Agile Clinical Decision Support

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Disclosure

• We and our partners have no relevant relationships with commercial interests to disclose.
UT Southwestern Health System

William P. Clements Jr. University Hospital

- 604 Beds
- 1700 Physicians
- 40+ Clinics
- 23,132 Admissions
- 40,813 ED Visits
- 7947 Inpatient Surgeries

Academic Medical Center in Dallas
Partnered with Texas Health Resources

West Campus Professional Building 1
Radiation Oncology Facility
Moncrief Medical Center at Fort Worth
Clinical Decision Support (CDS)

- Types of CDS
- Alerts
  - Clinical practice alerts
  - Med alerts
  - Duplicate alerts
- Order sets
- Health maintenance reminders
- Order questions
- Reports
- Reference information

- Effective CDS Guiding principle “Do CDS with users, not to users”
Challenges Faced in Creating Clinical Decision Support Tools

- Differing understanding of intended solution among stakeholders
- Complexity
- Evolving requirements
Agile Methods for Clinical Decision Support Development
Benefits of Agile CDS Development

- Shared understanding
- Rapid-cycle time-boxed development
- Agility in responding to evolving requirements
Lightweight Requirements with User Stories

• A user story is a brief statement of intent that describes something the system needs to do for the user.

<table>
<thead>
<tr>
<th>Story Title:</th>
<th>&lt;short name&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>As a</td>
<td>&lt;role&gt;</td>
</tr>
<tr>
<td>I want</td>
<td>&lt;something&gt;</td>
</tr>
<tr>
<td>so that</td>
<td>&lt;a benefit can be achieved&gt;</td>
</tr>
</tbody>
</table>

• Some advantages:
  o Short, easy to read
  o Understandable to developers, stakeholders, and users
  o Focuses on customer and value to be delivered:
    • “who”, “what”, and “why” in one sentence.
Acceptance criteria for a CDS User Story

• Acceptance criteria
  o “conditions of satisfaction” for customer
  o Definition of success
• Can be any/all of:
  o simple bulleted list
  o set of Acceptance Tests
  o CDS “Five Rights”

• CDS “Five Rights”
  o The right information
    evidence-based, suitable to guide action, pertinent to circumstance
  o to the right person
    considering all care team members, patients, and their caretakers
  o in the right CDS intervention format
    Alert, order set, documentation tool, data display/report, reference information
  o through the right channel
    e.g., through EHR, patient portal, or more general channel such as a website or mobile app
  o at the right time in workflow
    when it is most needed to make a decision or take action
User Story

As a specialist caring for patients with Rheumatoid Arthritis,
I want to be alerted when such a patient is not on DMARD
so that I can increase the percentage of my patients on optimal medical treatment for rheumatoid arthritis.

Acceptance Criteria

• Alert to prompt ordering of DMARD on patients with rheumatoid arthritis
• Alert fires for patients with rheumatoid arthritis on their Problem List in the EHR (based on SNOMED)
• Alert does not fire if a DMARD medication is already on their active medication list
• Alert allows designation of reasons why the patient is an exception, and should not be on a DMARD currently
• Tipsheet to train on use of alert
Agile Modeling
Agile Modeling

• Why Model?
  o To understand
  o To communicate

• ‘Agile Modeling’ goal: high value for degree of model creation effort expended

• Agile Modeling core practices include:
  o Active Stakeholder Participation
  o Model With Others
  o Apply the Right Artifact(s)
  o Use the Simplest Tools
  o Model in Small Increments
  o Create Simple Content
Rheumatoid Arthritis: CDS (Best Practice Advisory)

BPA Trigger criteria met (provider, Rheumatology)

Rheumatoid Arthritis on the problem list

Yes

On DMARD

Yes

No

Don’t display BPA

Display BPA to prompt ordering of DMARD

No

No

Yes

This patient has an active problem of rheumatoid arthritis but is not currently prescribed a DMARD.

Acknowledge reason:

- Medical Reason
- System Reason
- Insurance/Cost

Prescribe DMARD

Accept & Stay  Accept  Cancel
Use Case Diagram for an Osteoporosis Registry: Data Collection

Purpose:

- Show “verbs” (uses) of the system, organized by role.
- No sequence or timing implied.
- A graphical table-of-contents of Use Cases.
Solution Object Diagram

Purpose:
Depict the software objects (records) to be built or employed in our EHR, and how they relate to one another, as a road-map for understanding the detailed design.
Useful tools

• Requirements Discovery: what’s the destination?

