Lessons Learned from Implementation of a Radiology Clinical Decision Support System

JAMES BRIAN ALLISON, MD, UNIVERSITY OF VERMONT MEDICAL CENTER
(JAMES.ALLISON@UVMHEALTH.ORG)
NO DISCLOSURES
KEVIN O’NEAL, BA, I.S. PROJECT MANAGER, UNIVERSITY OF VERMONT MEDICAL CENTER
NO DISCLOSURES
KRISTEN K. DESTIGTER, MD, FACR, UNIVERSITY OF VERMONT MEDICAL CENTER
CONSULTANT, PHILIPS HEALTHTECH
CONSULTANT, MCKESSON CORP.
Overview

What is Clinical Decision Support?

- “Clinical decision support (CDS) provides clinicians, staff, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care.”[1]

- CDS systems “aid directly in clinical decision-making by providing specific clinical recommendations through matching patient characteristics with rules in a computerized knowledge base.”[2]

Radiology CDS Systems should:

- “Present the available choice of imaging procedures or range of imaging procedures determined as appropriate based on the medical evidence, to the extent possible, supplemented by clinical expertise.”[3]

- “Provide to the ordering clinician any procedure determined appropriate and not restrict selection to a specific exam whether defined by CPT® codes, charge master codes, or other manner that a facility may use to code a procedure.”[3]

Common User Interface Features

- Input field for clinical history, symptoms, diagnosis
- Input field for desired procedure
- CDS provides listing of relevant examinations
  - Links to published evidence behind recommendations
  - Displays ACR appropriateness level (1-9, color coded)
  - Clickable links for alternate exam types
    - Appropriateness rating and relative radiation doses displayed
    - Allows clinician to choose more appropriate exam without reentering data
- Transfer of appropriateness score, etc. into RIS for review by Radiologist
Selection and Preparation

- **Product Selection Criteria:**
  1. Integration of Standard Guidelines
  2. Links to supporting publications or consensus statements
  3. Modifiable guideline database
  4. Vendor-provided updates concurrent with evolving clinical guidelines and research.
  5. Traceable data, such as appropriateness of orders, identification of inappropriate orders for review, and overall utilization statistics

- **Committee Members:**
  - Radiology Chairman
  - Radiology Vice Chairman
  - Hospital Chief Medical Information Officer
  - IT Project Manager
  - Dedicated IT staff member
  - Five R4 Radiology Residents
  - Enterprise Imaging Architect
Our Goals of Implementation

1. Create Hospital CDS rule set
   - Incorporate established rule sets from the ACR and other sources such as the Royal Australian and New Zealand College of Radiologists.

2. Evaluate data collected through CDS
   - Provide feedback regarding ACR recommendations for further improvement
   - Evaluation ordering practices of individual and groups of clinicians

3. Integrate the Radiology CDS with Hospital EHR
   - Access CDS via Inpatient, Ambulatory, and Emergency Room EHR modules

4. Minimize claim denials
   - Reduce Medicare reimbursement denials through use of the radiology CDS system.
   - Obviate the need for pre-authorization from private insurers

5. Target a go-live date within four months of beginning of project
## Initial Decisions - Examples

<table>
<thead>
<tr>
<th>Concerns</th>
<th>Determinations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>User Status - Can we customize CDS usage requirements?</strong></td>
<td><strong>IT department could not guarantee accurate classification of users throughout organization</strong></td>
</tr>
<tr>
<td>- e.g. Can we make usage mandatory for all interns regardless of specialty?</td>
<td></td>
</tr>
<tr>
<td><strong>Order Set Conflicts</strong></td>
<td><strong>Avoid conflicts with existing order sets and use CDS data to address order set utilization in a broader context</strong></td>
</tr>
<tr>
<td>- e.g. Should imaging included in order sets (admission CXR) trigger CDS usage?</td>
<td></td>
</tr>
<tr>
<td><strong>Would use of the CDS hinder patient care in certain situations without significant benefit?</strong></td>
<td><strong>Include only high cost exams or those potentially requiring pre-authorization (CT, MRI, NM)</strong></td>
</tr>
<tr>
<td>- Clinician pop-up/alert fatigue</td>
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</table>
Integration with Existing Systems

