Practical Applications of Ontologies in Clinical Systems

Roberto A. Rocha, MD, PhD, FACMI

Sr. Corporate Manager
Clinical Knowledge Management and Decision Support,
Clinical Informatics Research and Development, Partners Healthcare System
Lecturer in Medicine
Division of General Internal Medicine and Primary Care, Department of
Medicine, Brigham and Women's Hospital, Harvard Medical School

BWH BRIGHAM AND WOMEN'S HOSPITAL   HARVARD MEDICAL SCHOOL   PARTNERS HEALTHCARE   CIRD Clinical Informatics Research & Development

Overview

- Background
  - Clinical System
  - Clinical Ontologies (*disclaimer*)
- Practical applications
  - Real-life examples from Partners
  - Local curation and management
- Next generation of clinical systems
  - Meaningful use, collaborative care
  - Continuous learning
- Conclusions

Background

Clinical System

Clinical Ontologies (disclaimer)

Clinical System

- "… an automated system with a long term database containing clinical information used for patient care."

  – Bruce Blum, 1986

- Support (automation) for one or multiple *clinical* (patient care) functions

- **Electronic Health Record** system is an integrated *suite* of clinical systems

Outpatient EHR @ Partners

| BwhImrartest,Thirtyfive | 🔍 | 🧪 ❓ ⭐ | RMG15 | 1 |
| 21804729 (BWH) | 01/14/1933 (75 yrs.) F | | BROOKSIDE | |

| Select | Desktop | Pt Chart: Summary | Oncology | Custom | Reports | Admin | Sign | Results | ? | Resource | Popup |

Reminders

- No known documented smoking status. Click to enter status.
- Patient due for repeat pneumovax.   [Done ▼]   Execute
- Recommend bone densitometry and appropriate treatment for patients at high risk for osteoporosis.   [Order Bone Density Scan ▼]   Execute
- Patient has CAD-equivalent on problem list and aspirin is not on the med list. Recommend aspirin.   Execute
- Patient with DM overdue for urine microalb/creatinine ratio (rec: q1 year).   Execute
- Patient with DM overdue for HbA1C (rec: q 6 months).   Execute
- Patient with DM overdue for ophthalmology exam (rec: q 1 year).   Execute
- Patient has CHD-equivalent, overdue for lipid assessment (rec: q 1 year).   Execute

Dropdown options:
- Order Bone Density Scan
- Done elsewhere
- Patient refuses bone density test
- Patient refuses medication
- Patient does not tolerate meds
- Bone Density scheduled today
- Medication started today
- Provider deferred
- Other

Problems [Add New]

- ℹ️ Diabetes mellitus ℹ️⭐
- ℹ️ Coronary arteriosclerosis ⭐

Health Maintenance

HM Item	Date of Last	
Influenza Vaccine		
Breast Exam		
Rectal exam		
M-alb/creat ratio	03/24/2008	O
Mammogram	05/29/2006	
Pap Smear		
Stool Guaiac		
Pneumovax	01/07/2004	
Colonoscopy		
Ophthal Exam		
Nutrition Referral		

Advance Directives

Allergies [Add New]

| Allergen | Reaction |

Family History [Add New]

| Family History Problem | Relative |

Flowsheets [Add New]

Item Name	10/04/2007	04/25/2006	04/24/20
BLOOD PRESSURE	140/90	141/91*	140/90
TEMPERATURE			
PULSE			
RESPIRATORY RATE			
O2			
HEI			
WE			
BMI			
PAIN LEVEL			

Sticky Notes [Add New]

Documentation, ordering, results review, messaging, etc.

Clinical Ontologies

- "… a **looser definition** of Clinical Ontology, which also includes well-organized, but not always formally represented, **clinical classifications**, **nomenclatures** and **terminologies**."

- "Clinical Ontologies represent clinical phenotypes, diseases, syndromes and many other clinical elements such as medications and personal habits …"

Lussier YA and Bodenreider O. Clinical Ontologies for Discovery Applications. In: Baker CJO, Cheung K-H, editors. Semantic Web: Revolutionizing knowledge discovery in the life sciences: Springer; 2007. p. 101-119.

CIRD
Clinical Informatics
Research & Development

SNOMED CT

- **Systematized Nomenclature of Medicine – Clinical Terms**
- *Organization*: International Health Terminology Standards Development Organisation (**IHTSDO**)
  - SNOMED Terminology Solutions - College of American Pathologists
- *Purpose*: Encoding of multiple clinical domains
- *Content*: Comprehensive (diseases, signs, symptoms, living organisms, chemicals, body parts, morphology, occupations, modifiers, etc.)
- Information:
  - http://www.ihtsdo.org/

LOINC

- **Logical Observation Identifiers Names and Codes**

- Organization: LOINC Committee

- Purpose: identification of laboratory and clinical observations (HL7 messages)

- Content: laboratory tests, clinical measurements, documents, etc.

