Advancing Clinical Decision Support: Initiatives and Implications for Next Generation EHRs

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Acknowledgments

Key project participants

- Davide Sottara, PhD  ASU/Mayo, Scottsdale, AZ
- Peter J. Haug, MD, PhD, Matthew Ebert, BS  Intermountain Healthcare, Salt Lake City, UT

Project original scope included:

- Mary Goldstein, MD, Palo Alto VA
- Samson Tu, PhD, Stanford Univ.
- Emory Fry, MD, US Navy Research Center, San Diego, and then Cognitive Medical Systems, Inc.
- Other participants at Intermountain Health and ASU
The Landscape of CDS

- Much work over a 50-year history
- Large body of evidence of effectiveness
- Yet limited and spotty uptake
- Focus up to a decade ago largely on:
  - Orders, alerts/reminders, doc templates, infobuttons

- Greatly expanding focus now
  - Broader range of CDS potential:
    - Precision medicine, personal sensors, patient self-management, NLP progress, big data/analytics, visualization/cognitive support, app interfaces and CDS as a service
  - Expanded focus on need for CDS:
    - Emphasis on wellness/prevention, pay for value, quality measurement and reporting, meaningful use incentives
To illustrate:

- **CDS: The Road Ahead (2007), 544 pgs**

- **CDS: The Road to Broad Adoption (May 2014), 926 pgs, 8 new chapters**
  - Reflecting growth and broadening of the topic from social, health care finance, legal, organizational, and technical perspectives
Initial issues addressed by project 2B

- Difficulty sharing of CDS knowledge
  - Lack of an interlingua
  - A dialectic: Level of specificity vs. ease of sharing

- Enterprise issues
  - Time-consuming nature of site-specific, workflow-specific adaptation
  - Difficulties managing and updating CDS knowledge artifacts
  - Lack of an “implementation science” – ability to capture and utilize experience of what works and what doesn’t
  - Particular challenges for small practices without IT staff

- Disconnect between artifacts and readability
  - Can UI be created that hides the technical details and facilitates SME viewing – and authoring?
Original Goals of Project 2B

- Create model of how decision rules are adapted to local workflow, setting, and preferences
  - An ontology of Setting–Specific Factors (SSFs)
  - Authoring tools for adaptation process
- Build on abstracted model of rules plus adaptations, as basis for:
  - Sharing
  - Capturing of implementation decisions
  - Framework for knowledge management
- Demonstrate ability to convert to host–specific representation
Revised Goals of Project 2B
(as of July, 2012)

- Tied to initiation of ONC’s Health eDecisions (HeD) Initiative:
  - Part of the ONC’s Standards and Interoperability Framework
    - [http://wiki.siframework.org/Health+eDecisions+Homepage](http://wiki.siframework.org/Health+eDecisions+Homepage)
  - Two main use cases:
    1. CDS Artifact Sharing
      - Computable representations for rules, order sets, and documentation templates
    2. CDS Guidance Service
      - Service model for delivery of CDS
Health eDecisions Homepage

Announcements

- We just finished our HeD Pilots Virtual OPEN HOUSE....A SHOWCASE FOR USE CASE 1 PILOTS!! Take a look at what we have done....
  - [open house_final_v2.pptx](open house_final_v2.pptx)
  - View a recording: [https://vimeo.com/70201880](https://vimeo.com/70201880)
- On June 5 we presented at an AMIA webinar. This presentation included an introduction to the S&I framework as well as a description of our methodology. We also presented a brief history of HeD as well as the work we have done and are continuing to do with Use Case 1, Use Case 2, and our pilots. Thank you to all who contributed! The presentation material can be seen [here](here).
- **Consensus was achieved on the HeD CDS Guidance Service Use Case (Use Case 2) on April 4, 2013!** Congratulations and thank you to everyone who participated in the Use Case development process. To review the implementation guide and consensus statement votes, see the HeD Consensus Page.
- Use Case 1 Pilots has started!! To participate as a pilot for Use Case 1 please complete the Pilots Survey. If you are interested in partnering with another organization be sure to complete the entire survey including the "Areas of Potential Partnership" question.
- We submitted our HL7 Ballot. To see what was submitted see the HL7 Ballot Section of the Reference wiki: [HL7 Ballot](HL7 Ballot)
- The Health eDecisions Schema can be seen [HERE](HERE) (in our HeD Google Code Repository).

