Neonatal Resuscitation New Guidelines

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Birth is Stressful

• Birth by vaginal delivery is a stressful process, but despite enduring this process for several hours, most newborn infants are pink, and breathing regularly by 1-2 minutes of age.

Transition at Birth

Neonatal Resuscitation

• Timely and appropriate resuscitation at birth can mean the difference between death, survival with neurological impairment or intact survival.
• In no other area of medicine are the benefits of prompt and correct action more rewarding and more immediate

Vital Statistics 2008

• There are approximately 4,251,095 births in the United States in 2008 (↓ 2%).
• 8.2% of these are low-birth weight (LBW) infants (↔).
• Preterm (<37 weeks) – 12.3 % (12.7% in 2007)
• Late preterm – 8.8% (9% in 2007)
• C-section: 32.3%
• Although 99% of these births occur in hospital delivery room settings, the remaining 1% may take place in extramural settings
• Need for intubation
  – 70% - high risk situations (anticipated)
  – 30% - low risk situations (unanticipated)

TJ Mathews et al, Pediatrics 2011

Which Babies Require Resuscitation?

• Most newly born babies are vigorous
• Only about 10% of newborns require some assistance
• Only 1% need major resuscitative measures (intubation, chest compressions, and/or medications) to survive
What Can Go Wrong During Transition

- Lack of ventilation of the newborn’s lungs results in sustained constriction of the pulmonary arterioles, preventing systemic arterial blood from being oxygenated.
- Prolonged lack of adequate perfusion and oxygenation to the baby’s organs can lead to brain damage, damage to other organs, or death.

Tactile Stimulation is not Adequate in Secondary Apnea

Signs of a Compromised Newborn

- Bradycardia
- Poor muscle tone
- Depressed respiratory drive
- Low blood pressure
- Tachypnea
- Cyanosis

Basic Principle of NRP

Effective ventilation of the lungs is the primary objective of neonatal resuscitation.

Improving heart rate is the best sign of effective resuscitation.

Primary & Secondary Apnea

Lakshminrusimha and Carrion: Clinical Pediatric Emergency Medicine 2008

The New NRP Algorithm
Evaluating the Newborn

Immediately after birth, the following questions must be asked:

- Term gestation?
- Breathing or crying?
- Good muscle tone?

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

Neonatal Resuscitators Cannot Assess Color!

At the end of the Golden Minute:
Initial Evaluation – Two Vital Characteristics

Initial evaluation
HR and respiration
color - unreliable

- Heart Rate
- Respirations – crying, regular vs. apnea/gasping

Heart Rate

Cardiac Output = Stroke Volume x Heart Rate

Stroke Volume Does not Change Significantly in Neonates

Heart Rate determines the output to the lungs and vital organs

The Most Important

Two Vital Signs

Progression to the next step following the initial evaluation is now defined by the simultaneous assessment of 2 vital characteristics: heart rate and respirations. Oximetry should be used for evaluation of oxygenation because assessment of color is unreliable.
Keeping Premature Babies Warm

- Increase delivery room temperature
- Preheat radiant warmer
- Use warming pad
- Consider polyethylene bag for babies <28 weeks' gestation

Avoid Hyperthermia

- Amniotic fluid is clear
  - Suctioning should be reserved for babies who have obvious obstruction to spontaneous breathing or those who require positive pressure ventilation

Clearing the Airway

- Suction mouth first, then nose
- “M” before “N”
Clearing Airway - Meconium

- Suctioning of oropharynx at delivery of shoulders – not effective
- Direct suctioning of trachea in vigorous babies – does not reduce risk of meconium aspiration

Meconium Present and Newborn Not Vigorous

Tracheal Suction
- Monitor heart rate
- Insert laryngoscope, use 12F or 14F suction catheter to clear mouth
- Insert endotracheal tube into trachea
- Attach endotracheal tube to suction source
- Apply suction as tube is withdrawn
- If attempted intubation is prolonged and unsuccessful, bag-mask ventilation should be considered, particularly if there is persistent bradycardia.

Assessment of Oxygen Need and Administration of Oxygen

Change in SpO2 Following Birth (Term)

Mariani et al, J Pediatrics 2007

Pre- Post Ductal Oxygenation

Targeted Preductal SpO2 After Birth
Pulse Oximeter

- Every delivery area should have an oximeter readily available (but not necessarily physically present at every delivery).
- An oximeter is recommended whenever supplemental oxygen, positive ventilation, or CPAP is used.

**Pulse Oximeter Use in the Delivery Room**

- Apply sensor to the baby first
- Then connect the sensor to the pulse oximeter
- Turn on the pulse oximeter
- Time to display oxygen saturation 68 (58-90) sec from birth
- If sensor is applied to the baby last – 100 (74-150 sec)

**Administration of Supplemental Oxygen**

**Goal of Supplemental Oxygen**

- Maintain oxygen saturation in the interquartile range in both term and preterm babies
- Term babies – initiate resuscitation with room air
- Preterm babies – blended oxygen

**Supplemental Oxygen (Blender)**

For babies born at term it is best to begin **resuscitation** with air rather than 100% oxygen
Heart Rate and not Color
• If the baby is bradycardic (HR < 60/min) after 90 sec of resuscitation with a lower concentration of oxygen, oxygen concentration should be increased to 100% until recovery of a normal heart rate.

