Real-Time Critical Values Monitoring System

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Background

• Timely critical result notification to caregivers is necessary for patient care and accreditation compliance.

• Improvements in alerting laboratory staff of unreported critical values could improve time to communication and reduce call back failures.
Objective

• Develop an automated system that detects and displays to laboratory staff pending critical results that are awaiting communication to the caregivers.
Result Verification

- Only a small number of autoverification failures are critical results.
- The technologist must scroll through autoverification failures sequentially.
- Once a critical result is encountered (in LIS) the laboratory has 30 minutes to notify the caregiver.
- After a critical result is reported, the technologist appends a “modifier” in LIS indicating that the result has been called.
- Technologists do not have the ability to look ahead at other potentially critical results within the batch.
Real-Time Critical Values Monitoring System Design – System Overview

- Laboratory Information System (Sunquest)
- Application Server (Windows Service)
- Web Server (Windows Server)
- SQL Database Server
- SCALA - Player
- Digital Display
- PC – Web Access

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A Windows Service (.NET) on Application Server, continuously queries the LIS (Sunquest) for Potassium (K) and Glucose (GLU) results.

Results are stored in an SQL Server database for display by the website if they:
- fall in the critical value range AND
- lack a “called back” modifier in LIS
Design – Database Structure

- **CVTests** – Configurable list of test codes used by the Windows Service to query LIS.

- **ExtractionLog** – Last unreported critical result set to be displayed on the website.

- **ClearETCCodes** – A predefined set of ETC codes denoting if a “call” has been made to the ordering physician. (i.e., reported result)
Design – Web Server/Site

- Internet Information Services (6.0) running on Windows Server 2005.

- The latest query results of the unreported critical values are read from the SQL Server Database [ExtractionLog table].
Design – “Putting It All Together”

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Sample – Display Site

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Pathology and Laboratory Medicine

Critical Values Monitor

Current Date/Time: 09/27/2012 10:46
Last Sunquest Update: 09/27/2012 10:44

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td>128</td>
<td></td>
<td>DIUR</td>
<td>09/27/2012 10:00</td>
<td>09/27/2012 10:05</td>
<td>2.1</td>
<td></td>
<td>45</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>K</td>
<td>1452</td>
<td></td>
<td>DIUR</td>
<td>09/27/2012 10:16</td>
<td>09/27/2012 10:33</td>
<td>1.9</td>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>1450</td>
<td></td>
<td>DIUR</td>
<td>09/27/2012 10:25</td>
<td>09/27/2012 10:30</td>
<td>2.4</td>
<td></td>
<td>20</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>GLU</td>
<td>115</td>
<td></td>
<td>DIUR</td>
<td>09/27/2012 10:34</td>
<td>09/27/2012 10:34</td>
<td>41</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exception Log

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Results awaiting communication to the caregivers are grouped by test and displayed in chronological order (based on the difference between the current time and the “Instrument Post Time”).

<table>
<thead>
<tr>
<th>Post D/T</th>
<th>Result D/T</th>
<th>Result</th>
<th>Result Modifiers</th>
<th>Minutes Since Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/27/2012 10:00</td>
<td>09/27/2012 10:05</td>
<td>2.1</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>09/27/2012 10:15</td>
<td>09/27/2012 10:33</td>
<td>1.9</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>09/27/2012 10:25</td>
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<td></td>
<td>20</td>
</tr>
<tr>
<td>09/27/2012 10:34</td>
<td>09/27/2012 10:34</td>
<td>41</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Acc. No.</td>
<td>Test Code</td>
<td>CID</td>
<td>Cup No.</td>
<td>Result Method</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
<td>-----</td>
<td>---------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td></td>
<td>1450</td>
<td>DIUR</td>
</tr>
</tbody>
</table>

- Results awaiting communication which are < 30 “Minutes Since Measurement” will display as yellow, indicating they are not yet late but require attention.
Results awaiting communication which are > 30 “Minutes Since Measurement” will display as red, indicating they have surpassed the laboratory designated target for reporting.
Clearing Results

- After caregiver notification, the technologist appends one of the several possible “Call Back” codes to the result in LIS.

- The next query iteration from the Windows Service will consider this result as reported and will not store it in the database.

- Therefore, the “Called Back” result will not display the next time the website refreshes.
Results

• Over 3.5 million ‘K’ and ‘GLU’ results processed (Feb. – July 2012).

• 835 results/hr were analyzed, of which 1.7 results/hr were displayed as critical.

• For outpatient, where timely communication is more difficult than for inpatient:
  - Laboratory met targets (92% within 30 minutes) in 5 of 6 months (83%), vs. only 3 of 6 months (50%) for the same months in 2011.

• For inpatient:
  - Laboratory met targets in all 6 months (100%), vs. 5 of 6 months (83%) in 2011.
Conclusions

• We developed an automated system that detects critical results not yet communicated to caregivers and displays them efficiently to laboratory staff through a web browser.

• Post-implementation, the laboratory realized improvements in meeting targets for critical value reporting time.

• The design paradigm may be extended to “urgent” results as well.
Real-Time Critical Values Monitoring System

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