NRP Update I: Temperature Stabilization and Airway Management:

Myra H. Wyckoff, MD
Associate Professor of Pediatrics
UT Southwestern Medical Center at Dallas

Neonatal Resuscitation Snapshot

- Assess baby’s risk for needing resuscitation
- Provide warmth
- Position, clear airway (if needed)
- Dry, stimulate to breathe
- Establish EFFECTIVE ventilation
- Give supplemental O₂ as needed
- Establish Airway
- Give meds
- Provide chest compressions

Cold Stress Inhibits Effective Neonatal Transition!

- Cold Stress
  - Increases Apnea
  - Decreases Surfactant Function
  - Increases metabolic acidosis, lowers pH and thus may reduce pulmonary artery relaxation

Admission Temperature and Associated Morbidities for Infants < 1500g

- 15 NICHD Neonatal Network Centers, Jan 2002-Dec 2003
- 401-1499g infants Admitted to NICU directly from DR
- No major congenital anomalies
- Mean Admission Temperature
  - 35.9 ± 1.0°C (range: 26 - 39.6°C)
- Frequency of admission temp < 35 and < 36°C increased with decreasing EGA and BW.
- For every 1°C decrease in admission temperature
  - Odds of late onset sepsis increased by 11%
    - (OR 1.11; CI: 1.02-1.20)
  - Odd of death increased by 28%
    - (OR 1.28; CI: 1.16-1.41)

Strategies to Provide Warmth

- For all newborns
  - Environmental Temperature at least 25°C (77°F)
Increased Ambient Temperature at Delivery and Admission Temperature for Infants ≤ 28 wks EGA

<table>
<thead>
<tr>
<th></th>
<th>Traditional Care</th>
<th>Ambient Temp 26-28°C</th>
<th>Plastic Wrap + Ambient Temp 26-28°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admit Temp (°C)*</td>
<td>35.3 ± 1.0</td>
<td>35.9 ± 1.0</td>
<td>37.0 ± 0.7</td>
</tr>
</tbody>
</table>

*p<0.0001

Kent et al. J Paed Child Health 2008

Strategies to Provide Warmth

- For all newborns
  - Environmental Temperature at least 25°C (77°F)
  - Warm Blankets for Drying
  - Hats

- For newborns requiring resuscitation
  - Radiant Warmer
  - Warm, humidified gases?

Humidified and Heated Air During Stabilization at Birth Improves Temperature in Preterm Infants

Te Pas et al. Pediatrics 2010

Strategies to Provide Warmth

- For all newborns
  - Environmental Temperature at least 25°C (77°F)
  - Warm Blankets for Drying
  - Hats

- For newborns requiring resuscitation
  - Radiant Warmer
  - Warm, humidified gases?

- For Preemies < 28 wks EGA
  - Polyethylene Occlusive wrapping
  - Heated (NaAcetate) Mattresses

Polyethylene Occlusive Wrapping Improves Admission Temperature for ELBW ≤ 28 wks

<table>
<thead>
<tr>
<th>&lt;28wks EGA</th>
<th>Control</th>
<th>Wrap</th>
<th>Difference in Means (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N=55</td>
<td>35.6±1.3</td>
<td>36.5±0.8</td>
<td>0.9  p=0.002</td>
</tr>
<tr>
<td>N=27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=28</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vohra et al. J Pediatrics, 2004

Warming Mattress vs Plastic Wrap on Admission Temperature for ≤ 28 wk Infants

<table>
<thead>
<tr>
<th></th>
<th>Warming Mattress</th>
<th>Plastic Wrap</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n=17)</td>
<td>(n=19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admit Temp (°C)*</td>
<td>36.5 ± 0.7</td>
<td>36.1 ± 0.7</td>
<td>0.04</td>
</tr>
<tr>
<td>Hypothermic (&lt;36.5°C)</td>
<td>41%</td>
<td>68%</td>
<td>0.10</td>
</tr>
</tbody>
</table>

No differences in morbidities but significantly underpowered for this

Simon et al. J Perinatol 2010
The Addition of a Warming Mattress to Plastic Wrap on ELBW Admission Temperature

<table>
<thead>
<tr>
<th></th>
<th>Traditional Care</th>
<th>Plastic Wrap</th>
<th>Plastic Wrap + Warming Mattress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admit Temp (°C)</td>
<td>(n=230)</td>
<td>(n=48)</td>
<td>(n=97)</td>
</tr>
<tr>
<td>Hypothermic (&lt;36.5°C)</td>
<td>192 (84%)</td>
<td>33 (69%)</td>
<td>25 (26%)</td>
</tr>
<tr>
<td>Hyperthermic (&gt;37.5°C)</td>
<td>1 (0.4%)</td>
<td>2 (4.2%)</td>
<td>27 (27.8%)</td>
</tr>
</tbody>
</table>

Singh et al. J Perinatol 2009

Position to Open the Airway

- Position on back or side
- Slightly extend neck
- "Sniffing" position
- Aligns posterior pharynx, larynx and trachea

Stop the Attack of the Blue Bulb!

