The New ABCs of Neonatal Resuscitation and Respiratory Support

Marie Berg, MD
April 14, 2016
Disclosures

I have no relevant financial relationships to disclose.

http://kimberlygphotography.com/
Learning Objectives

- Review upcoming changes to the Neonatal Resuscitation Protocol based on ILCOR recommendations
- Provide an update regarding management of infants with respiratory distress syndrome
- Review recent trials and optimization of respiratory care for neonates in the delivery room and beyond
Neonatal Resuscitation
What Changed Before?

A. BIRTH
- Term gestation?
- Amniotic fluid clear?
- Breathing or crying?
- Good muscle tone?
- Provide warmth
- Position, clear airway* (as necessary)
- Dry, stimulate, reposition

B. Evaluate respirations, heart rate, and color
- Breath, HR >100 but pink
- Give supplementary oxygen
- Persistent Cyanosis

C. Provide positive-pressure ventilation*
- HR <60
- Administer epinephrine and/or volume*

D. Consider intubation
- Hypoxemia
- Pneumothorax

* Endotracheal intubation may be considered at several steps

Targeted Pre-ductal SPO₂ After Birth
1 min 60-65%
2 min 65-70%
3 min 70-75%
4 min 75-80%
5 min 80-85%
10 min 85-95%
Neonatal Resuscitation Algorithm—2015 Update

Antenatal counseling
Team briefing and equipment check

Birth

Term gestation? Good tone? Breathing or crying?
Yes
Infant stays with mother for routine care: warm and maintain normal temperature, position airway, clear secretions if needed, dry, stimulate

No
Warm and maintain normal temperature, position airway, clear secretions if needed, dry, stimulate

Apnea or gasping? HR below 100/min?
Yes
PPV SpO₂ monitor Consider ECG monitor

No
Labored breathing or persistent cyanosis?

Yes
Position and clear airway SpO₂ monitor Supplementary O₂ as needed Consider CPAP

No
Postresuscitation care Team debriefing

HR below 100/min?

Yes
Check chest movement Ventilation corrective steps if needed ETT or laryngeal mask if needed

No
HR below 60/min?

Yes
Intubate if not already done Chest compressions Coordinate with PPV 100% O₂ ECG monitor Consider emergency UVC

No
IV epinephrine If HR persistently below 60/min Consider hypovolemia Consider pneumothorax

Table: Targeted Preductal SpO₂ After Birth

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>SpO₂ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60%-65%</td>
</tr>
<tr>
<td>2</td>
<td>65%-70%</td>
</tr>
<tr>
<td>3</td>
<td>70%-75%</td>
</tr>
<tr>
<td>4</td>
<td>75%-80%</td>
</tr>
<tr>
<td>5</td>
<td>80%-85%</td>
</tr>
<tr>
<td>10</td>
<td>85%-95%</td>
</tr>
</tbody>
</table>

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What is different now?

Birth

Term gestation? Breathing or crying? Good tone?

Yes, stay with mother

Routine Care
- Provide warmth
- Clear airway if necessary
- Dry
- Ongoing evaluation

No

Warm, clear airway if necessary, dry, stimulate

HR below 100, gasping, or apnea?

No

Labored breathing or persistent cyanosis?

Yes

Clear airway SPO$_2$ monitoring Consider CPAP

No

HR below 100?

Yes

Take ventilation corrective steps

No

HR below 60?

Yes

Consider intubation

Chest compressions Coordinate with PPV

No

HR below 60?

Yes

IV Epinephrine

Take ventilation corrective steps

Intubate if no chest rise!

Consider:
- Hypovolemia
- Pneumothorax

Targeted Pre-ductal SPO$_2$ After Birth

1 min 60-65%
2 min 65-70%
3 min 70-75%
4 min 75-80%
5 min 80-85%
10 min 85-95%

Birth

Term gestation? Good tone? Breathing or crying?

Yes

Warm and maintain normal temperature, position airway, clear secretions if needed, dry, ongoing evaluation

No

HR below 100?

Yes

Apnea or gasping? HR below 100/min?

