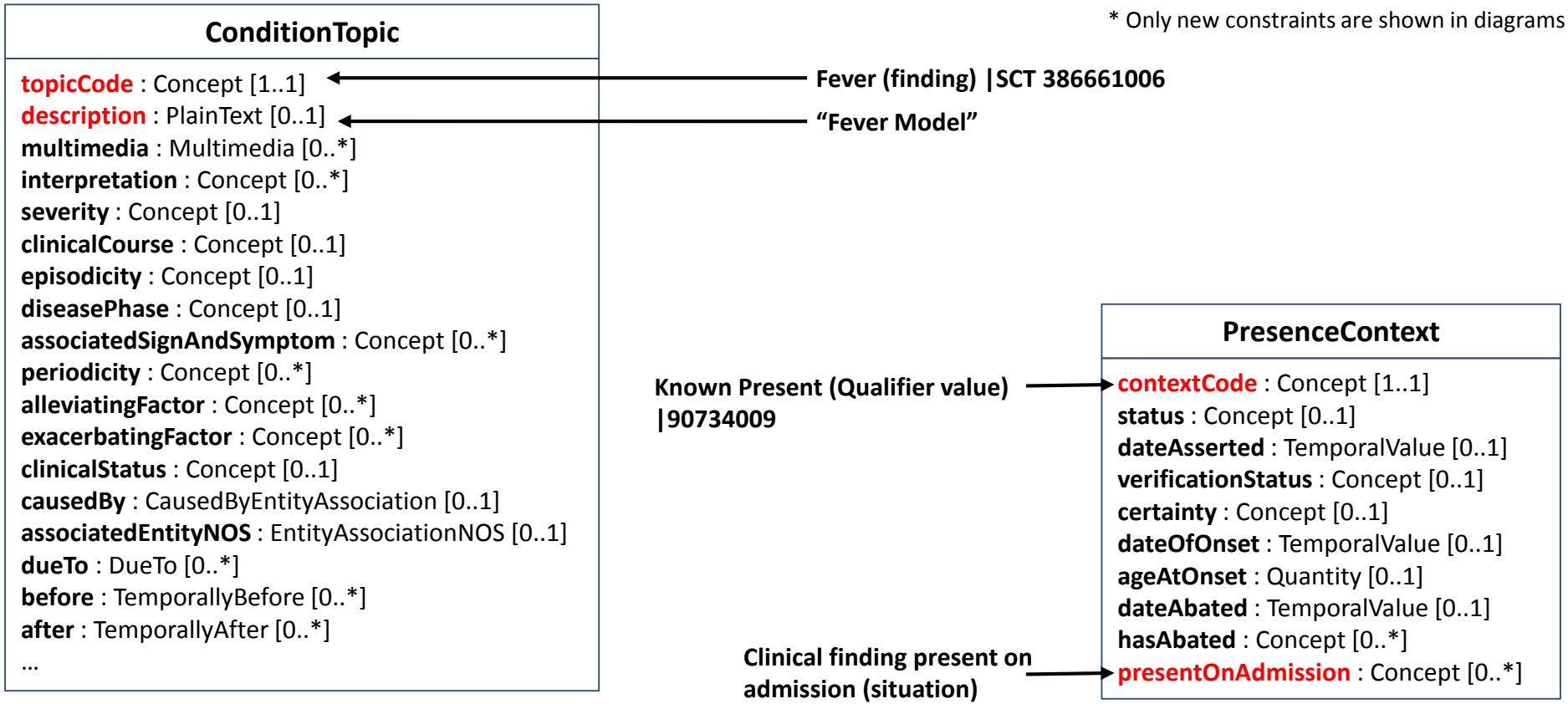
contextCode : Concept [1..1]
status : Concept [0..1]
dateAsserted : TemporalValue [0..1]
verificationStatus : Concept [0..1]
certainty : Concept [0..1]
dateOfOnset : TemporalValue [0..1]
ageAtOnset : Quantity [0..1]
dateAbated : TemporalValue [0..1]
hasAbated : Concept [0..*]
presentOnAdmission : Concept [0..*]

Condition Exercise "RLL Pneumonia"



Condition Exercise "Fever"

* Only new constraints are shown in diagrams



Step 1 Identify Patterns: Evaluation Result

Joe is a 24 year-old male paraplegic admitted to an inpatient unit from his home with a Right Lower Lobe Pneumonia. He is confined to a wheelchair and requires two-person assist with movement. His oxygen saturation by pulse ox is 88% on room air. The evaluation of his vitals show a oral temperature of 101F. His skin is clammy.

O2 Sat

Temperature

Skin moisture

Evaluation Result Exercise "Oxygen Saturation by Pulse Ox"

* Only new constraints are shown in diagrams

PhysicalEvaluationResultTopic

topicCode : Concept [1..1] ← **Oxygen saturation by Pulse oximetry| LNC 59408-5**
description : PlainText [0..1] ← **"Oxygen Saturation by Pulse Oximetry Model"**
multimedia : Multimedia [0..*]
interpretation : Concept [0..*]
method : Concept [0..*]
device : ClinicalDevice [0..*]
referenceRange : ReferenceRange [0..*]
evaluationProcedure : ProcedurePerformedStmt [0..1]
precondition : Concept [0..*]
partOf : ProcedureStatement [0..*]
basedOn : ClinicalStatement [0..*]
derivedFrom : ClinicalStatement [0..*]
diagnosticService : Concept [0..1]
poctIndicator : Concept [0..1]
…

