Utilizing Automated Adverse Event Detection

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September 13th, 2010
What are the problems with Manual Trigger Methods?

• Small sample size
• Subject to errors in detection
• Resource intensive
Benefits of using an electronic trigger system?

• Focused chart review
  – Less Time
  – Less expense

• Better accuracy
  – Electronic detection
  – Repeatability and therefore reliability

• Higher capture rates
  – Better positive predictive value

• Improved detection of preventable errors
  – Better able to correct process problems
  – Quality assurance/quality control
Daily electronic query of the Hospital EMR for previous 24 hrs identifying presence of any trigger

Electronic report created

Each trigger pts EMR reviewed

Trigger represents adverse event?

Yes, adverse event → Preventable or non-preventable?

No, false positive

Level of harm/severity?

Severe (≥ Level 5): Enter Incident Report & Alert Safety Team Immediately

Less Severe (≤ Level 5) Enter Incident Report

Serious events investigated by Safety Team

Trends identified and presented to relevant clinical teams

Review all events at Monthly AAED Steering Committee Adjust preventability or severity as identified

Monthly reports to all Inpatient Units

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Less Severe (≤ Level 5) Enter Incident Report

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Inclusion Criteria

- Electronically identifiable
- Frequency of trigger
- Favorable positive predictive value of detecting an adverse event
- Anticipated serious level of harm
- Expected adverse events are not being investigated by other teams at local institution
## Trigger Utilization

<table>
<thead>
<tr>
<th>Children’s National Medical Center</th>
<th>Active/Retired</th>
<th>Months in use</th>
<th>Adverse Event Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medication Administration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digoxin immune fab</td>
<td>Active</td>
<td>36</td>
<td>Digoxin overdose/overuse</td>
</tr>
<tr>
<td>Flumazenil</td>
<td>Active</td>
<td>36</td>
<td>Benzodiazepine over-sedation</td>
</tr>
<tr>
<td>Hyaluronidase</td>
<td>Active</td>
<td>18</td>
<td>Limit impact of IV Infiltrate</td>
</tr>
<tr>
<td>Kayexalate</td>
<td>Retired</td>
<td>9</td>
<td>Potassium supplements or potassium sparing medication overdose/overuse</td>
</tr>
<tr>
<td>Naloxone</td>
<td>Active</td>
<td>36</td>
<td>Opiate over-sedation</td>
</tr>
<tr>
<td>Protamine</td>
<td>Active</td>
<td>36</td>
<td>Heparin overdose/overuse</td>
</tr>
<tr>
<td><strong>Laboratory Value</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti Factor Xa &gt; 1.5</td>
<td>Active</td>
<td>18</td>
<td>LMWH Overdose/overuse</td>
</tr>
<tr>
<td>(aPTT) &gt; 100 seconds</td>
<td>Active</td>
<td>27</td>
<td>Heparin overdose/overuse</td>
</tr>
<tr>
<td>Bilirubin &gt; 25 mg/dl</td>
<td>Active</td>
<td>14</td>
<td>Management of neonatal hyperbilirubinemia</td>
</tr>
<tr>
<td>Creatinine Doubling from Baseline</td>
<td>Active</td>
<td>10</td>
<td>Impact of nephrotoxic medications</td>
</tr>
<tr>
<td>Glucose &lt; 50 mg/dL</td>
<td>Active</td>
<td>36</td>
<td>Hypoglycemia related to care</td>
</tr>
<tr>
<td>international normalized ratio (INR) &gt; 4.0</td>
<td>Active</td>
<td>27</td>
<td>Warfarin overdose/overuse</td>
</tr>
<tr>
<td>Ionized calcium (iCal)&gt; 1.5 mmol/L</td>
<td>Retired</td>
<td>10</td>
<td>Calcium supplement overdose/overuse</td>
</tr>
<tr>
<td>Potassium &gt; 6.0 mmol/L</td>
<td>Retired</td>
<td>9</td>
<td>Potassium supplements or potassium sparing medication overdose/overuse</td>
</tr>
</tbody>
</table>

