Utilizing Automated Adverse Event Detection

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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

No, false positive

Preventable or non-preventable?

Serious events investigated by Safety Team

Level of harm/severity?

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

Less Severe (≤ Level 5) Enter Incident Report

Trends identified and presented to relevant clinical teams

Monthly reports to all Inpatient Units

Preventable or non-preventable?

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

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Preventable or non-preventable?

Level of harm/severity?
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>
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<tbody>
<tr>
<td><strong>Medication Administration</strong></td>
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<tr>
<td>Digoxin immune fab</td>
<td>Active</td>
<td>34</td>
<td>Digoxin overdose/overuse</td>
</tr>
<tr>
<td>Flumazenil</td>
<td>Active</td>
<td>34</td>
<td>Benzodiazepine over-sedation</td>
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<tr>
<td>Hyaluronidase</td>
<td>Active</td>
<td>16</td>
<td>Limit impact of IV Infiltrate</td>
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<tr>
<td>Kayexalate</td>
<td>Retired</td>
<td>34</td>
<td>Potassium supplements or potassium sparing medication overdose/overuse</td>
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<tr>
<td>Naloxone</td>
<td>Active</td>
<td>34</td>
<td>Opiate over-sedation</td>
</tr>
<tr>
<td>Protamine</td>
<td>Active</td>
<td>34</td>
<td>Heparin overdose/overuse</td>
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<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>16</td>
<td>LMWH Overdose/overuse</td>
</tr>
<tr>
<td>(aPTT) &gt; 100 seconds</td>
<td>Active</td>
<td>25</td>
<td>Heparin overdose/overuse</td>
</tr>
<tr>
<td>Bilirubin &gt; 25 mg/dl</td>
<td>Active</td>
<td>12</td>
<td>Management of neonatal hyperbilirubinemia</td>
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<tr>
<td>Creatinine Doubling from Baseline</td>
<td>Active</td>
<td>8</td>
<td>Impact of nephrotoxic medications</td>
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<tr>
<td>Glucose &lt; 50 mg/dL</td>
<td>Active</td>
<td>34</td>
<td>Hypoglycemia related to care</td>
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<td>international normalized ratio (INR) &gt; 4.0</td>
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<td>Warfarin overdose/overuse</td>
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<td>Ionized calcium (iCal)&gt; 1.5 mmol/L</td>
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<td>Calcium supplement overdose/overuse</td>
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<td>Potassium &gt; 6.0 mmol/L</td>
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<td>Potassium supplements or potassium sparing medication overdose/overuse</td>
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<tr>
<td><strong>Admission, Discharge, Transfer</strong></td>
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<tr>
<td>Transfer to an intensive care unit (ICU)</td>
<td>Active</td>
<td>30</td>
<td>Missed diagnosis/ appropriate discharge criteria not met</td>
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AAED Reports

AntiXa (LMWH) Results
Calcium Results
Creatinine Report
Digibind Orders
Glucose Results
Hyaluronidase Orders
INR Results
Kayexalate Orders
Narcotic Antagonist Orders
PTT Results
Patient Readmissions
Patient Transfers
Potassium Results
Protamine Orders
Total Bili Report

Creatinine Report
Dietary Labels & Reports
ED Reports
Imaging - Document
Infectious Disease Reports
Nursing Reports
Other Clinical Reports
Physician Fax Notification
Rad Reports
Respiratory Therapy Reports
Surgery Reports
User Position Maintenance

Personal Menu
Recent Programs
Patient Transfers
PTT Results
Narcotic Antagonist Orders
Patient Readmissions
Digibind Orders
Hyaluronidase Orders
Glucose Results
AntiXa (LMWH) Results
<table>
<thead>
<tr>
<th>NURSE_UNIT</th>
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<th>MNF_NUMBER</th>
<th>LAB_TEST</th>
<th>ACC_NUM</th>
<th>RESULT_DT</th>
<th>RESULT_VAL</th>
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June Harm and Preventability

- Triggers: 212
- Adverse Events Detected: 99

- Preventability:
  - Preventable Adverse events: 14
  - Non Preventable: 85

- Harm and Severity:
  - Increased need for monitoring: 51
  - Need for treatment or intervention and caused temporary patient harm: 42
  - Prolonged hospitalization and caused temporary patient harm: 6

- Voluntary incidents reported for June: 3
Summary of All Adverse Events
(09/04/07 – 06/30/10)

• Triggers: 7260
  – 32 triggers/1000 Pt days
  – 18 triggers/100 Pt admissions

• Adverse Events Detected: 1580

• Preventability
  – Preventable adverse events: 471
  – Non-Preventable: 1109

• Harm and Severity
  – Incident reached patient but not caused harm: 3
  – Increased monitoring but no harm: 376
  – Need for treatment/intervention and caused temporary patient harm: 1072
  – Prolonged hospitalization caused temporary patient harm: 129

• Voluntary Incidents written on Same events: 54
## AAEDC Electronic Trigger Yield
### June 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>3</td>
<td>3 (100%)</td>
</tr>
<tr>
<td>Protamine</td>
<td>2</td>
<td>1 (50%)</td>
</tr>
<tr>
<td>Flumazenil</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hyaluronidase</td>
<td>1</td>
<td>1 (100%)</td>
</tr>
<tr>
<td>Glucose &lt; 50 mg/dl</td>
<td>71</td>
<td>15 (21.1%)</td>
</tr>
<tr>
<td>PTT &gt; 100 sec</td>
<td>14</td>
<td>8 (57.1%)</td>
</tr>
<tr>
<td>INR &gt; 4.0</td>
<td>4</td>
<td>1 (25%)</td>
</tr>
<tr>
<td>Anti Factor Xa &gt; 1.5</td>
<td>2</td>
<td>1 (50%)</td>
</tr>
<tr>
<td>Creatinine Doubling</td>
<td>67</td>
<td>62 (92.5%)</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>48</td>
<td>7 (14.5%)</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>212</strong></td>
<td><strong>99 (46.2%)</strong></td>
</tr>
</tbody>
</table>
# AAEDC Electronic Trigger Yield Summary Data (09/04/07 - 06/30/10)