Indications for Positive-Pressure Ventilation
• Apnea/gasping
• Heart rate less than 100 beats per minute (bpm) even if breathing
• Persistent cyanosis despite 100% free flow oxygen
Ventilation of the lungs is the single most important and most effective step in cardiopulmonary resuscitation of the compromised infant

Signs of Effective Ventilation
Sign of adequate ventilation:
• Improved heart rate
If heart rate does not improve:
• Assess chest rise

T-piece Resuscitator
Advantages:
• Consistent delivery of pressure
• Reliable control of peak inspiratory and positive end-expiratory pressure
• Reliable delivery of 100% oxygen
• No fatigue from bagging

T-piece Resuscitator: Troubleshooting
Disadvantages:
• Requires compressed gas source
• Must have tight face-mask seal to inflate lungs
• Compliance of the lung cannot be “felt”
• Requires pressure to be set prior to use
• Changing pressures during use is more difficult
Additional Emphasis on Ventilation

Extra 30 sec period for assuring adequate chest movement

Mnemonic for remembering the six steps for improving efficacy of positive-pressure ventilation

Endotracheal Intubation: Indications

- To suction trachea in presence of meconium when the newborn is not vigorous
- To improve efficacy of ventilation after several minutes of bag-and-mask ventilation or ineffective bag-and-mask ventilation
- To facilitate coordination of chest compressions and ventilation
- Special circumstances – diaphragmatic hernia or extreme prematurity
- To administer epinephrine while IV access is being established

CO₂ Detection – Dependent of Pulmonary Blood Flow

Alternatives to Endotracheal Intubation:
Laryngeal Mask Airway
Inserting a Laryngeal Mask Airway

1. Hold the airway tube like a pen in your dominant hand with the rim deflated.
2. Open the baby’s mouth and place the back or flat part of the mask against the roof of the baby’s mouth (palate). The back of the mask is the part with no opening.
3. Using your index finger, guide the mask along the baby’s palate and into the throat until you feel resistance.
4. Stabilize the tube with your other hand and remove your index finger from the baby’s mouth.

Chest Compressions: Indications

Heart rate remains less than 60 beats per minute (bpm) despite 30 seconds of effective positive-pressure ventilation.

Epinephrine Indications

Epinephrine, a cardiac stimulant, is indicated when the heart rate remains below 60 beats per minute despite adequate chest compressions and effective ventilation.

Medication Administration via Umbilical Vein

Placing catheter in umbilical vein
- Preferred route for intravenous access
- 3.5F or 5F end-hole catheter
- Sterile technique
Epinephrine Administration

**Recommended concentration**
1:10,000

**Recommended route**
- Intravenously (consider endotracheal route while intravenous access being obtained)
- Right atrial epinephrine
- Femoral vein epinephrine
- Endotracheal epinephrine
- Femoral vein placebo

**Recommended dose**
- 0.1 to 0.3 mL/kg of 1:10,000 solution (consider 0.3 to 1 mL/kg if giving endotracheally)

Plasma epinephrine concentration plotted against time in minutes before cardiac arrest (baseline) and after epinephrine or placebo administration. N = 8 for all groups. Epinephrine vs. the endotracheal tube vs. epinephrine via the right atrium, analysis of variance (ANOVA), interactions, F = 9.85, p < .05; and epinephrine via the endotracheal tube vs. epinephrine via the femoral vein, ANOVA, interactions, F < 17.15, p < .05. CPR, cardiopulmonary resuscitation. Triangles, right atrial epinephrine; filled circles, femoral vein epinephrine; open squares, endotracheal epinephrine; open circles, femoral vein placebo; filled squares, endotracheal placebo. Values are expressed as mean ± SEM. *p < .05 vs. endotracheal epinephrine by analysis of variance.


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Why should UVC be inserted only 2-4 cm below the skin during resuscitation?

**Umbilical Catheterization**

1. Place a loose tie of umbilical tape around the base of the cord
2. Pre-fill a 3.5 or 5F umbilical catheter with normal saline
3. Stopcock – connect & close
4. UV is usually at 11-12 o’clock position

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Correct Placement of an UV catheter

Insert 2-4 cm
Free-flow of blood when aspirated
Less depth in preterm newborns

Correct Placement of an UV catheter
Correct Placement of an UV catheter during resuscitation

Incorrect Placement of an UV catheter

Correct Placement of an UV catheter for long-term access in the NICU

These lines should be used only after checking placement with an X-ray

**Poor Response to Resuscitation: Hypovolemia**

**Indications for volume expansion**
- Baby is not responding to resuscitation AND
- Baby appears in shock (pale color, weak pulses, persistently low heart rate, no improvement in circulatory status despite resuscitation efforts)
- There may be a history of a condition associated with fetal blood loss (e.g., extensive vaginal bleeding, abruptio placentae, placenta previa, twin-to-twin transfusion, etc)

**Blood Volume Expansion: Dose and Administration**
- Recommended solution = Normal saline
- Acceptable solution = Ringer's lactate, or O Rh-negative blood
- Recommended dose = 10 mL/kg
- Recommended route = Umbilical vein
- Recommended preparation = Correct volume drawn into large syringe
- Recommended rate = Over 5 to 10 minutes
Supportive Therapy

- Temperature Control
  - Hyperthermia (incl. maternal fever)
  - Therapeutic Hypothermia (within 6 h)
- Glucose Supplementation
  - Avoid hypoglycemia
- Delayed Cord Clamp
  - For babies not requiring resuscitation

Consequences of Delayed Cord Clamping

- Increased need for phototherapy
- Better systemic blood pressure during stabilization
- Lower need for PNEC transfusions

Delayed Cord Clamp

If baby does not require resuscitation...

Conclusions

- The goal of neonatal resuscitation is to effectively ventilate the lungs.
- Improving heart rate is the best sign of effective resuscitation.