<table>
<thead>
<tr>
<th>Question</th>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who, what, and why?</td>
<td>User Story</td>
</tr>
<tr>
<td>Rest of CDS “5 rights”, other success descriptions</td>
<td>Acceptance Criteria</td>
</tr>
</tbody>
</table>

• 4 practical “agile modeling” goals & tools: what’s the map to the destination?

<table>
<thead>
<tr>
<th>Question</th>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where does this CDS fit in the bigger picture?</td>
<td>Swimlane or Use case diagram</td>
</tr>
<tr>
<td>Under what circumstances should it appear?</td>
<td>Decision tree</td>
</tr>
<tr>
<td>Once displayed, what happens when used?</td>
<td>UI mockup with Use case text</td>
</tr>
<tr>
<td>What do you need to build in your EMR?</td>
<td>Object diagram</td>
</tr>
</tbody>
</table>
Acceptance Test-Driven Development
Test-Driven Development

• What it is
  o Specify software behavior first, in a testable manner
  o Then build until the test(s) pass
  o “Make it work, then make it better”: “Red-Green-Refactor”

• Encourages
  o Simple design
  o Confidence

• Builds up a regression test suite automatically

• Acceptance Test-Driven Development = “Executable Requirements”
FIT = Framework for Integrated Testing

FitNesse is a HTML wiki based open-source “front-end” to FIT

Guarantee business rules
Automated Acceptance Testing and FitNesse

User Story
As a ___, I want to be able to ____ so that ____.

Fit Table (Test Case)

Expected Output = Actual Output

Expected Output ≠ Actual Output

### CKD CDS FitNesse

<table>
<thead>
<tr>
<th>Test</th>
<th>Pages:</th>
<th>Right,</th>
<th>Wrong,</th>
<th>Ignored,</th>
<th>Exceptions</th>
<th>Assertions:</th>
<th>Right,</th>
<th>Wrong,</th>
<th>Ignored,</th>
<th>Exceptions</th>
<th>(Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No BPA</strong></td>
<td></td>
<td>0, 1</td>
<td>0, 0</td>
<td>0, 0</td>
<td>0</td>
<td></td>
<td>0, 19</td>
<td>0, 0</td>
<td>0, 0</td>
<td>0</td>
<td>0.967</td>
</tr>
<tr>
<td><strong>Pre-Build</strong></td>
<td>Query:</td>
<td>SELECT LTRIM([Line]) AS [Line], LTRIM(TRIM(ISNULL(EncType, 'n/a'))) AS EncType, LTRIM(TRIM(ISNULL(DepSpec, 'n/a'))) AS DepSpec FROM [Table] WHERE [Conditions]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line</td>
<td>EncType</td>
<td>DepSpec</td>
<td>Department?</td>
<td>Provider Type?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Office Visit</td>
<td>Kidney Panc Transplant</td>
<td>n/a</td>
<td>Physician</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Office Visit</td>
<td>Nephrology</td>
<td>n/a</td>
<td>Physician</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **BPA with Errors** | Test Pages: | 0 right, 1 wrong, 0 ignored, 0 exceptions | Assertions: | 49 right, 2 wrong, 0 ignored, 0 exceptions | (0.734 seconds) | |
| Initial Build | | | | | | |
| Line | EncType | DepSpec | Department? | Provider Type? |
| 1 | Office Visit | Kidney Panc Transplant | n/a | Physician |
| 2 | Office Visit | Renal expected | n/a | Physician |
| | | Nephrology actual | | |

| **Correct BPA** | Test Pages: | 1 right, 0 wrong, 0 ignored, 0 exceptions | Assertions: | 51 right, 0 wrong, 0 ignored, 0 exceptions | (0.689 seconds) | |
| Final Build | | | | | | |
| Line | EncType | DepSpec | Department? | Provider Type? |
| 1 | Office Visit | Kidney Panc Transplant | n/a | Physician |
| 2 | Office Visit | Nephrology | n/a | Physician |
## Fault Handling