<table>
<thead>
<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>66</td>
<td>52 (78.7%)</td>
</tr>
<tr>
<td>Protamine</td>
<td>59</td>
<td>5 (8.4%)</td>
</tr>
<tr>
<td>Flumazenil</td>
<td>7</td>
<td>4 (57.1%)</td>
</tr>
<tr>
<td>Hyaluronidase</td>
<td>23</td>
<td>23 (100%)</td>
</tr>
<tr>
<td>Glucose &lt; 50 mg/dL</td>
<td>3467</td>
<td>719 (20.7%)</td>
</tr>
<tr>
<td>PTT &gt; 100 sec</td>
<td>717</td>
<td>336 (46.8%)</td>
</tr>
<tr>
<td>INR &gt; 4.0</td>
<td>277</td>
<td>31 (11.1%)</td>
</tr>
<tr>
<td>Anti Factor Xa &gt; 1.5</td>
<td>4</td>
<td>3 (75%)</td>
</tr>
<tr>
<td>Creatinine Doubling</td>
<td>333</td>
<td>106 (31.8%)</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>1117</td>
<td>232 (20.7%)</td>
</tr>
<tr>
<td>Retired: iCal; K+; Kayexalate</td>
<td>1182</td>
<td>68 (5.75%)</td>
</tr>
<tr>
<td>Totals</td>
<td>7260</td>
<td>1580 (21.7%)</td>
</tr>
</tbody>
</table>
Preventable Events/Month (%)
FY10-Hypoglycemia Rates/100 Admissions

FY10-Hypoglycemia Prevent & Non Prevent Rates/100 admits

- **PAE's /100 Admits**
- **NPAE's/100 Admits**
June - Hypoglycemia

June Hypoglycemia (T=15)

- CICU: 2 Patients, 5 AE's, 5 Prevent, 5 Non Prevent
- 7 East: 1 Patients, 1 AE's, 1 Prevent, 4 Non Prevent
- NICU: 2 Patients, 2 AE's, 2 Prevent, 2 Non Prevent
- NCU: 2 Patients, 2 AE's, 2 Prevent, 2 Non Prevent
# June-Hypoglycemia

<table>
<thead>
<tr>
<th>UNIT</th>
<th>PREVENTABLE (7)</th>
<th>NON PREVENTABLE (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CICU-5</td>
<td>5 - Post op Hypoglycemia</td>
<td></td>
</tr>
<tr>
<td>7East-5</td>
<td>1 NPO for surgical procedure – Insulin</td>
<td>4 Insulin induced-SS protocol followed</td>
</tr>
<tr>
<td>NICU-3</td>
<td>1 Insulin drip infusing- PICC out</td>
<td>2 Hypoglycemia despite TPN infusing</td>
</tr>
<tr>
<td>NCU-2</td>
<td></td>
<td>2 Ketogenic diet</td>
</tr>
</tbody>
</table>

*www.childrensnational.org*
June PTT Events (T=8)

![Bar chart showing CICU and HKU events]

- CICU: 2 Patients, 4 AE's, 4 Prevent, 4 Non Prevent
- HKU: 3 Patients, 4 AE's, 4 Prevent, 4 Non Prevent
Transfers to ICU (T=7)
Transferred within 12 hrs of admission(3) & ICU Readmissions in 24 hrs (4)

June Transfers to ICU (T=7)

<table>
<thead>
<tr>
<th></th>
<th>AE's</th>
<th>Prev</th>
<th>Non Prev</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Resp dist, 1 Shock</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1 Resp dist 24hr readmit; 1 thrombus</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1 Sepsis-24hrs readmit</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1 resp dist-24hrs readmit</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

7 East
HKU
HOC
SCU
June - Creatinine 0.6 (T=62)

June-Creatinine AE's (T=62)

NICU  CICU  PI 2  HKU  HOC  6EN  PICU  7 East

patient's
AE's
Preve
Non Prevent
<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>
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)

- All inpatient units receive monthly reports on adverse events
  - Several interventions in floor admission criteria reviewed to improve appropriate placement of patients to the appropriate unit for their illness severity
    - Seizure floor admission criteria
    - Bacterial meningitis floor admission criteria
    - Electrolyte repletion floor admission criteria
  - Asthma floor admission criteria
    - Asthma patients: Question raised regarding the safety of continuous nebulization in children under age 5 years
    - Program was able to identify few children older than 2yrs old with asthma transferred to PICU soon after admission
    - Reviewing the data allowed patients older than 2 years to receive continuous Albuterol in a non-ICU setting
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

<table>
<thead>
<tr>
<th>Data Analysis</th>
<th>Implemented</th>
<th>Investigating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children’s Hospital and Clinics of MN</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Children's Hospital, Denver</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Children's Hospital Los Angeles</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Children’s National Medical Center</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Children's Mercy Hospital</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Cincinnati Children's Hospital</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Duke University Health System</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Helen DeVos Children's Hospital</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>King’s Daughters Medical Center</td>
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<td></td>
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<tr>
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<tr>
<td>OLOLRMC Children’s Hospital</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Seattle Children’s Hospital</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Shriners Hospitals for Children</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>St. Jude Children's Research Hospital</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>