Keeping Patients Safer Using Technology as Extra Eyes and Ears

Adalberto Torres, Jr., Daniela Melendez

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Disclosures

• No financial relationships to report.
Learning Objectives
After the presentation, the participant should be able to:

• Understand how a remote patient monitoring unit keeps patients safer

• Understand the functions, challenges, and opportunities of a remote patient monitoring unit
Nemours’ Hospitals

Opened October, 2012

Opened November, 2014
The Clinical Logistics Center (CLC)

Functions

• Clinical Paramedics
• Physiologic monitoring
• Protocol-driven responses
• Alarm escalation and redundancy
• Audiovisual communication

• Automated electronic surveillance of EMR
• Documentation compliance

Physiological Alarms

Pulse Oximetry Protocol

- If poor wave continues
  - Send to High Priority 3C, If no response after 30 min
  - Stop & inform
  - Change flow
- If no response
  - Call nurse
- If no one available
  - Call Pulse Flow Supervisor

Remember:
1. Ask DN if they want to contact the physician
2. Ask HR if they want to contact Leadership
3. Document non-compliance in 2410 if DN or nurse not called
Automated Electronic Surveillance

**CVL Infection (Central Venous Line Infections)**
- **Property 1:** Patient has a CVL (may be defined as a Central Venous Line, Peripherally Inserted Central Catheter, PICC, Implanted Port)
- **Property 2:** Patient has documented fever ≥100.4
- **Property 3:** Patient has elevated WBC (WBC is a component of a CBC)

**Score: 1 –**
Patient has a Central Venous Line (CVL)

**Intervention:**
- Place patient on watch list

**Score: 2 –**
Patient has a Central Venous Line
AND
Has a documented fever of 100.4 or greater  OR  Has an elevated White Blood Cell (WBC) count.

**Intervention:**
- Place patient on watch list, if not there already

**Score: 3 –**
Patient has a Central Venous Line
AND
Has a documented fever of 100.4 or greater
AND
Has an elevated White Blood Cell (WBC) count

**Intervention:**
- Check Medication administration record (MAR) for Vancomycin or Zosyn order.
  - **NOTE:** For Hematic patients look for Cefepime.
  - If no order present, notify MD of triggered CVL infection rule and request an order for antibiotic.
  - Send email to Director of Infection Control (Lydia Edwards)
Clinical Rules Surveyed by Epic Monitor

- **CLABSI** — Central Line Associated Bloodstream Infection
- **CAUTI** — Catheter Associated Urinary Tract Infection
- **Neonatal Sepsis**
- **PEWS** — Pediatric Early Warning Score
Does it change clinical care?

- A total of 83 alerts were collected during the study period of 300 hours
  - 53/83 (64%) were CLABSI
  - 20/83 (24%) were CAUTI
  - 8/83 (10%) were PEWS
  - 2/83 (2%) were neonatal sepsis

- 17/83 (20%) of the alerts had high (> 3) scores
  - 8/17 (47%) were PEWS
  - 5/17 (29%) were CLABSI
  - 2/17 (12%) were neonatal sepsis
  - 2/17 (12%) were CAUTI
Three therapeutic clinical interventions occurred within two hours of the alert:

- Piperacillin-tazobactam
- Vancomycin and cefepime
- Vest therapy

One diagnostic clinical intervention occurred within twenty minutes of an email sent by the paramedics regarding the neonatal sepsis alert:

- An infectious disease consult was ordered to discuss the possibility of septic shock
Alarm Escalation and Redundancy
Alarm Redundancy Necessary? Yes!

- 1137 physiologic alarms recorded
  - 244/1137 (21%) immediate false alarms
  - 893/1137 (79%) potential true alarms
  - 442/1137 (39%) reached third tier escalation

- 159/893 (18%) paramedic actions to true alarms
  - 28/159 (18%) actions post-third tier escalation
  - 12/159 (8%) clinical interventions

- 241/442 (55%) true alarms reached third tier

- No significant correlation between timing of action and interventions (10 pre-alarm vs. 2 post-alarm escalation, p=0.99).

*Crit Care Med 2015; 43(12S):923*
Audiovisual Communication

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AV Communication Impact Patient Care?