- Information:
  - http://loinc.org/

http://search.loinc.org/

Many others (incomplete list)

- **RxNorm**: clinical drugs and drug delivery devices (NLM)
- **ICNP**: International Classification For Nursing Practice (ICN)
- **NDF-RT**: National Drug File - Reference Terminology (VA)
- **CVX**: Vaccines Administered (CDC)
- **ICD-9-CM**, **ICD-10-CM/ICD-10-PCS**: International Classification of Diseases
- **CPT-4**: Current Procedural Terminology (AMA)
- **HL7 Vocabulary domains** (messaging, documents, services)

Practical applications

Examples from Partners HealthCare:
(1) Problem Lists; (2) Bedside Documentation

Local curation and management

1ˢᵗ Example: Problem List

- Management of **patient-specific problems** (as a list):
  - All active (and inactive) problems associated with a patient
  - Detailed "provenance" (source, onset, changes, status, etc.)
  - Associate problems with encounters, orders, medications, notes, etc.
  - Order (filter) the problem list
- Problems correspond to chronic conditions, diagnoses, symptoms, functional limitations, and visit-specific conditions
  - Managed over time (e.g., single visit, life of a patient)
  - Documentation of historical information
  - Tracking the changing character of problems and their priority
- **Multiple disciplines** can contribute to the problem list

Adapted from HL7 Electronic Health Record - System Functional Model, Release 1 February 2007; Chapter Three: Direct Care Functions.

Problem List @ Partners (1)

	Problem Description	Additional Details
☐	ⓘ Depression	**Type:** Acute **Severity:** Major **Condition:** Worse **Comments:** no changes pt still depressed... 📝📄
☐	ⓘ Brain cancer	**Comments:** inoperable
☐	ⓘ Diabetes mellitus ⓘ	
☐	ⓘ Hypertension	**Onset:** 04/04/2011 **Comments:** must reduce their stress an...
☐	ⓘ R/O Depression	**Type:** Chronic **Onset:** 11/30/2007
☐	ⓘ Asthma	**Type:** Acute **Onset:** 09/11/2001 **Comments:** updating a problem that was...
☐	ⓘ PR Foot pain	**Type:** Acute **Severity:** Minor **Condition:** Unchanged **Location:** Right **Onset:** 03/02/2011 **Comments:** hurts
☐	ⓘ Appendectomy	
☐	ⓘ F/H Dyspnea	
☐	ⓘ H/O Bulimia nervosa	**Type:** Chronic **Severity:** Minor **Onset:** 02/16/2011 **Resolution:** 05/09/2011 **Comments:** stress of high school
☐	ⓘ H/O Verruca plantaris	**Onset:** 07/07/2010
☐	ⓘ Glaucoma	
☐	ⓘ RSK Melanocytic nevus of skin	**Onset:** 04/05/2011
☐	ⓘ RSK Arteriosclerotic vascular disease	**Onset:** 06/15/2011

Test,A A   PG

4223068 (MGH)   05/12/1967 (44 yrs.) M

Home | Select | Desktop | Pt Chart: Problems | Oncology | Custom | Reports | Admin | Sign | Results | ? | Resource

Active Problems (23)   Inactive Problems (7)   Procedures (4)   All   Practice   My

Add New | Favorites | Re-order Problems | Inactivate | Switch to Fam Hx

Problem List @ Partners (2)

1

Problem: pain

Lookup   Favorites   Cancel

2

Favorites: Term
H/O ankle pain
Results: Term
ⓘ Pain
ⓘ Abdominal pain
ⓘ Knee pain
ⓘ Chest pain
ⓘ Neck pain
ⓘ Shoulder pain
ⓘ Joint pain
ⓘ Foot pain
ⓘ Ankle pain
ⓘ Muscle pain
ⓘ Flank pain
ⓘ Musculoskeletal pain
ⓘ Hip pain

3

ⓘ Problem: Chest pain

Modifier:
Type:
Severity: Family History of
Conditions: History of
Location: Probable
                   Risk of
                   Rule out
                   Question of
                   Status Post
Comment: Negative Family History
                   Negative History of

Onset Date: T [   ] ↕ ↕↕ Resolution Date: T [   ] ↕ ↕↕

Add to Favorites for: ☐ My List ☐ Practice

CIRD
Clinical Informatics
Research & Development

Problem List @ Partners (3)

1

Problem: ketogenic

Lookup   Favorites   Cancel

Select a term or synonym. To append text to the problem name, enter text in "Customizable Description" before selecting the term

Results: Term	Synonym
No Match Found. Take as typed or choose another Problem.	
ketogenic [Uncoded problem - will NOT be used for clinical decision support]	

2

Windows Internet Explorer

You have selected an uncoded problem.
An uncoded item is NOT recommended and will NOT be used for:
- Clinical Decision Support
- Reporting
- Performance Measurements
Select OK to proceed with the uncoded item. Select CANCEL to go back to the search results and select a coded item.

