Nosocomial infections: Are they inevitable or preventable?

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OBJECTIVES

- Review epidemiology and importance of nosocomial infections (NI) in the ICU
- Risk factors for NIs in the PICU and CICU
- Data regarding preventability of NIs

NOSOCOMIAL INFECTIONS ARE A GLOBAL PICU PROBLEM

NOSOCOMIAL INFECTIONS IN THE CICU

- Central line associated bloodstream infection (CLABSI)
- Urinary tract infection (UTI)
- Ventilator associated pneumonia (VAP)
- Wound infections/Mediastinitis

MECHANISM FOR INFECTION OF INVASIVE DEVICES

- Colonized or contaminated
- Colonization→biofilm→migration along extraluminal or luminal surface→invasion of sterile tissue→infection

1. Safdar N. Intens Care Med 2003

CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS (CLABSI)

- Most common NI
- Catheter-related vs associated
- Increased costs: $39k-50k/infection
- Increased LOS: 6.5 – 15 days
- Attributable mortality rate: 13.1%
- Associated with poor outcome on ECMO\(^{(2)}\)
- Mean pooled rate for PICUs: 7.7/1000 cath-days
- Most common organism is coagulase negative staph\(^{(2)}\)


RISK FACTORS FOR CLABSI

- Severity of Illness
- Invasive lines
- ECMO
- Dialysis
- Mechanical ventilation
- Genetic syndromes
- Transfusions
- TPN\(^{(3)}\)


VENTILATOR ASSOCIATED PNEUMONIA (VAP)

- Second most common NI in PICUs
- Reported incidence 5-10% in pediatric patients
- $5,000-8,000/event in adults
- Mean rate 6/1,000 vent-days
- Early (community acquired pathogens) vs Late (Gram negative, MRSA)\(^{(4)}\)
- Risk factors: genetic syndrome, transfusions, re-intubation
- Associated with delayed extubation by 3.7 days in pediatric cardiac patients\(^{(4)}\)


URINARY TRACT INFECTION

- PICU rate is higher than adults (5.2/1000 cath-days)
- Predominately Gram -, enterococcus, and yeast
- Risk factors: catheterization > 3 days and CV surgery\(^{(5)}\)


SURGICAL SITE INFECTIONS

- Superficial vs Deep
- Mediastinitis incidence: 0.04-3.9% (higher in with delayed sternal closure)
- Surgical site infection incidence: 0.1-7% (10% with delayed sternal closure)
- Risk factors: neonates, duration of surgery, and transplant patients (? genetic syndrome)\(^{(6)}\)

WOUND INFECTIONS/ MEDIASTINITIS

- Mediastinitis
  - 2/3 of infections are Gram +
  - Approximately 30% are Gram - infections
  - 1/2 have positive blood cultures
  - *S. aureus* is associated with BSI(6)


CICU AND NIs: OUR PATIENTS ARE SPECIAL

- Severity
  - Systemic inflammatory response
  - Hypothermia
  - Hyperglycemia
  - Multiple access sites
- Patient age (Neonates)
- Multiple transfusions
- Benchmarking difficult- adjustment
- Frequent use of TPN

CICU SPECIFIC STUDIES

  - 16.4% acquired NI
  - BSI infection in 10% and wound infections in 8% (85% of all infections)
  - 76% of infections were gram -
  - Risk factors: neonates, delayed sternal closure, LOS, and complexity(7)

7. Levy I. JTCVS 2003

CICU SPECIFIC STUDIES

- Valera (2001)
  - NI in 30.8%
  - BSI 19/1000 cath-days
  - Wound infection 4.8%
  - Gram + most common
  - Risks for NI: LOS, CVC duration, delayed sternal closure and prosthetic valve(8)


CAN WE AVOID THE INEVITABLE....?

THE PRESSURE IS ON
Dominguez TE. Nosocomial infections

Nosocomial Infections Are a Major Issue

- Ventilator associated pneumonia, central line associat-
ed bloodstream infection, and surgical site infection
- Bundles of care-pediatric supplements

Nosocomial Infections Can Be Prevented in Adults

- 108 adult ICUs
- CLABSI, daily goals sheet, VAP, and safety culture pro-
gram
- Mean rate reduction 7.7 to 1.4/1,000 cath-days
- Hand washing
- Chlorhexidine prep
- Full barrier precautions
- Avoid femoral vessels
- Remove lines ASAP