- 1137 total physiological alarms
- 244/1137 (21%) false alarms
- 159/893 (18%) actions taken by paramedics
- 115/159 (72%) were AV communications
- 24/115 (21%) audio only
- 91/115 (79%) were audio and visual
AV Communication Impact Patient Care?

- Type of alarms led to AV communication:
  - low SpO2 (76/115, 66%)
  - tachycardia for age (19/115, 17%)
  - bradycardia for age (12/115, 10%)
  - bradypnea for age (3/115, 2.5%)
  - arrhythmia (3/115, 2.5%)
  - unknown (2/115, 2%)

- 45/115 (39%) secondary actions performed:
  - 26/45 (58%) texts to provider
  - 17/45 (38%) phone calls to nurses’ station
  - 2/45 (4%) rapid response team activated
## YES!

<table>
<thead>
<tr>
<th>Type of Alarm</th>
<th>Initial Action Performed by Paramedic</th>
<th>Secondary Action Performed by Paramedic</th>
<th>Clinical Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low SpO₂</td>
<td>Audiovisual communication</td>
<td>Unit called</td>
<td>Supplemental oxygen increased</td>
</tr>
<tr>
<td>Low SpO₂</td>
<td>Audiovisual communication</td>
<td>Provider sent text and unit called</td>
<td>Supplemental oxygen increased</td>
</tr>
<tr>
<td>Low SpO₂</td>
<td>Audiovisual communication</td>
<td>Provider sent text and unit called</td>
<td>Supplemental oxygen increased</td>
</tr>
<tr>
<td>Low SpO₂</td>
<td>Audiovisual communication</td>
<td>Unit called</td>
<td>Supplemental oxygen initiated</td>
</tr>
<tr>
<td>Low SpO₂</td>
<td>Audiovisual communication</td>
<td>Provider sent text and unit called</td>
<td>Nasopharyngeal suction applied</td>
</tr>
<tr>
<td>Low SpO₂</td>
<td>Audio communication</td>
<td>None</td>
<td>Laboratory tests ordered</td>
</tr>
<tr>
<td>High heart rate</td>
<td>Audiovisual communication</td>
<td>None</td>
<td>Laboratory tests ordered</td>
</tr>
<tr>
<td>High heart rate</td>
<td>Audio communication</td>
<td>None</td>
<td>Laboratory tests and intravenous fluids ordered</td>
</tr>
</tbody>
</table>

SpO₂, pulse oximeter oxygen saturation

**Crit Care Med 2015; 43(12S):868**
Operational Costs

• “...the added cost of supplies, salary/benefits, and other operational expenses results in a cost of approximately $20 per occupied bed per inpatient day.”

• “Based upon the frequency of alarms, number of patients, time required to answer and determine false vs. true alarms, number of minutes needed to coordinate an appropriate clinical team response, and a nurse hourly salary, the financial margin that the CLC generates is at least $6 per occupied bed per inpatient day.”

Dr. Stephen Lawless, VP Quality and Safety, Nemours
Success Stories

• Zero delays to get the patient the help they need, exactly when they need it
Success Stories

- Catching seizures when no one is around
- CLABSI protocol triggers early intervention and patient to have surgical procedure with no delay
- Caught in the act
Success Stories

• Simple text to RN about lead placement or rhythm changes results in MD interventions
• Early warning signs during a blood transfusion catches blood transfusion reaction
Challenges

- Cultural acceptance

How do you team build with someone so far away?
Challenges

• Linking Technology
• Technology Downtime
Challenges

- Standard work
- Medics work outside of CLC
- Quality metrics

- Optimal patient:paramedic ratio
- Reimbursement
- Tracking outcomes
Future Steps

• New clinical prediction rules
• Monitoring hospitalized children at non-Nemours hospitals
• Determining cost-effectiveness
• Electronic reporting
PEDIATRIC SEPTIC SHOCK COLLABORATIVE
SEPTIC SHOCK IDENTIFICATION TOOL

PRESENTED AT:

**Septic Shock Checklist**
- Temperature abnormality (Table 2) [52°C]
- Hypotension (Table 2) [80 mm Hg]
- Tachynea (Table 2) [120 bpm]
- Capillary refill abnormality (Table 3) [>3 sec]
- Mental status abnormality (Table 3)
- Pulse abnormality (Table 3)
- Skin abnormality (Table 3)