OK   Cancel

3

☐	Problem Description
N ⓘ	Ketogenic [uncoded]

Problem list concepts @ Partners

- Initial phase (+1,200 terms)
  - Controlled (limited) list of terms developed by Partners
  - Physician-centered
  - Limited synonyms; no classification or editorial policy
- Current phase (+1,600 concepts)
  - Terms have been mapped to **SNOMED CT** concepts
  - Additional synonyms
  - Concepts manually aggregated into reusable clinical states (classification subsets)
  - Evolving editorial policy (concept granularity)
- Ongoing **expansion** – **multidisciplinary** (currently +3,500 concepts)

Adoption of SNOMED CT

- Local terms were manually mapped to SNOMED CT
  - Based on the "VA/KP Problem Lists subset"
    - Almost all successfully mapped – few 'local' concepts remain
  - Local identifiers were preserved for backwards compatibility
  - Ongoing **maintenance** with semi-annual SNOMED updates
  - Extensive use of the SNOMED hierarchies to create **classification subsets** used in decision support rules

Examples of Problem concepts

- Chronic Renal Dysfunction
  - Chronic renal failure syndrome
- Nephropathy
  - Kidney disease
- Cardiac bypass graft surgery
  - Coronary artery bypass graft
- Coronary artery disease
  - Coronary arteriosclerosis
- Diabetes mellitus
  - Diabetes mellitus
- Diabetes of pregnancy
  - Gestational diabetes mellitus
- G6PD deficiency
  - Deficiency of glucose-6-phosphate dehydrogenase
- Low platelets
  - Thrombocytopenic disorder

- Bright red blood per rectum
  - Hematochezia
- Lower GI bleeding
  - Lower gastrointestinal hemorrhage
- Unspecified GI bleed
  - Gastrointestinal hemorrhage
- Hypotension
  - Low blood pressure
- Peptic ulcer disease
  - Peptic ulcer
- Angioplasty
  - Percutaneous transluminal coronary angioplasty
- Pregnancy
  - Patient currently pregnant
- Unwanted fertility
  - Unplanned pregnancy

Classification subsets

- Grouping and filtering concepts (not in use)
  - User-interface, reporting and analytics
- Clinical **decision support rules**
  - Enable simple inferences that decrease the complexity of rules (maintenance)
- **Difficult** to create and maintain without more formal semantic representation
  - SNOMED hierarchies provide a starting point
  - Frequently require validation (local relevance)
- Ideally maintained at a national (international) level to ensure **shared understanding**
  - Collaborative development and maintenance

Management of subsets @ Partners

Management of subsets @ Partners

Benefits of SNOMED CT

- Detailed representation of clinical problems
  - **Consistent** set of concepts (enterprise view)
  - **Compositional** and fine-grained
- Broad **coverage** of clinical domains
- Improved term search (hierarchical views)
- Rich set of **relationships**: inference
- Active **maintenance** by international organization
- Mappings to billing classifications (ICD-9/10)

Implementation challenges

- Difficult reconciliation with pre-existing terms
  - Local ambiguity, redundancy, length restrictions
- Legacy codes 'hard-coded' into applications and decision support rules
  - Recently able to discontinue the generation of legacy identifiers
- SNOMED limitations
  - Terms are frequently not clinician-friendly
  - Inconsistencies caused by conflicting intents (over time)
  - Ongoing changes compromise stability (early adoption)
  - Lack of reference implementations (best practices)

CIRD
Clinical Informatics
Research & Development

Capturing relevant clinical details

- ## Problem concept
  - ## [Location]
    - Body site, Laterality, …
  - ## [Etiology]
  - ## [Severity]
  - ## [Chronicity]
  - ## […]
  - ## [*Modifiers*]
    - History of, Family History of, Probable, Risk of, Rule out, Question of, Status Post, Negative Family History, …

- What is **displayed** to the clinician (or patient)?
  - Simple keyword search that returns a list to terms
  - Form with multiple fields (multiple searches)
- What is **stored** in the patient problem list?
  - Single code representing a pre-coordinated concept
  - Multiple codes representing a concept expression
- Current **limitations:**
  - Clinical systems (free text?)
  - Clinical ontologies

