CONTRIBUTIONS OF THE GENERAL PEDIATRICIAN TO THE DECREASE IN ICU MORTALITY

Rochester 2014

THE BIG QUESTION

WHY HAS MORTALITY DECREASED?
PROGRESS IN THE UNDERSTANDING OF SYSTEMS,
MAKING AVAILABLE INTERVENTIONS ACCESSIBLE, AND DELIVERING RIGHT CARE RIGHT NOW

MAGNITUDE OF DECLINE

- 1970 35% mortality
- 1976 31% mortality
- 2000 4% mortality
- 2006 3.0% mortality
- 2012 2.8% mortality (VPSdata)

Crit Care Med 2006; 34 (Suppl.) s 183-190

ORIGINS OF ICU

- 1960’s Adults with heart attacks dying from arrhythmia and cardiogenic shock
- Concentration of resources and personnel
- Children dying from respiratory failure (Kennedy baby)
- Early identification of danger signs

CARDIAC ARREST

- No arrest to happen outside of ICU
- No unexpected arrests in ICU
- Intensive observation of patients with or at risk for physiologic instability
- Post catheterization care
- Post op general surgery and heart surgery (> 24hrs)
- Otherwise critically ill children

THE ORIGINAL GOALS
1976 ORIGINS OF ICU

"Neither monitors nor the most complicated electronic gear makes a critical care unit. The fundamental ingredient is a properly indoctrinated nursing staff. The reason for this is obvious. The nurse is usually the only trained medical professional at the bedside during important clinical events. The time for effective action is brief and does not usually allow delay for the arrival of a physician. The nurse is trained in the recognition of arrhythmias and is delegated the authority for enacting the entire repertory of lifesaving techniques. In fact, many well-functioning critical care units have been successful because of the elite spirit and competence of the nursing staff."  

Scientific American July 1968 vol. 219 No. 1 21-22

THE VALUE OF ICU CARE

- Intensive Care reduces Death from Sepsis, the leading cause of death in Children worldwide (1) (3)
- Pediatric Intensive Care reduces death from trauma, the leading cause of death in children in the western world (2)

2. WHO report on violence and accidental death, in press 2007
3. Crit Care Med 2002; 30; 1365-1378

MORTALITY IN CHILDREN

Why has mortality decreased?
THE BIG QUESTION

WHY HAS MORTALITY DECREASED?

ANSWERS

• The single most important contribution to the decrease in mortality is coordination of ICU care.
• Advances in the understanding of goal directed therapy
• Team coordination and participation
• Pre-ICU care

Reducing Mortality in ICU

• Protocol approaches to:
  • Sepsis
    - Mechanical ventilation
    - Analgesia and sedation
    - Infection surveillance and prevention
    - Weaning
    - Catheters
    - Planned removal of devices

EARLY GOAL DIRECTED THERAPY

• Supplemental oxygen or endotracheal intubation
• Fast and effective I.V access
• Support of circulation
• Normalization of physiologic and biochemical parameters
• Strict control of fluids and renal replacement therapy if needed

GOAL THERAPEUTIC END POINTS

• Capillary refill of <2 seconds
• Normal pulses with no differential between peripheral and central pulses
• Warm extremities
• Urine output >1 mL/kg/hr
• Normal mental status
• Decreasing anion gap
• Superior vena cava or mixed venous oxygen saturation >70%
SOMETHINGS MAKE A DIFFERENCE

• The organization of physician services meeting standards (1)
• Management skills of intensivists influence outcomes in pediatric intensive care (2)
• Leadership and management training affects outcomes in pediatric ICU (3)

2. Pediatr Crit Care Med 2007 Vol. 8, No. 6

SOMETHINGS DID NOT MAKE A DIFFERENCE

• 24 hr Physician presence improves quality of care, processes and staff satisfaction it also decreases complications rate and length of stay (1)

(1) Crit Care Med 2008 Vol. 36, No.1

WHY HAS MORTALITY DECREASED?

