Defining the Problem: Epidemiology of Prolonged Critical Illness

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Disclosures

• I have no relevant financial or commercial disclosures or conflicts to report
LOS in the CICU: Opportunities abound

*Pagowska. 2010.*
Occurrence of CCI in the CICU

CCI (or long stay) patients experience a duration and complexity of critical illness out of proportion to their initial illness, suffering high mortality, poor long term outcomes, and consuming disproportionate health care resources.
Objectives

• Definitions:
  • *Pediatric chronic critical illness (PCCI)*

• Risk Factors for, and outcomes in PCCI

• Pathophysiology of PCCI
  • *Are CICU patients different?*

• Targeted Interventions to Improve Outcomes in PCCI
Prolonged Critical Illness

Chronic Critical Illness

Persistent Critical Illness

Prolonged Mechanical Ventilation
Definitions:

- **Prolonged Critical Illness:**
  - Time in ICU, based on some threshold
    - 8 days? 28 days?
- **Prolonged Mechanical Ventilation:**
  - Tracheotomy?
  - 10 days? 30 days?
- **Persistent Critical Illness:**
  - When initial illness resolves, patient remains in ICU as a result of acquired conditions
- **Chronic Critical Illness:**
  - Composite diagnosis with both time and physiology components
Definition Criteria

1. Pediatric patients who remain hospitalized in a NICU >28 days postterm corrected age or in a PICU for >14 consecutive days or who have a history of prolonged ICU stay and ≥2 acute care or ICU admissions within 12 months;

AND

2. Ongoing dependence on one or more forms of technology to sustain vital functions or persistent multiple vital organ system involvement.

*Shapiro. Defining PCCI for clinical care, research, and policy. 2017.*
## PCCl in the Pediatric CICU:

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Population</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>Namachivayam</td>
<td>CICU (Melbourne)</td>
<td>ICU LOS &gt; 28 days</td>
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<tr>
<td>2010</td>
<td>Pagowska</td>
<td>Post-op CHD in PICU (Lodz)</td>
<td>ICU LOS &gt; 14 days</td>
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<td>2008</td>
<td>Shi</td>
<td>Post-op CHD in PICU (China)</td>
<td>MV &gt; 3 days</td>
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<td>2005</td>
<td>Garcia-Montes</td>
<td>Post-op CHD in PICU (Mexico)</td>
<td>MV &gt; 5 days</td>
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<td>2003</td>
<td>Brown</td>
<td>CICU (GOS)</td>
<td>LOS</td>
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<tr>
<td>2002</td>
<td>Davis</td>
<td>Post-op CHD in PICU</td>
<td>Length of MV</td>
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</table>
What’s Leads to Long ICU Stays in CICU?

- Patients may require long ICU stays due to isolated, single system problems, or complex, multi-system processes.

**ISOLATED PROBLEMS:**
- Vocal cord injury
- Diaphragm paresis
- Chylous effusion
- Pericardial effusion
- Rhythm disturbance
- Feeding Dysfunction
- Mild Pump Failure
- Empiric: Interstage patients with high risk factors
- Delay in discharge

**COMPLEX PROBLEMS:**
- Prolonged low cardiac output
- Residual lesions
- SIRS
- Sepsis
- Chronic draining effusions
- JET with low CO
- Feeding Dysfunction with chronic aspiration and/or inadequate nutrition
- Advanced CHF

**Long stay**

**Chronic Critical Illness**
Pathophysiology of PCCI

• A clinical syndrome which may be marked by:
  • Pro-inflammatory state
  • Prolonged catabolism
  • Multi-system deficiencies: metabolic, endocrine, immunology, neuro-muscular, psychologic

• Chronic stress leads to:
  • Alterations in cortisol axis hormonal regulation
    • Results in relative adrenal insufficiency, catabolism
  • Autonomic nervous system activation
  • RAS system activation
Risk factors for long intensive care unit stay after cardiopulmonary bypass in children*

Kate L. Brown, MRCP; Deborah A. Ridout, MSc; Allan P. Goldman, MRCP; Aparna Hoskote, MRCP; Daniel J. Penny, MD, FRCPI

- Age (neonate) (RR 2.1)
- 2 additional medical problems (RR 3.8)

- Intra-op Risk Factors:
  - High complexity, long operative times

- Post-op Factors:
  - Complication score, including:
    - Delayed sternal closure (RR 2.6)
    - Sepsis (RR 4.2)
    - Renal Failure (RR 4)
    - PHTN (RR 2.2)
    - Diaphragm paresis (RR 4)
    - Arrhythmia (RR 2.65)

undergoing CPB at GOS
-12% classified as “long stay” (> 14 days in ICU)
-Mortality = 17%

-These patients accounted for 30% of the bed days
More Risk Factors…

“Predictors of long ICU stay following cardiac surgery in children.”