Problem List information models
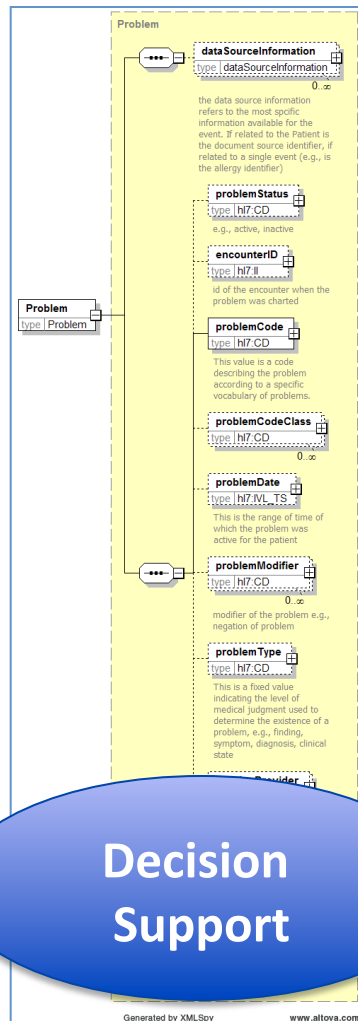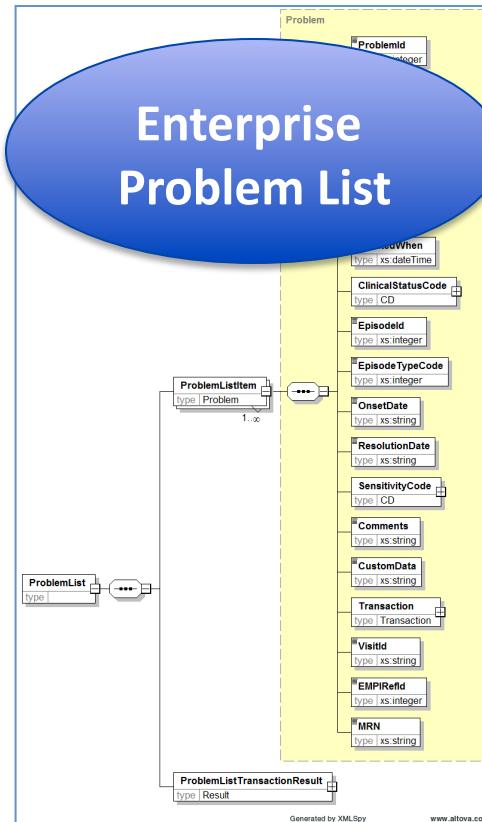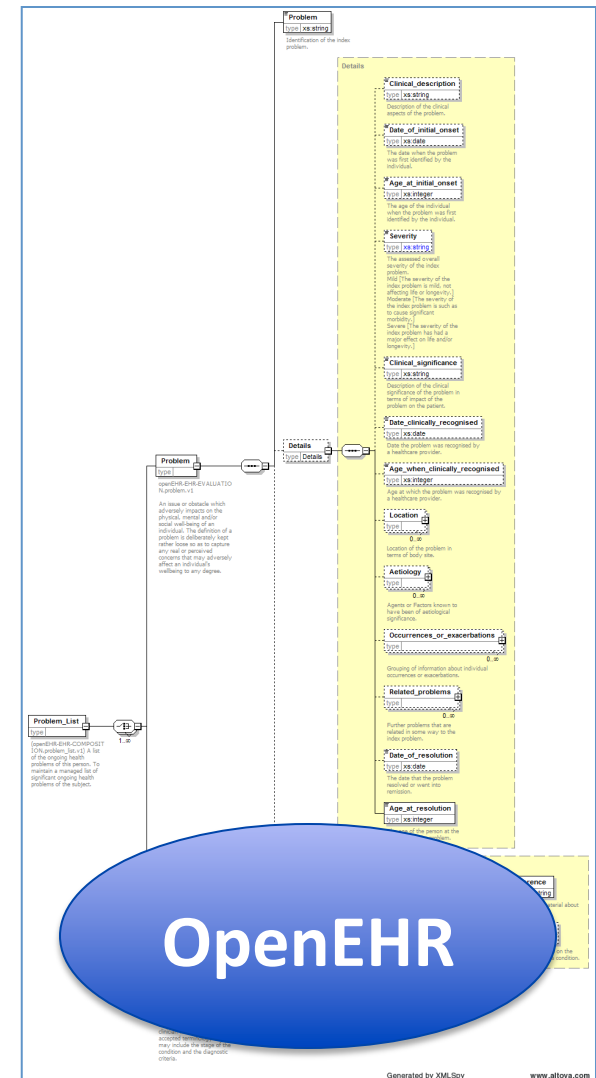
Alignment of Clinical Ontologies with models used by Clinical Systems is critical!

2nd Example: Bedside documentation

- Documentation of Care, Measurements and Results
  - Manage clinical **measurements**: document and annotate measurements of physiologic parameters and clinical conditions (e.g., vital signs, height, weight, I&O, pain severity, size of wound, etc.)
  - Manage clinical **documents** and **notes**: create, modify, and sign *unstructured* (narrative) and *structured* (templates with coded fields) documents and notes, including details about exams and procedures, assessments, and patient-specific care plans and instructions
  - **Medication** administration: list of medications (including vaccines) to be administered and administration details
  - Manage **results**: review, annotate, and communicate test results from ancillary departments or performed at the bedside

- **Multiple disciplines** contribute to bedside documentation
  - Large variety of clinical details typically represented in **narrative form**

Adapted from HL7 Electronic Health Record - System Functional Model, Release 1 February 2007; Chapter Three: Direct Care Functions.

CIRD
Clinical Informatics
Research & Development

Bedside documentation @ Partners

Initial Nursing Assessment — Attending (07/19/2011 11:41 AM)

☐ Show sessions log ⏪ ◀ ▣ 07/19/2011 11:22 AM (Saved at : 07/19/2011 11:40 AM) By : ▼ ▶ ⏩ ▤

☐ Include error sessions 🕐 07/19/2011 11:22 AM ▲ ▼ Refresh

| Patient Profile | Health Management | Health Screening | Advance Directive | Belongings | Psychosocial | Spiritual Cultural | Teaching | Sexual Reproductive | Problem List | Incomplete Assessment |

Patient Information

Information source   Son-Michael

Preferred language   Spanish ▼ 🔍

Other

Preferred name   Steven

Interpreter source

- ◉ Hospital interpreter
- ○ Telephonic service

Other

Cognitive/Perceptual

Sensory aides

- ☑ Contact lenses
- ☑ Eye glasses
- ☑ Hearing aides

Other
phone amplifier

Memory deficit

- ☑ Appointments
- ☑ Completing tasks
- ☑ Dates
- ☑ Directions
- ☑ Medication
- ☑ Times

Orient to room

| Parameter viewer | Sign | Preview note | Mark as error | | Save and Close |

CIRD
Clinical Informatics
Research & Development

Bedside documentation process

- **Concurrent** authoring for multiple disciplines
  - Overlap? Multiple ways to capture the same data?

