PEWS: Early Recognition of Clinical Deterioration in Hospitalized Children with Cancer

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Innovative Evidence-Based Interventions
Multidisciplinary, evidence-based interventions to improve the quality of care for critically ill children with cancer. These efforts include:

Multicenter PEWS (EVAT) Program:
Collaboration of 45 pediatric hematology-oncology centers in Latin America dedicated to early identification of clinical deterioration in hospitalized children with cancer through the implementation of a Pediatric Early Warning System (PEWS) proyectoEVAT@stjude.org

Education
To improve healthcare provider knowledge on the care of critically ill children with cancer we work with experts in the field to develop curricula, workshops and training materials on pediatric onco-critical care. These efforts include:

- Pediatric onco-critical care workshops and conferences, including the annual Pediatric Onco-Critical Care Symposium (POCCS) at St. Jude
- Curriculum development for physicians and nurses on oncocritical care in Spanish
- St. Jude Global Academy in Pediatric Onco-Critical Care (starting on November 2019)
- Critical Care observerships in the St. Jude PICU

Research
High-quality research on topics related to pediatric onco-critical care in high-resource and resource-limited settings. These efforts include:

- PROACTIVE - Development of a tool to assess capacity and quality of pediatric onco-critical care in resource-limited settings (Dra. Anita Arias, proactive@stjude.org)
- Communication - Qualitative study regarding interdisciplinary communication around patient deterioration (Dra. Dylan Graetz, dylan.graetz@stjude.org)

Horizontal Collaboration Network
A collaborative network of providers interested in improving the care and survival of critically ill children with cancer worldwide through sharing knowledge, experience, and best practices. These efforts include:

- GLECIOP (Grupo Latinoamericano de Estudio para Cuidados Intensivos de Oncología Pediátrica) - a group for Spanish-speaking providers interested in oncocritical care.
Clinical Deterioration in Hospitalized Children

- Cardiopulmonary arrests are rare events in children:
  - 1.4% of PICU admissions
  - 0.08% of hospital admissions

- However, poor survival to hospital discharge
  - 27-48%

- Pediatric hematology-oncology/HSCT patients
  - Higher frequency of clinical deterioration
    - 1 in every 3-4 patients will require critical care during cancer treatment
  - Higher mortality following critical illness and cardiopulmonary arrests

Consequences of Delayed Identification

• Delayed ICU transfer in patients with cancer results poor outcomes
  – Increased organ dysfunction, longer ICU length of stay, higher hospital mortality
  – Every hour delay in ICU transfer after deterioration results in 3% increased odds of mortality

• Reasons for delays:
  – Failure to recognize physiologic changes, delays in notification of treating physician, lack of prompt bedside evaluation

Prevention

• Physiologic changes (VS, mental status) occur hours before acute event
  – Frequently missed or not acted upon by medical team
  – Delayed ICU transfer/notification lead to poor outcomes

• Systems to facilitate **early identification** and **early action** can improve outcomes
What are PEWS?
Pediatric Early Warning Systems

• Systems to improve **early identification of clinical deterioration** in hospitalized patients

• Two components:
  – **Scoring Tool**: vital signs, physical exam, interventions (O₂ use)
    • Calculated with every set of vital signs
  – **Algorithm**: guide clinical team in actions needed to respond to patient with deterioration
• Nurses calculate PEWS with every set of vital signs as part of routine patient care
• Physicians responsible for evaluating patients with abnormal scores and determining the next steps in management according to action algorithm
• PEWS is an **advocacy tool**
  – Empowers nurses to identify clinical changes and express concerns to the medical team
PEWS – Results

• Hospital-wide PEWS implementation (score + action algorithm) leads to:
  – Shorter time between deterioration and medical interventions
  – Lower severity of illness on ICU admission
  – Shorter ICU LOS for unplanned transfers
  – Fewer cardiopulmonary arrests outside the ICU
  – Lower hospital mortality

Are PEWS valid in hospitalized pediatric oncology and HSCT patients?

Validation of a Pediatric Early Warning Score in Hospitalized Pediatric Oncology and Hematopoietic Stem Cell Transplant Patients

Asya Agulnik, MD, MPH; Peter W. Forbes, MA; Nicole Stenquist, BA; Carlos Rodriguez-Galindo, MD; Monica Kleinman, MD, FAAP

Pediatric Critical Care Medicine • April 2016 • Volume 17 • Number 4

- Unplanned PICU transfers among hospitalized pediatric Oncology and HSCT patients over 2 years
  - 110 events
  - 15.5% PICU mortality
## Children's Hospital Early Warning Score (CHEWS) Reference Tool