Weekly Meetings

<table>
<thead>
<tr>
<th>Mondays</th>
<th>Tuesdays</th>
<th>Wednesdays</th>
<th>Thursdays</th>
</tr>
</thead>
<tbody>
<tr>
<td>HeD UC 1 Pilots meetings are now on Mondays.</td>
<td>HL7 CDS/HeD Joint Meeting</td>
<td>HeD Use Case 2 Standards Sub</td>
<td>All Hands Community Meeting</td>
</tr>
<tr>
<td></td>
<td>HeD Medical 2C2</td>
<td>HeD Use Case 2 Standards Sub</td>
<td>Monday, August 5</td>
</tr>
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<td></td>
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<td>HeD Use Case 2 Standards Sub</td>
<td>Monday, August 5</td>
</tr>
</tbody>
</table>
Our revised goals for Project 2B

1. Create (with HeD working group) a model–based specification for the knowledge artifacts
   ◦ Having an XML specification – as well as a formal model basis
   ◦ To be a standard (balloted by HL7 successfully in Jan 2013, and updates)
   ◦ To be required as an interlingua for knowledge distribution and incorporation in EHRs in MU stage 3 (use case 1)
   ◦ To be used as basis for model for CDS Guidance Service (use case 2)
2. Create a model–driven CDS authoring tool
   ◦ Unified model supporting different views
     • Different levels of abstraction/granularity
     • Views for SME vs. KE vs. technical code–level
   ◦ Reference state–of–the–art data models and terminology systems
   ◦ Convertible to existing CDS languages, data models, and standards
   ◦ Focus on declarative knowledge, not SSF adaptations
3. Explore approaches for ongoing refinement and extension
   ◦ To be distributed as open-source resource
     • Seek to establish user/developer community
   ◦ Extensions for enterprise knowledge management and workflow/setting localization and adaptation
   ◦ Incorporation of QM authoring
   ◦ Possible value to knowledge content vendors
HeD Semantic Model

- Companion to the HeD schema
  - Abstracts the content delivered by the syntax
  - HeD schema available at: https://code.google.com/p/health-e-decisions/
- Defined using a modular OWL ontology
  - Standards-based
  - Set in the context of well-known upper ontologies
  - Mirrors the HeD schema modules
  - Model component subontologies include:
    - metadata, information model, events, expressions, conditions, actions
HeD / model mapping

Upper Ontologies

Knowledge Artifact

- Name, version, publisher, etc.
- Metadata
- Domain (vMR)
- Dublin Core
- External Data

Operations

- Expressions
- Events
- May reference

Actions

- Conditions
  - Conditions under which actions are carried out
- Section 1
  - Behaviors 1..n
  - Title Description
  - Action 1
  - Action 2
  - ...
  - Action N
  - Behaviors 1..n
  - E.g.: Required unless documented

PRR

- Patient’s medical record which may be referenced by expressions and actions
- Named, re-usable expressions
- Corresponds to event in event-condition-action rules

Image taken from HeD Implementation Guide v0.8, available from the HeD google code repository
Model-based editor

First version

- Can edit elements in HeD model
- For rules, order sets, and documentation templates
- (Simplified) meta-data access
- Custom Expressions
- Main logic elements:
  - Triggers
  - Rule-clause types
  - Actions
Rule Logic

Define Rule Logic

Write a logic clause about: search

Select an option below (a new window will open)

- Patient on MEDICATION with DOSAGE
- Patient on MEDICATION

All of the items on the grey area may be dragged in to the canvas on the right.
Remember, you may drop anything in a container (including other containers), but nothing may go inside a clause.
Rule Actions

Choose Actions to be Executed

Begin by choosing an action type from the list below.