Yes

PPV SPO$_2$ monitor Consider ECG monitor

No

Postresuscitation care Team debriefing

Labored breathing or persistent cyanosis?

Yes

Position and clear airway SpO$_2$ monitor Supplementary O$_2$ as needed Consider CPAP

No

HR below 100/min?

Yes

Check chest movement Ventilation corrective steps if needed ETT or laryngeal mask if needed

No

HR below 60/min?

Yes

Intubate if not already done Chest compressions Coordinate with PPV 100% O$_2$ ECG monitor Consider emergency UVC

No

HR below 60/min?

Yes

IV epinephrine

If HR persistently below 60/min Consider hypovolemia Consider pneumothorax

Targeted Pre-ductal SPO$_2$ After Birth

1 min 60-65%
2 min 65-70%
3 min 70-75%
4 min 75-80%
5 min 80-85%
10 min 85-95%
ILCOR Recommendations 2015

- Endotracheal suctioning for meconium
- Electrocardiogram monitoring
- Use of supplementary oxygen in the delivery room
- Ventilation practices
  - Timing of intubation/use of LMA
  - PPV guidance (pressures)
- Delayed cord clamping
ILCOR Recommendations 2015

• Endotracheal suctioning for meconium
• Electrocardiogram monitoring
• Use of supplementary oxygen in the delivery room
• Ventilation practices
  – Timing of intubation/use of LMA
  – PPV guidance (pressures)
• Delayed cord clamping
Endotracheal Meconium Suctioning
ILCOR Recommendations 2015: Endotracheal Meconium Suctioning

• “There is insufficient published human evidence to suggest routine tracheal intubation for suctioning of meconium in nonvigorou... born through meconium-stained amniotic fluid.”
Fetal distress

Passage of Meconium

Meconium aspiration from amniotic fluid

Airway obstruction

Surfactant deactivation

Hypoxemia

Inflammation

Chemical pneumonitis

PPHN
Fetal distress

Passage of Meconium

Meconium aspiration from amniotic fluid

Airway obstruction

Surfactant deactivation

Hypoxemia

Inflammation

Chemical pneumonitis

PPHN
Endotracheal Suctioning for Meconium – Historic Perspectives

• Prior to 2000, endotracheal suctioning of all infants born through thick meconium was recommended

• After 2000, it was recommended only for infants who were apneic with low tone
  – Intrapartum suctioning was not recommended
Endotracheal intubation at birth for preventing morbidity and mortality in vigorous, meconium-stained infants born at term

Review: Endotracheal intubation at birth for preventing morbidity and mortality in vigorous, meconium-stained infants born at term
Comparison: 1 Routine tracheal intubation/suction vs control
Outcome: 4 Meconium aspiration syndrome

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Intervention n/N</th>
<th>Control n/N</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daga 1994</td>
<td>1/26</td>
<td>0/23</td>
<td></td>
<td>1.8%</td>
<td>2.67 [0.11, 62.42]</td>
</tr>
<tr>
<td>Linder 1988</td>
<td>2/308</td>
<td>0/264</td>
<td></td>
<td>1.8%</td>
<td>4.29 [0.21, 88.92]</td>
</tr>
<tr>
<td>Liu 1998</td>
<td>0/77</td>
<td>0/92</td>
<td></td>
<td></td>
<td>Not estimable</td>
</tr>
<tr>
<td>Wiswell 2000</td>
<td>34/1051</td>
<td>28/1043</td>
<td></td>
<td>96.3%</td>
<td>1.21 [0.74, 1.97]</td>
</tr>
</tbody>
</table>

**Total (95% CI)**

- **1462** (Intervention)
- **1422** (Control)

Total events: 37 (Intervention), 28 (Control)
Heterogeneity: Ch² 0.88, df = 2 (P = 0.64); I² = 0.0%
Test for overall effect: Z = 1.04 (P = 0.30)

(Intubation is better)  (No intubation is better)
ILCOR Recommendations 2015

• Endotracheal suctioning for meconium
• Electrocardiogram monitoring
• Use of supplementary oxygen in the delivery room
• Ventilation practices
  – Timing of intubation/use of LMA
  – PPV guidance (pressures)
• Delayed cord clamping
Electrocardiogram Monitoring and Supplementary Oxygen
ILCOR Recommendations 2015: ECG Monitoring

• “It is suggested in babies requiring resuscitation that the ECG can be used to provide a rapid and accurate estimation of heart rate.”