<table>
<thead>
<tr>
<th>Behavior/Neuro</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Playing/sleeping appropriately</td>
<td></td>
<td>* Sleepy, somnolent when not disturbed</td>
<td>* Irritable, difficult to console</td>
<td>* Lethargic, confused, floppy</td>
<td></td>
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<tr>
<td>* Alert at patient’s baseline</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>* Pale</td>
<td></td>
<td>* Capillary refill 3-4 seconds</td>
<td>* Grey</td>
<td>* Grey and mottled</td>
<td></td>
</tr>
<tr>
<td>* Capillary refill ≤ 2 seconds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Intermittent ectopy or irregular heart rhythm (not new)</td>
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<td></td>
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</tr>
<tr>
<td>Cardiovascular</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>* Skin tone appropriate for patient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Capillary refill ≥ 2 seconds</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Within normal parameters</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>* No retractions</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>* Mild tachypnea/</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>* Mild increased WOB (flaring, retracting)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>* Up to 40% supplemental oxygen via mask</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Up to 1L NC &gt; patient’s baseline need</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Mild desaturation (&lt; 95 below patient’s baseline)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Intermittent apnea self-resolving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Moderate tachypnea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Moderate increased WOB (flaring, retracting, grunting, use of accessory muscles)</td>
<td></td>
<td></td>
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<tr>
<td>* 40-60 % oxygen via mask</td>
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<tr>
<td>* 1-2L NC &gt; patient’s baseline need</td>
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<tr>
<td>* Nebs q 1-2 hr</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>* Moderate desaturation (&lt; 10 below patient’s baseline)</td>
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<td></td>
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<tr>
<td>* Apnea requiring repositioning or stimulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Staff Concern</strong></td>
<td>Concerned</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Family Concern</strong></td>
<td>Concerned or absent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Please refer to [Vital Sign Reference Tool](#), the CHEWS Heart Rate and Respiratory Rate Reference Tool, and the Electronic Physiological Bedside Monitoring Policy.

### Respiratory Rate and Heart Rate

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant</td>
<td>≥ 10% for age</td>
<td>≥ 15% for age</td>
<td>≥ 25% for age</td>
</tr>
<tr>
<td>Toddler and Older</td>
<td>≥ 10% for age</td>
<td>≥ 25% for age</td>
<td>≥ 50% for age</td>
</tr>
<tr>
<td>All ages</td>
<td>5 points</td>
<td>10 points</td>
<td>15 points</td>
</tr>
</tbody>
</table>
**0-2 (Green)**
- Continue routine assessment

**3-4 (Yellow)**
- Increase frequency of assessment
- Notify charge nurse and resident
- Discuss treatment plan in team huddle
- Consider higher level of care (ICP/ICU)
- Electronic monitoring per guidelines
- Document interventions

**5 or > (Red)**
- Clinician evaluation at bedside
- Notify attending physician
- Discuss treatment plan in team huddle
- Electronic monitoring per guidelines
- Document interventions

**Additional assessment criteria:**
- Patients requiring more than 2 fluid boluses in < 4 hours
- Pain that exceeds expected for patient’s condition

**Consider:**
- ICU Evaluation* *(MO/IP/PA Initiated)*

**Additional assessment criteria:**
- Patients requiring continuous bedside nursing care for >1 hour
- New onset hypotension

**Consider:**
- Rapid Response Team [ICU STAT] (5-5555)

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For immediate assistance at any time:

**CODE BLUE 5-5555**
Results—Validation

• PEWS valid to identify patients requiring unplanned PICU transfer
  – AUROC Onc—0.95
  – AUROC HSCT—0.96

• PEWS elevate ~12 hours prior to PICU transfer
  – 8 hours earlier than standard ICU notification by floor team
## PEWS and PICU Outcomes

### PICU LOS

<table>
<thead>
<tr>
<th>Maximum PEWS before PICU transfer</th>
<th># Cases</th>
<th>PICU LOS (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 or less</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>7 or more</td>
<td>19</td>
<td>14</td>
</tr>
</tbody>
</table>

* p = 0.004

### PICU Mortality

* p = 0.028

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Agulnik PCCM 2016

St. Jude Advanced Warning System

sJAWS

Adapted from Boston’s PEWS tool by multidisciplinary team at St. Jude

Modification of PEWS  
Pilot in Leukemia  
Hospital-wide Implementation

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

2016

St. Jude Emergency Activations
Activations/ 1000 Inpatient Days

- Inpatient RRTs
- sJAWS RRTs
- Inpatient HT

sJAWS Pilot Hospital Implementation

St. Jude Unplanned PICU Transfers

- PICU transfer with sJAWS 3+
- PICU Transfer via RRT
- PICU Transfer via HT

Agulnik SCCM 2018

sJAWS Pilot  Hospital Implementation

Unidad Nacional de Oncología Pediátrica (UNOP)

- Guatemala City, Guatemala
- 67-bed hospital
  - >2000 admissions/year
- 9-bed PICU
  - 300-400 admissions/year
- >50% childhood cancer cases in Guatemala (500 new dx/year)

Escala de Valoración de Alerta Temprana (EVAT)