- Pagowska et al. 2010
- 693 patients, Polish Mothers Memorial Hospital
- Long LOS defined as > 14 days
- Risk Factors:
  - Ventilated > 7 days (RR 33)
  - Acute kidney injury (RR 11)
  - Delayed sternal closure (RR 11)
  - Reoperation (RR 8)
  - PHTN (RR 8)
  - Prolonged LCOS (RR 7)

-Mortality = 12%
Outcomes of Long Stay PICU Patients

• Melbourne, 1989-2008
• 233 long stay patients (> 28 days) in PICU
• 1% of all admissions, 19% of total bed days

Outcomes at follow up:
• 50% had died
• 71% poor or very poor QOL

Bed occupancy increased from 8% to 21% during this study
The Epidemiology of Chronic Critical Illness in the United States*

Jeremy M. Kahn, MD, MS\textsuperscript{1,2}; Tri Le, MS\textsuperscript{2}; Derek C. Angus, MD, MPH\textsuperscript{1,2}; Christopher E. Cox, MD, MPH\textsuperscript{3}; Catherine L. Hough, MD, MS\textsuperscript{4}; Douglas B. White, MD, MAS\textsuperscript{1}; Sachin Yende, MD, MS\textsuperscript{1}; Shannon S. Carson, MD\textsuperscript{5}; for the ProVent Study Group Investigators

![Graph showing cost in billions by hospital size and type of sepsis. The graph indicates that hospital-acquired sepsis costs more than community-acquired sepsis across different hospital size categories.](image-url)
116 long stay cardiac patients in Melbourne (>28 d) 

1997 – 2012

Long stay incidence increased from 1% to 2.7%

Comparing 3 year survival following discharge from ICU in those long stay patients who required early reoperation

Log-rank p=0.01

Comparing 3 year survival following discharge from ICU in those long stay patients who required early reoperation
# Impact of Extra-Cardiac Complications

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<th>ECC present N=482</th>
<th>p-value</th>
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<tr>
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<td>14</td>
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<tr>
<td>Total admits</td>
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<td>1</td>
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<td>Unplanned hospital days</td>
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<td>Hospital days</td>
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<td>Charges post-index procedure</td>
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<td>Charges incl index procedure</td>
<td>$142,495</td>
<td>$363,780</td>
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</table>
Median Unplanned Hospital Days and Median Charges following Discharge from Index Procedure

*P < 0.001 for all comparisons
“It’s Relentless”: Providers’ Experience of Pediatric Chronic Critical Illness

Pamela K. Donohue, ScD, Erin P. Williams, MBE, Laura Wright-Sexton, MD, and Renee D. Boss, MD

It Seems Like the Resuscitation Happened Ages Ago—Chronic Critical Illness in Children: Digging in for the Long Haul*

*Therefore in medicine we ought to know the causes of sickness and health. –Avicenna

Ericka L. Fink, MD, MS
Patrick M. Kochanek, MD, MCCM
Department of Critical Care Medicine
Safar Center for Resuscitation Research
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Pittsburgh, PA
Strategies to Improve Outcomes in PCCI

• Prevention

• Care Models / Care Emphasis Adapts to Patient
  • Acute care versus chronic care focus

• ICU-Based Multi-disciplinary CCI teams

• Supporting the patient and family
  • Communication innovations

• Outcomes after the ICU: ICU survivorship programs
What can we do? Prevention…

- Re-examine our assumptions
- Do interventions which win the battle, lose the war?

No CCI is better than good CCI

“To decrease the incidence of CCI, the best medical practice might be the proper use of bundles, following the prudent recommendation that ‘less is more’ (less aggressive ventilator support, lower calorie intake, less fluid administration, lower dose and shorter duration of sedation).”

-Loss et al. “Chronic critical illness: are we saving patients or creating victims?”
Attuning Care Models to PCCI

“Stuck in the ICU – Caring for Children with Chronic Critical Illness.”