• “The use of ECG does not replace the need for pulse oximetry to evaluate the newborn’s oxygenation.”
ECG Use

- ECG is placed faster than pulse (20 vs 36 seconds) and acquires a signal faster (4 vs 32 seconds)

Katheria et al. Pediatrics 2012
ECG Use

- HR measurements may be significantly lower on pulse oximetry

vanVonderen et al, JPeds 2014
ILCOR Recommendations 2015

- Endotracheal suctioning for meconium
- Electrocardiogram monitoring
- Use of supplementary oxygen in the delivery room
- Ventilation practices
  - Timing of intubation/use of LMA
  - PPV guidance (pressures)
- Delayed cord clamping
“It is recommended that oximetry be used when resuscitation can be anticipated, when PPV is administered, when central cyanosis persists beyond the first 5 to 10 minutes of life, or when supplementary oxygen is administered.”
ILCOR Recommendations 2015: Supplementary Oxygen

• “If blended oxygen is not available, resuscitation should be initiated with air.”

• “Resuscitation of preterm newborns of less than 35 weeks of gestation should be initiated with low oxygen (21% to 30%) and the oxygen titrated to achieve preductal oxygen saturation [targets].”

<table>
<thead>
<tr>
<th>Targeted Preductal Saturation (SpO2)</th>
<th>After Birth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 min</td>
<td>60%-65%</td>
</tr>
<tr>
<td>2 min</td>
<td>65%-70%</td>
</tr>
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<tr>
<td>10 min</td>
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</table>
ILCOR Recommendations 2015: Supplementary Oxygen and Chest Compressions

• “Although there are no available clinical studies about oxygen use during CPR, the [group] continues to endorse the use of 100% oxygen whenever chest compressions are provided.”

• “It is still suggested that compressions and ventilations be coordinated to avoid simultaneous delivery.”
ILCOR Recommendations 2015

• Endotracheal suctioning for meconium
• Electrocardiogram monitoring
• Use of supplementary oxygen in the delivery room
• Ventilation practices
  – Timing of intubation/use of LMA
  – PPV guidance (pressures)
• Delayed cord clamping
Ventilation Practices

Neonatal Resuscitation Algorithm—2015 Update

- Antenatal counseling
  - Team briefing and equipment check

- Birth

- Term gestation? Good tone? Breathing or crying?
  - Yes
  - Infant stays with mother for routine care, warm and maintain normal temperature, position airway, clear secretions if needed, dry, stimulate
  - No
  - Warm and maintain normal temperature, position airway, clear secretions if needed, dry, stimulate

- Apnea or gasping? HR below 100/min?
  - Yes
  - PPV
    - SpO2 monitor
    - Consider ECG monitor
  - No
  - Labored breathing or persistent cyanosis?
    - Yes
    - Position and clear airway
    - SpO2 monitor
    - Supplementary O2 as needed
    - Consider CPAP
    - Postresuscitation care
    - Team debriefing
    - No
    - HR below 100/min?
      - Check chest movement
      - Ventilation corrective steps if needed ETT or laryngeal mask if needed
      - No
      - HR below 60/min?
        - Intubate if not already done
          - Chest compressions
          - Coordinate with PPV
          - 100% O2
          - ECG monitor
          - Consider emergency LUC
        - Yes
          - HR below 60/min?
            - IV epinephrine
            - If HR persistently below 60/min
              - Consider hypovolemia
              - Consider pneumothorax

Targeted Preadult SpO2 After Birth

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>SpO2 (%):</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>60-65</td>
</tr>
<tr>
<td>2</td>
<td>66-70</td>
</tr>
<tr>
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ILCOR Recommendations 2015: Ventilation Practices

• Timing of intubation
• Use of LMA
• Guidance on PPV
Timing of Intubation

Timing of Intubation

Birth

Term gestation? Breathing or crying? Good tone?

