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A Prototype Knowledge-Sharing Service for Clinical Decision Support Artifacts

Janet M. Lewis, Tonya M. Hongsermeier, Blackford Middleton, Douglas S. Bell

Sponsored by the U.S. Department of Health and Human Services
The research described in this report was sponsored by the Office of the National Coordinator for Health Information Technology (ONC) of the U.S. Department of Health and Human Services. The work was conducted under the direction of RAND Health, a division of the RAND Corporation.

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Published 2012 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
4570 Fifth Avenue, Suite 600, Pittsburgh, PA 15213-2665
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This report, by researchers from Partners HealthCare and the RAND Corporation, describes a structured data format (called a schema) and a web portal architecture for sharing computer-based clinical decision support (CDS) knowledge artifacts, such as clinical alert specifications. Twenty-two CDS artifacts and 16 value sets were developed that cover five CDS intervention types. This document should be of interest to electronic health record developers, health information technology policymakers and researchers, decision support experts, and clinical leaders.

This study was funded by the U.S. Office of the National Coordinator (ONC) for Health Information Technology through Contract HHSP23320095649WC, Task Order HHSP23337009T. The contractors have granted to the government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license for all data produced in this contract, to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the government.
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Summary

Objectives

The Office of the National Coordinator for Health Information Technology (ONC) Advancing Clinical Decision Support (ACDS) effort is a project intended to accelerate the effective use of computer-based clinical decision support (CDS) interventions to facilitate evidence-based clinical practice and the meaningful use of health information technology (IT). In Task 4 of this effort, a team of CDS and knowledge management experts led by Tonya Hongsermeier, M.D., of Partners HealthCare has proposed a functional architecture, governance model, and standard format for a knowledge-sharing service (KSS) that could potentially be deployed on a national scale. In addition, the team has built a first-generation version of a KSS that expands on the infrastructure previously developed for the Clinical Decision Support Consortium (CDSC). This report primarily describes the work associated with Task 4.8, led by Janet Lewis. The key objectives were to develop CDS artifacts for at least 20 interventions of different types, targeted toward guidelines and clinical conditions called for in the 2011 meaningful use criteria, and to disseminate the tools, content, and materials through the KSS. This report also describes key findings from the other Task 4 subtasks.

Methods

The ACDS team collaborated with other federally funded efforts, including the CDSC project, the National Quality Forum (NQF) eMeasures effort, and the Structuring Care Recommendations for Clinical Decision Support (eRecs) project. The ACDS interventions or artifacts were built utilizing the extensible markup language (XML) schema developed by the CDSC project and were published on the CDSC portal, which functions as the ACDS KSS. The CDSC portal resides on a Partners HealthCare server and utilizes Documentum’s Web Publisher for content life-cycle management, workflow management, metadata tagging, and publishing. The artifact content was based on CDS interventions implemented at Partners and refined based on related CDS projects, especially the NQF eMeasures and eRecs projects. Clinical subject matter experts were consulted to review and finalize the ACDS artifacts. We reviewed our approach with vendors and worked with Allscripts to conduct a demonstration of artifact transformation.
Results

While the original CDSC Level 3 XML schema adequately supported the development of the ACDS alert/reminder artifacts, we worked with the CDSC team to expand the schema to support additional intervention types (order sets, documentation templates, infobuttons, relevant data display, and value sets). Twenty-two CDS artifacts and 16 value sets were developed that cover the five CDS intervention types. Three custom style sheets were developed to render the XML files in human-readable form. We worked with the CDSC portal team to enhance the portal to support the ACDS artifacts and custom style sheets. We also established a new page on the portal to link to the related work performed by the NQF and eRecs project teams. The ACDS artifacts may be viewed at http://cdsportal.partners.org/.

Conclusion

The ACDS Task 4 work was instrumental in identifying requirements for a KSS and exercising an XML schema for CDS sharing. Chapter Five highlights the lessons learned, key barriers to knowledge-sharing, recommendations for the future, and reasons for knowledge-sharing. The foundational building blocks for shareable CDS described in Chapter Five, such as dictionaries and value sets, are essential regardless of whether CDS developers and implementers utilize a CDS intervention-sharing or services consumption approach. The CDS content on the portal needs to be expanded and maintained in order for it to remain a viable resource for CDS implementers.
Acknowledgments

This report was made possible by Task Order HHSP23337009T, “Advancing Clinical Decision Support,” from the Office of the National Coordinator for Health IT. The leaders of this task order are

Douglas S. Bell, M.D., Ph.D.  Project Director (RAND Corporation)
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The author would like to acknowledge the following people:

• ACDS Project Team: Li Zhou, M.D.; Perry Mar, M.D.; Kensaku Kawamoto, M.D.; Marilyn Paterno; and Alisha Tucker
• CDS Consortium Team: Saverio Maviglia, M.D.; Aziz Boxwala, M.D.; Beatriz Rocha, M.D.; and Roberto Rocha, M.D.
• Clinical Systems Development Team: Yelena Vulfovich
• Partners Web Framework and Infrastructure Development Team: Hong Lou, Timothy Labrie, Mahesh Shanmugam, Dan Bogaty, and Paul Rapoza.
### Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACDS</td>
<td>Advancing Clinical Decision Support&lt;br&gt;A project funded by the Office of the National Coordinator for Health Information Technology (ONC). This report describes Task 4 of the ACDS project.</td>
</tr>
<tr>
<td>ADHD</td>
<td>attention deficit hyperactivity disorder</td>
</tr>
<tr>
<td>AHRQ</td>
<td>Agency for Healthcare Research and Quality&lt;br&gt;The federal agency sponsoring the Clinical Decision Support Consortium project</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>CDS</td>
<td>clinical decision support&lt;br&gt;Interactive software designed to assist physicians and other health professionals with decisionmaking tasks, such as determining diagnosis of patient data</td>
</tr>
<tr>
<td>CDS artifact</td>
<td>clinical decision support artifact&lt;br&gt;A general term used to refer to all of the deliverables that were created for the ACDS project</td>
</tr>
<tr>
<td>CDS knowledge/intervention</td>
<td>The ACDS project focused on specific CDS intervention types: alerts/reminders, order sets, documentation templates, infobuttons, and relevant data display</td>
</tr>
<tr>
<td>CDS knowledge/intervention sharing</td>
<td>In the simplest form, sharing CDS knowledge may refer to the process of reviewing or reading a CDS artifact online or in hard copy form and then authoring the artifact logic in the local CDS environment. A utility may also be developed to facilitate the processes of importing the artifact logic and integrating it with the local environment. Even when a utility is available, there is often considerable work to fully integrate the logic with the local dictionary and local CDS software before the logic or rule can be executed as expected.</td>
</tr>
</tbody>
</table>
The CDS service consumption approach is more technically sophisticated than the CDS knowledge/intervention sharing approach. Systems are built to send the local data to common, reusable services. The service executes the rule logic against the local data and returns the applicable messages and action items to the appropriate workflow context for the local environment. All of the local data must be mapped to the services-supplier dictionaries, and these mappings need to be maintained if the local content or the common service is modified.

**CDSC**
Clinical Decision Support Consortium
A project funded by AHRQ. See http://www.partners.org/cird/cdsc/.

**CDSC Knowledge Management Portal**
This public web-based portal (http://cdsportal.partners.org/) was deployed in 2009 as a part of the CDSC project. The ACDS project leveraged and enhanced the portal functionality. The ACDS deliverables/artifacts are published on this portal.

**CDSC XML schema**
The XML schema developed by the CDSC project specifies the rule format (terminologies expected, classifications expected, logic expressions, response messages, action recommended returned) and the execution content (input format of patient data, output format for responses).

**CMS**
Centers for Medicare and Medicaid Services

**CPT**
Current Procedural Terminology

**displayable resources**
The ACDS artifacts contain multiple types of related reference resources. Displayable resources are those that may be considered for displaying to CDS recipients when the artifact is implemented in a software application.

**Documentum**
EMC Corporation’s content management product used to implement key components of the CDSC portal

**EHR**
electronic health record

**HL7**
Health Level Seven International
The global authority on standards for interoperability of health information technology, with members in over 55 countries. See http://www.hl7.org/.

**ICD-9**
International Classification of Diseases, Ninth Revision

**IHTSDO**
International Health Terminology Standards Development Organisation
A not-for-profit association that develops and promotes use of SNOMED CT to support safe and effective health information exchange. See http://www.ihtsdo.org/.

**JCO**
Journal of Clinical Oncology
KE  knowledge engineer
The individual who authors the ACDS artifacts

KSS  knowledge-sharing service
A term used in the original contract for the ACDS project. The CDSC Knowledge Management Portal was enhanced to meet the ACDS requirement of delivering a KSS, and the ACDS deliverables were published on this public portal.

KTS  Knowledge Translation and Specification
One of the subteams within the CDSC project. The CDSC KTS team developed the initial XML schema, which was utilized by the ACDS team.

LOINC*  Logical Observation Identifiers Names and Codes
A universal code system for identifying laboratory and clinical observations. See http://loinc.org/.