### Test Summaries

<table>
<thead>
<tr>
<th>Parent Incident</th>
<th>FIT Name</th>
<th>Initial Records</th>
<th>2017,06</th>
<th>2017,07</th>
<th>2017,08</th>
<th>Total</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>INC0653546</td>
<td>FIT0653546:OR Procedure records without SHx/EAP value</td>
<td>2012</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2012</td>
<td>0</td>
</tr>
<tr>
<td>INC0656674</td>
<td>FIT0656674:Test patients but do not conform to ZZZTEST as the last name</td>
<td>88</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>88</td>
<td>0</td>
</tr>
<tr>
<td>INC0656678</td>
<td>FIT0656678:Patients with a last name like test but not marked as test patient</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>INC0657263</td>
<td>FIT0657263:Individual statin medication records not in groupers that identify whether</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>INC0657288</td>
<td>FIT0657288: E-Prescribe flag set to “Y” for ordering 25 or more prescriptions in Epic</td>
<td>18</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>47</td>
<td>0</td>
</tr>
<tr>
<td>INC0678844</td>
<td>FIT0678844:Radiology departments missing vital items - facility, center, rev location</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>INC0683631</td>
<td>FIT0683631:Test of POS Business Rule</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>51</td>
<td>0</td>
</tr>
<tr>
<td>INC0683633</td>
<td>FIT0683633:Test to find out if 205 = 14 or if 5012 = 76 or 99 for Radiology procedure</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>INC0683635</td>
<td>FIT0683635:Test to find Visit Types that are active but not attached to a correct EAP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>INC0683641</td>
<td>FIT0683641:Test of PRL Business Rule</td>
<td>114</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>114</td>
<td>0</td>
</tr>
<tr>
<td>INC0683645</td>
<td>FIT0683645:Test of POS Business Rule</td>
<td>27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td>INC0683647</td>
<td>FIT0683647:Test of PRL Business Rule + HCM Metadata records</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>INC0699493</td>
<td>FIT0699493:MSDRG Grouper 1 check</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>INC0700559</td>
<td>FIT0700559:Billing providers with grouper 9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
CDS Monitoring
CDS Failure

**Overexpression**
CDS displaying for patient that it is not supposed to (false positive)

**Under expression**
CDS not displaying for patient that it is supposed to (false negative)
Alert Display Data Model

- Grain: 1 row per Alert Display Event
- Event context of interest:
  - Date?
  - Which alert?
  - Which user?
  - In what patient location?
  - What encounter type?
  - How was it triggered?
  - With what user response?
Power BI Dashboard: “Top 10 Alerts”
I conclude that though the individual physician is not perfectible, the system of care is, and that the computer will play a major part in the perfection of future care systems.

~ Clem McDonald, MD NEJM 1976
Rheumatoid Arthritis: Quality Measurement & Improvement

- DMARD Compliance:
  - 96.3 → 98.6
  - 3.7 → 1.4 Defect

- CDAI Assessment:
  - 42.7 → 80.9

- CDAI Score Severity: Low
  - Disease Activity (> 2.8 and <= 10)
  - 38.6 → 42.3

- CDAI Score Severity: High
  - Disease Activity (> 22)
  - 13.7 → 10.1
Provider Dashboard

CDAI Assessment

Report completed: Tue 9/19 08:48 AM

Number of patients with CDAI assessment of low, moderate, and high; grouped by gender.

Ambulatory Quality Metrics

This component displays data on local quality measures from enterprise data warehouse for the Rheumatology

Clinic: Rheumatology
Registry: Rheumatology
Measure: CDAI Assessment

<table>
<thead>
<tr>
<th>Month</th>
<th>Percent</th>
<th>Numerator</th>
<th>Denominator</th>
<th>Exclusion</th>
<th>Percent</th>
<th>Numerator</th>
<th>Denominator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct-16</td>
<td>95%</td>
<td>40</td>
<td>40</td>
<td>0</td>
<td>60%</td>
<td>314</td>
<td>371</td>
</tr>
<tr>
<td>Nov-16</td>
<td>95%</td>
<td>45</td>
<td>40</td>
<td>0</td>
<td>63%</td>
<td>335</td>
<td>371</td>
</tr>
<tr>
<td>Dec-16</td>
<td>100%</td>
<td>40</td>
<td>40</td>
<td>0</td>
<td>70%</td>
<td>371</td>
<td>371</td>
</tr>
<tr>
<td>Jan-17</td>
<td>100%</td>
<td>43</td>
<td>43</td>
<td>0</td>
<td>75%</td>
<td>384</td>
<td>416</td>
</tr>
<tr>
<td>Feb-17</td>
<td>100%</td>
<td>43</td>
<td>43</td>
<td>0</td>
<td>77%</td>
<td>416</td>
<td>416</td>
</tr>
</tbody>
</table>
As a ___, I want to be able to ____ so that ____.
Questions

• Contact us at:
  o Mujeeb.Basit@UTSouthwestern.edu
  o Vaishnavi.Kannan@UTSouthwestern.edu
  o Duwayne.Willett@UTSouthwestern.edu

• Thank you!