Quality Improvement: Prevention of Hospital Acquired Infections in the NICU

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SWAN Conference, 2012
Temple, TX
Clinical Spectrum of Neonatal Sepsis

Timing of infection in VLBW infants

* Approximately 70% cases of LOS in preterms are associated with central lines
Why should we worry about HAI?

- HAI’s cause 100,000 deaths/year in U.S.
- 50 to 60% caused by antibiotic resistant bacteria
- Late onset sepsis causes 45% of NICU deaths after 2 weeks of age
- Associated with longer hospital stay, increased costs and worse developmental outcome
- Non-reimbursed care?
Infection Increases Relative Risk of Poor Neurodevelopmental Outcome

<table>
<thead>
<tr>
<th></th>
<th>Clinical Infection (n=1538)</th>
<th>Sepsis (n=1922)</th>
<th>Sepsis + NEC (n=279)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDI &lt; 70</td>
<td>1.3</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>PDI &lt; 70</td>
<td>1.5</td>
<td>1.5</td>
<td>2.4</td>
</tr>
<tr>
<td>CP</td>
<td>1.3</td>
<td>1.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Microcephaly</td>
<td>1.3</td>
<td>1.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

@ 18 month follow-up

Stoll et al. JAMA 2004; 292:2357
# Rates of HAI by Birth Weight

<table>
<thead>
<tr>
<th>Birth Weight (g)</th>
<th>UVC &amp; CV BSI*</th>
<th>VAP*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1000</td>
<td>10.3</td>
<td>2.0</td>
</tr>
<tr>
<td>1001 - 1250</td>
<td>6.3</td>
<td>0</td>
</tr>
<tr>
<td>1251 - 1500</td>
<td>3.7</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 2500</td>
<td>2.8</td>
<td>0</td>
</tr>
</tbody>
</table>

* Per 1,000 device days

NNIS Data 1995 – 2003, median values
Epidemiology of Hospital-Acquired Infections in the NICU
Epidemiology of late-onset infections

- Risk factors include:
  - Lower gestational age
  - Lower birth weight
  - Prolonged mechanical ventilation
  - Necrotizing enterocolitis
  - Bronchopulmonary dysplasia
Other Associated Factors

- Use of parenteral nutrition and lipid emulsion
- Presence of central catheter
- Steroids for BPD (? hypotension)
- Histamine blockers
- Low serum IgG levels at birth
- Overcrowding and heavy workloads
Late-onset infections in NICHD Network

- 6215 VLBW infants in 15 sites
- 21% of infants diagnosed with LOS
- 72% with one episode; 28% more than one
- Considerable inter-center variability
  - Rates ranged from 10.7 to 31.7% of VLBWs
  - 18 to 51% in infants < 28 weeks

Epidemiology of Late-Onset Infections

Gram Positive 70%

Gram Negative 18%

Fungi 12%

Stoll et al. Pediatrics 2002
Epidemiology of late-onset infections: Gram-positive organisms

- CoNS: 68%
- S. aureus: 11%
- Enterococci: 5%
- GBS: 3%
- Other: 13%

Stoll et al. Pediatrics 2002
Coagulase Negative Staphylococci

- Most common cause of catheter related sepsis
- Also common contaminant
- Usual practice to obtain single blood culture; volume of blood critical
- Culture drawn through catheter hub may be line colonization or contamination
Coagulase Negative Staphylococci

- CoNS on NICU RN’s hands more likely to be antibiotic resistant
- Pre and post vacation isolates different
- Almost all blood isolates of CoNS genetically related to organisms isolated from hands of NICU personnel
- Suggests invasive CoNS nosocomially acquired

Hira V, J Clin Microbiol 2010
Venous Catheters and Infection

- Evidence basis for strategies to prevent intravascular catheter-related infections
What is a CLABSI?

- **Central Line Associated Blood Stream Infection** = **CLABSI**
- Positive blood culture x 2 with recognized pathogen in patient with central line in place without any other source identified
- Expressed as infection per 1000 line days
Catheter Site

- Catheter site important in incidence of CLABSI in adults
  - Groin > neck > subclavian
- Little data in pediatric population
- Tunneled versus non-tunneled catheters
## Infections by Type of Line

<table>
<thead>
<tr>
<th>Line Type</th>
<th>Adjusted RR</th>
<th>Days after insertion</th>
<th>Infections per 1000 line days</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVC</td>
<td>2.0</td>
<td>4 ± 8.9</td>
<td>7.2</td>
</tr>
<tr>
<td>PICC</td>
<td>3.5</td>
<td>10 ± 10.9</td>
<td>13.1</td>
</tr>
<tr>
<td>Broviac</td>
<td>3</td>
<td>16 ± 19.1</td>
<td>12.1</td>
</tr>
</tbody>
</table>

