SNOMED CT Adoption: Lessons and Challenges

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KR-MED 2008
• SNOMED CT *ought* to play an integral role in the semantically-enabled Healthcare Enterprise.

— How did we get here?
— What is Partners Healthcare doing with SNOMED CT?
— What are some of the challenges facing wide-scale adoption of SNOMED CT?
Origins of SNOMED CT
Origins Of SNOMED CT Formalisms

• Semantic networks, Frames, FOPL
  ─ Arbitrary semantics
  ─ Unknown complexity

• Description Logics
  ─ Subset of FOL
  ─ Well-defined semantics
  ─ Inferencing should be sound, complete, efficient
Origins of SNOMED CT
Description Logics

• KL-One: Brachman @ BBN
• Descendants:
  — NIKL (BBN successor to KL-One)
  — CLASSIC (Bell Laboratories)
  — K-REP (IBM)
  — LOOM (USC)
Origins of SNOMED CT
Expressivity Versus Tractability

• Haimowitz, Patil, Szolovits: ‘Representing Medical Knowledge in a Terminological Language is Difficult’ (1988)

• Principles
  — Knowledge should have similar structure to domain
  — Separate definitions from assertions
  — Modularize knowledge

• Barriers
  — Limited representation constructs
  — No assertional knowledge (only definitions)
  — Overload constructs in order to encode assertions

• ‘... we must emasculate the expressiveness of languages while retaining soundness and completeness in order to gain control over the inefficiency of their inferences . . . ’
Origins of SNOMED CT

Galen Experience

• GALEN/Grail—Rector, University of Manchester
  — Compositional vs enumerative
  — Language and Application independence
  — Concepts with Formal Properties
  — Related to Description Logics
• Successful demonstrations
  — Idioms for EHR
  — Knowledge-driven Documentation
  — Terminology Server
  — Natural Language Generation
  — Knowledge Mediation/Retrieval (Tambis)
Origins of SNOMED CT
Galen Experience

• Barriers to Dissemination
  — Conceptual
    • Modeling is hard
  — Technical
    • Inefficient classification algorithms
  — Cultural
    • Proprietary meta-terminology
Origins of SNOMED CT
Post-Galen

• Galen—What we want to say
• Can we express with ‘standard’ semantics
• Community
  — Deep understanding of complexity
  — Isolate barriers to expressivity
• Horrocks
  — Efficient algorithms for expressive DL’s
  — RDF-based languages grounded on DL’s
  — Commercial quality DL
Origins of SNOMED CT
K-REP

• Mays et al, IBM Watson Lab
• Started life as system configurator
• Supported KRSS semantics
• Role in healthcare?
  — Drug classes AHFS
  — Organizing CPMC MED
  — Terminology Maintenance
• Onyx $\rightarrow$ Apelon
Origins of SNOMED CT

UMLS

• Metathesaurus—Terminology cross-reference
• Dataset + Semantic Network + Lexical Tools
• Aggregating terminologies
  — String Matching
  — Manual Review
• Limited Machine Readability
  — Inconsistent ‘lumping’ and ‘splitting’
  — Inconsistent classification
  — Cycles
Origins of SNOMED CT

LTI

• Blois, Tuttle, Sheretz
• UMLS Maintenance Contract
• Importance of syntactic manipulation in terminology maintenance
• Metaphrase
  — Authoring / Runtime services
  — BIDMC, Mayo, BJC
• → Apelon
Origins of SNOMED CT
Formalisms in Informatics

• The “Canon” Group – JAMIA May/June 1994
• A common, uniform, and comprehensive approach to the representation of medical information
  — Current encodings are inadequate
  — Representation as concepts
  — Methodology
  — Empiric Evaluation
  — Completeness
  — Interdisciplinary
  — Realistic
Galapagos—The Maintenance Problem—Campbell et al.

- Support evolutionary design—accumulate and reconcile large number of changes
- Local update penalty—most changes incur most pain
- Galapagos
  — Style Guide!!
  — Aristotelian Classification via classifier
  — Automated conflict detection
  — Configuration management
Scaling to Large Terminologies

SNOMED Phases

- 1975-1994 Roger Cote phase
- 1995-1997 Kaiser CMT phase
- 1997-1999 CAP phase – building SNOMED RT
- 1999-2002 SNOMED – Read merge phase
- 2002-2004 US/UK endorsement phase
- 2004- adoption, use & maintenance phase

Number of Concept Codes

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<thead>
<tr>
<th>Edition of SNOMED</th>
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Origins of SNOMED CT

- SNOMED CT—
  - Great medical informatics
  - Great informatics research
  - Fusion of community around converging lines of research
Terminology Services at Partners Healthcare System
High Performance Medicine

• Infrastructure
  — EHR adoption
  — Enterprise clinical service creation and integration
• Patient safety
• Quality of care delivery
• Efficient care delivery wrt clinical staff
• Service Organization
High Performance Medicine Execution Platform

- Reduce unacceptable variance in care delivery
  - Standardize care
  - Allow acceptable variation
- Proactively detect and remediate ‘defects in care’
  - Critique and monitor care plans
  - Execute care plan by system, not individuals
  - Personalize care plans just-in-time
- Provide aggregate outcomes feedback to the point-of-care
- Enable semantic interoperability
  - Clinicians
  - Systems
Common Clinical Systems Through Common Services

- Unified underpinnings for all PHS systems:
  - Common Terminologies
  - Common Data
    - Meds, allergies, problems, observations
  - Common Reference Dictionaries
    - Observables, orderables
  - Common Reference Knowledge
  - Common Decision Support
  - Common Events
Terminology Services at PHS

- PHS seeks to collect highly-detailed clinical descriptions that can be used for
  - clinical documentation
    - Problem lists
    - Clinical notes
  - decision support
    - Point-of-care
    - Proactive surveillance
  - data warehousing
    - Aggregate reporting
    - Plan-of-care analysis
Why Terminology?