- Multiple **restrictions** imposed by the documentation system
  - Very limited support for synonyms and reference clinical ontologies
  - Prevalence of pre-coordinated concepts (clinician-friendly)
  - Underlying information models not explicitly defined (no reuse)
    - Relations between data elements exist within data entry template (UI)
    - Context largely defined by data entry template (UI)

- Lack of **reference models** to inform what should be captured in coded format
  - Significant portions captured as free text within discrete fields
  - Compromises reporting and computerized decision support

- Alignment with reference standards **after** content is defined
  - Limited expertise to search and use reference clinical ontologies

Content definition

- **Iteratively** define content with stakeholders
  - Start with existing paper & electronic forms
  - Define what will be documented and how, including:
    - Coded elements and their respective values
    - Formulas and calculations
    - Sequencing and disposition of elements
    - Required vs. optional elements
  - (*Crosswalk with previously defined content - as needed*)
  - Iterate until reach consensus

Examples of Documentation concepts

- Easy Bruising
- Change in appetite
- Difficulty in Walking
- Heart Murmur
- Hearing Loss
- Ambulating
- Depressed
- Constipation
- Stool Consistency

- Reflexes: Babinski, right
- Motor strength: elbow extension, right
- Nephrostomy tube (right) insertion site
- Head of bed elevation
- Polyuria or polydipsia
- Rash/pruritus
- Redness
- Tolerating orals

Data types: true/false, free text, numeric, enumerated, etc.

Content modeling

- Extract **data elements** & **data values** from approved content
  - Name data elements using defined naming conventions
    - Preserve clinician-friendly labels
  - Classify data elements using defined categories (strict assignments)
  - **Index** (tag) data elements using applicable reference clinical ontologies: SNOMED, LOINC, ICNP, … (enable subsequent retrieval)
  - **Map** coded data values to applicable reference clinical ontologies
  - (*Additional crosswalk with previously defined data elements – as needed*)
  - Iterate until all data elements and values are properly defined
- Update (import) data elements within documentation system
  - Current phase of content development: **+6,500 data elements**

Data Element: numeric measurement with unit

Birth Weight: <number><units>

Topic

LOINC
8339-4: Body weight^at birth
Mass; Pt; ^Patient; Qn; Measured

Value set

SNOMED CT (or UCUM)
258681007: Units of mass (SI)

Value
(concept)

Linking to reference clinical ontologies

SNOMED CT
258682000: gram, g
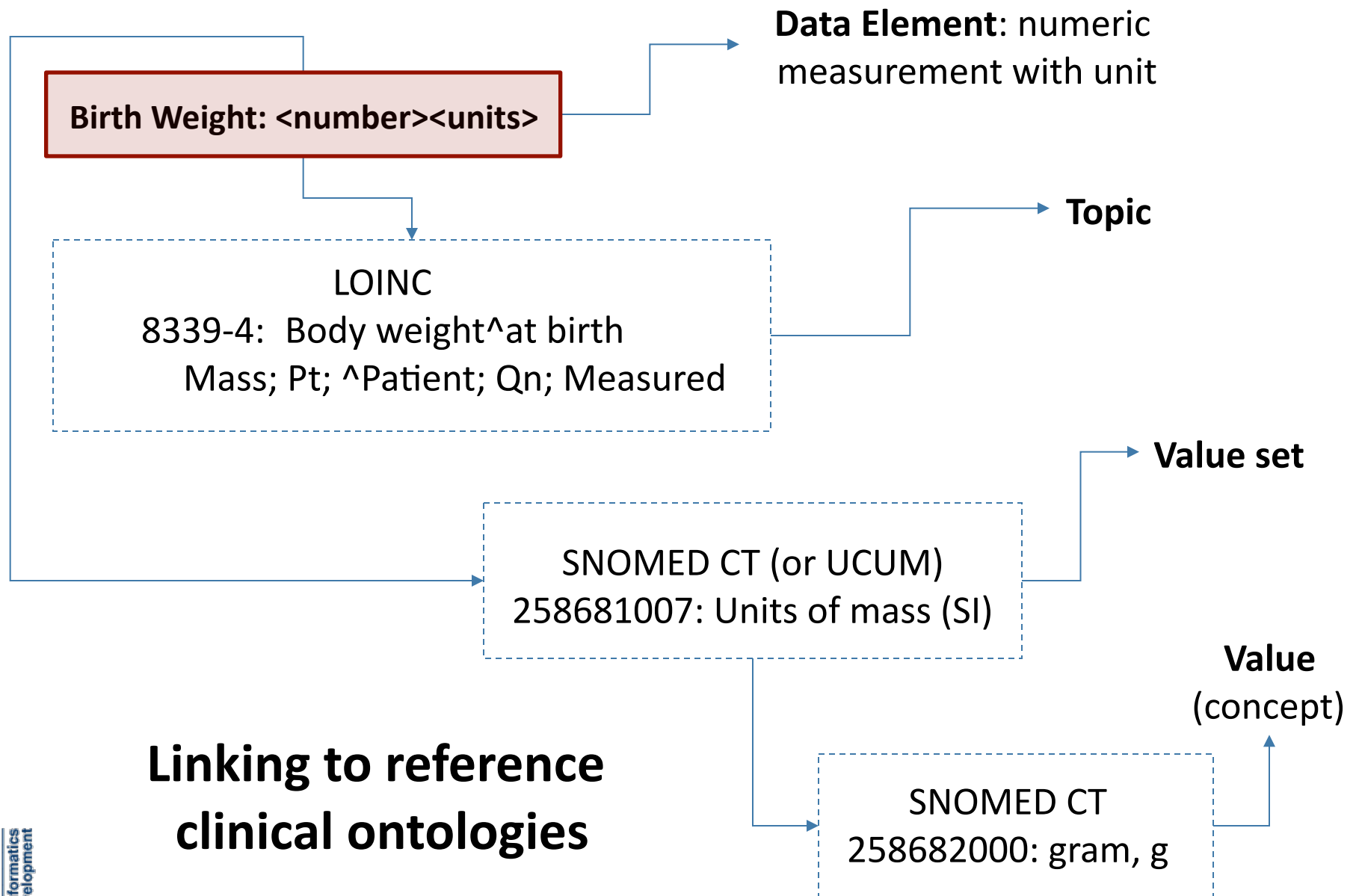
Indexing & Mapping sources

