A quality improvement initiative: the quest for zero Central Line-associated Bloodstream Infections (CLABSI) in hospitalized infants in a Neonatal Intensive Care Unit (NICU) in Chile

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Setting
This quality improvement project was performed at a level IV non-profit hospital in Chile, a middle income country in South America. The Neonatal Intensive Care Unit (NICU) consists of 25 beds, 8 of which are Intensive Care beds, 5 are Hybrid (for Intensive or Intermediate Care) and 12 are Intermediate Care beds. A total of 15 neonatologists, 50 bedside nurses and 47 nurse assistants influence this care process. The NICU coverage rate for bedside nurses is 1 per 3 patients and for nurse assistants 1 per 2 patients. There are 2 Neonatology attendings in house and 2 additional Neonatology Coordinator attendings that provide continuity of care.

During FY 2017 the NICU had 6,997 bed days and occupancy of 76%. A total of 15% (n=55) of admitted infants were <1500g and/or <32 weeks gestational age at birth. In this group of premature infants, from January 2016 to June 2018 the average LOS was 59.1 days and the average weight for gestational age delta z score upon discharge was -0.42. Premature infants are at increased risk of acquiring CLABSI related to a longer duration of hospitalization, increased need for central lines for nutrition and intrinsic immunodeficiency.

Problem description/rationale
During FY 2015 a multidisciplinary team within the NICU developed insertion and maintenance central line checklists, and kept close surveillance of protocol adherence in all patients with central lines. During FY 2016 the NICU reached and maintained a CLABSI rate of zero. From June 2017, the CLABSI rate in the NICU increased from 0 to 17.9 per 1.000 line days (includes umbilical, central and peripherally inserted central lines). During the following months the rate increased to 22 per 1.000 line days. We performed a Fishbone diagram and acknowledged the following main topics: (1) increased nº of infants <1500g, (2) hybrid bed infrastructure suboptimal for intensive care, (3) decrease in checklist surveillance and CLABSI team audit meetings, and (4) increase in census. The average census in the Intensive care beds for the first semester of FY 2017 was 98%, but from July 2017 it increased up to 138%, which implied using Hybrid beds for Intensive care.
In the literature, an infant with a CLABSI may increase their LOS at least 10 days and increase the cost of their hospitalization by USD 50,000. Additionally, premature infants that present with a CLABSI pose a higher risk of bronchopulmonary dysplasia, retinopathy of prematurity, necrotizing enterocolitis, short gut syndrome, malnutrition and death. In alignment with our Institutional goal, we aimed to decrease our CLABSI rate back to zero, as in FY 2016.

Aim
To reduce CLABSI rates in hospitalized infants in the NICU from 14 to 2 per 1,000 line days by February 28, 2018 and to 0 per 1,000 line days by May 30, 2018. CLABSI was defined per CDC recommendations.

Drivers of change

Interventions

- **PDSA nº 1 CLABSI Bundle**
  - PDSA cycle 1a: Development of Bundle and checklists
  - PDSA cycle 1b-1e: Bundle item applicability (handwashing surveillance, TPN administration checklist, central line installation and maintenance checklist, and documentation)
  - PDSA cycle 1f: Implementation of Bundle

- **PDSA nº 2 Physician central line Documentation**
  - PDSA cycle 2a: Phrase Development
  - PDSA cycle 2b-2c: Phrase incorporation and revision in daily note
  - PDSA cycle 2d: Phrase implementation

- **PDSA nº 3 Total parenteral nutrition (TPN) procedure**
  - PDSA cycle 3a: TPN updated procedure
  - PDSA cycle 3b-3c: TPN procedure simulation
  - PDSA cycle 3d: TPN procedure implementation

- **PDSA nº 4 Central line cap**
  - PDSA cycle 4a: Search for appropriate cap
  - PDSA cycle 4b-4c: Cap use simulation
  - PDSA cycle 4d: Cap implementation