<table>
<thead>
<tr>
<th>Controlled Trials</th>
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<tbody>
<tr>
<td>Type of trial</td>
</tr>
<tr>
<td>Amiodarone</td>
</tr>
<tr>
<td>Anti-CD25</td>
</tr>
<tr>
<td>Anti-TNF</td>
</tr>
<tr>
<td>Anti-IL-1</td>
</tr>
<tr>
<td>Anti-IL-1</td>
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<tr>
<td>Anti-IL-1</td>
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<tr>
<td>Anti-IL-2</td>
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<tr>
<td>All studies</td>
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</tbody>
</table>

*Adapted from Stollerman and colleagues.*

NEW MONITOR

OLD MONITOR
**MOST FREQUENT**

- 53 Consecutive Days
- 26 Of 36 Beds In Study

**ALARM REDUCTION**

**OXYGEN SATURATION**

**RESPIRATORY RATE**

**LEAD FAIL**

**REDUCTION ?**

<table>
<thead>
<tr>
<th>Alarm Type</th>
<th>Total Alarms</th>
<th>Adjustment</th>
<th>New Reduced Alarm Total</th>
<th>% Reduction Alarm Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPO2 LO</td>
<td>102141</td>
<td>Change lower limit from 93% to 90%</td>
<td>39285</td>
<td>62%</td>
</tr>
<tr>
<td>RR LEADS FAIL</td>
<td>14491</td>
<td>Add 4-second delay</td>
<td>5217</td>
<td>64%</td>
</tr>
<tr>
<td>LEADS FAIL</td>
<td>13259</td>
<td>Add 4-second delay</td>
<td>5171</td>
<td>61%</td>
</tr>
</tbody>
</table>
A major barrier to action in child health has been the erroneous perception that only expensive, high-level technology and facility-based care can reduce mortality (Lancet Series, Neonatal Survival March 2005).

Integrated Management of Childhood Illness
- From cholera to respiratory infections
- Identification of early danger signs
- Appropriate access to appropriate care

Who declares a child “ill”
- What are the signs of danger
- What to do if signs of danger
- Education of different levels of licensure
- Outcomes of intervention

Children 0-5 years of age
- Respiratory rate > 50
- Temperature 102.8 F or greater
- Use of accessory muscles of respiration

GO TO THE HOSPITAL

Decrease in overall Mortality in the Americas: Children 0 – 5 yrs

Epidemiology of childhood and neonatal mortality in the Americas over time

DECREASE IN MORTALITY IN CHILDREN < 5 YRS: A PENDING ASSIGNMENT

60% of mortality in the first 90 days of life

WHAT TO DO

“...The highly trained and critically minded intensive care community is uniquely qualified to contribute in the saving hundreds of thousands of lives outside of the ICU”

Crafer 2011

CONTRIBUTION OF THE PEDIATRICIAN

- PALS
- NALS
- IMCI
- Sepsis Protocol
- WHO oral rehydration
- Neonatal and maternal interventions

Shock reversal from community hospital resulted in better survival

Improved survival by 38%
Number Needed to Treat = 3.3
EVERY HOUR DELAYED OF ANTIBIOTICS RESULTS IN 7.6% DECREASE IN SURVIVAL PER HOUR IN ADULTS WITH SEPTIC SHOCK

Kumar et al, Crit Care Med 34: 2006

Sepsis: a disease continuum

- Patients with life-threatening infection often present with fever and excessive, persistent tachycardia
- Tachycardia, tachypnea, and signs of worsening perfusion (weak pulses, lethargy, and poor capillary refill) precede hypotension
- Hypotension is a late, ominous sign in pediatrics
- Often followed by cardiopulmonary collapse
- Stopping progression to hypotension via early reversal improves outcomes


1. Recognize a problem

2. Do Something.

PROTOCOL

2007 American College of Critical Care Medicine Clinical Practice Parameters for Hemodynamic Support Of Pediatric Septic Shock

- Incorporated in American Heart Association PALS manual
- Published in Spanish and Portuguese and disseminated in American continents
- In 2008, 57 peer reviewed publications since 2002 citing these guidelines
- No evidence of harm