- Based on PEWS validated in pediatric oncology
- Changes made by multidisciplinary team:
  - Translate into Spanish and adjust for practice variation
PEWS Errors at UNOP

Nov 2014 – Dec 2015

% Errors in PEWS

Date of Measurement

% PEWS Errors
n=300-400/day

Outcome of PEWS at UNOP

Clinical Deterioration Events

- Year 2013: 9.3
- Year 2015: 6.5

PICU Patient-Days (Unplanned Transfers)

- Year 2013: 1376
- Year 2015: 1088

Agulnik Cancer 2017

PEWS Validation (UNOP)

• **PEWS is valid** to predict unplanned PICU transfer in these patients in this setting
  – Abnormal PEWS as early as 24 hours prior to unplanned PICU transfer

• **Higher PEWS** at PICU admission predicts organ dysfunction, severity of illness (**PIM2**), need for **PICU interventions** (mechanical ventilation, vasoactive infusions) and **mortality**
Costing Analysis of PEWS

- UNOP had 457 fewer ICU days for unplanned PICU transfers in the year following PEWS implementation
- Cost of PEWS implementation at UNOP in 2014 was ~$14,000 – $7 per hospital admission that year
- Implementation of PEWS resulted in a cost-savings of over $350,000 in 2015

**Conclusion:** Implementation of PEWS can improve quality of care and reduce hospital costs though reducing unplanned PICU transfer
Ongoing Questions

• Is UNOP’s experience with PEWS generalizable to other pediatric oncology centers in Latin America?
  – Different hospital organization
  – Different nursing ratios
  – Different access to PICU

PEWS Multicenter Program
(Proyecto EVAT)
Proyecto EVAT Goals

• Compare frequency, characteristics, and outcomes of clinical deterioration events in hospitalized pediatric oncology and HSCT patients across Latin America

• Evaluate effect of PEWS implementation on frequency and severity of clinical deterioration events

• Identify center, team, and implementation factors associated with successful PEWS implementation
Proyecto EVAT
45 Centers, 17 Countries
Steering Committee Proyecto EVAT

- 24 members from Latin America
- 7 countries
  - México
  - El Salvador
  - Ecuador
  - Guatemala
  - Perú
  - Honduras
  - Chile
- 11 nurses
- 2 pediatricians
- 6 oncologists
- 5 intensivists

St. Jude, Memphis
5th EVAT SC Meeting, August 13-14, 2019

Clinical Deterioration:
- Unplanned PICU transfers
- PICU interventions (vasopressors, mechanical ventilation, CPR) on the floor
- Non-palliative floor deaths
Results

Pediatric oncology patients hospitalized in 16 centers between June 2017 and May 2018 (12 months)

11,797 hospital admissions
116,191 patient days
546 clinical deterioration events
4.6% hospital admissions
4.7/1000 patient-days

159 (29%) died during event
192 (35%) died prior to hospital discharge
Center Variability

- CDE rate
  - % hospital admissions
- CDE rate
  - rate / 1000 patient days
- CDE mortality
  - % CDE events
- Hospital Mortality
  - % CDE events

Clinical deterioration events

- 546 clinical deterioration events
  - **Floor interventions**: 155 (28%) required PICU-level interventions on the floor
    - Higher risk of mortality (p=0.004)
  - **PICU transfer**: 494 (90%) ultimately transferred to PICU
    - 10% never had access to PICU care
  - **Delays**: 228 (42%) noted delays in identification of deterioration or PICU transfer
Lessons Learned

• One goal: successful implementation of PEWS at each center
  – Lead to improved patient outcomes
  – Achieving program sustainability

• Centers need different timelines, resources, support to achieve this goal
  – But every center can achieve it with appropriate support
    • Currently: 21 centers with successful PEWS implementation
    • More than 2000 clinicians trained in EVAT across 17 countries
    • Over 1500 clinical deterioration events registered

• There are center and team-specific factors associated with programmatic success
Factors Associated with Implementation Success

- Strong multidisciplinary leadership team
  - Oncology, pediatrics, nursing, PICU
  - All team leaders dedicated to the project and participate in all program activities
  - Helps to have prior experience with quality improvement (but not required)
- Support of hospital leadership (from the beginning)
- Active communication with St. Jude and Mentor Center of Excellence
  - Attend online meetings, answer emails, actively ask questions
- Think of programmatic sustainability from the beginning
  - Prepared for a long-term program plan (3 years!)
1st Annual Meeting
March 22-23, 2019
HITO
Queretaro, Mexico

Thank You!

ProyectoEVAT@stjude.org

Questions?

globalcriticalcare@stjude.org
Asya.Agulnik@stjude.org
registration:
www.stjude.org/POCCS

PDIEATRIC
ONCOLOGY
Critical Care
SYMPOSIUM

SAVE the DATE
APRIL 2-3, 2020

Department of Global Pediatric Medicine

St. Jude Global
Transversal Program

CRITICAL CARE