NCQA  National Committee for Quality Assurance

NLM  National Library of Medicine

NQF  National Quality Forum

NQF eMeasures  Driven by the Health Information Technology for Economic and Clinical Health (HITECH) Act, the Department of Health and Human Services requested that NQF convert, or “retool,” 113 NQF-endorsed quality measures from a paper-based format to an electronic “eMeasure” format.

ONC  Office of the National Coordinator for Health Information Technology

SNOMED CT  Systematized Nomenclature of Medicine—Clinical Terms
Considered to be the most comprehensive, multilingual clinical health care terminology in the world. See http://www.ihtsdo.org/snomed-ct/.

SCRCDS  Structuring Care Recommendations for Clinical Decision Support
An AHRQ-funded project to accelerate the implementation of evidence-based clinical recommendations into CDS systems by reducing a key barrier to the recommendations’ use: the lack of a formalized process for translating the prose version to an unambiguous, structured, and coded format that can then be adopted widely for local conversion into machine-executable CDS rules. The structured, coded logic statements that were created are called eRecommendations (or eRecs). The ACDS project team worked with the SCRCDS team to share lessons learned, best practices, and deliverables.

SME  subject matter expert
UML  Unified Modeling Language™
Object Management Group's (OMG's) most-used specification, and
the way the world models not only application structure, behavior, and
architecture, but also business process and data structure.
See http://www.uml.org/.

value set  A collection or set of values. Most of the value sets utilized in the ACDS
project were developed by NQF (NQF eMeasures), which are collections
of standard clinical codes (e.g., SNOMED CT, ICD-9, LOINC). We
also developed some Level 4 value sets, which contain local codes used in
production at Partners HealthCare. Level 3 and Level 4 are described in
Chapter Two of this document.

XML  extensible markup language
A standard for representing data in a highly structured, yet flexible way.
Some of the ACDS artifacts were authored in XML format.

XSL  extensible stylesheet language
A family of languages used to transform and render XML documents

XSLT  extensible stylesheet language transformations
A declarative, XML-based language used for the transformation of XML
documents
Task 4 Summary

This document focuses on the work and deliverables associated with Task 4 of the Advancing Clinical Decision Support (ACDS) project, titled CDS Sharing Approaches. Each of the Task 4 subtasks fed into or built on one or more other subtasks, as shown in Figure 1.1. The project started with Task 4.1, then Tasks 4.2 to 4.6 ran concurrently, and the project closed with Tasks 4.7 and 4.8.

Figure 1.1
Task 4 Diagram
Task 4 Dissemination Channels

The Task 4 findings were disseminated in multiple ways:

- The final reports were submitted to the Office of the National Coordinator for Health Information Technology (ONC).
- The Task 4.8 artifacts were published on the public Clinical Decision Support Consortium (CDSC) portal at http://cdsportal.partners.org/.
- Gaps in standards and recommendations were presented to HL7.
- Manuscripts are being developed for several Task 4 subtasks.

Why Share Knowledge? Why Make Knowledge Shareable?

Health care delivery institutions face significant barriers to configuring their electronic health care record systems to support quality improvement efforts. They lack resources, content, know-how, or all three to realize the benefits achieved by the few leading institutions. The following four items are key to achieving effective electronic health record–enabled (EHR-enabled) quality improvement:

1. Data and Classification Definitions

A dictionary or library of encoded data and classification definitions that underlie quality measurement and clinical decision support should be in the public domain as a public good. Vendors and health systems have been understandably unsuccessful in sharing or evolving to standard dictionaries or definitions. It is currently the case that even institutions on a common vendor application struggle to normalize and share data definitions. For lack of a standard, implementers are left to reconcile across too many stakeholder interests. Health care delivery institutions typically face the hardship of building these definitions de novo because vendors usually lack complete dictionaries. The lack of a standard definitions library also means that the vast majority of health care delivery systems must build their quality measures and clinical decision support (CDS) interventions on a proprietary foundation.

A centralized government entity (e.g., the National Library of Medicine [NLM]) should host, steward, curate, and crowd-source (with stakeholder input) a standard library of this content for all institutions and vendors to utilize or map to so that the nation can move toward a common definitional framework for quality improvement. The Centers for Medicare and Medicaid Services (CMS) would be a key stakeholder for such an initiative, which could improve the measurability of cost-effectiveness in health care. Quality measures and CDS interventions should dictate the requirements for such definitions. The Task 4 deliverables describe the need for such a resource that would make the creation and sharing of CDS interventions easier.

2. Quality Measures and Clinical Decision Support Interventions

Standard quality measures are increasingly being pushed into the public domain (eMeasures). However, the content of many of the measures is either incomplete or defines data not typically collectable by most vendor EHR systems, in some cases for lack of a standard dictionary. Further, quality measures in some cases represent a “least common denominator” approach to the decision rule in question, with considerably less detail than the full version of a clinical guideline.
For example, the National Quality Forum (NQF) measure for pneumococcal immunization considers only those older than 65 in tracking the measure, whereas the full guideline includes indications other than age and addresses revaccination. Some EHR and content vendors offer out-of-the-box CDS content for licensing. These are typically limited offerings based on a proprietary definitions approach and do not represent the array of approaches that many leading health systems have developed. Another potential concern regarding proprietary CDS is credibility. “Open source” CDS, developed by a transparent process, sharing a common format, and vetted through peer review, may have more credibility with users than a proprietary solution promoted by a vendor.

A catalog of standard definitions and schemas for commonly deployed intervention types could render this type of CDS content more easily shareable by leading health systems for implementation in vendor systems and would also make it easier for the content vendor market to develop more granular and generalizable CDS intervention solutions.

3. Know-How and Organizational Effectiveness

Organizational know-how, CDS design know-how, quality measurement know-how, and resources to implement and maintain the products are variable from institution to institution. Figure 1.2 illustrates the interplay between the actual care process and the quality improvement cycle. When these two environments are decoupled, the content in the EHR is typically fragmented or poorly implemented. The relationship between the data collected in the care setting and the knowledge derived in the EHR-driven learning environment must be established, vetted, and maintained.

Further, what constitutes the best approach is greatly determined by the size and context of any organization. Many health care delivery systems have not implemented vendor-supplied CDS content that they already own and license. A small, loosely affiliated rural practice will be particularly resource-constrained for CDS configuration or maintenance. With pay for performance, service suppliers are emerging with lightweight “map, integrate-and-play solutions.” A large, multi-institutional system may have resources but lack the know-how.

Figure 1.2
Intersection of CDS and Clinical Knowledge Management
The emergence of Web 2.0 models of collaboration, such as Facebook, Google, and Wikipedia, creates new opportunities for health care systems to share their narratives and lessons learned for how they are tackling quality improvement. A “Facebook for CDS effective practices” sharing environment, though, is unlikely to succeed without stewardship and curation to foster and build collaborative behaviors. Even PatientsLikeMe, a data-driven social networking health website (http://www.patientslikeme.com/), depends on super-users for their disease-centric communities. Given that health narratives are less structured, they are more easily shared than CDS or eMeasure content. In addition, they do not need to pass the peer-review hurdles required of a journal article. A library of health narratives could serve as a resource for CDS developers to advance the architectures that will be needed for truly personalized medicine. The Task 4 deliverables describe the tools, functions, and architecture that would enable such intervention and narrative sharing.

4. Advancing the Health Care Market to Enable New Ways of Sharing CDS Content

Another model for sharing or deploying such interventions is via services-oriented architecture or substitutable applications (open source or commercial). Many health care delivery organizations and clinical practices, being resource-constrained, would rather not “reinvent the wheel.” It is unclear if the haves will share with the have-nots, but the “have somes” might be willing to share with each other.

Further, most of the effective CDS in production is proprietary to a few leading health care organizations. Thus, significant resources would be required to convert these into standard, shareable formats. The more likely scenario is that with the establishment of standard, public-domain catalogs and value sets, it will be easier for EHR and content vendors to deploy out-of-the-box CDS solutions as a web service so that the customer sites are relieved of the implementation and maintenance burden. A national knowledge repository of a standard set of eCDS intervention components and definitions aligned with eMeasures could represent a “floor” or minimum for effective use of EHRs and serve as a foundation for enabling the emergence of CDS web services, much in the same way the national highway system enabled interstate commerce in the 1950s.
Leveraging the CDSC Four-Level Model for Knowledge Translation

The Knowledge Translation and Specifications (KTS) subteam of the CDSC project defined the four levels of knowledge translation below to enable organizations to share information about documented CDS artifacts. Figure 2.1 provides additional detail about the model. The ACDS project built Level 3 specifications based on this CDSC model and the associated XML schema. The ACDS project also delivered some Level 4 value sets.

- **Unstructured (Level 1/L1):** Any human-readable knowledge in any document format.
- **Semi-structured (Level 2/L2):** Knowledge is deconstructed and encapsulated as individual recommendations. These knowledge specifications are primarily authored by clinical domain experts. An XML schema has been developed for this level, but knowledge is not codified.
- **Structured (Level 3/L3):** This level defines and specifies the structure and semantics of all the data elements and logic needed to make the knowledge interpretable by computers. The Level 3 artifact has the following major characteristics:
  - The primary authors of the knowledge specifications are knowledge engineers.
  - The knowledge is independent of implementation in a particular type of CDS tool or a particular clinical setting to maximize its ability to be shared.
  - Unified Modeling Language™ (UML) models and XML schemas have been developed for this level.
  - Data elements are codified as necessary.