<p>| <strong>Admission, Discharge, Transfer</strong> |                |               |                   |
| Transfer to an intensive care unit (ICU) | Active | 32            | Missed diagnosis/ appropriate discharge criteria not met |</p>
<table>
<thead>
<tr>
<th>NURSE_UNIT</th>
<th>FIN_NUMBER</th>
<th>MRN_NUMBER</th>
<th>LAB_TEST</th>
<th>ACC_NUM</th>
<th>RESULT_DT</th>
<th>RESULT_VAL</th>
<th>BASE_DT</th>
<th>BASE_VAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 21:00</td>
<td>1.3mg/dL</td>
<td>01/25/2010 18:35</td>
<td>0.6mg/dL</td>
</tr>
<tr>
<td>3E</td>
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<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/28/2010 05:56</td>
<td>0.7mg/dL</td>
<td>01/17/2010 00:42</td>
<td>0.3mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 03:47</td>
<td>1.2mg/dL</td>
<td>01/21/2010 03:37</td>
<td>0.5mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 13:13</td>
<td>1.2mg/dL</td>
<td>01/21/2010 03:37</td>
<td>0.5mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/28/2010 00:02</td>
<td>1.2mg/dL</td>
<td>01/21/2010 03:37</td>
<td>0.5mg/dL</td>
</tr>
<tr>
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<td>Creatinine result</td>
<td></td>
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<td>01/22/2010 03:36</td>
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<tr>
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<td>Creatinine result</td>
<td></td>
<td>01/27/2010 04:10</td>
<td>0.6mg/dL</td>
<td>12/16/2009 03:45</td>
<td>0.2mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/28/2010 03:52</td>
<td>0.6mg/dL</td>
<td>12/16/2009 03:45</td>
<td>0.2mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/26/2010 04:42</td>
<td>1.7mg/dL</td>
<td>01/06/2010 13:00</td>
<td>0.8mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 04:53</td>
<td>1.6mg/dL</td>
<td>01/07/2010 06:00</td>
<td>0.7mg/dL</td>
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<tr>
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<td>01/06/2010 13:00</td>
<td>0.8mg/dL</td>
</tr>
<tr>
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<td>Creatinine result</td>
<td></td>
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<td>1.7mg/dL</td>
<td>01/06/2010 13:00</td>
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<tr>
<td>3E</td>
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<td>Creatinine result</td>
<td></td>
<td>01/28/2010 05:46</td>
<td>1.0mg/dL</td>
<td>01/27/2009 16:41</td>
<td>0.3mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/26/2010 05:35</td>
<td>1.0mg/dL</td>
<td>01/27/2009 16:41</td>
<td>0.3mg/dL</td>
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<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 13:07</td>
<td>0.9mg/dL</td>
<td>01/27/2009 16:41</td>
<td>0.3mg/dL</td>
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<tr>
<td>3E</td>
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<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 13:07</td>
<td>0.9mg/dL</td>
<td>01/27/2009 16:41</td>
<td>0.3mg/dL</td>
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<td>3E</td>
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<td></td>
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<td></td>
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<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/26/2010 06:00</td>
<td>0.7mg/dL</td>
<td>01/03/2010 04:29</td>
<td>0.3mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 05:45</td>
<td>0.8mg/dL</td>
<td>01/03/2010 04:29</td>
<td>0.3mg/dL</td>
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<td></td>
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<td>0.7mg/dL</td>
<td>01/03/2010 04:29</td>
<td>0.3mg/dL</td>
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<td></td>
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<td></td>
<td>01/28/2010 05:47</td>
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<td>01/03/2010 04:29</td>
<td>0.3mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 08:21</td>
<td>2.0mg/dL</td>
<td>06/12/2009 18:02</td>
<td>0.8mg/dL</td>
</tr>
<tr>
<td>3E</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 17:45</td>
<td>2.1mg/dL</td>
<td>06/12/2009 18:02</td>
<td>0.8mg/dL</td>
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<tr>
<td>3E</td>
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<td></td>
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<td></td>
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<td>1.9mg/dL</td>
<td>01/10/2010 04:38</td>
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</tr>
<tr>
<td>MCY</td>
<td></td>
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<td>Creatinine result</td>
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<td>01/26/2010 05:42</td>
<td>0.6mg/dL</td>
<td>01/03/2010 05:46</td>
<td>0.2mg/dL</td>
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<tr>
<td>PI2</td>
<td></td>
<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/26/2010 04:26</td>
<td>0.6mg/dL</td>
<td>01/16/2010 20:30</td>
<td>0.2mg/dL</td>
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<td>PI2</td>
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<td></td>
<td>Creatinine result</td>
<td></td>
<td>01/27/2010 07:00</td>
<td>0.7mg/dL</td>
<td>01/16/2010 20:30</td>
<td>0.2mg/dL</td>
</tr>
</tbody>
</table>
July Harm and Preventability

