Neonatal Resuscitation Program 2011: Changes and Controversies

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Disclosures

- I am not on any speakers bureaus
- I do not intend to discuss unapproved uses of a commercial product
- I received a manikin from Laerdal for cardiac compression research
- I have a translational research grant funded by Ikaria
Achieving Consensus on Resuscitation Science

- The American Academy of Pediatrics, under the auspices of its relationship with the American Heart Association, participates with other member councils of International Liaison Committee on Resuscitation (ILCOR) for a complete review of resuscitation science every 5 years.
33 questions assigned to a minimum of two experts for in-depth literature review
Each expert worked independently to create a detailed worksheet for the assigned topic
Worksheets followed a strictly defined format
  – Search Strategy
  – Number of articles identified
  – Reasons for any rejections of papers
  – Classification of the quality of the study
  – Level of Evidence
Guidelines for Neonatal Resuscitation

- Guidelines available online October 18, 2010
- Printed Guidelines supplement published November 2, 2010 in Circulation and Pediatrics
- Can be downloaded at: www.heart.org/cpr
NRP 6th Edition

Released May 2011

- Major Changes in Required Equipment
- Major Changes in the Algorithm
- Major Changes in how NRP is taught
  - Content Knowledge learned independently
  - On line Exam prior to Instructor time
  - Course time with Instructor focused on skills, simulation and debriefing
Effective Positive Pressure Ventilation Devices

- Self-inflating bag with pressure monometer
- Flow-inflating Bag
- T-piece Resuscitator
Pulse Oximetry Replaces Assessment of Color

- Pulse Oximetry should be used for evaluation of oxygenation because assessment of color is very unreliable.
$O_2$ Saturation at Which Newborn is “Pink”

Pulse Oximetry in the Delivery Room

- Every delivery area should have an oximeter readily available

- Use an oximeter
  - Whenever resuscitation is anticipated
  - When positive pressure ventilation is administered for more than a few breaths
  - When cyanosis is persistent
  - When supplemental oxygen is administered
  - All infants ≤ 32 wks OB EGA

- How to use the oximeter
  - Turn machine on
  - Probe on right hand or wrist of baby
  - Connect probe to pulse ox as final step
    - For fastest signal
Must Have Ability to Blend Oxygen
“Respiratory Equipment on a Stick”
Laryngeal Mask Airway: An Alternative to Endotracheal Intubation
NRP 5th Edition Algorithm

Birth

- Term gestation?
- Clear amniotic fluid?
- Breathing or crying?
- Good muscle tone?

Yes = Routine Care
- Provide warmth
- Clear airway
- Dry
- Assess color

No

- Provide warmth
- Position; clear airway* (as necessary)
- Dry, stimulate, reposition

30 sec

Approximate Time

- Evaluate respirations, heart rate, and color
- Breathing
  - HR > 100
  - Pink
- Cyanotic

- Give supplemental oxygen

30 sec

- Apneic or HR < 100
- Persistently cyanotic

- Provide positive-pressure ventilation*
  - HR < 60

- Effective ventilation
  - HR > 100
  - Pink

- Provide positive-pressure ventilation*
  - HR < 60
  - Administer chest compressions*

- Administer epinephrine*

Post-resuscitation Care

* Endotracheal intubation may be considered at several steps.
Although the provider must know whether meconium is present in order to set up equipment appropriately, the mere presence of meconium does not drive the decision pathway.
6th Edition NRP Algorithm

- 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
    - No

30 sec
Provision of Warmth Affects Ventilation and Newborn Transition!

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

Cool, dry gas in DR
Warm, humidified gas in DR

Te Pas et al. Pediatrics 2010
Strategies to Provide Warmth

- For all newborns
  - Environmental Temperature at least 25°C (77°F)
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- For newborns requiring resuscitation
  - Radiant Warmer
  - Warm, humidified gases?