- LOINC
  - Data elements (1st choice)
  - Documents and notes (1st choice)
- SNOMED CT
  - Data values (1st choice)
  - Data elements (2nd choice)
- ICNP
  - Nursing problems, outcomes, interventions
- Others (Nutrition)

Benefits of Indexing and Mappings

- Availability of structured and coded data
  - **Consistency** across sites and disciplines
  - Identify (prevent) data **redundancy** (streamline workflow)
  - External **confirmation** that data content is relevant
  - Simplify data **reporting** (across clinical systems)
  - Enables advanced computerized **decision support**
  - Quality of the resulting clinical data (**analysis** & **research**)
- Compliance with efforts to promote interoperability
  - Data exchange and reporting
  - Import (adopt) templates and forms developed by others
- Contribute to the development and improvement of existing clinical ontologies

Terminology teams @ Partners

- Terminology engineers (4.0 FTE)
- Clinical Informaticians (2.6 FTE)
- Subject Matter Experts (domain specific)

- Software engineers (3.0 FTE)
- Project Manager (1.5 FTE)

Clinical Ontologies: advantages (1)

- Provide guidance (basis) for:
  - Concepts
  - Synonyms & Codes ('Designations')
  - Hierarchies & Classes
  - Mappings & Decompositions
  - Translations to other languages
- Required platform for data & knowledge **interoperability**

Clinical Ontologies: advantages (2)

- Contribute computable underpinnings for content **maintenance**
  - Advanced inference leveraging logic-based knowledge (e.g., SNOMED CT)
- Reduce local maintenance burden
  - Assuming **compatible** rate of change

Clinical Ontologies: limitations

- Must support local **customizations**
  - Concepts, designations, additional relationships
- Must accommodate **changes**
  - Reconcile concepts added locally with eventual availability in reference clinical ontologies
  - Reference clinical ontologies might evolve at incompatible speeds (too fast/slow)
- Must support concepts composed from **different sources**
  - Most clinical systems require concurrent/integrated use of multiple reference clinical ontologies

Core Principle @ Partners

- <u>All</u> reference clinical ontologies (e.g., LOINC, SNOMED, FDB, RxNorm, etc.) will be used by clinical systems through **local Partners concepts**

  - Concepts used by clinical systems and knowledge content are **always** local Partners concepts
  - Local concepts can be **mapped** to reference concepts in clinical ontologies

Core Principle: Motivation

- Local concepts will be created for all domains
  - Overcome **content coverage limitations** of clinical ontologies
  - Support research activities that require highly specialized content
  - Commitment to **submit** local extensions to organizations maintaining the reference clinical ontologies
- Local concepts will be **customized** as needed
  - Including 'granularity', designations, and associations
  - Consistent metadata and lifecycle management (unified *metamodel)*
- Local concepts will have stable **identifiers**
  - Internally defined and long-lived
  - Appropriate versioning and mappings to/from reference concepts
- Mappings to external concepts will occur as needed (**parsimonious**)
  - Enable resolution of overlapping content from different clinical ontologies
- Curation will follow KM lifecycle and collaboration best practices

CIRD

Clinical Informatics
Research & Development

Core Principle: Challenges

- Local and reference concepts must be complementary
  - Adopt **semantic technologies** for effective maintenance and inference
  - Manage local extensions, restrictions, and replacements (overrides)
  - No intent to replicate all reference designations and associations
- Adoption of compositional **identifiers**
  - Support for versioning and namespaces
  - Consistent with other knowledge assets (e.g., models, templates, rules, etc.)
- Mechanism to identify specific designations and associations
  - Proper support for classification (grouping) and contextual constraints