- Triggers: 197
- Adverse Events Detected: 95
  - Preventability:
    - Preventable Adverse events: 20
    - Non Preventable : 75
  - Harm and Severity:
    - Increased need for monitoring: 29
    - Need for treatment or intervention and caused temporary patient harm: 57
    - Prolonged hospitalization and caused temporary patient harm: 9

- Voluntary incidents reported for July: 3
Summary Harm and Preventability (09/04/07 – 07/31/10)

- Triggers: 7457
  - 31 triggers/1000 Pt days
  - 18 triggers/100 Pt admissions
- Adverse Events Detected: 1681
  - Preventability:
    - Preventable adverse events: 487
    - Non-Preventable: 1194
  - Harm and Severity:
    - Incident reached patient but not caused harm: 3
    - Increased monitoring but no harm: 405
    - Need for treatment/intervention and caused temporary patient harm: 1135
    - Prolonged hospitalization caused temporary patient harm: 138
- Voluntary Incidents written on Same events: 57
## AAEDC Electronic Trigger Yield
### July Data

<table>
<thead>
<tr>
<th>Electronic Trigger</th>
<th>Frequency</th>
<th>Adverse Events (PPV%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digibind</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Naloxone</td>
<td>5</td>
<td>5 (100%)</td>
</tr>
<tr>
<td>Protamine</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Flumazenil</td>
<td>1</td>
<td>1 (100%)</td>
</tr>
<tr>
<td>Hyaluronidase</td>
<td>3</td>
<td>2 (66.6%)</td>
</tr>
<tr>
<td>Glucose &lt; 50 mg/dl</td>
<td>59</td>
<td>18 (30.5%)</td>
</tr>
<tr>
<td>PTT &gt; 100 sec</td>
<td>36</td>
<td>25 (69.4%)</td>
</tr>
<tr>
<td>INR &gt; 4.0</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Anti Factor Xa &gt; 1.5</td>
<td>1</td>
<td>1 (100%)</td>
</tr>
<tr>
<td>Creatinine Doubling</td>
<td>36</td>
<td>32 (88.8%)</td>
</tr>
<tr>
<td>Bilirubin &gt; 25 mg/dl</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Transfers to the ICU</td>
<td>47</td>
<td>11 (23.4%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>197</strong></td>
<td><strong>95 (48.2%)</strong></td>
</tr>
</tbody>
</table>
## AAEDC Electronic Trigger Yield Summary Data (09/04/07- 07/31/10)

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<tr>
<th>Electronic Trigger</th>
<th>Frequency</th>
<th>Adverse Events (PPV%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digibind</td>
<td>2</td>
<td>1(50%)</td>
</tr>
<tr>
<td>Naloxone</td>
<td>71</td>
<td>57(80.2%)</td>
</tr>
<tr>
<td>Protamine</td>
<td>60</td>
<td>5(8.3%)</td>
</tr>
<tr>
<td>Flumazenil</td>
<td>8</td>
<td>5(62.5%)</td>
</tr>
<tr>
<td>Hyaluronidase</td>
<td>26</td>
<td>25(96.1%)</td>
</tr>
<tr>
<td>Glucose &lt; 50 mg/dL</td>
<td>3526</td>
<td>740(21%)</td>
</tr>
<tr>
<td>PTT &gt; 100 sec</td>
<td>753</td>
<td>364(48.3%)</td>
</tr>
<tr>
<td>INR &gt; 4.0</td>
<td>285</td>
<td>31(10.8%)</td>
</tr>
<tr>
<td>Anti Factor Xa &gt; 1.5</td>
<td>5</td>
<td>4(80%)</td>
</tr>
<tr>
<td>Creatinine Doubling</td>
<td>369</td>
<td>138(37.3%)</td>
</tr>
<tr>
<td>Bilirubin &gt; 25 mg/dL</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Transfers to the ICU</td>
<td>1164</td>
<td>243(20.8%)</td>
</tr>
<tr>
<td>R’td* I.cal; K+; Kayexalate</td>
<td>1182</td>
<td>68(5.75%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>7457</strong></td>
<td><strong>1681(22.5%)</strong></td>
</tr>
</tbody>
</table>
Preventable Events/Month (%)
<table>
<thead>
<tr>
<th>Electronic Trigger</th>
<th>Associated Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digibind</td>
<td>Units identified as appropriate</td>
</tr>
<tr>
<td>Naloxone</td>
<td>Sedation Committee&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>Protamine</td>
<td>Anticoagulation Task Force&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>Flumazenil</td>
<td>Sedation Committee&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>Hyaluronidase</td>
<td>Units identified as appropriate</td>
</tr>
<tr>
<td>Glucose &lt; 50 mg/dL</td>
<td>Endocrinology&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>PTT &gt; 100 sec</td>
<td>Anticoagulation Task Force&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>INR &gt; 4.0</td>
<td>Anticoagulation Task Force&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>Anti Factor Xa &gt; 1.5</td>
<td>Anticoagulation Task Force&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>Creatinine doubling</td>
<td>Nephrology&lt;br&gt;Radiology (Contrast Cases)&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>Bilirubin &gt; 25 mg/dL</td>
<td>Neonatology&lt;br&gt;Units identified as appropriate</td>
</tr>
<tr>
<td>Transfers to the ICU</td>
<td>Units identified as appropriate</td>
</tr>
</tbody>
</table>
July-Creatinine Doubling (T=32)