**Figure 2.1**
CDSC Four-Level Model

![CDSC Four-Level Model Diagram](image-url)
• **Executable (machine execution; Level 4/L4):** This level is dependent on the specific CDS tool and clinical setting. Programmers implement the knowledge into specific clinical systems. The knowledge may not be easily shareable.

**CDSC Level 3 XML Schema for Sharing Computable Knowledge**

Many of the ACDS artifacts were developed as Level 3 specifications. Figure 2.2 illustrates the structure of the CDSC Level 3 XML schema, which is intended to be flexible to support the range of artifacts from simple to complex. The dashed lines and boxes indicate that these are optional structures. Minimum and maximum cardinality values are also listed under specific boxes. Zero indicates that the item is optional, while the number one means that the item is required. The infinity symbol means that the maximum number of occurrences for the item is unlimited.

**Metadata**

Each L3 XML artifact begins with the Metadata section, which contains the title, description, coverage (e.g., patient focus, clinical focus, care setting), name of contributor or author, knowledge type (e.g., alert/reminder, order set), state change event (e.g., creation or revision date), and links to related resources.

---

**Figure 2.2**

**CDSC XML Schema**

![CDSC XML Schema Diagram](image-url)
Applicable Scenario
The Applicable Scenario section contains the logical condition statements or constraints for the CDS intervention. For the diabetes alerts/reminders, the constraint or primary logic is that patients must be greater than or equal to 18 years of age and have a clinical state of diabetes, which is determined by referencing the list of Systematized Nomenclature of Medicine—Clinical Terms (SNOMED CT) codes included in the NQF eMeasure for diabetes. Then each of the different diabetes alerts/reminders (Overdue HgbA1c, Almost Overdue HgbA1c, Overdue Eye Exam, Overdue Foot Exam, Overdue Lipid Profile, etc.) may contain additional custom logic. For example, the Overdue HgbA1c alert/reminder has an additional logical condition that if no HgbA1c result has been recorded in the last six months, then the patient is overdue to have the HgbA1c test performed. This statement references the list of Logical Observation Identifiers Names and Codes® (LOINC) codes included in the NQF eMeasure for HgbA1c. Multiple logical condition statements may be linked together in one or more sets in order to specify any complex AND/OR logic.

Module
The Module section is the key structure for organizing the L3 specification. It may be used to group or nest related alerts/reminders. For example, the CDSC project created a consolidated L3 spec for multiple diabetes alerts/reminders and grouped them into three different modules: Assess, Screen, and Manage. Each of these modules has an Applicable Scenario section in addition to the primary Applicable Scenario, which specifies the constraints for patient age and clinical state.

Modules may also be used to organize or group the advice or recommendations (e.g., messages, recommended interventions or actions, resources). For example, the simple ACDS infobutton artifact contains a single module with a single patient education resource, while the ACDS order set for smoking cessation contains multiple modules to distinguish between antismoking medications, physician recommendations, patient education, and displayable resources. The ACDS documentation template for smoking has four modules to support Social History, Plan of Care, Patient Education, and Displayable Resources.

The module section may also contain one or more logical conditions within the recommendation structure. This is why the Applicable Scenario structure is shown in two places in the Structured Module box in Figure 2.2. For example, an Applicable Scenario is needed within the recommendation section to support the ACDS Relevant Data Display artifact, which displays a physician message when a medicine is ordered for a patient and a related laboratory test has not been performed in a specified time period.

The ACDS team worked collaboratively with the CDSC KTS team to adapt and extend the L3 XML schema to support the different intervention types. For example, a new definition structure was added to the schema to support the L3 value sets.

The forthcoming Task 4.6 report, Structured Representation of Core Elements for CDS Knowledge Sharing (Zhou et al., forthcoming), will provide additional details regarding the CDSC L3 schema and key requirements for the representation of structured and shareable CDS intervention artifacts.
Approach for Selecting Content for ACDS Artifacts

The process we followed to identify the content scope of the ACDS artifacts was to analyze the meaningful use measures and identify specific clinical specialties (e.g., diabetes, coronary artery disease, smoking cessation). We leveraged specific content in production at Partners and integrated them with the relevant eMeasure value sets. We adjusted our focus areas along the way to ensure that we had addressed the five CDS intervention types (alerts/reminders, order sets, documentation templates, infobuttons, and relevant data display). Figure 2.3 shows the elements of the process. We conducted periodic review sessions of the artifacts with the project leadership team representing ONC, RAND, and Partners. The final set of artifacts is described in Chapter Three.

Leveraging NQF eMeasures

Figure 2.4 illustrates how the NQF eMeasures were merged into the ACDS artifacts.
Figure 2.4
ACDS Artifact Example Referencing NQF eMeasures

Knowledge Engineer Style Sheet

**Diabetes Mellitus Overdue Eye Exam - Rule for screening adult patients with diabetes.**

| Contributor: | Advancing Clinical Decision Support |
| Type: | Change |
| Event: | Created, 2011-11-18 |

**Related Resources:**


- **dependsOn:** National Quality Forum Performance Measures: [Link](http://cdsportal.org/RelatedResources.aspx?paperID=3)


- **associatedReference:** American Diabetes Association - Standards of Medical Care in Diabetes - 2009: [Link](http://care.diabetesjournals.org/content/25suppl_1/s012)

- **associatedReference:** American Diabetes Association - Diabetic Retinopathy: [Link](http://care.diabetesjournals.org/content/25suppl_1/s012)

*The full set of NQF eMeasures was published on the portal, so a portal link is listed as a related resource.*

*The following search tags have been assigned to this artifact:*

- **clinicalFocus:** Diabetes mellitus (SNOMED Clinical Terms: 73211009)
- **careSetting:** Outpatient (SNOMED Clinical Terms: 37384002)

**Applicable Scenario**

- **Patient is an adult, age is greater than or equal to 18 years old**
  - **Expression:** `CALCULATE_AGE_IN_YEARS(patient, patient)`
  - **Expression language:** nonstandard

- **Patient with clinical state of diabetes**
  - **Expression:** `PATIENT_HAS_CLINICAL_STATE(diabetesState)`
  - **Expression language:** nonstandard
  - **Clinical State:** `diabetesCodeList GROUPING (National Committee for Quality Assurance: 2.16.840.1.113883.3.484.0001.37)`

  **Last eye exam over 11 months ago or never**
  - **Expression:** `PATIENT_LAST_EYE_EXAM_IN_PAST_PERIOD(eyeExam, 11, MONTHS) == FALSE`
  - **Expression language:** nonstandard

  **Procedure:**
  - **Type:** `eyeExam CodeList GROUPING (Health Care Effectiveness Data and Information Set: 2.16.840.1.113883.3.484.0001.242)`

**Status**

- **diabetesCodeList GROUPING**
  - **Active:** (SNOMED Clinical Terms: 55561003)

- **lastEyeExamInPastPeriod**
  - **Completed:** (ActStatus: completed)
ACDS Artifacts

The terms of the ACDS contract were to deliver 20 XML artifacts addressing five different CDS intervention types, targeted toward guidelines and clinical conditions called for in the 2011 meaningful use criteria. We developed 38 CDS interventions or artifacts. Twenty-two artifacts covered the five CDS intervention types (see Table 3.1). Sixteen value sets were also developed to support the other artifacts (see Table 3.2).

All of the artifacts were published on the CDS portal, except for the two prototype artifacts footnoted in Table 3.1. The Pneumonia Severity Index artifacts were developed to further extend the XML schema. However, they are not representative of content in production at Partners HealthCare, so they were not published on the portal.

Level 4 Value Sets Based on Partners Production Content

Because the L3 alerts/reminders were developed based on Partners production content, we were able to supplement the 14 L3 alerts/reminders with 14 L4 value sets. We extracted user response examples from production applications at Partners HealthCare System.

For example, the recommended action for the L3 diabetes alerts/reminders is to order the procedure hemoglobin, glycosylated (A1c). At Partners the user responses for this procedure request are Done, Patient Refuses, Done Elsewhere, Deferred, Other, Appointment Scheduled, and HbA1c. The L4 value sets contain this list of user options, the standard codes (when available), and the related snooze periods. An example is provided in Appendix B (Figure B.7).

