PICU Care - Does more care equate to better outcomes?

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Structure of the talk

- Input-outcome relationship
- Why does more care not necessarily improve outcome?
- How can we detect overtreatment?
- How much care is best?
Input - outcome relationship
Input-outcome relationship

Life expectancy vs. spending

http://ucatlas.ucsc.edu
The law of diminishing returns

Input-outcome relationship

Benefit

Inputs of Medical Care

Fisher ES, JAMA, 1999
PICU: Input and outcome

Input:
- Staff
- Diagnostic and therapeutic procedures

Outcome:
- ICU mortality (Standardised mortality ratio, SMR)
- Neurodevelopmental outcome
- Quality of life
# Input-outcome relationship

## More care may equate to worse outcome

<table>
<thead>
<tr>
<th>Author</th>
<th>Setting</th>
<th>Input</th>
<th>Outcome parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earle M, 1997</td>
<td>PICUs in Mexico, Ecuador, USA</td>
<td>Intubation, CVL</td>
<td>Adjusted mortality</td>
</tr>
<tr>
<td>Wilson D, 1996</td>
<td>PICU, USA, RSV</td>
<td>Invasive monitoring, inotropes, blood, paralysis, antibiotics, parenteral nutrition</td>
<td>LOS, nosocomial inf., mortality, hospital charges</td>
</tr>
<tr>
<td>Bednarek F, 1998</td>
<td>NICU, USA</td>
<td>arterial lines</td>
<td>blood transfusions</td>
</tr>
<tr>
<td>Callaghan L, 2003</td>
<td>NICU, Australia</td>
<td>staff to infant ratio</td>
<td>adjusted mortality</td>
</tr>
<tr>
<td>Lacroix J, 2007</td>
<td>PICUs, Canada, USA, UK, Belgium</td>
<td>Transfusion threshold (9.5 vs. 7g/dl)</td>
<td>Mortality, MODS</td>
</tr>
</tbody>
</table>
Input-outcome relationship

Invasive therapies and mortality

Earle M, 1997
Overdiagnosis and overtreatment

Inappropriate use of diagnostic and therapeutic procedures

- The mere availability
- Financial incentives
- Pressure to treat asymptomatic conditions
- Bad expertise
Why does more care not necessarily improve outcome?
Why does more care not improve outcome?

1. Abnormal physiology may be protective

<table>
<thead>
<tr>
<th>Author</th>
<th>Physiological variable</th>
<th>Protective effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russell PM, 2003</td>
<td>Fever in sepsis</td>
<td>Increased survival</td>
</tr>
<tr>
<td>Shibata K, 1998</td>
<td>Hypercapnic acidosis in ALI</td>
<td>Attenuation of ALI</td>
</tr>
<tr>
<td>Pepe PE, 2002</td>
<td>Blood pressure in trauma: less aggressive support</td>
<td>Decreased mortality</td>
</tr>
<tr>
<td>Hoskote A, 2004</td>
<td>Hypercapnic acidosis after BCPA</td>
<td>Increased SaO₂, decreased O₂-consumption</td>
</tr>
</tbody>
</table>

Kavanagh BP, 2005
Why does more care not improve outcome?

Glenn: hypercapnia and acidosis

- cerebral venous return ↑
- intrathoracic pressure drop: PVR ↓
- acidosis: PVR ↑
- paO2 ↑, SaO2 ↑
- oxygen consumption ↓

Hoskote A, 2004
Why does more care not improve outcome?

2. The intervention is too risky

<table>
<thead>
<tr>
<th>Physiologic variable</th>
<th>Intervention</th>
<th>Risk of intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypokalemia</td>
<td>K-infusion</td>
<td>Cardiac arrest</td>
</tr>
<tr>
<td>Hypotension</td>
<td>Blood pressure guided therapy after cardiac surgery</td>
<td>Increased cardiac work, side effects of catechol.</td>
</tr>
<tr>
<td>SIRS without infection</td>
<td>Broad spectrum antibiotics</td>
<td>Resistant bacteria</td>
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</tbody>
</table>
Why does more care not improve outcome?