July-Creatinine AE'S (T=32)

NICU CICU PICU HKU HOC NCU 7 East

Patients AE'S Prevent Non Preven
Actions Performed (2007-2010)

- After incidents of hypoglycemia and trends identified, insulin use and glucose variability presented to NICU physicians and nurses
  - New Insulin Protocol implemented as a result of the presented information

- Frequent events noted with over sedation during NICU PICC Placement and subsequent Narcan use, these findings were presented to the physician leadership
  - Currently with less events

- Trends identified with increased Narcan administration in patients using PCAs.
  - Complete review of the PCA ordering process, nursing practices and improved monitoring of clinical outcomes.
  - This comprehensive analysis and subsequent interventions appears to have resulted in less events
Actions Performed (2007-2010)

- After identifying hyperkalemia as a result of ongoing potassium supplementation while on potassium wasting medications (amphotericin and its various forms as well as loop and thiazide diuretics). Once the potassium wasting medication was discontinued, often the potassium supplements were inadvertently continued resulting in hyperkalemia
  - Alerts created to identify this situation to the provider and avoid hyperkalemia

- Hypercalcemia trends identified in premature neonates receiving TPN
  - Resulted in closer monitoring of dosing by NICU dieticians
- Hypercalcemia trends identified in post operative cardiac neonates
  - Lower dosing of calcium supplements when coming off of cardiac bypass

- Anticoagulation Triggers have been implemented to address NPSGs
  - These triggers are reviewed by a multidisciplinary team to identify trends and areas for improvement.
  - CICU PICU HKU were presented on the protocol for heparin drip, sample obtaining procedure, and appropriate timing of Hematology consult.
Actions Performed (2007-2010)

- Actual real time interventions when the AAED Coordinator has alerted clinical team to an adverse event on their patient
  - Potentially dangerous INR value not recognized by clinical team and AAEDC Coordinator’s contact allowed caregivers to hold coumadin dose
  - Nursing administration error identified in coumadin patient leading to increased INRs. AAEDC Coordinator’s intervention gave and explanation for high INR values and allowed for improvement strategies in administration.
  - AAEDC Coordinator identified Narcan event not documented on MAR with a Code Blue Event. Documentation intervention with relevant parties

- Creatinine Trigger investigation involving unit based pharmacist notification with rise in creatinine for close watch on nephro toxic drugs.

- Interventions on process with Dextrose infusion along with Amphotericin infusion to prevent hypoglycemia.
Collaborative Participants

- Cerner
- FDA

- Children’s Hospital and Clinics of MN
- Children’s Hospital, Denver
- Children's Hospital, Los Angeles
- Children’s National
- Children's Mercy Hospital
- Cincinnati Children's Hospital
- Duke University Health System
- Helen DeVos Children's Hospital
- King’s Daughters Medical Center
- Lucile Packard Children's Hospital
- OLOLRMC Children’s Hospital
- Seattle Children’s Hospital
- Shriners Hospitals for Children
- St. Jude Children's Research Hospital
## Implementation Matrix

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<tr>
<th>Data Analysis</th>
<th>Implemented</th>
<th>Investigating</th>
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