In addition to building and publishing the 14 L4 recommendation response value sets, we grouped the different responses by recommendation/alert category (Table 3.3). This table contains the different categories and lists both the action items and/or the exceptions that a user might enter in response. In some CDS environments, the action item may be “executed,” while in other CDS systems in which the alerts are not “actionable,” the responses are made as assertions that the actions will be taken. We provide examples of both, although vendors or CDS implementers may choose to utilize a subset of the response examples.
<table>
<thead>
<tr>
<th>ACDS Artifact</th>
<th>CDS Intervention Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Annual Blood Pressure Screening Overdue</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>2. Chlamydia Screening, Overdue</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>3. Diabetes, Lipid Profile Almost Overdue</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>4. Diabetes, Lipid Profile Overdue</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>5. Diabetes Mellitus, HgA1c Almost Overdue</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>6. Diabetes Mellitus, HgA1c Overdue</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>7. Diabetes Mellitus, Overdue Eye Exam</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>8. Diabetes Mellitus, Overdue Foot Exam</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>9. Diabetes Mellitus, Poorly Controlled, HgA1c Overdue</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>10. No ADHD [attention deficit hyperactivity disorder] on Problem List, on ADHD Meds</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>11. No Coronary Artery Disease on Problem List, History of CAD-Related Procedures</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>12. No Diabetes on Problem List, on Anti-Diabetes Meds</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>13. Pneumococcal Vaccine Due</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>14. Pneumonia Severity Index (PSI) Score Stratification(^a)</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>15. Undocumented Smoking Status</td>
<td>alert/reminder</td>
</tr>
<tr>
<td>16. Smoking Status</td>
<td>documentation template</td>
</tr>
<tr>
<td>17. Pneumonia Severity Index—See PSI Alert(^a)</td>
<td>documentation template</td>
</tr>
<tr>
<td>18. Medication-Related Patient Education</td>
<td>infobutton</td>
</tr>
<tr>
<td>19. Obesity Management, Outpatient</td>
<td>order set</td>
</tr>
<tr>
<td>20. Smoking Cessation, Outpatient</td>
<td>order set</td>
</tr>
<tr>
<td>21. Venous Thromboembolism Prophylaxis, Inpatient</td>
<td>order set</td>
</tr>
<tr>
<td>22. Drug-Lab (display specific labs when ordering a med)</td>
<td>relevant data display</td>
</tr>
</tbody>
</table>

\(^a\) Not published on CDSC portal.
Table 3.2
List of ACDS Value Sets

<table>
<thead>
<tr>
<th>ACDS Value Set</th>
<th>Spec Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CDC Recodes for Smoking Status.xml</td>
<td>Level 3</td>
</tr>
<tr>
<td>2. CDC Recodes for Active Smoker.xml</td>
<td>Level 3</td>
</tr>
<tr>
<td>3. ACDS-Response-Value-Set-L4-Blood-Pressure-Screening.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>4. ACDS-Response-Value-Set-L4-Chlamydia-Screening-Overdue.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>5. ACDS-Response-Value-Set-L4-Lipid-Profile-Almost-Overdue.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>6. ACDS-Response-Value-Set-L4-Lipid-Profile-Overdue.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>7. ACDS-Response-Value-Set-L4-Diabetes-A1c-Almost-Overdue.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>8. ACDS-Response-Value-Set-L4-Diabetes-A1c-Overdue.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>9. ACDS-Response-Value-Set-L4-Diabetic-Eye-Exam-Overdue.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>10. ACDS-Response-Value-Set-L4-Diabetic-Foot-Exam-Overdue.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>11. ACDS-Response-Value-Set-L4-Diabetes-Poorly-Controlled-A1c-Overdue.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>12. ACDS-Response-Value-Set-L4-ADHD-NotonProblemList.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>13. ACDS-Response-Value-Set-L4-CAD-NotonProblemList.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>14. ACDS-Response-Value-Set-L4-Diabetes-NotonProblemList.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>15. ACDS-Response-Value-Set-L4-Pneumococcal-Vaccine-Due.xls</td>
<td>Level 4</td>
</tr>
<tr>
<td>16. ACDS-Response-Value-Set-L4-CDC-Smoking-Codes.xls</td>
<td>Level 4</td>
</tr>
</tbody>
</table>

**Pseudocode Development**

The Advancing CDS Task 4 team utilized pseudocode as the expression language for the ACDS artifacts. This approach is simple, unambiguous, and human-readable, and it can be transformed into executable logic. The ACDS pseudocode falls into six categories, as shown in Table 3.4.

**Human-Readable Style Sheets**

The style sheets were developed to allow portal users to view the ACDS artifacts in human-readable form. We developed three different XSL files to support the different user types:

- **Subject Matter Expert (SME).** This high-level style sheet is intended for subject matter experts. It does not contain the codes, code system names, or the coverage metadata (e.g., patient focus, clinical focus, care setting). The Applicable Scenario in this view is limited to a textual description of the logic.
- **Knowledge Engineer (KE).** This style sheet is intended for knowledge engineers. It contains the codes and code system names for LOINC, SNOMED CT, and so on. The logic and expression language are displayed for the Applicable Scenario, and the coverage metadata are listed.
<table>
<thead>
<tr>
<th>Category</th>
<th>Action Items</th>
<th>Exceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For problem list update recommendations:</td>
<td>• Add a problem</td>
<td>• Assert patient does not have a problem</td>
</tr>
<tr>
<td></td>
<td>• Assert problem is added</td>
<td>• Defer (snooze) for a later date</td>
</tr>
<tr>
<td>2. For procedure recommendations:</td>
<td>• Order procedure (Current Procedural Terminology [CPT], SNOMED CT, or International Classification of Diseases, Ninth Revision [ICD-9] for procedure)</td>
<td>• Assert procedure was performed elsewhere</td>
</tr>
<tr>
<td></td>
<td>• Order a referral to the appropriate specialist who might perform the procedure</td>
<td>• Assert a procedure was performed by another clinician (i.e., specialist)</td>
</tr>
<tr>
<td></td>
<td>• Assert a procedure is performed within the visit</td>
<td>• Assert patient does not have the problem indicating the recommended procedure</td>
</tr>
<tr>
<td></td>
<td>• Assert a procedure is to be scheduled for a later date</td>
<td>• Assert patient is not on medication indicating recommended procedure</td>
</tr>
<tr>
<td></td>
<td>• Assert patient will be referred to a specialist</td>
<td>• Defer (snooze) for a later date</td>
</tr>
<tr>
<td></td>
<td>• Other (open comment field)</td>
<td>• Assert patient refuses (HL7 21710 version 3.0)</td>
</tr>
<tr>
<td>3. For medication recommendations:</td>
<td>• Order the medication</td>
<td>• Assert a problem that is a contraindication to the recommended medication</td>
</tr>
<tr>
<td></td>
<td>• Assert medication therapy will be initiated today</td>
<td>• Assert patient does not have the problem indicating the recommended medication</td>
</tr>
<tr>
<td></td>
<td>• Discontinue proposed medication</td>
<td>• Assert patient is allergic to the medication</td>
</tr>
<tr>
<td>4. For drug-drug interaction alerts:</td>
<td>• Discontinue active medication that would interact with proposed medication</td>
<td>• Assert patient has had a reaction to the medication in the past</td>
</tr>
<tr>
<td></td>
<td>• Continue both medications and assert that risks are understood and patient will be monitored</td>
<td>• Defer (snooze) for a later date</td>
</tr>
<tr>
<td>5. For drug-disease interaction alerts:</td>
<td>• Discontinue proposed medication</td>
<td>• Assert patient refuses (HL7 21710 version 3.0)</td>
</tr>
<tr>
<td>6. For drug–duplicate therapy alerts:</td>
<td>• Discontinue preexisting medication</td>
<td>• Assert new evidence supports therapy of this type</td>
</tr>
<tr>
<td></td>
<td>• Discontinue proposed medication</td>
<td>• Assert patient has tolerated this drug in the past</td>
</tr>
<tr>
<td></td>
<td>• Assert transitioning from one drug to the other</td>
<td>• Assert advised by a consultant</td>
</tr>
<tr>
<td>7. For drug-lab interaction alerts:</td>
<td>• Discontinue proposed medication</td>
<td>• Assert no reasonable alternatives</td>
</tr>
<tr>
<td>8. For drug-pregnancy alerts</td>
<td>• Discontinue proposed medication</td>
<td>• Assert low risk cross sensitivity, will monitor</td>
</tr>
<tr>
<td>9. For drug-allergy interaction alerts:</td>
<td>• Discontinue proposed medication</td>
<td>• Assert patient currently tolerates the medication</td>
</tr>
<tr>
<td>10. For all alerts and reminders, the following is an exception:</td>
<td>• Other (open comment field)</td>
<td>• Assert patient advised by a consultant</td>
</tr>
</tbody>
</table>
Table 3.4
Sample Pseudocode Statements