Yes, stay with mother

Routine Care
- Provide warmth
- Clear airway if necessary
- Dry
- Ongoing evaluation

No

Warm, clear airway if necessary, dry, stimulate

HR below 100, gasping, or apnea?

Yes, labored breathing or persistent cyanosis?

PPV, SPO2 monitoring

Targeted Pre-ductal SPO2 After Birth
1 min 60-65%
2 min 65-70%
3 min 70-75%
4 min 75-80%
5 min 80-85%
10 min 85-95%

No

Clear airway SPO2 monitoring Consider CPAP

HR below 100?

Yes

Take ventilation corrective steps

Post-resuscitation care

No

HR below 60?

Yes

Consider intubation

Chest compressions Coordinate with PPV

Take ventilation corrective steps

Intubate if no chest rise!

Consider:
- Hypovolemia
- Pneumothorax

No

HR below 60?

Yes

IV Epinephrine

No

HR below 60 min? Consider hypovolemia Consider pneumothorax

IV epinephrine

Intubate if not already done

Chest compressions Coordinate with PPV 100% O2 ECG monitor Consider emergency UVC

Targeted Pre-ductal SpO2 After Birth
1 min 60-65%
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10 min 85-95%

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Use of LMA

Neonatal Resuscitation Algorithm—2015 Update

Antenatal counseling
Team briefing and equipment check

Birth

Term gestation? Good tone? Breathing or crying?

Yes

No

Term gestation? Good tone? Breathing or crying?

Infant stays with mother for routine care: warm and maintain normal temperature, position airway, clear secretions if needed, dry, stimulate

Warm and maintain normal temperature, position airway, clear secretions if needed, dry, stimulate

Apnea or gasping? HR below 100/min?

Yes

No

PPV SpO₂ monitor
Consider ECG monitor

Position and clear airway
SpO₂ monitor
Supplementary O₂ as needed
Consider CPAP

Labored breathing or persistent cyanosis?

Yes

No

HR below 100/min?

Yes

No

Check chest movement
Ventilation corrective steps if needed
ETT or laryngeal mask if needed

Intubate if not already done
Chest compressions
Coordinate with PPV
100% O₂
ECG monitor
Consider emergency UVC

HR below 60/min?

Yes

No

Postresuscitation care
Team debriefing

Targeted Predicted SpO₂ After Birth

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<tr>
<td>5</td>
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</tr>
<tr>
<td>10</td>
<td>85%–95%</td>
</tr>
</tbody>
</table>

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ILCOR Recommendations 2015: Use of a Laryngeal Mask Airway

- “A laryngeal mask may be considered as an alternative to tracheal intubation if face-mask ventilation is unsuccessful [and/or] tracheal intubation is unsuccessful or not feasible.”
- “Data are limited in preterm infants less than 34 weeks of gestation or who weigh less than 2000 g.”
PPV

- Rate
- Inflation pressures
- Initial breaths
ILCOR Recommendations 2015: Positive Pressure Ventilation

• Rate:
  – “Assisted ventilation should be delivered at a rate of 40 to 60 breaths per minute to promptly achieve or maintain a heart rate >100 per minute.”
ILCOR Recommendations 2015: Positive Pressure Ventilation

- Inflation Pressures:
  - “When PPV is administered to preterm newborns, approximately 5 cm H2O PEEP is suggested.”
    - “This will require the addition of a PEEP valve for self-inflating bags.”
  - “An initial inflation pressure of 20 cm H2O may be effective, but 30 to 40 cm H2O may be required in some term babies without spontaneous ventilation “
PPV: Initial Breaths

Vali et al, 2015
ILCOR Recommendations 2015: Positive Pressure Ventilation

• Initial breaths
  – “There is insufficient data regarding short and long-term safety and the most appropriate duration and pressure of inflation to support routine application of sustained inflation of greater than 5 seconds’ duration to the transitioning newborn.”
ILCOR Recommendations 2015: Positive Pressure Ventilation

• “Spontaneously breathing preterm infants with respiratory distress may be supported with continuous positive airway pressure initially rather than with routine intubation for administering PPV.”
ILCOR Recommendations 2015: Positive Pressure Ventilation

• “Spontaneously breathing preterm infants with respiratory distress may be supported with continuous positive airway pressure initially rather than with routine intubation for administering PPV.”