- CDS required to integrate with two major existing Enterprise systems:
  - Radiology Information System (Centricity, GE Healthcare)
    - Hub through which orders are received from EHR, scheduled, protocled, and charged
  - Electronic Health Record (EPIC)
    - Provides clinical interface for ordering studies
    - Desire to seamlessly integrate the CDS into the EHR interface
    - All agreed a external interface would deter users and introduce workflow inefficiencies.

- Challenges to integration:
  1. EHR and RIS use different designations for the same studies.
  2. One-to-one relationship does not exist between the two systems
    - RIS contains many additional study codes than are available to clinician in EHR.
  3. Multiple relationships between orderable exams and the ACR clinical indications
    - Relationships had to be mapped through the CDS.
  4. CPT codes provide only universal terminology
    - No accounting for exam variations (e.g. single vs. multiphase CT)
    - Non-specificity for certain exams (e.g. lower extremity MRI)
Available orders in Electronic Health Record: 668
Total Number of Unique Radiology Information System Exam Codes (with applicable CPT codes): 844

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Map the EHR codes to RIS codes: Certified Radiology Coders mapped the EHR Rad Orders to RIS codes - One to Many relationship (more than one applicable RIS code per EHR code)</td>
</tr>
<tr>
<td>2.</td>
<td>Map RIS/EHR code set to ACR appropriateness guidelines: RIS/EHR map sent to vendor to be mapped to ACR clinical guidelines - Codes were matched primarily according through CPT codes - Not a 1 to 1 relationship and therefore suboptimal - However, CPT provided only common terminology across multiple systems</td>
</tr>
</tbody>
</table>

Outcome: (RIS) CPT codes matched to available CDS CPT codes
CT – 145 Matched / 10 Unmatched = 94% Matched
NM – 30 Matched / 36 Unmatched = 45% Matched
MR – 120 Matched / 2 Unmatched = 98.4% Matched
Other Modalities - 266 Matched / 222 Unmatched = 54.5% Matched

<table>
<thead>
<tr>
<th>Decision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Focus on high cost exams (CT, MR, NM)</td>
</tr>
<tr>
<td>2.</td>
<td>Do not create new rules unless evidence based and accept some gaps - Additional guidelines applied to 1 CT and 3 NM exams</td>
</tr>
</tbody>
</table>

Outcome: Initial Mapping Completed
Available EHR orders mapped 553
Available EHR orders not mapped 115
RIS codes mapped to ACR guidelines: Initial: 1026 Second Round: 2495

Validation Effort - Due to the non-specificity of some CPT codes, some mapping was inaccurate - Performed by six R4 residents with focus on removing inappropriate exam to guideline mapping - Total RIS code to ACR guideline mapping instances removed: 1232

CT, NM, and MR Radiology orders (as seen by provider) mapped to ACR clinical guidelines: 81%
Validation