<table>
<thead>
<tr>
<th>Category</th>
<th>Pseudocode Statements</th>
</tr>
</thead>
</table>
| Patient Demographics | • CALCULATE_AGE_IN_YEARS(DoB)>=18  
• PATIENT_IS_OF_GENDER(femaleGender)                                                                                                                     |
| Clinical States      | • PATIENT_HAS_CLINICAL_STATE(chronicKidneyDiseaseState) == FALSE  
• PATIENT_HAS_CLINICAL_STATE(chronicKidneyDiseaseState)                                                                                               |
| Events               | • PATIENT_HAD_EVENT_IN_PAST_PERIOD(HgbA1cResults, 6, MONTHS) == FALSE  
• PATIENT_HAD_EVENT_IN_PAST_PERIOD(HgbA1cResults, 5, MONTHS) == FALSE  
• MOST_RECENT_RESULT_IN_PAST_TIME_INTERVAL_HAD_VALUE(HgbA1cResults, 3, 5, MONTHS, >, 8, %)  
• MOST_RECENT_RESULT_HAD_VALUE(PsiScoreResults, <=, 70)  
• MOST_RECENT_RESULT_HAD_VALUE(PsiScoreResults, >, 70) AND MOST_RECENT_RESULT_HAD_VALUE(PsiScoreResults, <, 91)  
• PATIENT_HAD_EVENT_IN_PAST_PERIOD(creatinineResults, 365, DAYS) == FALSE  
• PATIENT_HAD_EVENT_IN_PAST_PERIOD(creatinineResults, 365, DAYS) == FALSE                                                                                   |
| Medications          | • PATIENT_ON_CURRENT_MEDICATION(adhdMedication)  
• PATIENT_MEDICATION_ORDERED(azathioprineMedication)                                                                                                      |
| Immunizations        | • PATIENT_HAD_IMMUNIZATION(pneumococcalVaccination) == FALSE  
• PATIENT_HAD_IMMUNIZATION(pneumococcalVaccine) == FALSE                                                                                                  |
| Social History       | • PATIENT_HAS_SOCIAL_HISTORY(tobaccoUser)  
• PATIENT_HAS_SOCIAL_HISTORY(tobaccoNonUser) == FALSE                                                                                                     |

- **KE with Tags/Developer.** This style sheet contains the same details as the KE style sheet. It is intended for developers or users who want to compare the content with the L3 XML schema, so it includes references to the structure of the L3 XML schema.

We selected the KE style sheet to be the default template for the CDSC portal. It automatically opens when the user clicks on the file name for the L3 artifacts on the portal. The other two style sheets can be downloaded from the Related References portal page. Sample style sheets are provided in Appendix A and they can be viewed on the portal (http://cdsportal.partners.org/).

**Publishing the ACDS Artifacts on the CDSC Portal**

The ACDS artifacts were published using the tools and processes defined by the CDSC project team. We used EMC Documentum’s eRooms for virtual asynchronous collaboration and subject matter expert reviews. We used Altova tools and WordPad when authoring the XML files. We used EMC Documentum’s Web Publisher to tag the artifacts with metadata, publish them, and export them to the portal.

Figure 3.1 illustrates this content management process. While the diagram does not illustrate it, this process is iterative. Published artifacts are frequently reviewed, refined, and republished. During the publishing process, we can indicate that specific artifacts are related to or were derived from other artifacts. We also established a process to retain multiple versions to preserve the history of the CDS artifacts. The ACDS artifacts can be accessed via the portal (http://cdsportal.partners.org/).
Furthermore, the forthcoming ACDS Task 4.4 report, *Key Principles and Practices for Maintaining Clinical Decision Support Content: Review and Synthesis of Industry Best Practices* (Hongsermeier, Kawamoto, et al., forthcoming), will describe the recommended governance structure, the components of an editorial policy, regulations and legal considerations, and related implications for a national KSS.

**Figure 3.1**
CDSC Portal Infrastructure

![Overview of CDSC Content Asset Management](RAND TR 207-3.1)
Vendor Recommendations

**Expert Panel Convened During Task 4.1**

Vendors were contacted throughout the project. The forthcoming Task 4.1 report, *Key Principles for a National CDS Knowledge Sharing Framework: Synthesis of Insights from Leading Subject Matter Experts* (Kawamoto, Middleton, et al., forthcoming), will summarize the results of surveys and in-depth interviews with key stakeholders and opinion leaders, including EHR vendors, knowledge content producers, and informaticians in the academic and community settings. The key conclusions include the following:

- Strive to make the use of a national CDS knowledge-sharing framework available for meeting relevant meaningful use requirements.
- Apply the resources and authority of the federal government to accelerate desired changes.
- Support multiple complementary approaches to CDS knowledge-sharing, ranging from shareable content to shareable services, and allow the marketplace to determine the “winners.”
- Make the knowledge-sharing framework as simple as possible to understand and to adopt, but no simpler.
- Provide high-value content and tooling, preferably in an open-source manner.
- Focus on use cases with clearly identified business needs.
- Accelerate the development or licensing of required, pragmatic standards, particularly foundational building blocks for CDS, such as value sets of orders, observations, disease states, and medication classes.
- More closely coordinate related efforts and seek to establish a common “wave” that propels all stakeholders toward a common destination.
- Acknowledge and address the need for local adaptation and customization.
- Acknowledge and address concern for medical-legal liability.
- Utilize a flexible and adaptive design and development strategy.
- Establish a self-sustaining business model.

**Transformation Demonstration with Allscripts**

Allscripts was the only EHR vendor that was willing to participate in the artifact transformation demonstration. We had several conference calls with Allscripts over the course of the project. During these conversations we reviewed the L3 XML schema, the artifact development methodology, the evolving artifacts, and the ACDS style sheets.
We also discussed the pros and cons of GELLO (an object-oriented query and logical expression language for clinical decision support) versus pseudocode for the expression language. The Allscripts team provided valuable input into the XML schema approach and concurred that the pseudocode approach was the most pragmatic in the near term.

The Allscripts team indicated that they would welcome government-sponsored initiatives that spare the health IT community and healthcare organizations from reinventing the same wheel, particularly in the realm of foundational building blocks for CDS. More robust industry standards and processes would ensure that all stakeholders apply the same foundations to solve the problems associated with delivery of quality care at an affordable price.

This collaboration culminated on November 10, 2011, when the Allscripts team provided a demonstration illustrating that they had transformed and imported the logical condition section of the ACDS Diabetes HgbA1c Overdue artifact into their local test environment. The Allscripts team built a compiler to perform this import process and demonstrated how the rule logic fired in the local test environment.

**Vendor Input on CDS Artifact Transformation**

All other EHR vendors indicated that CDS artifact transformation was not a priority or was not feasible within the project timeline. The reasons provided include the following:

- Most vendors already have CDS artifacts that assist their clients with meeting quality performance and meaningful use requirements.
- Many indicated that “importable artifacts” are of questionable utility because many local adaptation issues still remain to be addressed.
- Some vendors already have knowledge-sharing portals for their clients, most of which support the exchange of human-readable artifacts.
- Many vendors have most of their engineering resources focused on getting their products to meet meaningful use certification requirements and ICD-10 migration. The ability to demonstrate download and execution of externally supplied artifacts is not a priority.

**Input on XML Schema from Two Medical Informaticians**

Toward the end of this project, two vendor medical informaticians visually reviewed our XML schema and various interventions and gave us positive feedback. However, we strongly believe that the XML schema and related CDS artifacts still need to undergo more concentrated testing and validation with real-world vendor compilers. Visual inspection is inadequate to fully define the optimal XML schema approach.

**Observations from Joseph Bormel, Chief Medical Officer of QuadraMed**

QuadraMed is a leading provider of award-winning health care software and services that improve the safety, quality, and efficiency of patient care.

- The XML schema looks thoughtfully designed.
• QuadraMed users (CDS implementers) primarily read intervention specifications and then author them into their workflow tools utilizing local table editors.
• The knowledge-import approach reduces some of the overhead of CDS design and maintenance, but customers would still be required to invest much effort in local adaptation.
• QuadraMed is more focused on building the strategic capability to consume ACDS as a service so that its customers can significantly reduce the burden of knowledge implementation and maintenance that exists with shareable CDS artifacts.
• QuadraMed would welcome initiatives that advance the robustness of standards and policies that encourage the commercial marketplace to develop ACDS services at a price and total cost that most community hospitals can afford. QuadraMed is currently progressing with this services approach for medication-related decision support.

Observations of David McCallie, Cerner Corporation
• The XML schema approach looks pragmatic, but it is expected that users (CDS implementers) will still prefer to view a human-readable version and enter the content utilizing local editors. Vendor experience with commercial order sets demonstrates the significant overhead of mapping and then pruning the order set choices down to the local order catalog. Some of this overhead is due to the lack of standard dictionaries and value sets for content (such as orderables), as described in Chapter One in the section “Why Share Knowledge? Why Make Knowledge Shareable?”
• Cerner is investing in object-oriented architectures that will make it possible to consume CDS from CDS web services suppliers.
• Most customers implementing eMeasures are largely importing the value sets and then building the queries using the local tools. There is a need for similar value sets for CDS.
• Standards work and participation by vendor-stakeholders merits further investment to ensure that “volunteer” resources are not building unimplementable standards that are unlikely to be adopted.
• There is a strong need for well-defined value sets and definitions to help solve the “semantic granularity mismatch” among the myriad of standard clinical terminologies, quality measures, and vendor dictionaries.
• The pseudocode approach looks good, and it would be useful to create a library of such expressions.
Lessons Learned During Task 4

- Some of the findings from the earlier Task 4 subtasks are listed below. Many of these reports are being prepared for publication.
- The forthcoming Task 4.2 and Task 4.3 report, *Key Principles in the Design of a National Knowledge Sharing Service for Clinical Decision Support: Review and Analysis of Previous Efforts* (Paterno, Karipineni, et al., forthcoming), proposes that the following items be considered while the KSS and underlying repository are designed and architected:
  - The KSS and repository must be independent of vendor ownership or intellectual property rights.
  - We should find a way to include and not lose the content developed by earlier initiatives.
  - We should ensure that the KSS meets the needs of potential customers and provide recommendations for marketing to the vendors and others whom we think are part of our customer base.
- The forthcoming Task 4.7 report, *Identification of Standard Gaps for CDS Sharing and Recommendations for Future Directions* (Mar et al., forthcoming), covers such topics as
  - identified gaps in the standards landscape
  - assessment of the most important gaps that exist
  - recommendations for how those gaps could potentially be filled in the near future
  - reporting on the reception of the Health Level 7 (HL7) CDS Work Group on two proposed standards based on the Advancing CDS Task 4 work.
Key Barriers Encountered

• The KSS is a first-generation, proof-of-concept portal and repository. In order to build out a service that offers all the recommended features, functions, governance, authoring tools, architecture, and models, it is anticipated that a multiyear investment in appropriately skilled resources, infrastructure, and open-source tools would be necessary.