- Search
- Alerts
- Send REMINDER to Patient

Available actions on the grey area may be dragged into the canvas on the right.

Perform exactly one
    - Documentation
    - Condition
    - isAllergic

Perform
    - Documentation
    - Condition
    - ProcedureProposal

Create
    - Documentation
    - Condition
    - ActionSentence
    - Reminder

Create
    - Documentation
    - Condition
    - ActionSentence
    - anotherProcedureProposal
SME–oriented editor

- Initiated
  - Will need to be furthered by open source community and other extensions/follow-ons of HeD and project 2B work

- Main features
  - Palettes of primitives and templates for common components
    - Trigger types, action types, expression clause types
  - Can select type of artifact
    - Primitives guide and constrain entries
  - Or can start creating it
    - Wizard recognizes possible primitives intended, enables selection
  - Output in HeD model format, with metatags based on
    - Metadata, problem domain, types and domains of primitives used, workflow (e.g., trigger, actions) choices
  - Use of descriptors that are more user–friendly
    - e.g., “diabetes present” or “HbA1c exceeds threshold” as labels that can be shown rather than formal logic that represents it

- Still to be done
  - Usability design/refinement
  - Evaluation of degree to which implementation detail can be captured without need for KE tweaking
Templates

- Parametric expression templates
  - Derived from HeD templates
  - Extensible collection
Templates
Beyond–SHARP possible directions

- Dependency on creation of demand for interlingua
  - Meaningful Use Stage 3
  - National or commercial best-practice KBs available in this form

- Enterprise needs
  - Knowledge repositories
  - Versioning
  - Independence of vendor (e.g., in multi-vendor settings)
  - Organize by any model components
    - e.g., meta-tags, encounter/setting types, provider types, user types, problem foci, logic clause types/primitives, workflow trigger types, action types

- Development of adapters
  - To EHR rule authoring and execution environments
  - To EHR data models
  - For service-based execution
Other implications of model–based representation of knowledge

- Ability to find all related knowledge for a situation
  - Enables situation–aware, context–aware knowledge access
  - Could lead to new ways of providing guidance
Model-based knowledge repository uses

<table>
<thead>
<tr>
<th>Knowl. Artifact</th>
<th>Problem</th>
<th>Setting</th>
<th>Provider type</th>
<th>Workflow step</th>
<th>Action</th>
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</thead>
<tbody>
<tr>
<td>IF ... THEN ...</td>
<td>XXXXX</td>
<td>YYYY</td>
<td>ZZZZ</td>
<td>N33</td>
<td>ABC</td>
</tr>
<tr>
<td>If ........... THEN ...........</td>
<td>XXXXXX</td>
<td>YYYY</td>
<td>ZZZZ</td>
<td>N27</td>
<td>DEF</td>
</tr>
<tr>
<td>ORDER SET ..........</td>
<td>XXXXXX</td>
<td>YYYY</td>
<td>ZZZZ</td>
<td>N118</td>
<td>GHI</td>
</tr>
<tr>
<td>INFOBUTTON ..........</td>
<td>XXXXXX</td>
<td>YYYY</td>
<td>ZZZZ</td>
<td>N6</td>
<td>JKL</td>
</tr>
<tr>
<td>DOC TEMPLATE ..........</td>
<td>XXXXXX</td>
<td>YYYY</td>
<td>ZZZZ</td>
<td>N20</td>
<td>MNO</td>
</tr>
</tbody>
</table>
A perspective re: next generation

- KM has challenge of core knowledge but multiple possible deployments
  - Shareability is limited once customized/adapted
- But if we can create model-based descriptions of settings – clinical problem, state, venue, user, activity – then:
  - Can index all knowledge by these attributes
  - Can identify gaps, resolve conflicts
  - Can find knowledge artifacts suited to a particular setting
- Also forms basis for an “implementation science”
  - Tags define characteristics of settings
  - Can associate with indicators of success, usage, overrides, etc.
  - Can find settings similar to “my own” and select approach that is most successful
Thank you!

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www.sharpc.org