• Which brings us to management of the infant on CPAP......
NICQ NEXT: Initial Respiratory Management Work Flow for Infants 26+0 – 29+6 Weeks with Completed Antenatal Steroids

BEGIN: 26+0 – 29+6 weeks Antenatal Steroids

- Parent Brochure
- Resuscitation (NRP)
  - No
  - ETT?
    - Yes
    - BMV?
      - No
      - DR CPAP
        - Follow DR CPAP Assessment Work Flow
          - Initiate CPAP at 6 cm H2O
      - Yes
        - DR Surfactant
    - Yes
      - DR Parent Touch
      - Transport & Admit to NICU

FIRSTs Card at Bedside

- Maintain Neutral Head Position
  - Apply TOCOM
  - Load Caffeine

60-90 Minute of Life Assessment
1. FiO2 Requirement to maintain target saturations
2. Work of breathing (RR, GFR)

NICU Admission & First 2 Hours of Life

- 60-90 Minute of Life Assessment

  - CO2 Risk
    - pCO2 < 35
      - Mean CPAP
    - pCO2 > 35 - 55
      - Optimize CPAP
    - pCO2 > 55
      - CXR
        - ROS?
          - Yes
            - Pneumothorax?
              - No
                - Care per NICU team
              - Yes
                - Consider ETT
        - No
          - Provide INSURE

  - FiO2 > 30%?
    - No
      - pCO2 or TOCOM > 45?
        - No
          - Optimize CPAP
        - Yes
          - pCO2 > 65?
            - No
              - Consider ETT
            - Yes
              - Care per NICU team
    - Yes
      - GFR or RR > 70?
        - No
          - Care per NICU team
        - Yes
          - Care per NICU team

Parent 3-3 Hour LifeData

- Surfactant Assessment Work Flow
  - INSURE Work Flow
  - Gentle Ventilation Work Flow
  - Surfactant Assessment Work Flow

June 26, 2014

This guideline is designed for the general use of most patients, but may need to be adapted to meet the special needs of a specific patient as determined by the patient's caregiver team.
Prophylactic versus selective use of surfactant in preventing morbidity and mortality in preterm infants

<table>
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<tr>
<th>Study or subgroup</th>
<th>Prophylactic n/N</th>
<th>Selective n/N</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
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</thead>
<tbody>
<tr>
<td>1 Studies without routine application of CPAP Dunn 1991</td>
<td>16/62</td>
<td>12/60</td>
<td>3.1 %</td>
<td>1.29 [0.67, 2.49]</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>62</strong></td>
<td><strong>60</strong></td>
<td><strong>3.1 %</strong></td>
<td><strong>1.29 [0.67, 2.49]</strong></td>
<td></td>
</tr>
<tr>
<td>2 Studies with routine application of CPAP Dunn 2011</td>
<td>76/208</td>
<td>67/220</td>
<td>16.4 %</td>
<td>1.20 [0.92, 1.57]</td>
<td></td>
</tr>
<tr>
<td>SUPPORT 2010</td>
<td>353/653</td>
<td>323/663</td>
<td>80.6 %</td>
<td>1.11 [1.00, 1.23]</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>861</strong></td>
<td><strong>883</strong></td>
<td><strong>96.9 %</strong></td>
<td><strong>1.12 [1.02, 1.24]</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>923</strong></td>
<td><strong>943</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>1.13 [1.02, 1.25]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Favours experimental | 0.5 | 0.7 | 1 | 1.5 | 2
Favours control

Cochrane Database of Systematic Reviews
14 MAR 2012 DOI: 10.1002/14651858.CD000510.pub2
Respiratory Assessment and Management
Infants 26+0 – 32+6 Weeks Gestational Age

Work Flow

Infant On Nasal CPAP (Surfactant Naive)

HOURLY (ongoing) Risk Assessment

Positive Risk Assessment – Anyone:
1. FiO2 > 30% OR 5% above baseline as measured over 2 hours
2. TcPCO2 of PCO2 (CBC) > 55
3. Increased work of breathing (persistent tach or persistent RR > 60)

AP Chest Xray

Optimizing Nasal CPAP
1. Ensure chinstrap is in place
2. Optimize size of nasal CPAP prongs
3. Ensure head in neutral AND sniffing position

Findings of NCS?