- Put down your bulb syringe and catheters!
- Suctioning should be reserved for babies who have obvious air way obstruction or those who require PPV.

Only If Needed: Suction to Clear the Airway

- ONLY IF REALLY NEEDED!!
  - Apneic, copious secretions,
- Suction with a bulb syringe
  - Mouth before Nose
  - "M comes before N"
- May use a suction catheter attached to mechanical suction (negative pressure should read ~100 mmHg) but...
  - Easy to induce vagal response due to laryngeal reflex (laryngospasm, profound bradycardia, apnea, cough)

Routine Suction Reduces Initial Oxygenation

Dry, Stimulate to Breathe, Reposition

- Slapping the back
- Squeezing the rib cage
- Forcing thighs onto the abdomen
- Dilating the anal sphincter
- Using hot or cold compresses or baths
- Shaking

Tactile Stimulation

6th Edition NRP Algorithm

Heart Rate Remains The Most Important Vital Sign

Cardiac Output = Stroke Volume X Heart Rate
Stroke Volume Does not Change Significantly in the Newborn
Therefore, Heart rate determines the output to the lungs

What about Respiratory Distress in the Delivery Room?

- After the initial steps, heart rate and respiratory effort are adequate but there is increased work of breathing or a perception of cyanosis then CPAP can be considered

Role of CPAP in the Delivery Room

- CPAP may help establishment of functional residual capacity
  - CPAP can be delivered with a flow-inflating bag or a T-piece resuscitator, but NOT a self-inflating bag.
CPAP for Term Newborns in the Delivery Room

- No evidence to support or refute the use of CPAP in term infants with respiratory distress in the delivery room
- Key though to note that CPAP should only be considered for the spontaneously breathing newborn with an adequate heart rate

CPAP for Preterm Newborns in the Delivery Room

- 2 Multi-centered RCT looked at 25-28 weeks EGA newborns on CPAP vs intubated in DR:
  - Almost 2000 preterm infants randomized
  - No difference in outcomes of death or BPD
  - Reduced the rates of intubation and mechanical ventilation, surfactant use, and duration of ventilation.
  - Increased rates of pneumothorax with CPAP 8 cm H₂O but not with CPAP 5 cm H₂O

Assessment

- After initial steps, if heart rate is < 100 bpm or
- Respiratory effort is inadequate
  - (Apnea, Intermittent Apnea, Gasping)

Effective Positive Pressure Ventilation Devices

- Self-inflating bag with pressure monometer
- Flow-inflating Bag
- T-piece Resuscitator

Is One PPV Device Superior?

- Can’t reliably give PEEP even with PEEP valve with self-inflating bag
  - Oddie et al. Resuscitation 2005
  - Morley et al. J Paediatr Child Health 2010
- Can more reliably achieve target pressures (PIP and PEEP) and long inspiratory times with T-piece resuscitator compared to ventilation bags
  - Finer et al. Resuscitation 2001
  - Bennett et al. Resuscitation 2005
  - Dawson et al. J Paediatr Child Health 2011

Additional Emphasis on Ventilation

Extra time period for assuring adequate chest movement
Techniques for Achieving Effective Ventilation (MR. SOPA)

<table>
<thead>
<tr>
<th>Actions</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>M Adjust Mask</td>
<td>to assure good seal on the face</td>
</tr>
<tr>
<td>R Reposition</td>
<td>airway by adjusting head to &quot;sniffing position&quot;</td>
</tr>
<tr>
<td>S Suction</td>
<td>mouth and nose of secretions, if present</td>
</tr>
<tr>
<td>O Open</td>
<td>mouth slightly and move jaw forward</td>
</tr>
<tr>
<td>P Increase</td>
<td>Pressure to achieve chest rise</td>
</tr>
<tr>
<td>A Consider Airway alternative (endotracheal intubation or laryngeal mask airway)</td>
<td></td>
</tr>
</tbody>
</table>
Laryngeal Mask Airway: An Alternative to Endotracheal Intubation