Table 2: Sample of validation process

<table>
<thead>
<tr>
<th>CDS Procedure ID</th>
<th>CDS Procedure Name</th>
<th>CDS Modifiers</th>
<th>CDS CPT codes</th>
<th>CPT4</th>
<th>EHR Procedure CODE</th>
<th>RIS Exam Codes</th>
<th>PROCEDURE RECORD NAME</th>
<th>Remove Procedure Record ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACR114226</td>
<td>Core biopsy breast</td>
<td>Adult</td>
<td>19102</td>
<td>76942</td>
<td>76942</td>
<td>SPUGUIDE</td>
<td>IR US DRAINAGE</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US113</td>
<td>USBRBI</td>
<td>RAD US BREAST BIOPSY</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US117</td>
<td>USBRNLI</td>
<td>RAD US GUIDE NEEDLE LOC, BREAST ONLY</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US129</td>
<td>USGDBX</td>
<td>RAD US GUIDANCE, BX, ASP, INJ, LOC</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US130</td>
<td>USGDBXFNAL</td>
<td>RAD US GUIDANCE BIOPSY FNA THYROID</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US131</td>
<td>USGDCORDO</td>
<td>RAD US GUIDANCE CORDOCENTESIS</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US134</td>
<td>USGDNLLOC</td>
<td>RAD US GUIDE NEEDLE LOC, NON-BREAST ONLY</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US135</td>
<td>USGDPARA</td>
<td>RAD US GUIDANCE PARACENTESIS</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US137</td>
<td>USGDTHOR</td>
<td>RAD US GUIDE THORACENTESIS</td>
<td>Y</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US144</td>
<td>USLPN</td>
<td>RAD US ASPIRATION ANY SITE</td>
<td>Y</td>
</tr>
</tbody>
</table>

- Aforementioned process was used to automatically identify and assign EHR/RIS codes to CDS ACR guidelines
- Senior residents manually removed errors in the mapping process
  - Due to the non-specificity of CPT codes, clinically irrelevant studies/procedures erroneously assigned to guidelines.
Hurdles and Limitations

1. Process of mapping the CDS to RIS/EHR examination codes was labor intensive
   - Required many hours from clinicians and IT staff, delaying go-live date.
   - Vendor did not feel responsible for this as their system technically worked as advertised.

2. Validation of mapping process was achieved fairly rapidly
   - Senior residents could quickly identify and exclude irrelevant mappings.
   - Did not address potential mappings which escaped inclusion
     - Would require intensive review of all guidelines and identification of relevant exams which were not mapped to them.

3. Desire to integrate CDS into running instance of EHR required significant effort from the IT department
   - Many institutions might not be willing or able to provide this level of tech support.

4. The effort exposed many difficulties related to integrating new technology with legacy RIS
   - Mainly due to lack of unified terminology that provides one-to-one relationships between orders, the myriad variations of a single exam, and charge codes.
Barriers to Utilization

1. Opted against mandatory usage
   - Some institutions have shown success targeting mandatory usage to specific modalities or clinical scenarios\(^{(1,2,3,4)}\)

2. Technical issues with integration into EPIC inpatient module
   - Initial go-live only in EPIC outpatient module.
   - No data accumulated in ER or inpatient setting.

3. Several factors resulted in limited vendor access to future ACR guideline updates

<table>
<thead>
<tr>
<th>Month</th>
<th>Unique CDS Users</th>
<th>CDS Consult Started</th>
<th>CDS Orders Submitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov '14</td>
<td>10</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Dec '14</td>
<td>5</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Jan '15</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

Summary: Over three months, 20 unique users engaged the system 22 times, but only submitted 4 orders through the CDS interface. During the same period, over 1900 applicable outpatient radiology orders were submitted without CDS.

Product deemed ineffective and decommissioned 4 months after go-live.

Take Home Points

1. Installing a Radiology CDS is a complex undertaking
   - Take steps to ensure compatibility with existing systems
   - Consider engaging third party expert prior to implementation, particularly if organizational resources are limited
   - Choose vendor with proven integration to existing EHR/RIS

2. Define objectives and outcomes clearly prior to installation
   - Set clear clinical and administrative goals
   - Engage ordering clinicians to establish targets for certain tests or clinical scenarios

3. Despite challenges with our installation, the future potential of Radiology CDS deemed essential within our organization.
   - Data mining of EHR with natural language processing algorithms to identify relevant clinical and safety information (e.g. MRI hazards, contrast allergies)
   - Potential to negate need for preauthorization if appropriateness criteria met
     - Automatic documentation of adherence to guidelines
     - Minimize unnecessary or inappropriate exams

4. Choose vendor positioned to withstand future economic and regulatory changes.
References

- http://www.healthit.gov/policy-researchers-implementers/clinical-decision-support-cds