- For Preemies
  - Polyethylene Occlusive wrapping
  - Heated (NaAcetate) Mattresses
- Put down your bulb syringe and catheters!
- Suctioning should be reserved for babies who have obvious airway obstruction or those who require PPV.
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!
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

- Dry thoroughly
- Remove wet linen
- Reposition the head

Drying and removing wet linen to prevent heat loss and repositioning the head to ensure an open airway.
Tactile Stimulation

Inappropriate

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

Appropriate

Acceptable methods of stimulating a baby to breathe
After the initial steps, further actions are based on simultaneous evaluation of heart rate and respiratory effort.
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

Morley et al NEJM 2008
Finer et al NEJM 2010
6th Edition NRP Algorithm

HR below 100, gasping, or apnea?

PPV, consider SPO₂ monitoring

HR below 100?

Ensure adequate ventilation

Consider ET intubation!
Effective Positive Pressure Ventilation is Still the KEY

- PPV is THE most important step in newborn resuscitation!
- Count out loud to maintain a rate of 40-60 breaths per minute
  - Do a Texas Waltz with your counting

*Counting out loud to maintain a rate of 40 to 60 breaths per minute*
Additional Emphasis on Ventilation

Additional time period for assuring optimization of ventilation

- Term gestation? Breathing or crying? Good tone?
  - No: Warm, open airway, dry, stimulate
  - Yes: PPV, consider SPO2 monitoring

- HR below 100? (30 sec)
  - Yes: Ensure adequate ventilation, Consider ET intubation!
  - No: HR below 60? (60 sec)
    - Yes: Consider ET intubation!
Techniques for Achieving Effective Ventilation (MR. SOPA)

<table>
<thead>
<tr>
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<td>M</td>
<td>Adjust <strong>Mask</strong> to assure good seal on the face</td>
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<td>R</td>
<td><strong>Reposition</strong> airway by adjusting head to “sniffing position”</td>
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<tr>
<td>S</td>
<td><strong>Suction</strong> mouth and nose of secretions, if present</td>
</tr>
<tr>
<td>O</td>
<td><strong>Open</strong> mouth slightly and move jaw forward</td>
</tr>
<tr>
<td>P</td>
<td>Increase <strong>Pressure</strong> to achieve chest rise</td>
</tr>
<tr>
<td>A</td>
<td>Consider <strong>Airway</strong> alternative (endotracheal intubation or laryngeal mask airway)</td>
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Poor Mask Seal Often Inhibits Effective Ventilation

48% demonstrated significant mask leak
- Majority were corrected with repositioning of the mask
- Some required changing the way mask was held

Schmolzer et al. ADC 2011
Inappropriate Position Often Inhibits Effective Ventilation

- 25% demonstrated significant airway obstruction
  - Majority corrected with repositioning the infant in the open airway position

Schmolzer et al. ADC 2011
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Intubation
ETCO$_2$ Detection: Confirmation of Endotracheal Intubation
Laryngeal Mask Airway: An Alternative to Endotracheal Intubation

STEP 1

STEP 2

STEP 3

STEP 4
Laryngeal Mask as an Alternative Airway in Newborns

Zhu et al. Resuscitation 2011

<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>36 ± 24</td>
<td>66 ± 35</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
6th Edition NRP Algorithm

**Yes**
- PPV
- SPO₂ monitoring

**Yes**
- Clear airway
- SPO₂ monitoring
- Consider CPAP

**No**
- HR below 100?

- Take ventilation corrective steps

**Post-resuscitation care**

**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%
“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% $O_2$ 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 O$_2$ 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 \( \text{SpO}_2 \) Values Following Birth at Term While Breathing Room Air

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</tr>
<tr>
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<td>65%-70%</td>
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<tr>
<td>3 min</td>
<td>70%-75%</td>
</tr>
<tr>
<td>4 min</td>
<td>75%-80%</td>
</tr>
<tr>
<td>5 min</td>
<td>80%-85%</td>
</tr>
<tr>
<td>10 min</td>
<td>85%-95%</td>
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</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 $O_2$ and air as needed to match $SpO_2$ to that of healthy term babies
- Connect an oximeter and blend oxygen as needed when stabilizing any preterm baby
60 sec