**Table 1. High Risk Conditions**
- Malignancy
- Asplenia (including SCD)
- Bone marrow transplant
- Central or indwelling line/catheter
- Solid organ transplant
- Severe MR/CP
- Immunodeficiency, immunocompromise or immunosuppression

**Table 2. Vital Signs (PALS)**

<table>
<thead>
<tr>
<th>Age</th>
<th>Heart Rate</th>
<th>Resp Rate</th>
<th>Systolic BP</th>
<th>Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 d – 1 m</td>
<td>&gt; 205</td>
<td>&gt; 60</td>
<td>&lt; 60</td>
<td>&lt; 36 or &gt; 38</td>
</tr>
<tr>
<td>≥ 1 m – 3 m</td>
<td>&gt; 190</td>
<td>&gt; 60</td>
<td>&lt; 70</td>
<td>&lt; 30 or &gt; 38</td>
</tr>
<tr>
<td>≥ 3 m – 1 r</td>
<td>&gt; 190</td>
<td>&gt; 60</td>
<td>&lt; 70</td>
<td>&lt; 30 or &gt; 38</td>
</tr>
<tr>
<td>≥ 1 y – 2 y</td>
<td>&gt; 140</td>
<td>&gt; 40</td>
<td>&lt; 70 + (age in yr x 2)</td>
<td>&lt; 30 or &gt; 38.5</td>
</tr>
<tr>
<td>≥ 2 y – 4 y</td>
<td>&gt; 140</td>
<td>&gt; 40</td>
<td>&lt; 70 + (age in yr x 2)</td>
<td>&lt; 30 or &gt; 38.5</td>
</tr>
<tr>
<td>≥ 4 y – 6 y</td>
<td>&gt; 140</td>
<td>&gt; 34</td>
<td>&lt; 70 + (age in yr x 2)</td>
<td>&lt; 30 or &gt; 38.5</td>
</tr>
<tr>
<td>≥ 6 y – 10 y</td>
<td>&gt; 140</td>
<td>&gt; 30</td>
<td>&lt; 70 + (age in yr x 2)</td>
<td>&lt; 30 or &gt; 38.5</td>
</tr>
<tr>
<td>≥ 10 y – 15 y</td>
<td>&gt; 100</td>
<td>&gt; 30</td>
<td>&lt; 80</td>
<td>&lt; 36 or &gt; 38.5</td>
</tr>
<tr>
<td>&gt; 15 y</td>
<td>&gt; 100</td>
<td>&gt; 10</td>
<td>&lt; 30 or &gt; 38.5</td>
<td></td>
</tr>
</tbody>
</table>

**Table 3. Exam Abnormalities**

<table>
<thead>
<tr>
<th></th>
<th>Cold Shock</th>
<th>Warm Shock</th>
<th>Non-specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulses</td>
<td>Decreased</td>
<td>Bounding</td>
<td></td>
</tr>
<tr>
<td>Capillary refill (central vs. peripheral)</td>
<td>≥ 3 sec</td>
<td>Flash (&lt; 1 sec)</td>
<td></td>
</tr>
<tr>
<td>Skin</td>
<td>Mottled, cool</td>
<td>Flushed, ruddy, erythroderma (other than face)</td>
<td>Pseudo-palmar below the nipple, any purpura</td>
</tr>
<tr>
<td>Mental status</td>
<td>Decreased, irritability, confusion, inappropriate crying or drowsiness, poor interaction with parents, lethargy, diminished arousability, obtundation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pilot Evaluation of Automated Shock Tool

- 70 patients, median score 30 (25 – 75)
- 4/70 (6%) sepsis and 5/70 (7%) suspected sepsis
- Shock scores ≥ 45 in 4 patients with sepsis
- Sepsis/suspected sepsis patients had higher scores than non-sepsis patients
  - (12.5, 95% CI 6.5 – 18.5, p <0.001)

*Crit Care Med 2015; 43(12S): 821*
Elements of Performance for NPSG.06.01.01

1. Leaders establish alarm system safety as a hospital priority.

2. Identify the most important alarm signals to manage based on the following:
   - Input from the medical staff and clinical departments
   - Risk to patients if the alarm signal is not attended to or if it malfunctions
   - Whether specific alarm signals are needed or unnecessarily contribute to alarm noise and alarm fatigue
   - Potential for patient harm based on internal incident history
   - Published best practices and guidelines
   (For more information on managing medical equipment risks, refer to Standard EC.02.04.01.)