Pneumothorax

No

Yes

Pneumothorax? Care per NICU Team

Consider ETT & MV

Optimize Nasal CPAP
Consider NIPPV

Nasal CPAP Optimized?

No

No

No

Optimize Nasal CPAP Work Flow

ETT & MV: Surfactant
1. IF Surfactant NAIVE – Provide initial dose (Curosurf 2.5 mL/kg)
2. IF Post INTURE – Consider repeat dose (Curosurf 1.25 mL/kg)

More than 32 hours of life?

Infant Surfactant Work Flow

REFERENCE:

This guideline is designed for the general use of most patients, but may need to be adapted to meet the special needs of a specific patient as determined by the patient's caregiver team.
InSuRE Work Flow Process
For NICU Surfactant

Endotracheal Intubation for InSuRE
1. Maintain neutral head positioning for infants \( \leq 32 \) weeks PMA.
2. Perform procedure verification.
3. Visually confirm and state ETT placement.
   \( \leftarrow 5 + \text{weight (kg)} = \text{cm insertion at lip} \)
4. Manually maintain ETT position.

Curosurf Administration for InSuRE
1. Administer as a single dose.
2. Use a multi-use utility catheter.
3. Administer over 1 minute or until no surfactant remains visible in the ETT.
4. Do NOT interrupt ventilation.
5. Keep head in midline with neck slightly extended.

O2 Saturation Targets for Infants < 37 weeks
Low Target: 88%
High Target: 95%

Infant is eligible for INSURE

Prepare Curosurf

Endotracheal Intubation

Perform O2 saturation monitoring
Perform tcPCO2 monitoring
Leave RAM cannula in place

Turn OFF flow to RAM cannula

Provide ventilation for 30 seconds
(15 breaths)

Use Neopuff\textsuperscript{TM} Infant T-Piece Resuscitator
OR Ventilator

TV = 5cc/kg OR PIP=20 PEEP=6
IMV=30 AND
FiO2 to titrate to O2 saturation target

Turn ON flow to RAM cannula

Curosurf 2.5 cc/kg
Instill over 1 minute

Exubate infant to nasal CPAP
at 6 cm H2O

June 26, 2014

This guideline is designed for the general use of most patients, but may need to be adapted to meet the special needs of a specific patient as determined by the patient’s caregiver team.
• Avoidance of intubation is beneficial. But what if you need surfactant? Isn’t there a way that does not involve PPV?

http://www.theguardian.com/lifeandstyle/2012/oct/15/up-down-apples-pears
Alternative Approaches to Surfactant Administration

• Minimally invasive surfactant
  – Retains laryngoscopy, without ETT
  – Avoid mechanical ventilation

• Nebulized surfactant
211 infants between 23+0 and 26+6 weeks gestation randomized to receive surfactant by thin endotracheal catheter or to conventional surfactant administration on mechanical ventilation.

- No reduction seen in primary outcome (death without BPD)
- Significant reduction seen in survival without major complications, need for intubation, duration of mechanical ventilation, and pneumothorax.
• UVMMC IRB Approval underway for participation in this multicenter randomized controlled trial.
• Includes infants with a need for CPAP because of RDS, without need for imminent intubation
• Curosurf provided by semi-rigid catheter
• Outcomes: death, CLD, IVH, PVL, ROP, NEC, pneumothorax, PDA, need for intubation and additional surfactant, duration of mechanical ventilation, length of stay, and outcome at two years.
# Nebulized Surfactant in Preterm Neonates