(The intervention is too risky)

<table>
<thead>
<tr>
<th>Author</th>
<th>Physiologic variable</th>
<th>Intervention</th>
<th>Risks of intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dreyfuss D,</td>
<td>SaO₂ and paCO₂</td>
<td>Ventilation to normal levels</td>
<td>Aggravation of lung injury</td>
</tr>
<tr>
<td>1998</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skippen P,</td>
<td>PaCO₂</td>
<td>Hyperventilation in TBI</td>
<td>Cerebral ischemia</td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tin W,</td>
<td>SaO₂ in premature infants</td>
<td>Keep SaO₂ &gt;88%</td>
<td>More retinopathy, less weight gain, longer ventilation</td>
</tr>
<tr>
<td>2001</td>
<td></td>
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How can we detect overtreatment?
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On a local level

- Critical incident monitoring
- Calculation of Standardised Mortality Ratio
- Comparison between number of invasive procedures and adjusted mortality
- Mortality-morbidity conferences (audits)
- Medical record review (Dunn KL, 2006)
How can we detect overtreatment?

Critical incident monitoring in Swiss ICUs

Number of reported critical incidents in last month
How can we detect overtreatment?

**Standardised mortality ratio (SMR)**

$$\text{SMR} = \frac{\text{Observed mortality}}{\text{Expected mortality}}$$

e.g. SMR = \frac{3.7\%}{3.1\%} = 0.84 \ (95\% \ CI \ 0.6 \ - \ 1.1)
How can we detect overtreatment?

Invasive procedures and mortality

- Paediatric Intensive Care Unit (Latin American)

- Predicted (by PRISM Score)
- Observed

- Patients [%]
  - USA
  - Latin America

- Central Catheters
- Intubation
How can we detect overtreatment?

On a multicenter level

- Comparing invasive with simple approaches
- Registers of invasive therapies (e.g. ECMO)
How much care is best?
How much care is best?

...One of the greatest opportunities to improve patient outcomes comes not from discovering new treatments, but using existing therapies more effectively.

Pronovost P, Lancet, 2004
## Maintenance of natural organ functions

<table>
<thead>
<tr>
<th>Author</th>
<th>Normal function</th>
<th>Artificial intervention</th>
<th>Risks of intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marik P, 2003</td>
<td>Enteral nutrition</td>
<td>Parenteral nutrition</td>
<td>Atrophy of intestinal mucosa, infection, liver damage</td>
</tr>
<tr>
<td>Bhutani V, 1988</td>
<td>Spontaneous</td>
<td>Muscle relaxation</td>
<td>Decrease of lung compliance, increase of lung resistance</td>
</tr>
<tr>
<td></td>
<td>breathing in intu-</td>
<td></td>
<td>critical illness neuropathy</td>
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<td>tated patients</td>
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<tr>
<td></td>
<td>Adaptation to</td>
<td>Transfusion</td>
<td>Infection, bone marrow depression, GVH</td>
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<tr>
<td></td>
<td>anemia</td>
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</table>
How much care is best?

Safe and simple procedures for appropriate periods

- Limitation of the number of drugs
- Mechanical ventilation and CVL for short periods

![Graph showing the relationship between mean intubation time and rate of accidental extubations (per 100 intubation days).]
Closed format PICU

- Decrease in admissions with very low severity
- Decrease in adjusted mortality

Pollack M, 1988
Guidelines

- Reducing physician practice variability

- Areas lacking evidence based guidelines → prone to overtreatment (e.g. transfusion)

- Simply „protocolising“ care without the introduction of any new intervention may improve outcome (Morris AH, Am J Respir Crit Care Med, 1994)
Most PICU patients can be managed with simple, safe procedures, according to guidelines.

A small proportion can be saved with extraordinary measures. Appropriate selection!