- EHR
- Data Warehousing
- Clinical Decision Support
- Terminology
Terminology Services Enable Semantic Interoperability

- **Shared**
  - Reference set of symbols
  - Interrelationships
  - Meta-model
- **Clinical**
  - Content standards for clinical terminologies
  - Enforce standards for describing clinical entities
- **System**
  - Common definitions
  - Common asserted knowledge
PHS Initiatives

- Reference terminology services
  - Lookups
  - Classification
    - Subsets
    - Hierarchical
  - Crosswalks
  - Post-coordination
  - Navigation
PHS Initiatives

• Enterprise clinical rules service
  — Clinical state model
    • Normalization of problem list data
    • ‘Complex definitions’ incorporate obs data

• Enterprise patient problem repository
  — Snomed-CT enabled
  — One patient, one list
  — Multi-disciplinary usage

• Order template mapping
Enterprise Problem List Repository
Episodes and Concerns
Lessons Learned
Retro-fitting is hard

• Ambulatory Medical Record (LMR)
  — Bolted to Partners Problem Dictionary
    • Proprietary list and identifiers
    • Flat
  — Intolerant of multiple inheritance
  — Custom, hard-wired classification
  — Other unknown Easter egg functionality
  — Brittle decision support dependencies
• How to avoid false negative DS
Lessons Learned
Backward Compatibility

PPL

Cerebrovascular Dz
PPLID 829

SCT

Mapped PPLID 829
Most Specific PPLID 829

PPL

Dementia
PPLID 99

SCT

Mapped PPLID 99
Most Specific PPLID 99

SCT

Multi-Infarct Dementia
Mapped PPLID [99,829]
Most Specific PPLID ??
Lessons Learned
Keeping up with change

• SNOMED continues to evolve rapidly
  — Remodeling
  — Hierarchy changes
  — New modeling idioms
  — Retirement
• Vigorous maintenance program
  — Scrutinize changes to DS triggers
  — Remove retired concepts from lookups
  — Freshen subsets
• Content set must be manageable
• Tools, scripts, etc.
• Adequate capacity for clinical review
Lessons Learned
“On the road . . .”

• Introduce 1:1 Lookup Service
  — Maintain local identifiers for backward compatibility
• Remediate code to be PPL-independent
  — Externalize classification
  — Externalize decision support
• Target VA-Kaiser subset
  — Order of magnitude expansion
  — Participate in content expansion
Challenges in SNOMED Adoption
Challenges in SNOMED Adoption—Domain Perspective

• SNOMED retains a pathologic perspective versus clinical perspective
  — Generally reasonable as source of truth
  — Complicated if target is EMR use
    • Peripheral Arterial Disease (vs PVD)
    • Cerebrovascular Disease
  — Need to support clinical perspective if expect use in the clinical domain
Challenges in SNOMED Adoption—
Modularity / Competing Uses

• Cluttering of terminology space in support of multiple uses
  — Pre-coordinated terms for anatomic localization of tumors in breast and lung cancer
  — Pathologists versus clinicians
• Strong need for standard subset comprising unique disease entities
  — Utility of similar subsets to Kaiser-VA subset
  — Lack of unencumbered content set limits introduction of large swaths of SNOMED
Challenges in SNOMED Adoption—Specialist Society Coordination

- Disease classification drives evidence-based medicine!
- Lag between specialty-sanctioned terminology and appearance in SNOMED
  - 1999 WHO Lung Tumor Classification
  - K/DOQI guidelines for chronic kidney disease
- Clinician expectation for up-to-date, specialty-sanctioned terminology
Challenges in SNOMED Adoption—Applying Micro-models

- Limited documentation of micromodels for post-coordination
- Inconsistent completion of attributes
  - Abnormal lab values
    - Elevated CPK declined as pre-coordinated term
    - ‘Leukocytosis’ versus low serum potassium measurement—missing attributes
Challenges in SNOMED Adoption—Change Management

- SNOMED continues to change at a rapid pace
  - Content
  - Micro-models
  - Hierarchy Changes
- Change management is greatest barrier to adoption
  - Large effort where adoption has required mapping to legacy
Challenges in SNOMED Adoption—Decision Support

- Classification drives decision support!
- SNOMED hierarchies insufficient for production-quality decision support
- Goal—International standard subsets based on SNOMED hierarchies
  — Validated by a sanctioned committee
  — Change-resistant
  — Collaboration infrastructure supports scaling
Challenges in SNOMED

Conclusions

• At the beginning of a long journey . . .
• Institutional and vendor adoption help shape and define roadmap
• Add value to clinical process
  — Relevant to EHR
  — Relevant to evidence-based practice
  — Relevant to decision support
• Practical demonstrations of feature set
• Considerate change management
• Continue to leverage advances in the KR and DL communities