• As mentioned above, the gaps in standards presented a significant barrier to translating artifacts from the robust Partners HealthCare System CDS library into shareable, encoded L3 artifacts. The lack of modeling standards limited us in our ability to fully extend the L3 XML schema. The lack of a standard order catalog limited our choices for order sets that could be transformed. The lack of a standard observation dictionary limited our choices for transforming documentation templates.

• The NQF eMeasures value sets are an excellent beginning for a value set library. However, this initiative lacks a sustainable content maintenance and publishing approach. Most disease management rules in the Partners inventory could not be translated because of gaps in available disease-state, contraindication definition, and medication class value sets.

• The lack of vendor resources to test our proposed schemas limited our ability to further validate and refine the L3 representations. The Allscripts team, for example, determined that an additional field in the data-mapping component of the XML schema would be helpful for import. We suspect that further testing will result in additional change requirements for the XML schema.

Foundational Building Blocks

Figure 5.1 describes the collaborative work and key components needed to establish a foundation for CDS sharing.

Recommendations for the Future

• Invest in further dialogue with appropriate vendor and health care delivery organization representatives. Given that our research uncovered a wide range of divergent perspectives regarding barriers to CDS adoption, problem framing, strategies, and solutions, further dialogue is needed with a diverse group of “business-line accountable” vendor representatives and CDS implementers to determine which government sponsored-initiatives will create the proper incentives and substrate for vendor deployment and consumer adoption of CDS.

• Invest in standards activities with a requirement for active participation by vendor representatives who have business-line accountability for product development. It was noted by some of the subject matter experts that the progress of standards work is glacial and sometimes rather academic because of the lack of true vendor representative participation.
• Invest in the legal frameworks and standards that advance the market for CDS services. Some EHR vendor representatives indicated that they plan to focus on workflow architectures that enable consumption of external services because it is unlikely that their local capabilities can compete with what will emerge in the broader commercial market, such as substitutable applications, CDS services, and workflow engines. The emergence of cloud computing and substitutable applications is rapidly changing the market.

• Invest in the foundational building blocks for shareable CDS, such as dictionaries and value sets. These will be essential regardless of whether CDS developers and implementers utilize a CDS intervention-sharing or services consumption approach. Thus it is recommended to invest early in an International Health Terminology Standards Development Organisation–style (http://www.ihtsdo.org/) organization that is tasked with extending these standards across the multiple terminology and classification needs.

NOTES: JCAHO = Joint Commission on Accreditation of Healthcare Organizations, KM = knowledge management, LSID = Life Science Identifier, OID = Object Identifier.
The three different style sheets are shown here to illustrate the various levels of detail in each view. The three examples are for the same artifact: Diabetes Mellitus, Overdue HgbA1c. The SME version is relevantly high-level, while the developer version is the most detailed view.
Figure A.1
SME Style Sheet for Diabetes Mellitus, HgbA1c Overdue

Subject Matter Expert Style Sheet

<table>
<thead>
<tr>
<th><strong>Diabetes Mellitus, HgbA1c Overdue, Order HgbA1c - Rule for managing adult patients with diabetes.</strong> Glycosylated hemoglobin A1c should be monitored biannually.</th>
</tr>
</thead>
</table>

**Contributor:** Advancing Clinical Decision Support

**Knowledge:** Alert or Reminder

**Type:**

**Change:** Created, 2011-11-18

**Event:**

**Related Resources:**


- **associatedReference:** American Diabetes Association - Standards of Medical Care in Diabetes - 2009: http://care.diabetesjournals.org/content/32/Supplement_1/S18.full

- **associatedReference:** National Quality Forum eMeasure (0575): Comprehensive Diabetes Care: HbA1c control (less than 8.0%): http://www.qualityforum.org/MeasureDetails.aspx?action=0&SubmissionID=5468&SubmitterID=1&at=1&mt=1&vt=1&sr=1&rc=1

**Applicable Scenario**

- Patient is an adult, age is greater than or equal to 18 years old
- Patient with clinical state of diabetes
- No glycosylated hemoglobin A1c result within last 6 months

**Messages and Recommended Interventions / Actions**

- **Physician Message:** Diabetic patient is overdue for HgbA1c measurement (recommended every 6 months).
- **Patient Message:** Hemoglobin A1c (Hgb A1c) is a blood test that measures your average blood sugar levels over the previous three months. Most people with diabetes have an Hgb A1c test every 6 months. If it's been more than 6 months since your last test, you may want to discuss Hgb A1c testing with your doctor.
- **Procedure Request:** Hemoglobin, glycosylated (A1C)

**Displayable Resources**

- **Knowledge Asset Request:** American Diabetes Association - Standards of Medical Care in Diabetes - 2009: http://care.diabetesjournals.org/content/32/Supplement_1/S18.full
- **Knowledge Asset Request:** American Diabetes Association - Standards of Medical Care in Diabetes - 2009 - Reference Documentation
- **Target:** Physician (SNOMED Clinical Terms - 306549000)
Figure A.2
KE Style Sheet for Diabetes Mellitus, HgbA1c Overdue

Knowledge Engineer Style Sheet


Contributor: Advancing Clinical Decision Support
Knowledge: Alert or Reminder
Type: Change
Event: Created, 2011-11-18

Related Resources:
associatedReference: American Diabetes Association - Standards of Medical Care in Diabetes - 2013: http://care.diabetesjournals.org/content/33/Supplement_1/S131
associatedReference: National Quality Forum eMeasure (5975): Comprehensive Diabetes Care: HbA1c control (less than 8.0%): http://www.qualityforum.org/MeasureDetails.aspx?ActorID=3&SubmeasureID=5975&emId=&spId=&spMrId=&spAnId=

The following search tags have been assigned to this artifact:
patient: Adult (SNOMED Clinical Terms: 13938004)
clinicalFocus: Diabetes mellitus (SNOMED Clinical Terms: 73211009)
careSetting: Outpatient (SNOMED Clinical Terms: 373864002)

Applicable Scenario

<table>
<thead>
<tr>
<th>AND</th>
<th>Patient is an adult, age is greater than or equal to 18 years old</th>
<th>Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expression: CALCULATE_AGE_IN_YEARS(DOB) &gt;= 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expression language: nonstandard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient with clinical state of diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expression: PATIENT_HAS_CLINICAL_STATE(diabetesState)</td>
<td>Type</td>
<td>Status</td>
</tr>
<tr>
<td></td>
<td>Expression language: nonstandard</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clinical State:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No glycosylated hemoglobin A1c result within last 6 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expression: PATIENT_HAD_EVENT_IN_PAST_PERIOD(HgbA1cResults, 6, MONTHS) = FALSE</td>
<td>Type</td>
<td>Status</td>
</tr>
<tr>
<td></td>
<td>Expression language: nonstandard</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laboratory Result:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>Status</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HbA1c test [LCIN] code list [Health Effectiveness Data and Information Set: 2.18.840.1.113883.3.464.1001.73]</td>
<td>completed (ActStatus: completed)</td>
<td></td>
</tr>
</tbody>
</table>
Figure A.2—continued

Messages and Recommended Interventions / Actions

Physician Message: (SNOMED Clinical Terms: 3093430009)
Diabetic patient is overdue for HgbA1c measurement (recommended every 6 months).

Patient Message: (SNOMED Clinical Terms: 116154003):
Hemoglobin A1c (Hgb A1c) is a blood test that measures your average blood sugar levels over the previous three months. Most people with diabetes have an Hgb A1c test every 6 months. If it’s been more than 6 months since your last test, you may want to discuss Hgb A1c testing with your doctor.