Compared to no CVC infection rate of 2.9 per 1000 non-line days

CLABSI Free Rate by Duration of UVC Use

Butler-O’Hara, J Pediatr 2012
Quality Improvement Teams and Prevention of Hospital Acquired Infections
Guidelines v. Bundles

- Guidelines tend to be long, all-inclusive, and confusing
  - Many potential interventions are supported by some evidence
- Guidelines are difficult to translate into action and often ignored by clinicians
- What if just a few key, actionable interventions, supported by strong evidence, were culled from the guidelines?
What Is a Bundle?

- Grouping of best practices that individually improve care; when applied together result in substantially greater improvement
- Sound evidence base
- Bundle elements are dichotomous; compliance can be measured: yes/no answers
- Bundles reject the piecemeal application of proven therapies in favor of an “all or none” approach
- Occur in a specific point in time
CLABSI: Access to Patient

Catheter Insertion Bundles

- Associated with decreased CLABSI in adults and pediatric patients
- Little data in newborns
- Stress hand hygiene, full barrier precautions, site, sterile technique and teamwork
- Use of checklists
Central Line Insertion Checklist - Adults

Operator: ___________________________ Date: ______________________
RN Assisting: ________________________ Room/Location: ________________

Safety Pause:
☐ Correct Patient ☐ Correct Procedure
☐ Correct Site ☐ Verbal agreement from all members of the team.

In order to eliminate central line associated blood stream infections, we will be following the Central Line Insertion Procedure Checklist based on CDC Guidelines.

Prior to the Procedure:
1. Hand Hygiene, done with Chlorhexidine Gluconate (CHG) 2% surgical hand scrub and water or waterless alcohol based gel before patient contact and before donning sterile gloves.
   YES
2. Cleanse Site, with 2% CHG with sponge 1.5mL.
   YES
3. Disinfect Site, with a back and forth friction scrub, utilizing 2% CHG wand 10.5mL for 30 seconds and allow to dry completely before catheter insertion.
   YES
4. Maximum Barriers, Did the operator wear:
   YES Cap/Bouffant
   YES Mask
   YES Sterile Gown
   YES Sterile Gloves
   YES Patient draped with full body sterile sheet.

During the procedure:
5. YES Operator(s) maintained the sterile field.
6. YES Personnel assisting wore a cap, mask and donned gloves appropriately.

After the procedure:
6. Sterile dressing applied immediately by the operator.
   YES

QUALITY IMPROVEMENT

THIS FORM IS NOT PART OF THE PATIENT'S PERMANENT RECORD.
Please return the form to your Nurse Manager. If a step has not been followed, please note and the Nurse Manager will follow up with the physician.
Keystone ICU Project

- 103 participating adult ICUs in Michigan, United States
- Implementation of CVL insertion bundle
- Additional interventions
  - Daily goal sheet
  - VAP reduction
  - Unit-based safety program

<table>
<thead>
<tr>
<th>Study Period</th>
<th>No. of ICUs</th>
<th>No. of Bloodstream Infections per 1000 Catheter-Days</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Overall</td>
</tr>
<tr>
<td>Baseline</td>
<td>55</td>
<td>2.7 (0.6–4.8)</td>
</tr>
<tr>
<td>During implementation</td>
<td>96</td>
<td>1.6 (0–4.4)†</td>
</tr>
<tr>
<td>After implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–3 mo</td>
<td>96</td>
<td>0 (0–3.0)‡</td>
</tr>
<tr>
<td>4–6 mo</td>
<td>96</td>
<td>0 (0–2.7)‡</td>
</tr>
<tr>
<td>7–9 mo</td>
<td>95</td>
<td>0 (0–2.1)‡</td>
</tr>
<tr>
<td>10–12 mo</td>
<td>90</td>
<td>0 (0–1.9)‡</td>
</tr>
<tr>
<td>13–15 mo</td>
<td>85</td>
<td>0 (0–1.6)‡</td>
</tr>
<tr>
<td>16–18 mo</td>
<td>70</td>
<td>0 (0–2.4)‡</td>
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</table>

* Because the ICUs implemented the study intervention at different times, the total number of ICUs contributing data for each period varies.
† P≤0.05 for the comparison with the baseline (preimplementation) period.
‡ P≤0.002 for the comparison with the baseline (preimplementation) period.