3. Establish policies and procedures for managing the alarms identified in EP 2 above that, at a minimum, address the following:
   - Clinically appropriate settings for alarm signals
   - When alarm signals can be disabled
   - When alarm parameters can be changed
   - Who in the organization has the authority to set alarm parameters
   - Who in the organization has the authority to change alarm parameters
   - Who in the organization has the authority to set alarm parameters to “off”
   - Monitoring and responding to alarm signals
   - Checking individual alarm signals for accurate settings, proper operation, and detectability
   (For more information, refer to Standard EC.02.04.03)

4. Educate staff and licensed independent practitioners about the purpose and proper operation of alarm systems for which they are responsible.
A Team-Based Approach to Reducing Cardiac Monitor Alarms

abstract

BACKGROUND AND OBJECTIVES: Excessive cardiac monitor alarms lead to desensitization and alarm fatigue. We created and implemented a standardized cardiac monitor care process (CMCP) on a 24-bed pediatric bone marrow transplant unit. The aim of this project was to decrease monitor alarms through the use of team-based standardized care and processes.

METHODS: Using small tests of change, we developed and implemented a standardized CMCP that included: (1) a process for initial ordering of

AUTHORS: Christopher E. Dandoy, MD, MSc,*a Stella M. Davies, MBBS, PhD,* Laura Flesch, CRNP,* Melissa Hayward, BSN,* Connie Koons, BSN,* Kristen Coleman, BSN,* Jodi Jacobs, CPNP,* Lori Ann McKenna, CPNP,* Alera Olomoyeje, BS,* Chad Olson, CBET,* Jessica Powers,* Kimberly Shoemaker,* Sonata Jodele, MD,* Evalee Alessandrini, MD,* and Brian Weiss, MD*

Departments of *Bone Marrow Transplantation and Immunodeficiency, and *Oncology, Cancer and Blood Disease Institute, *James M. Anderson Center for Health Systems Excellence, *Clinical Engineering, and *Clinical Integration, Cincinnati Children’s Hospital Medical Center, Cincinnati, Ohio

Pediatrics 2014; 134: e1686-1694
## Alarm Parameters [2181]

### Orders

**0-1 Month**

[X] **Cardio Respiratory Monitoring**
- Routine, CONTINUOUS, Starting S
- Heart Rate Alarm High/Low: 180-90
- Systolic BP Alarm High/Low: 90-65
- Diastolic BP Alarm High/Low: 70-45
- MAP Alarm High/Low
- RR Alarm High/Low: 90-20

**1-23 Months**

[X] **Cardio Respiratory Monitoring**
- Routine, CONTINUOUS, Starting S
- Heart Rate Alarm High/Low: 180-80
- Systolic BP Alarm High/Low: 90-65
- Diastolic BP Alarm High/Low: 70-45
- MAP Alarm High/Low
- RR Alarm High/Low: 90-20

**2-4 Years**

[X] **Cardio Respiratory Monitoring**
- Routine, CONTINUOUS, Starting S
- Heart Rate Alarm High/Low: 160-80
- Systolic BP Alarm High/Low: 90-65
- Diastolic BP Alarm High/Low: 70-45
- MAP Alarm High/Low
- RR Alarm High/Low: 80-20

**5-10 Years**

[X] **Cardio Respiratory Monitoring**
- Routine, CONTINUOUS, Starting S
- Heart Rate Alarm High/Low: 130-75
- Systolic BP Alarm High/Low: 120-90
- Diastolic BP Alarm High/Low: 75-55
- MAP Alarm High/Low
- RR Alarm High/Low: 60-15

**11 Yrs and Greater**

[X] **Cardio Respiratory Monitoring**
- Routine, CONTINUOUS, Starting S
- Heart Rate Alarm High/Low: 120-60
- Systolic BP Alarm High/Low: 133-110
- Diastolic BP Alarm High/Low: 85-55
- MAP Alarm High/Low
- RR Alarm High/Low: 40-10

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**QUALITY AND SAFETY**

[Children's Hospital Association Logo]
Questions?