Displayable Resources
Knowledge Asset Request: American Diabetes Association - Standards of Medical Care in Diabetes - 2009 - Reference Documentation (SNOMED Clinical Terms: 309910008) Target: Physician (SNOMED Clinical Terms: 3093430009)
http://care.diabetes.org/content/32/Supplement_1/5/13.s1/
Figure A.3
Developer Style Sheet for Diabetes Mellitus, HgbA1c Overdue


Contributor: Advancing Clinical Decision Support [Metadata/contributor/organization/shortName]
Knowledge: Alert or Remind [Metadata/implementation/knowledgeType]
Type: Change Event: Created, 2011-11-18 [Metadata/variable/ChangeEvent/eventCode/Metadata/value/ChangeEvent/verDate]

Related Resources:
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]
- [Metadata/referencedResource/relatedResource/resourceVersion/altId]

The following search tags have been assigned to this artifact. [Metadata/getIdentity/description]
patient: Adult (SNOMED Clinical Terms: 133050004) [Metadata/coverage/coder/supplementaryName] (Metadata/coverage/cover/Code/CodeSystemName)
clinicalFocus: Diabetes mellitus (SNOMED Clinical Terms: 7321109) [Metadata/coverage/cover/Code/CodeSystemName]
careSetting: Outpatient (SNOMED Clinical Terms: 37385000) [Metadata/coverage/cover/Code/CodeSystemName]

Applicable Scenario [LogicalCondition/requirementGroup]

Patient is an adult, age is greater than or equal to 18 years old [LogicalCondition/singleExpression]
Expression: \( \text{CALCULATE_AGE_IN_YEARS} \geq 18 \) [LogicalCondition/singleExpression]

Patient with clinical state of diabetes [LogicalCondition/singleExpression]
Expression: \( \text{PATIENT_HAD_CLINICAL_STATE} \text{diabetesState} \) [LogicalCondition/singleExpression]

AND [LogicalCondition/requirementGroup]

No glycosylated hemoglobin A1c result within last 6 months [LogicalCondition/singleExpression]
Expression: \( \text{PATIENT_HAD_EVENT_IN_LAST_PERIOD} \text{HgbA1cResult} \) [LogicalCondition/singleExpression]

No diabetes Code List GROUP303 (National Committee for Quality Assurance: 2.19.940.1.113883.3.494.0001.37) [LogicalCondition/requiredExpression]

HgbA1c test. [LogicalCondition/requiredExpression]
Expression: \( \text{HgbA1cTest} \text{HCNCodig laboreal result} \) [LogicalCondition/requiredExpression]

Messages and Recommended Interventions: [ActionList]

Physician Message: (SNOMED Clinical Terms: 388438006) [MessageSource/coder/SoftwareSystemName]

HgbA1c is a blood test that measures your average blood sugar levels over the previous three months. Most people with diabetes have an HgbA1c test every 6 months. If it’s been more than 6 months since your last test, you may want to discuss HgbA1c testing with your provider.
Figure A.3—continued

![Figure A.3](image-url)
This section contains examples of the different ACDS artifacts. The full set may be found on the portal at http://cdsportal.partners.org/.
### Knowledge Engineer Style Sheet

**DM Problem List Maintenance: Rule for adding diabetes mellitus to the problem list for adult patients 18 and older who do not have a DM diagnosis, and are taking anti-diabetic medication.**

- **Contributor:** Advancing Clinical Decision Support
- **Knowledge Type:** Alert or Reminder
- **Change:** Created, 2011-11-18

**Related Resources:**
- [National Quality Forum Performance Measures](http://coidsportalpartners.org/RelatedResources.aspx?passid=5)
- [Associated Reference](http://www.qualityforum.org/MeasureDetails.aspx?acrid=0&SubmissionId=9444&c=0575&l=1&tag=64f$c=or&n=0&g=0&i=1)

**The following search tags have been assigned to this artifact:**
- Patient: Adult (SNOMED Clinical Terms: 139938004)
- Clinical Focus: Diabetes mellitus (SNOMED Clinical Terms: 73211009)
- Care Setting: Outpatient (SNOMED Clinical Terms: 373864002)

#### Applicable Scenario

| Patient is an adult, age is greater than or equal to 18 years old |
|---|---|
| Expression: | CALCULATE_AGE_IN_YEARS(DOB)>>=18 |
| Language: | nonstandard |

| Patient is on Anti-Diabetic Medication |
|---|---|
| Expression: | PATIENT_ON_CURRENT_MEDICATION(antiDiabeticMedication) |
| Language: | nonstandard |

**Medication:**

<table>
<thead>
<tr>
<th>Product Class</th>
<th>Status for the Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medications indicative of diabetes Code List GROUPING (Health Effectiveness and Data Information Set: 2:16.840.1.113663.3.464.0001.94)</td>
<td>Active (SNOMED Clinical Terms: 55561003)</td>
</tr>
</tbody>
</table>

| Patient does not have steroid induced diabetes on problem list |
|---|---|
| Expression: | PATIENT_HAS_CLINICAL_STATE(steroidInducedDiabetesState) == FALSE |
| Language: | nonstandard |

<table>
<thead>
<tr>
<th>Clinical State:</th>
<th>Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>steroid induced diabetes Code List GROUPING (Health Effectiveness and Data Information Set: 2:16.840.1.113663.3.464.0001.113)</td>
<td>Active (SNOMED Clinical Terms: 55561003)</td>
<td></td>
</tr>
</tbody>
</table>

| Patient does not have polycystic ovaries on problem list |
|---|---|
| Expression: | PATIENT_HAS_CLINICAL_STATE(polycysticOvariesState) == FALSE |
| Language: | nonstandard |

<table>
<thead>
<tr>
<th>Clinical State:</th>
<th>Type</th>
<th>Status</th>
</tr>
</thead>
</table>

### Messages and Recommended Interventions / Actions

**Physician Message:** (SNOMED Clinical Terms: 309343006): 
Based on this patient’s clinical data, this patient may have Diabetes Mellitus. Consider adding Diabetes Mellitus to the problem list.

**Event Request:** Add Diabetes Mellitus to problem list. - New diagnosis (SNOMED Clinical Terms: 44138006)

### Displayable Resources

**Knowledge Asset Request:** Standards of Medical Care in Diabetes - Reference Documentation (SNOMED Clinical Terms: 308910008)  **Target:** Physician (SNOMED Clinical Terms: 309343006)

[http://care.diabetesjournals.org/content/52/supplement_1/S173.full]
Figure B.2
Order Set for Smoking Cessation

Knowledge Engineer Style Sheet

Smoking Cessation Advice, Patients >12: Order set for cessation advice to patients who smoke.

Contributor: Advancing Clinical Decision Support
Knowledge Type: Order Set
Change Event: Created, 2011-11-10

Related Resources:


The following search tags have been assigned to this artifact:

patient: Adult (SNOMED Clinical Terms: 13309006)

condition: Smoking (SNOMED Clinical Terms: 37384902)
clinicalFocus: Smoker (SNOMED Clinical Terms: 77178002)

Applicable Scenario

Patient is an adolescent or adult, i.e. age is greater than 12 years old
Expression: CALCULATE_AGE_IN_YEARS(DOB)=12

OR

Patient is a tobacco user
Expression: PATIENT_HAS_SOCIAL_HISTORY(TobaccoUser)

AND

Patient is a smoker
Expression: PATIENT_HAS_SOCIAL_HISTORY(SmokingHistory)

Anti-Smoking Medications

- Substance Administration Request: Nicoderm-CQ 14mg 1 patch/day - Nicoderm-CQ (RxNorm: 351437)
- Substance Administration Request: Varenicline po 1mg Tab/Tab - Varenicline (Chartis) (RxNorm: 637190)
- Substance Administration Request: Zyban Eff po 150mg 1 Tab/day - Buproprion (RxNorm: 93658)

Referrals

- Encounter Request: Smoking cessation education (SNOMED Clinical Terms: 225225000)
- Encounter Request: Referral to smoking cessation advisor (SNOMED Clinical Terms: 36870008)
- Encounter Request: Referral to stop-smoking clinic (SNOMED Clinical Terms: 31532000)
Patient Education

- Knowledge Asset Request: Smoking Cessation Education Leaflet - Smoking cessation education (SNOMED Clinical Terms: 225023000)
  Target: Patient (SNOMED Clinical Terms: 116104003)  
  [Link to Leaflet](http://www.nhsggc.nhs.uk/ashc/publications/stop_smoking/index.htm)

Displayable Resources

  Target: Physician (SNOMED Clinical Terms: 30034068)
  [PDF Link](http://www.fda.gov/downloads/AdvisoryCommittees/CommitteeMeetingMaterials/TobaccoProducts/ScientificadvisoryCommittees/UCM324243.pdf)
Figure B.3
Documentation Template for Smoking Status

Knowledge Engineer Style Sheet

Smoking Status Assessment Template

Contribution: Enhancing Clinical Decision Support

Knowledge Documentation TemplateForm

Type: Created, 2011-11-18

Related Resources:


The following search tags have been assigned to this artifact:

patient: Adolescent (SNOMED Clinical Terms: 139957009)

patient: Adult (SNOMED Clinical Terms: 253287008)

clinicalFocus: Smoker (SNOMED Clinical Terms: 77178002)

careSetting: Inpatient (SNOMED Clinical Terms: 416900009)

careSetting: Outpatient (SNOMED Clinical Terms: 375884003)

Applicable Scenario

<table>
<thead>
<tr>
<th>Patient age in greater than or equal to 12 years old</th>
</tr>
</thead>
</table>