- PPV, consider SPO₂ monitoring
  - HR below 100? (No)
    - Consider SPO₂ monitoring
    - Consider CPAP
  - HR below 100? (Yes)
    - Ensure adequate ventilation
      - Consider ET intubation!
      - HR below 60? (No)
        - Post-resuscitation care
      - HR below 60? (Yes)
        - Chest compressions
          - Coordinate with PPV
          - HR below 60? (Yes)
            - IV Epinephrine
          - HR below 60? (No)
2011 NRP Cardiac Compression Guidelines

- Compress to depth of 1/3 AP diameter of chest
- Compress the lower 1/3 of the sternum
- Use 2-thumb technique rather than 2-finger technique
- 3:1 compressions to ventilation ratio for asphyxial arrest
- Coordinate compressions and ventilations to avoid simultaneous delivery
- Avoid frequent interruptions in compressions
Use Two-Thumb Method Rather than Two-Finger Method for Neonatal Cardiac Compressions

- 2 small human neonate case series (3 infants)
  - Two-Thumb Method achieved superior MAP, DBP
- 2 randomized animal trials
  - Two-Thumb Method achieved superior MAP, CPP
- 3 manikin studies—only one using NRP Guidelines
  - Two-Thumb superior depth of compression with less fatigue
### Depth and Variability During 3:1 Compression: Ventilation CPR for 2 min

<table>
<thead>
<tr>
<th></th>
<th>Two Thumb (n=21)</th>
<th>Two Finger (n=21)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Depth of Compression (mm)</td>
<td>29.6±5.3</td>
<td>24.4±5.8</td>
<td>0.002</td>
</tr>
<tr>
<td>2. Variability in Compression Depth (CV)</td>
<td>5.9±3.0</td>
<td>9.5±3.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>4. Number of Compressions per min</td>
<td>193±28</td>
<td>198±33</td>
<td>NS</td>
</tr>
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Coefficient of variation (CV) = standard deviation/mean *100

- 20/21 subjects achieved greater depth of compression with the Two Thumb Method vs Two Finger Method (p=0.00005)
- 20/21 subjects achieved less variability with the Two Thumb Method vs Two Finger Method (p=0.00005)

Cristman et al. ADC 2011
Proper Finger Placement with Two-Thumb vs Two-Finger

*P < 0.001 TT vs TF Proper Placement

Cristman et al. ADC 2011
Sounds good but.....

- Won’t the two-finger technique be needed at least briefly so that the compressors hands are not blocking access to the umbilical cord for emergent umbilical venous line placement?
Head of Bed Compressions Allows Continuous Two-thumb Technique

- Once an airway is established and secured, move the provider giving compressions to head of bed

- Potential Advantages:
  - Arms are in a more natural position
  - Umbilical access is more readily available while continuing Two-thumb technique
  - More space for person giving meds at the patient’s side
Compressor Drop-off

*\( p = 0.016 \)
Representative Tracing of Coronary Perfusion Pressure Generated by CCC vs 30:2 CC+V in an Adult V-fib Model

Continuous 30:2 CC+V

Ewy GA et al. Circulation 2007
PPV, consider SPO₂ monitoring

60 sec

HR below 100?

Yes

Ensure adequate ventilation

Consider ET intubation!

No

HR below 60?

Yes

Chest compressions
Coordinate with PPV

No

Consider SPO₂ monitoring
Consider CPAP

Post-resuscitation care

HR below 60?

Yes

IV Epinephrine

No

Yes
2011 NRP Epinephrine Guidelines

- Epinephrine (1:10,0000 solution) should be administered **intravenously** at 0.01 to 0.03 mg/kg per dose.

- Umbilical line placement should be a priority if epinephrine is needed as endotracheal delivery is unreliable.

- While access is being obtained, **a higher dose (0.05 to 0.1 mg/kg)** of endotracheal epinephrine may be given but the safety and efficacy of this practice have not been evaluated.
Summary – Important Changes

Room air for initial resuscitation of term newborn
Use of blender for supplemental oxygen

Color assessment is not accurate
Pulse oximeter - preductal

82  142

Use of PEEP

M.R.S.O.P.A mnemonic
Adequate ventilation

Two-thumb encircled hand preferred method for chest compressions

Epinephrine - Intravenous route preferred