CICU Intervention to Reduce NIS

- Dagan (1999)
- Change in practice 1987 vs 1992
- NIR decreased 25 to 20%
- Wound infections decreased 7 to 4.3%
- ! NIR in CPB patients
- Severity score (TISS) associated with BSI

ARE SOME RISK FACTORS FOR INFECTION MODIFIABLE?\(^{(11)}\)

<table>
<thead>
<tr>
<th>Modifiable Risk Factors</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central venous catheter &gt; 2 wks</td>
<td>2 (18.2)</td>
</tr>
<tr>
<td>Arterial catheter removed and not replaced</td>
<td>3 (27.3)</td>
</tr>
<tr>
<td>Central venous catheter removed and not replaced</td>
<td>2 (18.2)</td>
</tr>
<tr>
<td>Bladder catheter removed and not replaced</td>
<td>6 (45.5)</td>
</tr>
</tbody>
</table>

Total 13 (100)

11. Dominguez TE, Crit Care Med, 2004

RISK OF INFECTION AND MODIFIABLE PATIENT CARE

p=NS

\[
\text{CLABSI Rate} = 0.78, \quad \text{UTI Rate} = 0.82, \quad \text{Modified Care} = 0.39
\]

REDUCING CATHETER-ASSOCIATED BLOODSTREAM INFECTIONS IN CHILDREN:

SUSTAINABILITY & SPREAD PROJECT 2006

The Children’s Hospital of Philadelphia®

Cardiac Intensive Care Unit
Team Leader: Troy Dominguez, MD
Team Member: Sarah Tabbutt, MD
Front Line Leader: Leslie Shannon, RN
Front Line Leader: Ann Adams, RN
Team Member: Eve Teszner, RN
Team Member: Alyce Allenbach, RN
Team Member: Eileen Brunwasser, RN

CHANGES IMPLEMENTED TO DATE

1. Ten-second hub scrub
2. CHG skin antiseptic for children 2 months or older
3. Weekly dressing change day
4. Biopatch (≥ 2 months of age)
5. Masks with dressing changes
6. Change claves/stopcocks with all line changes
7. Reduce line access events
8. Use peripheral lines for IV medications when feasible
9. Central line care competency

CLABSI RATE CICU
OTHER INTERVENTIONS FOR PREVENTIONS OF CLABSI

- Special Catheters
  - Heparin bonded
  - Impregnated/Coated catheters
- Tunneled catheters (?)
- Reduce skin colonization (chlorhexidine)
- 28% reduction in neonatal mortality in LBW infants, 11% reduction overall(12)

12. Tielsch JM, Pediatrics, 2006

TIME TO BSI AFTER CATHETER INSERTION(13)

<table>
<thead>
<tr>
<th>Catheter type</th>
<th># CLA-BSI</th>
<th>Catheter Days</th>
<th>CLA-BSI rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunneled</td>
<td>14</td>
<td>981</td>
<td>14.3 (7.8-23.9)</td>
</tr>
<tr>
<td>Non-tunneled</td>
<td>32</td>
<td>2,523</td>
<td>12.7 (8.6-17.9)</td>
</tr>
<tr>
<td>PICC</td>
<td>8</td>
<td>785</td>
<td>10.2 (4.4-20.0)</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>4,289</td>
<td>12.6 (9.5-16.4)</td>
</tr>
</tbody>
</table>


PICC LINES

- No difference in infection rates in inpatients (6.4/1,000 cath-days in hospitalized children)(14)
VAP BUNDLE

- Head of bed elevation
- Extubation readiness
- GI prophylaxis
- DVT prophylaxis-age appropriate

SSI BUNDLE

- Directed toward the timely antimicrobial prophylaxis (0-60 minutes prior to incision)
- Other measures (†):
  - Hair removal
  - Glucose control
  - Normothermia

RISK OF SSI: ASA SCORE

Physical status
1. A normal healthy patient
2. A patient with a mild systemic disease
3. A patient with a severe systemic disease that limits activity, but is not incapacitating
4. A patient with an incapacitating systemic disease that is a constant threat to life
5. A moribund patient not expected to survive 24 hours with or without operation

E Emergency Most neonates

PREVENTION OF UTI

- Timely removal of device
  - Boston: 3.8 → 1.0/1000 pt-days
  - Toronto: 1.4 → 0.12/100 admissions (< 3 days)

SUMMARY

- Reviewed epidemiology and impact of nosocomial infections in the ICU
- Risk factors for NIs in the PICU and CICU
- Data regarding the preventability of NIs
- Ways to prevent NIs

SURGEON BUNDLE (AKA «SPRAY PLAN»)

I want everything out!