Information models as a basis for Interoperability

SemTechBiz
June 3-5, 2013

Stanley M Huff, MD
Chief Medical Informatics Officer
Core Assumptions

‘The complexity of modern medicine exceeds the inherent limitations of the unaided human mind.’

~ David M. Eddy, MD, Ph.D.

‘... man is not perfectible. There are limits to man’s capabilities as an information processor that assure the occurrence of random errors in his activities.’

~ Clement J. McDonald, MD
Intermountain can only provide the highest quality, lowest cost health care with the use of advanced clinical decision support systems integrated into frontline workflow.
Decision Support Modules

- Antibiotic Assistant
- Ventilator weaning
- ARDS protocols
- Nosocomial infection monitoring
- MRSA monitoring and control
- Prevention of Deep Venous Thrombosis
- Infectious disease reporting to public health
- Diabetic care
- Pre-op antibiotics
- ICU glucose protocols
- Ventilator disconnect
- Infusion pump errors
- Lab alerts
- Blood ordering
- Order sets
- Patient worksheets
- Post MI discharge meds
Strategic Goals

• **Minimum goal**: Be able to share applications, reports, alerts, protocols, and decision support with ALL customers of our same vendor.

• **Maximum goal**: Be able to share applications, reports, alerts, protocols, and decision support with anyone in the WORLD.
Order Entry API (adapted from Harold Solbrig)

Application

Interface

Service

Data

VA Order Entry

COS

Update Medication Order

Update PharmacyOrder
WHERE orderNumber = "4674" ...

MUMPS Database
Order Entry API: Different Client, Same Service  
(adapted from Harold Solbrig)

Application: Department of Defense
Interface: COS
Service: VA Order Services
Data: MUMPS Database

Update Medication Order
Update PharmacyOrder
WHERE orderNumber = "4674" ...

Different Client, Same Service (adapted from Harold Solbrig)
Order Entry API:
Different Server, Same Client (adapted from Harold Solbrig)

Department of Defense

Update Medication Order

Update PharmacyOrder WHERE orderNumber = “4674” ...

Oracle Tables

GE Repository

GE Services

COS

Service

Interface

Application

Data
Order Entry API (adapted from Harold Solbrig)
What Is Needed to Create a New Paradigm?

• Standard set of detailed clinical data models coupled with…
• Standard coded terminology
• Standard API’s (Application Programmer Interfaces) for healthcare related services
• Open sharing of models, coded terms, and API’s
• Sharing of decision logic and applications
Why do we need detailed clinical models?
A diagram of a simple clinical model

Clinical Element Model for Systolic Blood Pressure

- SystolicBP
  - SystolicBP
  - data: 138 mmHg
  - quals
    - BodyLocation
      - data: Right Arm
    - PatientPosition
      - data: Sitting
Need for a standard model

• A stack of coded items is ambiguous (SNOMED CT)
  – Numbness of right arm and left leg
    • Numbness (44077006)
    • Right (24028007)
    • Arm (40983000)
    • Left (7771000)
    • Leg (30021000)
  – Numbness of left arm and right leg
    • Numbness (44077006)
    • Left (7771000)
    • Arm (40983000)
    • Right (24028007)
    • Leg (30021000)
What if there is no model?

Site #1
Dry Weight: 70 kg

Site #2
Weight: 70 kg
- Dry
- Wet
- Ideal
Too many ways to say the same thing

• A single name/code and value
  – *Dry Weight* is 70 kg

• Combination of two names/codes and values
  – *Weight* is 70 kg
    • *Weight type* is dry
Pre-coordinated representation
<observation>
  <cd>Dry weight  (LOINC 8340-2) </cd>
  <value>70 kg</value>
</observation>

Post-coordinated (compositional) representation
<observation>
  <cd>Weight  (LOINC 3141-9) </cd>
  <qualifier>
    <cd>Weight type (LOINC 8337-8) </cd>
    <value>Dry  (SNOMED CT 13880007) </value>
  </qualifier>
  <value>70 kg</value>
</observation>
How would you calculate the desired weight loss during the hospital stay?