Catheter Site Cleansing

- Chlorhexadine as antiseptic more effective in prevention of CLABSI in adult and pediatric patients than povidone-iodine
- Approved in U.S. for use > 2 months of age
- Problems with skin irritation and absorption in newborns (especially preterm) – use controversial
Use of Chlorhexadine in U.S. NICUs

Tamma PD, Infect Control Hosp Epidemiol 2010
Restriction of Chlorhexadine Use by Gestational Age

- None: 71%
- < 28 wks: 15%
- 29 - 32 wks: 5%
- 33 - 37 wks: 2%
- > 38 wks: 7%

Tamma PD, Infect Control Hosp Epidemiol 2010
Catheter Dressing

- Biopatch® is chlorhexidine impregnated catheter dressing
- Used in adults and children also helps prevent CLABSI
- Cannot be used in preterm infants secondary to skin irritation (~15%)
“Maintenance” Bundles

- Guidelines for care of CVL
- Dressing type and change schedule
- Duration of IV tubing before change
- Specify when sterile field should be used
- Teamwork to prevent distraction/error
- Daily assessment of line necessity
### NICU Central Catheter Bundle

**California Children’s Hospital Association-California Children’s Services**  
**NICU Collaborative**  
1-15-08

#### Insertion

<p>| | |</p>
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</table>
| 1. | Maximum sterile barrier precautions  
   - Cover all infant with sterile drapes  
   - Staff assisting at bedside with procedure  
   - Wear maximum barrier  
   - Staff in immediate area wear face mask |
| 2. | Skin disinfection – Chlorhexidine (CHG) or povidone iodine (PI)  
   - Apply over 30 seconds & allow to dry (exception aqueous CHG) |
| 3. | Dedicated team for placement & maintenance  
   - Insertion training course, including sterile technique, hand hygiene, use of maximum sterile barrier precautions, proper skin disinfection  
   - Educational competencies for all aspects of care |
| 4. | Dedicated cart containing all supplies for central catheter insertion  
   - Ensures supplies required to perform according to standards are located in one place |
| 5. | Excellent hand hygiene |
| 6. | Insertion checklist  
   - Staff empowerment to stop non-emergent procedure if sterile technique not followed |
| 7. | Optimal timing of CVC insertion  
   - Prevention of excessive venipuncture attempts |

#### Maintenance

**Assessment & Site Care**

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| 1. | Daily documentation of catheter need  
   - Consider removal when infant reaches ≥120 ml/kg/day enteral nutrition |
| 2. | Reduce lipid days  
   - Consider discontinuing lipids when infant reaches >2.5 gm/kg/day of enteral fat intake |
| 3. | Daily review of dressing integrity and site cleanliness  
   - Change PRN using sterile technique and CHG or PI for skin antisepsis |

**Tubing, Injection ports, catheter entry**

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</table>
| 1. | Closed systems – for infusion, blood draws & medication administration  
   - May use manufactured or improvised closed system. If stopcocks are used, they are capped with swabable injection port  
   - Define consistent practice to be used when accessing catheters |
| 2. | Clean or sterile technique for infusion tubing assembly & connection. Consistent tubing configurations for each type of VAD  
   - Sterile technique ideally includes sterile barrier for tubing assembly and wearing of face mask, hat, sterile gloves & 2 staff members performing connection to central catheter  
   - Clean technique includes clean barrier for tubing assembly & wearing of clean gloves |
| 3. | Scrub injection port using friction with either alcohol or CHG/alcohol swab for at least 15 sec. prior to entry |
| 4. | Clean gloves for all VAD entries & excellent hand hygiene |
| 5. | Use prefilled, flush containing syringes |

**Standard precautions**
A statewide quality improvement collaborative to reduce neonatal central line-associated bloodstream infections

DD Wirtschafter¹, J Pettit², P Kurtin³, M Dalsey⁴, K Chance⁴, HW Morrow⁴, M Seid⁵, TL Byczkowski⁶,¹², TP Huber⁷, JM Milstein⁸, SM Bowles⁹, S Fichera¹⁰ and S Kloman¹¹,¹³

Development of a statewide collaborative to decrease NICU central line-associated bloodstream infections

J Schulman¹,²,³, RL Stricof⁴, TP Stevens⁵, IR Holzman⁶,⁷, EP Shields⁸, RM Angert⁹, RS Wasserman-Hoff¹⁰, SM Nafday⁹ and L Saiman¹¹, for the New York State Regional Perinatal Centers and the New York State Department of Health

Is Bloodstream Infection Preventable Among Premature Infants?
A Tale of Two Cities

Hany Aly, MD⁴, Victor Herson, MD⁴; Anne Duncan, RN⁵; Jill Herr, MSN⁶; Joan Bender, APRN⁶; Kansial Patel, PhD⁶; and Ayman A. E. El-Mohandes, MD, MPH⁶