<table>
<thead>
<tr>
<th>Author</th>
<th>Treatment</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jorch, 1997</td>
<td>Alveofact (synthetic); No control</td>
<td>Improved oxygenation, pCO2</td>
</tr>
<tr>
<td>Arroe, 1998</td>
<td>Exosurf; No control</td>
<td>No benefit</td>
</tr>
<tr>
<td>Berggren, 2000</td>
<td>Surfactant vs. none</td>
<td>No benefit</td>
</tr>
<tr>
<td>Minocchieri, 2013</td>
<td>Curosurf vs. none</td>
<td>Decreased intubation, no decrease in BPD</td>
</tr>
<tr>
<td>Finer, 2010</td>
<td>Aerosurf (lucinactant); No control</td>
<td>Safe, feasible</td>
</tr>
</tbody>
</table>

More et al. JAMA Peds 2014
Nebulized Surfactant

• Delivery reduced when nebulized
• Distribution not even

Linner et al. Neonatology 2015
CureNeb Study

- Infants 29+0 to 33+6 weeks, 0-4 hours of life with RDS on CPAP
- Curosurf, standard dose (200mg/kg) vs. no surfactant
- Vibrating mesh nebulizer

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- Still underway....
- PAS presentation in 2013
  - Reduction in CPAP failure vs no surfactant seen in infants 32-33 weeks (OR 0.118, 95% CI 0.178-0.784), but not 29-31 (OR 0.86, 95% CI 0.399-1.854).

ILCOR Recommendations 2015

- Endotracheal suctioning for meconium
- Electrocardiogram monitoring
- Use of supplementary oxygen in the delivery room
- Ventilation practices
  - Timing of intubation/use of LMA
  - PPV guidance (pressures)
- Delayed cord clamping
ILCOR Recommendations 2015: Delayed Cord Clamping

• “There is a new recommendation that delayed cord clamping for longer than 30 seconds is reasonable for both term and preterm infants who do not require resuscitation at birth…”

www.bloodtobaby.com
ILCOR Recommendations 2015: Delayed Cord Clamping

• “There is insufficient evidence to recommend an approach to cord clamping for infants who require resuscitation at birth and a suggestion against the routine use of cord milking.... for infants born at less than 29 weeks of gestation.”
Australian Placental Transfusion Study

- Randomized controlled trial on placental transfusion
- Infants <30 weeks gestation
- Infants randomized to 60 sec delayed cord clamping vs immediate clamping (within 10 sec)
- UVMMC first participating center in US.
Primary outcomes:
- Death and/or major morbidity at 36 weeks post menstrual age

Secondary outcomes
- 1. Death by 36 weeks postmenstrual age
- 2. Major morbidity at 36 weeks post menstrual age
- 3. Death and major morbidity in infants of $27^o$ weeks gestation or more
- 4. Death and major morbidity in infants of $26^6$
- 5. Death or severe disability to (i) 24 months and (ii) 3 years corrected age

Tertiary Outcomes
- Birth weight, number of exchange transfusions, number of partial exchange transfusions
• What is more important: delayed cord clamping or early resuscitation?

• ... Or both?

http://www.theguardian.com/lifeandstyle/2012/oct/15/up-down-apple
Resuscitation Prior to Cord Clamping

Platform for resuscitation at the beside with umbilical cord intact (LifeStart)
Next Challenges

• New frontiers in delayed cord clamping
• Alternative means of surfactant administration
  – Nebulized? Studies underway

• How to we best resuscitate?
  – Sustained inflation?
  – Optimal PEEP?
  – Can we use CO₂ detectors (colorimetric, TCO₂) to improve outcomes?
  – Optimal FiO₂ for ELBWs? In HIE?
  – Optimal doses of epinephrine?

• With these changes, what do APGAR scores mean?
Thank you!

T-REX also Hates...
Endotracheal Intubation Attempts...

This ain't working...maybe a 'cric...? Nah, forget that too!

...another possible reason they became extinct.
References


Andersson O, Domellöf M, Andersson D, Hellström-Westas L. Effect of Delayed vs Early Umbilical Cord Clamping on Iron Status and Neurodevelopment at Age 12 Months: A Randomized Clinical Trial. JAMA Pediatrics, 2014 Jun; 168(6):547-554. PMID:


