A Multisystem Approach to Improve Survival Without Morbidity for the Micropremature Infant
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Keywords
Bronchopulmonary dysplasia (BPD), “Golden Hour”, Micropremature infant, standardization, morbidity, CPAP

Background
• Unit Culture:
  o As we were a study site for surfactant and ventilation, the unit culture has been slow to adopt non-invasive ventilation as an acceptable model of care. Current practice was predicated on automatic intubation and mechanical ventilation for all infants ≤28 weeks gestation. Anecdotally, infants were seen as easier to care for intubated.
  o Practice guidelines for the care of premature infants including resuscitation, orders, fluid management, intubation/extubation criteria, etc. did not formally exist.
• Data supports focus on micropremature infant and common morbidities
  o Incidence of BPD (defined as oxygen requirement at 36 weeks corrected gestational age) above mean for inborn infants ≤26 weeks and ≤ 28 weeks gestation (Figure 1a)
  o Survival without morbidity* for infants ≤26 weeks is less than VON average (Figure 1b)
  o CPAP before intubation for infants ≤26 weeks in 2014 was 0% (VON average 25% (IQR 0-43%))
  o Ventilator days and infants discharged on oxygen above VON 3rd quartile
• Desired outcome to be at or better than the VON average

*(morfidity defined by VON: BPD, cystic PVL, late infection, necrotizing enterocolitis, pneumothorax, severe IVH)

Aim
Global Aim: To improve survival without specified morbidities for infants ≤26 weeks gestation from 12% to 20% by December 2015 with a stretch goal of 30% through the implementation of a micropreemie bundle of care practices.
Sub-Aim: To reduce bronchopulmonary dysplasia (BPD) for inborn infants ≤26 weeks gestation from 72% to 55% with a stretch goal of 50% by December 2015 through implementation of a multisystem approach.
Family-Aim: To improve family contact before, during and after resuscitation through pre-delivery introductions (Goal 100%) and a designated family liaison in the resuscitation room (goal is first update within 20 minutes).

Setting
• 46 bed, level IV, single-family room, regional referral center with 80% inborn population with an average of 20 micropremature infants per year.

Mechanisms
• The development of BPD is a multifactorial process that includes insults from inflammatory processes such as ventilator-induced lung injury to structurally and functionally premature lungs affecting both structure and function
• Current guidelines lack lung protective strategies
  o To meet our sub aim, key drivers of change to reduce ventilator induced lung injury include promoting intital support on CPAP, reducing ventilator days for intubated infants and revising care provided to infants durin ghe first few hours (see Figure 2)

Methods
• NICQ Next steering committee developed a driver diagram linking key drivers of change with outcome and process measures (see Figure 2)
Participants divided into six different systems-based groups including respiratory care, “Golden Hour”, and developmental care (see Figure 3)
- Each systems-based group focused on interventions to improve BPD with a strong emphasis on non-invasive ventilation (see Figure 4)

Golden hour
- Goal: To improve teamwork and communication with families and staff before, during and after resuscitation
  - Overall marker of success: “Top Down” in 60 minutes ( isolette closed and infant stabilized)
- Audit tool in use since May 2014 for baseline data, revised twice throughout planning
- “Easy” win: admission temperatures addressed while planning Golden Hour Script
  - PDSA #1: Increased resuscitation room temperature
  - PDSA #2: Reduced resuscitation room temperature and standardized method of placement into plastic wrap for infants <28 weeks
- Golden hour “timeout” initiated February 2015 (Figure 5)
  - Includes designated role for family liaison
- Time to IV fluids as surrogate for top down (last task):
  - PDSA #1: Pre-admission order entry for IV fluids March 2015
- Golden hour: script finalized May 2015 (Figure 6)
  - Materials for training: May through July 2015
- Future work: Interdisciplinary training for Golden Hour: July through August 2015

Respiratory Care
- Goal: Increase the use of non-invasive ventilation by promoting CPAP for initial stabilization and comprehensive weaning and extubation guidelines for those that require intubation
- Evidence and PBP’s reviewed from Aug 2014-Dec 2014
- Guidelines for initial management at delivery, CPAP use and weaning, and mechanical ventilation were developed Feb 2015-April 2015 (Figure 7 – CPAP weaning not shown)
- Transition to bubble CPAP as new device in April 2015
- Guidelines approved by faculty June 2015, Joint Practice July 2015
- Future work: guideline implementation with tracking sheet August 2015 (Figure 8)

Developmental Care
- Goals:
  1. To improve the quality of touch and handling
  2. To change from a provider-centered approach to a baby-centered approach for care
  3. Neuroprotection will be a central theme for all other practice changes
- Evaluation and trial of positioning device in March 2015
- Scent squares with maternal breast milk initiated May 2015
- Future work: defining and standardizing the care and handling of a micropremature infant

Fluid and Electrolytes
- Goal: To reduce the incidence of fluid and electrolyte derangements in the micropremature infant
- Chart review of last 15 micropremature infants looking at incidence of sodium and glucose derangements, maximum weight loss, and fluid management: December 2014
- Review of current literature and PBP’s and draft guidelines produced: April 2015
  - Decision made to wait on further development until after other roll-outs
- Selection of new standardized DOL 1 TPN: July 2015
- Future work: development of bedside worksheet for fluid and electrolyte calculations, standardize fluid orders in the EMR, and roll-out of FEN guidelines
**Measures** (all measures will be for inborn population)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Golden Hour</th>
<th>Respiratory Care</th>
<th>Fluid and Electrolytes</th>
<th>Developmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome</td>
<td>BPD for inborn infants ≤26 weeks gestation (goal 55%)</td>
<td>Survival without morbidity for infants ≤26 weeks gestation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Time to closed isolette</td>
<td>% CPAP before intubation</td>
<td>Sodium &gt;150 or &lt;130</td>
<td>Midline head positioning in DR</td>
</tr>
<tr>
<td></td>
<td>Time to IV fluids</td>
<td>Ventilator Days</td>
<td>Insulin infusion use</td>
<td>*Others to be developed</td>
</tr>
<tr>
<td></td>
<td>Family introductions</td>
<td>% Extubated within 6 hours of meeting criteria</td>
<td>Maximum % weight loss during 1st two weeks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time to touch or update</td>
<td>GA at time off CPAP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Admission temp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balancing</td>
<td>Surfactant &gt; 2 hours of age</td>
<td>Pneumothorax</td>
<td>Hypernatremia</td>
<td>TBD</td>
</tr>
<tr>
<td></td>
<td>Hyper- or hypothermia</td>
<td>Reintubation rate</td>
<td>Hyponatremia</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>PDA ligations</td>
<td></td>
</tr>
</tbody>
</table>

**Data (available prior to August 1, 2015)**

- Admission temperatures (see figure 9):
  - Baseline normothermia (36.5-37.5): 40% Goal: 80% Outcome: 67% (n=15)
  - Golden Hour “time-out” use:
    - No baseline available: 0% Goal: 80% Outcome: 100% (n=12)
  - Time to IV fluids (see figure 10)
    - Baseline: 77 min Goal: 60 min Outcome: 75 min (n=9)
  - Time to Family Update
    - No baseline available Goal: 20 min Outcome: 12 minutes (n=35)
  - Family Introductions
    - No baseline available Goal: 90% Outcome: 85% (n=7)

**Discussion**

- We have demonstrated improvement through PDSA cycles in our admission temperatures and slight improvement in the time to administer IV fluids (a marker of a completed resuscitation)
- Using multiple, interdisciplinary simulations, we were able to develop a comprehensive script to improve communication and teamwork in the delivery room
  - Golden hour training is beginning on July 27th, 2015 and will be completed by mid-late August.
- Changing to a culture that embraces non-invasive ventilation has been time-consuming and difficult due to personnel and equipment shifts
  - Respiratory guidelines will be effective August 15, 2015. Education and training will begin July 27th with bedside discussions and materials
- Next steps:
  - Golden hour training is beginning on July 27th, 2015 and will be completed by mid-late August.
  - Respiratory guidelines will be effective August 15, 2015. Education and training will begin July 27th with bedside discussions and materials
  - Plan to incorporate data in VON poster
- Lessons learned:
The Institute for Healthcare Improvement has an excellent resource on team composition to maximize efficiency and expertise (www.ihi.org).
Audit tools at the onset of a project to collect baseline data are valuable and can be revised over time to meet project needs.

Team Acknowledgement:
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Fluid Management: Alissa Doherty MD, Holly Brine MD, Kate Stanely MD, John Barks, MD

Figure 1: a) Incidence of BPD for inborn infants according to gestational age compared to type C NICU’s and b) Survival without morbidity for inborn infants 24-26 weeks gestation (no infants <24 weeks survived without morbidity)
Reducing BPD

**Aim:** Reduce BPD in infants ≤ 26 weeks gestation from 71% to 55% with a stretch goal of 50% by December 2015 through implementation of a BPD prevention bundle.

**Key Drivers:**
- Minimize ventilator induced lung injury
- Lung protection through DR management
- Optimize fluid and sodium therapy
- Early CPAP
- Volume ventilation
- Identify infants at risk for surfactant deficiency
- Avoid unnecessary oxygen delivery
- DR team communication
- PDA management
- Na and Fluid restriction
- PDA prophylaxis/ treatment guideline

**Secondary Process(es):**
- Promote extubation
- Extubation criteria
- Apnea management
- Ventilation Management Guidelines
- CPAP Guidelines
- RDS protocol with Vt monitoring
- Surfactant Management Guidelines
- DR guidelines

**Process Measures:**
- Ventilator days
- % Successful extubation
- % Extubated within 6 hours of criteria
- Reintubation rate
- CPAP before vent
- Compliance with guideline
- Surfactant delivery in eligible infants within 30 minutes
- Highest FiO2 in DR
- Top Down in 1 hour
- Time to IVF
- CPAP before vent
- Medically significant PDA
- PDA ligations

**Balancing Measures:**
- % Reintubations within 72 hours
- Pneumothorax
- Surfactant > 2 hours

**Figure 2:** Driver diagram to reduce BPD for infants born ≤ 26 weeks gestation.
NICQ NEXT Steering Committee

Aim: To improve survival without specified morbidities for infants ≤ 26 weeks gestation from 12% to 20% by December 2015 with a stretch goal of 30% through the implementation of a micropreemie bundle of care.

Sub-Aim: To reduce BPD for inborn infants ≤ 26 weeks gestation from 72% to 55% with a stretch goal of 50% by December 2015 through implementation of a “Reduce BPD” bundle.

Figure 3: Committee design for NICQ Next

Figure 4: NICQ Next timeline
Brandon Delivery Timeout

Fellow or Team Leader to initiate

“If any team member has any concerns or safety issues, please bring them to the team and team leader’s attention as soon as possible.”

- Introductions of all team members and disciplines (RN, RT, MD, NP, etc.)
- Patient situation (to include but not limited to):
  - Relevant maternal history
  - Diagnosis
  - Gestational age
  - Estimated weight
  - Specific concerns
  - Family issues
- Anticipated resuscitation steps with emphasis on steps that deviate from traditional NRP (to include but not limited to):
  - Immediate intubation vs. access and intubate pm
  - Positioning considerations of the baby
  - Starting IOG (peripheral vs. central) and prioritization
  - Need and availability for extra help or consultants (ENT, Cardiology, etc.)
- Assignment of roles and specific tasks:
  - Team leader
  - Intubation lead + backup
  - Primary RN
  - Second RN
  - Family liaison
- vasopressor access “routine and emergent”
- Equipment/Medication overview both routine and patient specific such as:
  - Anticipated ETT size, blade, special airway equipment
  - Medications (infusions, resuscitation meds or boluses)
- Special considerations (ref to do list...)
  - Notify Peds Surgery or Cardiology if needed
  - CDH: repleg
  - Myelomeningocele: saran wrap
  - Omphalocoele/gastrochisis: bag

“Any questions or concerns

*If any team member has any concerns or safety issues, please bring them to the team and team leader’s attention as soon as possible.*

Figure 5: Delivery Timeout led by Fellow or Team Leader

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**DELIVERY ROOM CHECKLIST FOR INFANTS ≤ 30 WEEKS GESTATION**

<table>
<thead>
<tr>
<th>TIME</th>
<th>Provider 1: Head of Bed</th>
<th>Provider 2: Back-right</th>
<th>Primary RN: Left side</th>
<th>Second RN: Back-left</th>
<th>RT: Right side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Time-Out</td>
<td>Load Time-Out</td>
<td>Load Time-Out</td>
<td>Load Time-Out</td>
<td>Load Time-Out</td>
<td>Load Time-Out</td>
</tr>
</tbody>
</table>

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**TEAM TIME-OUT**

Figure 6: First page of Golden Hour Script that delineates pre-delivery roles. Subsequent pages cover the first hour of life.
Figure 7: a) Initial ventilation management and b) ventilator management strategies for infants with respiratory distress syndrome.
Figure 8: Respiratory support monitoring tool

Figure 9: Run chart showing effect of two PDSA cycles to improve admission temperatures
Figure 10: Run chart showing baseline data through March 2015 when pre-admission order entry was introduced. Minimal improvement noted with decrease in median time. Intravenous fluids are typically the last task before an infant’s isolette is closed, thus serving as a surrogate marker for a completed resuscitation.