Steps to Achieve EFFECTIVE Ventilation: MR. SOPA

- M-MASK
- R-Reposition
- S-Suction
- O-Open the mouth
- P-Pressure increase
- Alternative Airway
  - Intubation
  - Laryngeal Mask Airway

Laryngeal Mask as an Alternative Airway in Newborns

<table>
<thead>
<tr>
<th></th>
<th>Laryngeal Mask (n=205)</th>
<th>Bag Mask (n=164)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Resuscitation</td>
<td>203 (99%)</td>
<td>138 (84%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Response Time (sec)</td>
<td>16 ± 8</td>
<td>18 ± 7</td>
<td>0.08</td>
</tr>
<tr>
<td>Ventilation Time (sec)</td>
<td>38 ± 24</td>
<td>66 ± 35</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Zhu et al. Resuscitation 2011

6th Edition NRP Algorithm

NRP Recommendations regarding Oxygen Use in Neonatal Resuscitation

“During resuscitation and when a baby is cyanotic, it is important to deliver as close to 100% oxygen as possible, without allowing it to mix with room air.”

“100% oxygen is recommended for assisted ventilation; however, if supplemental oxygen is unavailable, positive pressure ventilation should be initiated with room air.”

“The standard approach to resuscitation is to use 100% oxygen. Some clinicians may begin resuscitation with an oxygen concentration of less than 100%, and some may start with no supplementary oxygen (ie, room air).”

Meta Analysis: 100% O₂ vs Room Air During Delivery Room Resuscitation

Davies et al
Evidence in Support of Room Air Resuscitation

- 6 RCTs individually showed no outcome difference but meta-analysis showed decreased mortality with room air
- Babies resuscitated with room air resumed spontaneous respirations earlier
- Some biochemical evidence of oxidant injury in those resuscitated at birth with high FiO₂
- Room air resuscitation might reduce length of stay and chronic lung disease

Evidence Against Room Air Resuscitation

- Majority of subjects were from developing country
- Majority of studies not blinded
- Infants with MAS, infection, “apparent stillbirths” were excluded
- Relatively small proportion of the 1474 subjects likely to have had significant asphyxia (type 2 statistical error)
- Animal studies suggest advantage of oxygen in reducing anaerobic metabolism; improving pulmonary blood flow and V:Q match; stabilizing cerebral perfusion

Other Potential Harm?

  - Prospective association between any oxygen exposure in the DR and childhood acute lymphatic leukemia
    - 2.5X the risk of ALL (1.21-6.82)
    - > 3 minutes of O₂ with BMV
    - 3.54X the risk of ALL (1.16-10.8)

O₂ Saturations Start Low and Gradually Increase

Dawson et al. Pediatrics 2010;125:e1340–e1347

Normal SpO₂ Values Following Birth at Term While Breathing Room Air

<table>
<thead>
<tr>
<th>Target Pre-ductal SpO₂ After Birth</th>
<th>1 min</th>
<th>60%-65%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 min</td>
<td>65%-70%</td>
</tr>
<tr>
<td></td>
<td>3 min</td>
<td>70%-75%</td>
</tr>
<tr>
<td></td>
<td>4 min</td>
<td>75%-80%</td>
</tr>
<tr>
<td></td>
<td>5 min</td>
<td>80%-85%</td>
</tr>
<tr>
<td></td>
<td>10 min</td>
<td>85%-95%</td>
</tr>
</tbody>
</table>

What Oxygen Concentration Should we use for Premature Infants?

- 23-32 weeks (n=41)
  - 21% vs 100% FiO₂
  - Adjusted to match term goals

- < 29 wks (n=42)
  - Started with 30% vs 90%
  - Adjusted to match term goals
Summary of Oxygen Studies

- Routine 100% oxygen exposure is unnecessary and possibly harmful for the term newborn
- Increasing evidence that preterm infants can be successfully and safely stabilized in the DR with less than 100% O2
- Increasing evidence that term infants can be successfully and safely resuscitated with less than 100% O2
- Pulse Oximetry in the DR is very helpful in optimizing O2 delivery

6th Edition NRP Recommendations
Use of Oxygen and Oximeter

- Have an oximeter, blender, and compressed air immediately available at every delivery
- Begin PPV in term babies with 21%
- Attach oximeter early
  - Have someone available to connect an oximeter if PPV or supplemental oxygen is used
- Blend O2 and air as needed to match SpO2 to that of healthy term babies
- Connect an oximeter and blend oxygen as needed when stabilizing any preterm baby

Acknowledgments

- Thanks to the AAP for several of the drawings and photos used for illustration