- Long-term **stability** and overall **consistency** outweigh maintenance
  - Recognize that local ontology maintenance 'never ends'
  - Knowledge maintenance and software maintenance will be streamlined, while enabling interoperability and extensibility (innovation)

Next generation of clinical systems

Meaningful use

"Medical Home"

Continuous learning

Meaningful use of EHRs

- Universal use of EHRs by 2014

- Transformation of the healthcare system – improvements to outcomes and efficiency

- Requires "**meaningful use**" of EHRs, not just installation of the software

  – Incentive payments totaling up to $27 billion over 10 years

  – As much as $44,000 (through Medicare) and $63,750 (through Medicaid) per clinician

  – Incentives encourage early adoption; no incentives after 2014; Penalties begin in 2015

Blumenthal D, Tavenner M. The "meaningful use" regulation for electronic health records. N Engl J Med. 2010 Aug 5;363(6):501-4.

CIRD
Clinical Informatics Research & Development

Meaningful use components

- Use of a certified EHR in a **meaningful manner**, such as e-prescribing

- Use of certified EHR technology for **electronic exchange of health information** to improve quality of health care

- Use of certified EHR technology to **submit clinical quality** and other measures

https://www.cms.gov/EHRIncentivePrograms/30_Meaningful_Use.asp

MU <u>Stage 1</u> and Clinical Ontologies

- Problems: **ICD-9-CM** or **SNOMED CT**

- Procedures: **ICD-9-CM** (volume 3), Health Care Financing Administration Common Procedure Coding System (**HCPCS**), **CPT-4**

- Laboratory test results: **LOINC**

- Medications: **RxNorm**, or any source vocabulary that is included in RxNorm

- Immunizations: **CVX**

- Race and Ethnicity: OMB Directive No. 15

- HL7 Continuity of Care Document (**CCD**) & Messages

Meaningful Use stages

Improved
outcomes

Advanced
clinical
processes

Data capture
and sharing
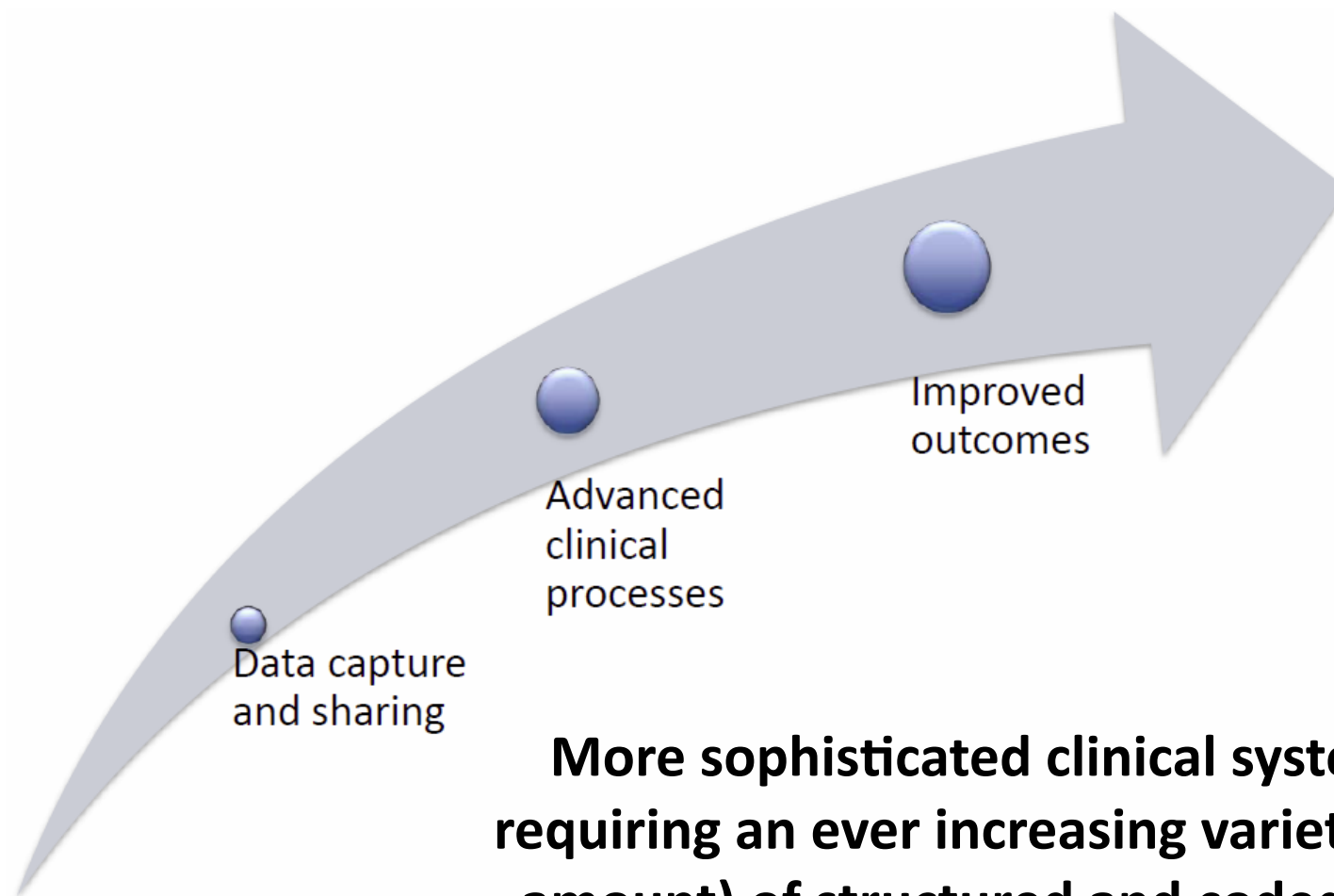
More sophisticated clinical systems, requiring an ever increasing variety (and amount) of structured and coded data