- **PDSA nº 5 Timer for handwashing**
  - PDSA cycle 5a: Search for appropriate timer in compliance with local regulations
  - PDSA cycle 5b: Timer simulation use
  - PDSA cycle 5c: Timer implementation
### Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Numerator</th>
<th>Denominator</th>
<th>Unit of measure</th>
<th>Test population</th>
<th>How was data obtained</th>
<th>Frequency of measurement</th>
<th>Data shared with team and senior leaders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTCOME</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>CLABSI rate</td>
<td>Nº of hospitalized infants with CLABSI</td>
<td>Total nº of line days in infants with central lines</td>
<td>1000 line days</td>
<td>Infants in NICU</td>
<td>EMR</td>
<td>Monthly</td>
<td>Yes</td>
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<tr>
<td><strong>PROCESS</strong></td>
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<tr>
<td>Handwashing</td>
<td>Nº workers hand hygiene according to guideline</td>
<td>Nº workers that were evaluated</td>
<td>%</td>
<td>Workers in NICU</td>
<td>Checklist</td>
<td>Daily</td>
<td>Yes</td>
</tr>
<tr>
<td>Central line installation</td>
<td>Nº infants with complete central line checklist</td>
<td>Nº infants with central line</td>
<td>%</td>
<td>Nurse/Physician</td>
<td>Checklist</td>
<td>Per procedure</td>
<td>Yes</td>
</tr>
<tr>
<td>Central line maintenance</td>
<td>Nº infants with complete maintenance checklist</td>
<td>Nº infants with central line</td>
<td>%</td>
<td>Nurse</td>
<td>Checklist</td>
<td>Daily</td>
<td>Yes</td>
</tr>
<tr>
<td>Central line documentation</td>
<td>Nº of notes with correct line documentation</td>
<td>Nº of notes reviewed</td>
<td>%</td>
<td>Physician</td>
<td>EMR</td>
<td>Weekly</td>
<td>Yes</td>
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<tr>
<td>TPN procedure</td>
<td>Nº TPN change per procedure</td>
<td>Nº TPN changes</td>
<td>%</td>
<td>Nurse</td>
<td>Checklist</td>
<td>Daily</td>
<td>Yes</td>
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<tr>
<td>Bioluminescence</td>
<td>Nº workers with bioluminescence &lt; 80 LrsI</td>
<td>Nº workers with bioluminescence</td>
<td>%</td>
<td>Workers</td>
<td>Nurse report</td>
<td>Weekly</td>
<td>Yes</td>
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<tr>
<td><strong>BALANCING</strong></td>
<td></td>
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</tr>
<tr>
<td>Weight Delta z score at discharge</td>
<td>Delta z score for weight at discharge in &lt;1500g</td>
<td></td>
<td>-</td>
<td>z score</td>
<td>Infant</td>
<td>EMR</td>
<td>At discharge</td>
</tr>
</tbody>
</table>

### Results

1. **Outcome metric: CLABSI rate per month**

![Central Line Associated Blood Stream Infection rate (CLABSI) - includes umbilical, central and picc-line- Run chart](image)

- **PDSA 1, CLABSI bundle**
- **PDSA 2, Documentation**
- **PDSA 3, TPN procedure**
- **PDSA 4, Central line cap**
- **PDSA 5, Timer**

**Goal:**

- Median: 3.85
- **PD5A** 1-2: 3.85
- **PD5A** 3-4: 10.8
- **PD5A** 5: 22.3
2. Process metric:
   a. Bundle compliance

   ![Bundle compliance - Run chart](image)

   **Bundle compliance per item**

   ![Bundle compliance per item - Run chart](image)
c. Hand Bioluminescence

% workers in NICU with Bioluminescence < 80 Ugs - Run chart

- PDSA 1. CLABSI bundle
- PDSA 2. Documentation
- PDSA 3. TPN procedure
- PDSA 4. Central line cap
- PDSA 5. Timer

3. Balancing metric

% workers in NICU with Bioluminescence < 80 Ugs - Run chart

- PDSA 1. CLABSI bundle
- PDSA 2. Documentation
- PDSA 3. TPN procedure
- PDSA 4. Central line cap
- PDSA 5. Timer
Discussion
Premature infants are prone to CLABSIs due to intrinsic factors. Nevertheless, CLABSIs are considered to be preventable. Quality Improvement methodology and bundle implementation has demonstrated success in reducing the rate of CLABSIs in the NICU.

In this project, we implemented a bundle that consisted of: (1) hand hygiene protocol supervision, (2) central line installation procedure, (3) central line maintenance procedure, (4) central line documentation, and (5) a sterile 2 person TPN change procedure.

After 6 months of implementation, we obtained a bundle compliance greater than 95% and have maintained the effort. We have not had a CLABSI event in 165 days. Physician central line documentation needs further improvement and sustainability. Despite being more vigilant in removing central lines and the potential for increased extraterine malnutrition, the delta z score for weight at discharge in infants <1500g did not decline. Our limitations include: a short time period of evaluation and a lower intensive care bed occupation during the bundle implementation period. In order to sustain the gains, we are developing a Harm Prevention committee within the NICU and incorporate bundle compliance in our system.

Keywords
Central line-associated blood stream infections (CLABSI)
Premature infants
Infectious disease
Bundle
CLABSI bundle
Hand hygiene
Central line

Team acknowledgement
- Juan Carlos Muñoz MD, project physician leader, contributed in checklist development, physician documentation tracking, CLABSI audits, development and abstract revision.
- Beatriz Milet MD, project Improvement Advisor (IHI), contributed in quality improvement methodology, checklist revision, data analysis, CLABSI audits, development and abstract revision.
- Marcela Gómez RN, contributed in the development of new TPN protocol, checklist development and supervision, participated in CLABSI audits and abstract revision.
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- Pablo Gaete MD, contributed in the development of central line and TPN protocols, CLABSI audits and abstract revision.
- Marcial Osorio MD, NICU Director and stakeholder, contributed in CLABSI audits and abstract revision.