<table>
<thead>
<tr>
<th>Patient Identifier</th>
<th>Date and Time</th>
<th>Observation Type</th>
<th>Observation Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>123456789</td>
<td>7/4/2005</td>
<td>Dry Weight</td>
<td>70</td>
<td>kg</td>
</tr>
<tr>
<td>123456789</td>
<td>7/19/2005</td>
<td>Current Weight</td>
<td>73</td>
<td>kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Identifier</th>
<th>Date and Time</th>
<th>Observation Type</th>
<th>Weight type</th>
<th>Observation Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>123456789</td>
<td>7/4/2005</td>
<td>Weight</td>
<td>Dry</td>
<td>70</td>
<td>kg</td>
</tr>
<tr>
<td>123456789</td>
<td>7/19/2005</td>
<td>Weight</td>
<td>Current</td>
<td>73</td>
<td>kg</td>
</tr>
</tbody>
</table>
More complicated items:

- Signs, symptoms
- Diagnoses
- Problem list
- Family History
- Use of negation – “No Family Hx of Cancer”
- Description of a heart murmur
- Description of breath sounds
  - “Rales in right and left upper lobes”
  - “Rales, rhonchi, and egophony in right lower lobe”
What do we model?

- All data in the patient’s EMR, including:
  - Allergies
  - Problem lists
  - Laboratory results
  - Medication and diagnostic orders
  - Medication administration
  - Physical exam and clinical measurements
  - Signs, symptoms, diagnoses
  - Clinical documents
  - Procedures
  - Family history, medical history and review of symptoms
How are the models used in an EMR?

- Data entry screens, flow sheets, reports, ad hoc queries
  - Basis for application access to clinical data
- Computer-to-Computer Interfaces
  - Creation of maps from departmental/external system models to the standard database model
- Core data storage services
  - Validation of data as it is stored in the database
- Decision logic
  - Basis for referencing data in decision support logic
- Does **not** dictate physical storage strategy
Detailed clinical models and terminology
Model & terminology must be done together

- Terminology models and information models
  - models made by data modelers (message standards)
  - models made by terminology groups (maintenance of terms)

- “Impedance mismatch” arises when one group is making terms and another group is making the model

- Post coordination in a single field in the model is just another style of modeling – it is important to make the semantics explicit
Model Centered Data Representation

Models

Models and Concepts

SNOMED
LOINC
FDB
RxNorm
ICD-10
CPT

SNOMED
LOINC
FDB
RxNorm
ICD-10
CPT

Internal Terminology (ECIDS)

EcIS Thesaurus
Mayo Thesaurus
IH Thesaurus

Context Specific Mapping Tables

LexGrid Terminology Server
We assume that the model is used in association with a terminology server.
If the medicationOrder.drug is_a “antibiotic” then notify the infection control officer.
Concept Semantic Network

Drug

- Antibiotics
  - Penicillins
    - Pen VK
  - Cephalosporins
    - Amoxicillin
  - Aminoglycosides
    - Nafcillin
- Analgesics
- Cardiovascular
<table>
<thead>
<tr>
<th>Drugs</th>
<th>has-child</th>
<th>Antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drugs</td>
<td>has-child</td>
<td>Analgesics</td>
</tr>
<tr>
<td>Drugs</td>
<td>has-child</td>
<td>Cardiovascular</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>has-child</td>
<td>Penicillins</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>has-child</td>
<td>Cephalosporins</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>has-child</td>
<td>Aminoglycosides</td>
</tr>
<tr>
<td>Penicillins</td>
<td>has-child</td>
<td>Pen VK</td>
</tr>
<tr>
<td>Penicillins</td>
<td>has-child</td>
<td>Amoxicillin</td>
</tr>
<tr>
<td>Penicillins</td>
<td>has-child</td>
<td>Nafcillin</td>
</tr>
<tr>
<td>Drugs</td>
<td>has-member</td>
<td>Antibiotics</td>
</tr>
<tr>
<td>Drugs</td>
<td>has-member</td>
<td>Penicillins</td>
</tr>
<tr>
<td>Drugs</td>
<td>has-member</td>
<td>Pen VK</td>
</tr>
<tr>
<td>Drugs</td>
<td>has-member</td>
<td>Amoxicillin</td>
</tr>
<tr>
<td>Drugs</td>
<td>has-member</td>
<td>Nafcillin</td>
</tr>
</tbody>
</table>