PALS

CCM 2009 Vol. 37, No.2

0-5 min

Recognize decreased mental status and perfusion. Begin high flow O2. Establish IV/IO access.
**EARLY FLUID RESUSCITATION IN PEDIATRIC SEPTIC SHOCK IS ASSOCIATED WITH BETTER OUTCOME**

Oliveira et al, Ped Emergency Care 24:2008

**PRE ADMISSION INTERVENTIONS**

- Integrated management of childhood illnesses at the community level
  - PALS
  - Rapid response teams
  - Medical direction of transport teams
  - Delivering the ICU to the Child

**Which is the more lethal weapon?**

"...and as it turned out, the doctor didn’t know how to dig."
**FUTURE OF PICU PRACTICE**

- Development of chemical markers as sign of danger
- Different levels of licensure providers for optimal care and optimal training
- Processes that allocate patients appropriately with resources
- The limits to growth (specialized ICU’s)

**FUTURE PICU PRACTICE**

- A system to identify early the physiological signs and indicators of altered pathobiology
- A system of bedside care delivery that is a continuum between people and technology where hand offs are almost irrelevant
- The team is composed of individuals with different levels of licensure and with the physician as coordinator and rather than operator

**OUR BIGGEST CHALLENGES**

- Innovative high yielding interventions in collaboration between agencies, universities, and other groups.
- Making existing low cost effective interventions that are available **ACCESSIBLE**

**OUR BIGGEST CHALLENGES**

- Human factors in delivering intensive care (hours vs. hand offs, attention, battle creep)
- Percent of time dedicated to patient care versus time documenting what is done
- Percent of truthfulness in documentation
- Value of observation versus intervention (Chronotherapy)

**OUR BIGGEST CHALLENGES**

- Too big to know
- Team composed by individuals with different levels of licensure
- Need for research to assess the value of intensive observation and definition of signs of danger, thresholds for intervention to eliminate observer control
- Management sciences research and applications to improve efficiencies

**COMPLEXITY**

- 92 Patients 92 diagnosis
- Average of 5 secondary diagnosis
- 22 with 10 or more
- 7,000 registered medications
- 4,000 certified surgical procedures
- 14,000 diseases in WHO registry OMS
- 1122 specialists en 70 specialties and sub-specialties
“...I thank you, in a life of universal responsibility for one another and for the planet we share”

Dali Lama

OUTCOMES OF MODS

Children with MODS at admission have greater mortality, longer length of stay and worse functional outcomes. Infants have higher mortality and higher incidence of MODS.

Typpo and Mariscalco analyzed 44,693 admissions from 28 US Children’s Hospitals. Patients with MODS had a mortality of 10% vs. 1.2%. Infants have higher MODS incidence and higher mortality.

INDIVIDUAL ADVANCES

<table>
<thead>
<tr>
<th>Condition</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARDS</td>
<td>Permissive hypercapnia / low volume ventilation</td>
</tr>
<tr>
<td>Septic Shock</td>
<td>Goal directed therapy</td>
</tr>
<tr>
<td>Traumatic Brain Injury</td>
<td>Hypothermia and goal directed therapy</td>
</tr>
<tr>
<td>Congenital heart surgery</td>
<td>Cardiac ICU</td>
</tr>
</tbody>
</table>

RECENT ADVANCES

- Hypothermia
  - Two landmark studies showing 50% good outcome post resuscitation with Hypothermia
- Helium
  - Randomized studies showed the mixture with O₂ is beneficial for evation of intubation

- Fluid management strategies
- Superior vena cava Oxygen saturation
- Clotting management
- Improved survival
- A “vital sign”. Maintenance of a threshold reduces mortality

THE ICU LEDGERS

- Fluid Overload is Lethal

FLUID OVERLOAD IS LETHAL

- Lesser % FO a CVVH (D) initiation was associated with improved outcomes (p = 0.03)
- Lesser % FO at CVVH (D) initiation was also associated with improved outcomes when sample was adjusted for severity of illness (p = 0.03; multiple regression analysis)
GOAL DIRECTED THERAPY

PICU FUTURE RESEARCH

- Management Sciences successful application in most non-healthcare settings improve efficiencies
- Need more systematic research to incorporate Management Sciences to enhance efficiencies of healthcare delivery in PICU