Expression: \text{CALCULATE}_{	ext{AGE}_{	ext{BY}_{	ext{YEAR}}}>=12} \text{Expression language: } \text{standard}

Social History Observation Request:

- Check if Yes

<table>
<thead>
<tr>
<th>Observation Value</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current every day smoker (CDC Public Health Information Network Root: 1)</td>
<td></td>
</tr>
<tr>
<td>Current semi day smoker (CDC Public Health Information Network Root: 2)</td>
<td></td>
</tr>
<tr>
<td>Former smoker (CDC Public Health Information Network Root: 3)</td>
<td></td>
</tr>
<tr>
<td>Never smoker (CDC Public Health Information Network Root: 4)</td>
<td></td>
</tr>
<tr>
<td>Smoker, current status unknown (CDC Public Health Information Network Root: 5)</td>
<td></td>
</tr>
<tr>
<td>Unknown if ever smoked (CDC Public Health Information Network Root: 6)</td>
<td></td>
</tr>
</tbody>
</table>

Plan of Care Observation Request:

- Check if Yes

<table>
<thead>
<tr>
<th>Observation Value</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not interested in stopping smoking (SNOMED Clinical Terms: 394927009)</td>
<td></td>
</tr>
</tbody>
</table>

- Encounter Request: Referral to smoking cessation advisor (SNOMED Clinical Terms: 3987000008)

- Encounter Request: Referral to stop-smoking clinic (SNOMED Clinical Terms: 315238003)

- Procedure Request: Patient Counseled (SNOMED Clinical Terms: 170980003)

Patient Education

- Knowledge Asset Request: Smoking Cessation Education Leaflet - Smoking cessation education (SNOMED Clinical Terms: 225320008)

  Target: Patient (SNOMED Clinical Terms: 116914009) http://www.ahrq.gov/professionals/clinicians-providers/teaching-residents.htm

Displayable Resources


RAND TR1207-B.3
# Figure B.4
Prototype for Relevant Data Display for Drug-Lab

## Knowledge Engineer Style Sheet

This is a prototype Relevant Data Display artifact, which searches for specific lab results when a medication is ordered for a patient. The subset of the drug/lab examples shown here was based on content in production at Partners Healthcare.

**Contributor:** Advancing Clinical Decision Support  
**Knowledge Type:** Relevant Data Display  
**Change Event:** Created, 2011-11-18

The following search tags have been assigned to this artifact:
- Patient: Adult (SNOMED Clinical Terms: 133936004)
- Care Setting: Outpatient (SNOMED Clinical Terms: 373964002)
- Clinical Focus: Medication monitoring (regimen therapy) (SNOMED Clinical Terms: 395170001)

### Applicable Scenario

<table>
<thead>
<tr>
<th>Patient age is greater than or equal to 18 years old</th>
<th>Expression: CALCULATE_AGE_IN_YEARS(DOB) &gt;= 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression: CALCULATE_AGE_IN_YEARS(DOB) &gt;= 18</td>
<td>Language: nonstandard</td>
</tr>
</tbody>
</table>

### Med ordered and recent lab performed

<table>
<thead>
<tr>
<th>Medication ordered</th>
<th>Expression: PATIENT_MEDICATION_ORDERED(azathioprineMedication)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Class:</td>
<td>Status for the Medication</td>
</tr>
<tr>
<td>Azathioprine (RefNorm: 1250)</td>
<td>in progress (SNOMED Clinical Terms: 3855651009)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lab value</th>
<th>Expression: PATIENT_HAD_EVENT_IN_PAST_PERIOD(creatinineResult, 365, DAYS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Status</td>
</tr>
<tr>
<td>Creatinine [Mass/volume] in Serum or Plasma [Logical Observation Identifier Names and Codes: 2160-0]</td>
<td>completed (ActStatus: completed)</td>
</tr>
</tbody>
</table>

Physician Message: (SNOMED Clinical Terms: 309342006): %creatinineResult résultType:displayName = $|creatinineResult résultValue|value $|creatinineResult résultValue|unit on $|creatinineResult résultDateTime.

### Med ordered and no relevant lab

<table>
<thead>
<tr>
<th>Medication ordered</th>
<th>Expression: PATIENT_MEDICATION_ORDERED(azathioprineMedication)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Class:</td>
<td>Status for the Medication</td>
</tr>
<tr>
<td>Azathioprine (RefNorm: 1250)</td>
<td>in progress (SNOMED Clinical Terms: 3855651009)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lab value</th>
<th>Expression: PATIENT_HAD_EVENT_IN_PAST_PERIOD(creatinineResult, 365, DAYS) = FALSE</th>
</tr>
</thead>
</table>

Figure B.4—continued

Physician Message: [SNOMED Clinical Terms: 309343006]:
No $potassiumResult.resultType.displayName within the last 365 days.

Med ordered and recent lab performed

Physician Message: [SNOMED Clinical Terms: 309343006]:
No $potassiumResult.resultType.displayName within the last 365 days.

Med ordered and no relevant lab

Physician Message: [SNOMED Clinical Terms: 309343006]:
No $potassiumResult.resultType.displayName within the last 365 days.

Med ordered and recent lab performed
Figure B.4—continued

Physician Message: (SNOMED Clinical Terms: 309943006):
$\text{phenobarbitalResult.resultValue.value} = 1$

Med ordered and no relevant lab

Physician Message: (SNOMED Clinical Terms: 309943006):
No $\text{phenobarbitalResult.resultDisplay.valueName}$ within the last 365 days.

Med ordered and recent lab performed

Physician Message: (SNOMED Clinical Terms: 309943006):
$\text{phenobarbitalResult.resultDisplay.valueName} = 1$

Med ordered and no relevant lab

Physician Message: (SNOMED Clinical Terms: 309943006):
$\text{phenobarbitalResult.resultDisplay.valueName} = 1$
Figure B.4—continued

Phenytoin (RxNorm: 8183) in progress (SNOMED Clinical Terms: 365651009)

PATIENT_HAD_EVENT_IN_PAST_PERIOD(phenytoinResult, 365, DAYS) == FALSE

Phenytoin [Mass/volume] in Serum or Plasma (Logical Observation Identifier Names and Codes: 39955-5)

Physician Message: (SNOMED Clinical Terms: 30834006):
No Phenytoin Result resultType.display name within the last 365 days.

Figure B.5
Infobutton for Medication-Related Patient Education

Knowledge Engineer Style Sheet

Medication-Related Patient Education Infobutton - This artifact was based on Partners HealthCare System's KnowledgeLink Manager. Please note: The user credentials for proprietary resources have been removed, so those URLs will not open.

Contributor: Advancing CDS
Knowledge: Reference Information
Type: Query Parameter
Change Event: Created, 2011-11-18

Query Parameters:
taskContent: Medication order entry (HL7 V3 Coding Systems: MEDCORE)
Knowledge Asset Request: Patient Education (SNOMED Clinical Terms: 311401009) Target: Patient (SNOMED Clinical Terms: 118156002) http://example.com/infobutton wartimegetshere

RAND TR1207-B.4a
RAND TR1207-B.5
Figure B.6
L3 Value Set for CDC Smoking Status Recodes

<table>
<thead>
<tr>
<th>Knowledge Engineer Style Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value Set: CDC Smoking Status Recodes</strong></td>
</tr>
<tr>
<td><strong>Contributor:</strong> Advancing Clinical Decision Support</td>
</tr>
<tr>
<td><strong>Knowledge Type:</strong> Dictionary or Value Set</td>
</tr>
<tr>
<td><strong>Change Event:</strong> Created, 2011-11-18</td>
</tr>
<tr>
<td><strong>Related Resources:</strong></td>
</tr>
</tbody>
</table>

The following search tags have been assigned to this artifact:
- **patient:** Adult (SNOMED: 13380004)
- **clinicalFocus:** Smoker (SNOMED: 77176002)

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current every day smoker</td>
<td>1 (CDC Public Health Information Network Root: 2004)</td>
</tr>
<tr>
<td>Current some day smoker</td>
<td>2 (CDC Public Health Information Network Root: 2004)</td>
</tr>
<tr>
<td>Former smoker</td>
<td>3 (CDC Public Health Information Network Root: 2004)</td>
</tr>
<tr>
<td>Never smoker</td>
<td>4 (CDC Public Health Information Network Root: 2004)</td>
</tr>
<tr>
<td>Smoker, current status unknown</td>
<td>5 (CDC Public Health Information Network Root: 2004)</td>
</tr>
<tr>
<td>Unknown if ever smoked</td>
<td>6 (CDC Public Health Information Network Root: 2004)</td>
</tr>
</tbody>
</table>

Figure B.7 is a Level 4 value set because these recommendation responses were extracted from production applications at Partners. The standard codes are provided when they are available.

Figure B.7
L4 Value Set of Responses for Diabetes A1c Overdue

<table>
<thead>
<tr>
<th>ACDS Response Value Set L4 Diabetes A1c Overdue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Done</td>
</tr>
<tr>
<td>Done (followup)</td>
</tr>
<tr>
<td>Done</td>
</tr>
<tr>
<td>Done</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>