Neonatal Intensive Care Unit Collaboration to Decrease Hospital-Acquired Bloodstream Infections: From Comparative Performance Reports to Improvement Networks

Joseph Schulman, MD, MPH¹, David D. Wirtschafter, MD², Paul Kurtin, MD³

ORIGINAL ARTICLE
Utilizing a line maintenance team to reduce central-line-associated bloodstream infections in a neonatal intensive care unit

G Holzmann-Pazgal¹, A Kubanda², K Davis³, AM Khan¹, K Brumley¹ and SE Deason¹

¹Department of Pediatrics, University of Texas Medical School at Houston, Houston, TX, USA and ²Children’s Memorial Hermann Hospital-Texas Medical Center, Houston, TX, USA
California statewide collaborative to reduce NICU CLABSI

Wirtschafter DD, J Perinatol 2010
CLABSI Rate Improved by Higher Checklist Use

Schulman J, Pediatrics 2011
Use of Line Team to Decrease CLABSI

Holzmann-Pazgal G, J Perinatol 2012
CLABSI Rate at CMHH: QI at Work!
Decrease in Overall Infections
Driven by Decrease in CoNS

Puopolo and Eichenwald, PAS 2012
U.S. PICU Collaborative

Insertion-compliance rate

Maintenance-compliance rate

Precollaborative

Baseline Period

CA-BSI rate

Collaborative

Compliance

Ramp-up period 0.3

Stable-effect period 0.2

Miller et al. Pediatrics, 2010
Getting to Zero: Neonatal v. Adult CVL Infections

- Data suggest that most line infections in neonates “intraluminal” source
- Limited effect of insertion bundles
- Lines used differently
  - Access for blood draws
  - Longer duration
- Bedside management most critical
- Sustainability remains issue
Getting to Zero: Is it Harder in Neonates?

- Are all CLABSI’s really line related?
  - Other sources – porous gut, prolonged mechanical ventilation, altered microbiome
  - Adjudication of CLABSI may affect rate
  - Excellent line maintenance may not eliminate all infections in babies with CVL
  - Need additional strategies
BABIES HAVE THE RIGHT TO BARE ARMS!

**Please Remember To:**

- **Take off jewelry and watches on hands and wrists (1 plain band okay)**
- **Take off lab coats and sport coats; hang on hooks by room entrances**
- **Roll long sleeves up above elbows; ensure sleeves stay above elbows**
- **Wash hands and arms up to elbows thoroughly**
- **Use alcohol gel/foam or wash hands before and after patient contact**

Together, we can make a difference!
Other Strategies

- Fluconazole prophylaxis in ELBW
  - Recommended for centers with “high incidence” of invasive fungal infections
  - Reduces colonization and infection
  - Appears to be safe
  - Concerns remain
    - Anti-fungal resistance
    - Liver toxicity
## Targeted Fungal Prophylaxis in Low Incidence Center

<table>
<thead>
<tr>
<th>FP Policy</th>
<th>Number Exposed</th>
<th>Infections Targeted</th>
<th>Infections Not Targeted</th>
<th>NNT (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW &lt; 1000 g</td>
<td>585</td>
<td>18</td>
<td>0</td>
<td>33 (22, 60)</td>
</tr>
<tr>
<td>BW &lt; 1000 g ABX 7 days</td>
<td>293</td>
<td>16</td>
<td>2</td>
<td>19 (12, 35)</td>
</tr>
<tr>
<td>BW &lt; 750 g</td>
<td>224</td>
<td>15</td>
<td>3</td>
<td>15 (10, 29)</td>
</tr>
<tr>
<td>BW &lt; 750 g ABX 7 days</td>
<td>179</td>
<td>14</td>
<td>4</td>
<td>13 (9, 26)</td>
</tr>
</tbody>
</table>

Puopolo and Eichenwald, PAS 2012
Oral Bovine Lactoferrin Supplementation Reduces LOS in VLBW Infants

* P < 0.005

Control (n = 168)

Lactoferrin (n = 153)

Manzoni P, JAMA 2009
Common Sense Strategies

- Alcohol based gels for hand hygiene at every bedside
  - Compliance generally poor, though improving
- Minimize central line days (checklist)
- Use sterile barriers for line insertion and maintenance
- Encourage use of breast milk
Common Sense Strategies

- Limit use of drugs associated with HAI (e.g. H\textsubscript{2} blockers)
- Cohort infants with resistant or virulent organisms
- Antibiotic “stewardship”; use narrowest spectrum allowed
- Safety culture and training