CIRD
Clinical Informatics
Research & Development

Patient-centered medical homes

- "… highly **integrated**, team-based practices that promote **patient centered** care through routine patient feedback and better access … also promote improved clinical quality and efficiency through **increased care coordination.**"

- Critical improvements in EHRs:
  - **Clinical decision support**, **registries**, team care, **care transitions**, **personal health records**, telehealth technologies, and measurement

- **Information exchange** with integration of inpatient and outpatient EHRs

- **More data** on the aggregate and individual patient/ provider level

Bates DW and Bitton A. The Future Of Health Information Technology In The Patient-Centered Medical Home. Health Affairs 29(4):614–621, 2010.

COSTS

The right care • For the right price • Efficiently delivered

OUTCOMES

Lives saved • Health gained • People satisfied

SCIENCE-DRIVEN HEALTH CARE

By 2020, ninety percent of clinical decisions will be supported by accurate, timely, and up-to-date clinical information, and will reflect the best available evidence and informed personal preference.

COLLABORATIVE ACTION

Best Practices
Innovation Collaborative

Value Incentives Learning Collaborative

Evidence Communication
Innovation Collaborative

Clinical Effectiveness Research
Innovation Collaborative

Electronic Health Record
Innovation Collaborative
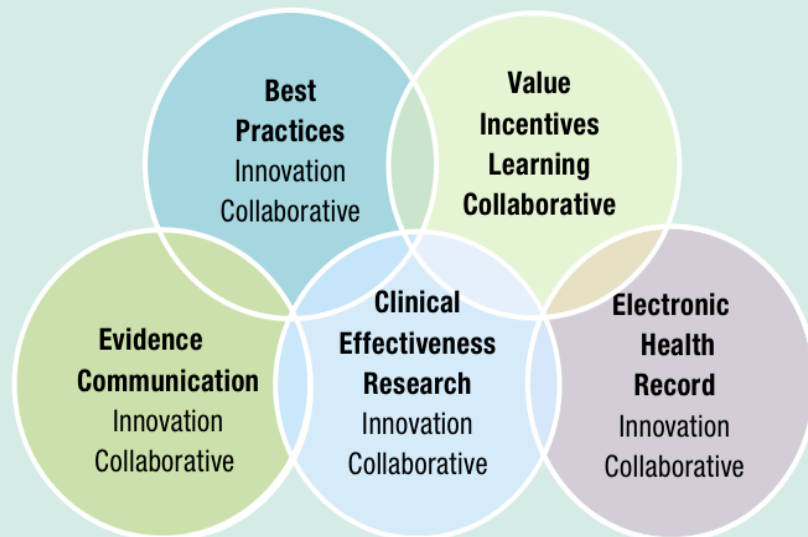
ONC & IOM: Emphasis now on the "**Electronic infrastructure** for continuous learning and quality-driven health and health care programs."

THE LEARNING HEALTHCARE SYSTEM

Conclusions

Challenges & Opportunities

Opportunities

- Government providing **exceptional incentives** for Healthcare IT adoption
  - IT identified as a key enabler of a more effective healthcare system
- Proposed healthcare delivery models require high levels of **integration** within and across institutions
  - Moving towards **seamless collaboration** where patients are active contributors
- Opportunity for a **new generation of clinical systems** beyond efficient record storage and communication
  - New paradigm with **pervasive** computerized data **analysis** and **decision support**
  - Widespread use of interoperable services and data, with advanced functions that enable **team-based care**

Challenges

- Cost-effective **semantic interoperability**
  - Existing standards make data exchange possible, but not simple or efficient (projects take months or years)
  - Data exchanged in a structured and coded format still represents a small portion of the electronic record
- Clinical systems that can seamlessly represent and process a **complete electronic patient care record**
  - Current systems frequently rely on legacy data architectures that limit the use of clinical ontologies
  - Slow adoption of technologies that can help overcome the current data representation limitations
- Clinical ontologies with proper **domain coverage** and **extensibility**
  - Existing methods and tools to use clinical ontologies are not accessible to typical clinicians

Acknowledgements

Blackford Middleton

Tonya Hongsermeier

Howard Goldberg

Beatriz Rocha

KM Team (terminology) @ Partners

Stanley Huff (Intermountain, U of Utah)

Terminology Team @ Intermountain

Thank you!

Roberto A. Rocha, MD, PhD

rarocha@partners.org