- Henderson et al. 2017
- Interviews of providers, parents, and patients

Findings:
- ICU training and care models don’t work for chronic care
- PCCI patients require gradual, slow change
- Developmental needs not met
- Shift work creates discontinuity and communication failures between providers
- Goals of care are different: goals of care for temporary improvement may contribute to long term problems
- Transitions are risky. Many are poorly prepared
“Hospitals, especially ICU’s, are not a place to rest. These chronic kids….they need rest. They need to not be woken up at 4 AM for a blood draw.”

“When somebody is facing an acute illness, everybody shows up and makes dinner and carpools your other kids. It’s a crisis, everybody pulls together. When you’re dealing with a chronic illness, the casseroles aren’t coming. Nobody’s carpooling your kid. Its this level of stress that’s always here.”

“This is a issue that’s not going away. With amazing advances in medical care, we are saving many children who would have died in the past, and that is wonderful. But we need to make sure we are supporting these children that we have saved. And not only their children, but their families as well.”
Environment of Care for PCCI

- Optimize family engagement:
  - Unrestricted visiting
  - Rooming in
  - Respite space
- Minimize risk of delirium
  - Day / night cycle
  - “Quiet time”
  - Encourage non-pharm solutions
- Early mobilization, therapy services, field trips

Marcus et al. 2016. “CCI in infants and children: a speculative synthesis on adapting ICU care to meet the needs of long stay patients
Life After the ICU: CCI and ICU Survival

Shapiro, 2017

- Children with CCI
- CMC
- Children with special health care needs

Shapiro, 2017
Long-Term Function After Pediatric Critical Illness: Results From the Survivor Outcomes Study*

Neethi P. Pinto, MD, MS\(^1\); Elizabeth W. Rhinesmith, MD\(^2\); Tae Yeon Kim, BA\(^3\); Peter H. Ladner, BA\(^3\); Murray M. Pollack, MD\(^2\)

- SOS study:
  - Mortality at 3 years = 10%
  - New morbidity = 10%
  - 38% either died or had a functional decline
A Tertiary Care–Primary Care Partnership Model for Medically Complex and Fragile Children and Youth With Special Health Care Needs

John B. Gordon, MD; Holly H. Colby, RN, MS; Tera Bartelt, BSN; Debra Jablonski, RN; Mary L. Krauthoefer, BSN; Peter Havens, MD

Objective: To evaluate the impact of a tertiary care center special needs program that partners with families and primary care physicians to ensure seamless inpatient and outpatient care and assist in providing medical homes.

Design: Up to 3 years of preenrollment and postenrollment data were compared for patients in the special needs program from July 1, 2002, through June 30, 2005.

Setting: A tertiary care center pediatric hospital and medical school serving urban and rural patients.

Participants: A total of 227 of 230 medically complex and fragile children and youth with special needs who had a wide range of chronic disorders and were enrolled in the special needs program.

Interventions: Care coordination provided by a special needs program pediatric nurse case manager with or without a special needs program physician.

Main Outcome Measures: Preenrollment and postenrollment tertiary care center resource utilization, charges, and payments.

Results: A statistically significant decrease was found in the number of hospitalizations, number of hospital days, and tertiary care center charges and payments, and an increase was found in the use of outpatient services. Aggregate data revealed a decrease in hospital days from 7926 to 3831, an increase in clinic visits from 3150 to 5420, and a decrease in tertiary care center payments of $10.7 million. The special needs program budget for fiscal year 2005 had a deficit of $400 000.

Conclusion: This tertiary care–primary care partnership model improved health care and reduced costs with relatively modest institutional support.

Arch Pediatr Adolesc Med. 2007;161(10):937-944
Aggregate Resource Use during up to 3 Years Equal Pre - and Post - Enrollment Periods

n = 505 patients (2002-2010)
mean 430 +/- 362 days (288)

From: Gordon
A Framework for Caring for PCCI

• Medical practice shift from “acute” to “chronic” care
  • Stop “doing stuff”
  • Recognize the transition point, and adapt care
• Prevention:
  • “No CPR is better than good CPR”
  • Wash your hands!
• Continuity of care
  • Primary intensivist, nursing
  • Utilize palliative care
  • Develop ICU survivorship programs, PCCI medical homes
• Keep families engaged and supported:
  • Implement ICU family meeting protocols
  • Cede control of daily care tasks and schedules
• Environment of care optimized to long stay patients
  • Rooming in, engaging patients and families in care
“The outliers is where we make the greatest impact”
Thank you