Percent (property) (qualifier value)| SCT 118582008 →

EvaluationResultContext

contextCode : Concept [1..1]
status : Concept [0..1]
issued : Instant [0..1]
comment : PlainText [0..1]
observed : Attribution [0..1]
exceptionValue : Concept [0..1]
deltaFlag : Concept [0..1]
resultValue : DataType [1]

Evaluation Result Exercise "Oral Body Temperature"

* Only new constraints are shown in diagrams

PhysicalEvaluationResultTopic

topicCode : Concept [1..1] ← **Body temperature| LNC 8310-5**
description : PlainText [0..1] ← **"Body Temperature Model"**
multimedia : Multimedia [0..*]
interpretation : Concept [0..*]
method : Concept [0..*]
device : ClinicalDevice [0..*] ← **Electronic thermometer probe, single-use (physical object)| 700836008**
referenceRange : ReferenceRange [0..*]
evaluationProcedure : ProcedurePerformedStmt [0..1]
precondition : Concept [0..*]
partOf : ProcedureStatement [0..*]
basedOn : ClinicalStatement [0..*]
derivedFrom : ClinicalStatement [0..*]
diagnosticService : Concept [0..1]
poctIndicator : Concept [0..1]
…

anatomicalLocation

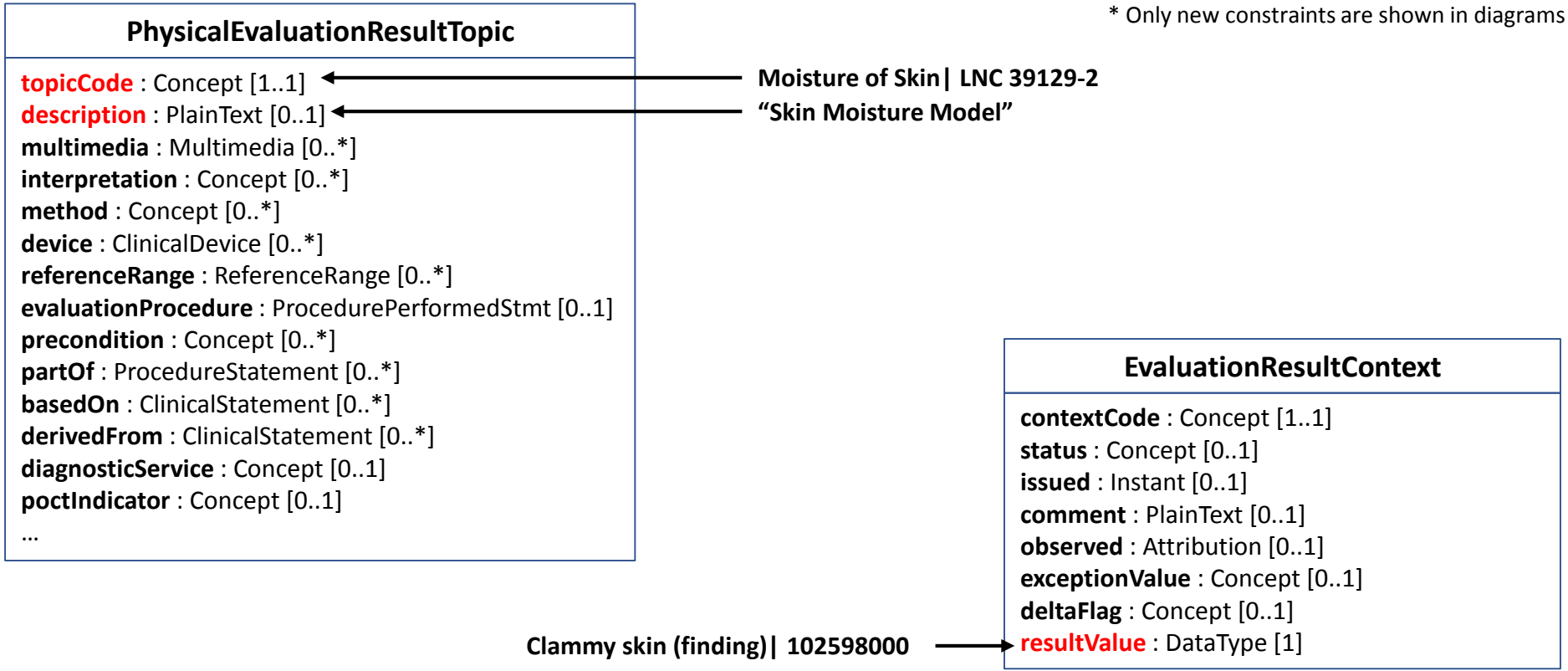
code : Concept [1..1] ← **Sublingual space (body structure)**
laterality : Concept [0..1]
direction : Concept [0..1]

EvaluationResultContext

contextCode : Concept [1..1]
status : Concept [0..1]
issued : Instant [0..1]
comment : PlainText [0..1]
observed : Attribution [0..1]
exceptionValue : Concept [0..1]
deltaFlag : Concept [0..1]
resultValue : DataType [1] ← **Degrees Fahrenheit (qualifier value)| 258712004**

Evaluation Result Exercise "Skin Moisture"

* Only new constraints are shown in diagrams



Discussion

- Lessons Learned
- Next Steps

Conclusion

- Identify Requirements and Use Case
- Complete the Model Request From
- Determine Model Patterns
- Bind to the Appropriate Standard Terminologies
- Create the Detailed Clinical Models (DCMs)

Questions