Resuscitation and Stabilization of the Newborn

June 7, 2018
Angela N. Burton, NNP-BC
Henry Ford Health System

Objectives
- Review the physiology of fetal / neonatal circulation and first breaths.
- Review normal transition to extra uterine life and specific situations needing immediate intervention.
- Understand the indications for bag/mask ventilation, chest compressions, and intubation of the newborn.
- Review medications used in the resuscitation of newborns.
- Understand the general principles of thermoregulation and the impact on the newborn infant, the preterm infant and the compromised newborn infant.

Which Babies Require Resuscitation?
- Most newly born babies are vigorous and need little assistance to transition to extra uterine life.
- Only about 10% of newborns require some assistance.
- Only 1% need major resuscitative measures (intubation, chest compressions, and/or medications) to survive.
- MOST infants need only respiratory support to transition.
Which Babies Require Resuscitation?

- Always needed by newborns:
  - Assess baby's response to birth
  - Keep baby warm
  - Position, clear airway, stimulate to breathe by drying, and give oxygen (as necessary)
- Needed less frequently:
  - Establish effective ventilation
  - Bag and mask
  - Endotracheal intubation
- Rarely needed by newborns:
  - Provide chest compressions
  - Administer medications

Fetal Physiology

In the fetus:
- In utero, the fetus is dependent on placenta for nutrition and gas exchange
- The lungs and alveoli are filled with fluid
- Only about 8-10% of the blood flow goes to the lungs in utero, this is needed for lung development

Fetal Physiology

In the fetus:
- Pulmonary arterioles constricted
- Blood takes the path of least resistance
- Pulmonary blood flow diminished
- Blood flow diverted across ductus arteriosus
Lungs and Circulation
After Delivery
- Once the infant is delivered, the lungs fill with air and expand.
- Fetal lung fluid is pushed from the alveoli.

Lungs and Circulation
- Pulmonary arterioles dilate in response to oxygen, which is the first line drug for newborn resuscitation.
- Pulmonary blood flow increases.
- Blood takes the path of least resistance.

Lungs and Circulation
- Blood flows through lungs to pick up oxygen.
- Blood oxygen levels rise.
- Ductus arteriosus constricts.
- The newborn slowly becomes pink.
Transition from Fetal to Neonatal Respiration

<table>
<thead>
<tr>
<th>Change at Birth</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>The baby breathes</td>
<td>The newborn uses the lungs, instead of the placenta, for gas exchange</td>
</tr>
<tr>
<td>The umbilical cord is clamped,</td>
<td></td>
</tr>
<tr>
<td>separating the placenta from</td>
<td></td>
</tr>
<tr>
<td>the baby.</td>
<td></td>
</tr>
<tr>
<td>Fluid in the alveoli is absorbed</td>
<td>Air replaces fluid in the alveoli. Oxygen moves from the alveoli into</td>
</tr>
<tr>
<td></td>
<td>the pulmonary blood vessels and CO2 moves into the alveoli to be</td>
</tr>
<tr>
<td></td>
<td>exhaled.</td>
</tr>
<tr>
<td>Air in the alveoli causes</td>
<td>Pulmonary blood flow increases and the ductus arteriosus closes.</td>
</tr>
<tr>
<td>blood vessels in the lung to</td>
<td></td>
</tr>
<tr>
<td>dilate.</td>
<td></td>
</tr>
</tbody>
</table>

Preparing for Birth

- Appropriate equipment
- Anticipating the need for resuscitation even before birth – Perinatal Risk Factors
- At least 1 qualified individual skilled in initial steps for every delivery
- If risk factors present, 2 skilled people devoted to the infant
- Debrief before delivery and plan

Pre-birth Questions

- What is the expected gestational age?
- Is the amniotic fluid clear?
- How many babies are expected?
- Are there any additional risk factors?
Delayed Cord Clamping (2017)
- At the time of birth, a large amount of blood remains in the placenta.
- Placental gas exchange will continue while additional blood flows to the baby.
- This placental blood transfusion which occurs during the first minute of life may have an important role in transition from fetal to neonatal circulation.
- Current recommendation delay for 30-60 seconds in most vigorous term and preterm infants.

Important to mark the time of birth (apgar timer).
- Exact interval is being researched.
- OB provider and neonatal team should evaluate tone and breathing and begin initial steps.
- If placenta not intact cord should be clamped immediately.
- Also should not be delayed in multiples and other scenarios where utero-placental perfusion is compromised.

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.
Signs of a Compromised Newborn

- Poor muscle tone
- Depressed respiratory drive or gasping
- Bradycardia (<100)
- Low blood pressure (not routinely measured in the delivery room)
- Tachypnea
- Cyanosis

Good tone with cyanosis
Bad tone with cyanosis

Evaluating the Newborn

Immediately after birth, the following questions must be asked:

- Is the infant Term?
- Is the infant breathing or crying?
- Is there good muscle tone?

Initial Steps

- Provide warmth – Prevent Heat Loss
  - Skin to Skin with mother

- Open the airway
  - Positioning the newborn in a “sniffing” position; aligns posterior pharynx, larynx, and trachea
  - Positioning on back or side, slightly extending neck
  - Remove secretions: Suction with bulb syringe, wipe with a cloth

- Dry and stimulate the infant
  - Drying thoroughly
  - Removing wet towels or blankets
Opening the Airway

Meconium stained amniotic fluid

- Non-vigorous infants with meconium stained fluid do not require routine intubation and tracheal suctioning (2017)
- However this continues to be a perinatal risk factor and a skilled resuscitation team member who can intubate must be present to make this decision.
Central Cyanosis and Acrocyanosis

Oxygen Use
- Resuscitation of newborns ≥ 35 weeks gestation, use 21% (room air to start)
- Resuscitation of newborns ≤ 35 weeks gestation, use 21 - 30%
- If baby is breathing, but oxygen saturation is below target range free-flow oxygen may begin at 30%

Oxygen Use
- Adjust flow rate to approximately 10 L/min
- Use a blender to adjust the concentration based on the target ranges
- Free-flow oxygen cannot be given reliably by a mask attached to a self-inflating bag, but may be given using the tail
- If respirations are labored consider PPV
Free-Flow Oxygen Given Via Oxygen Tubing

Targeted Pre-ductal $S_{Po2}$ after Birth

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>$S_{Po2}$ (%)</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>

Most infants will "pink up" slowly within 10 minutes as long as HR is > 100 and they are effectively breathing.

Pulse oximetry is now suggested as standard equipment in the resuscitation of newborns to measure the delivery of oxygen and prevent toxic effects.

Indications for Positive-Pressure Ventilation in Newborns

- Apnea/gasping
- Heart rate less than 100 beats per minute (bpm) even if breathing after a period of assessment
- Persistent cyanosis despite 100% free-flow oxygen
- Saturation remains below the target values despite free-flow oxygen being increased to 100%
- Continued use of tactile stimulation in an apneic newborn wastes valuable time
Ventilation of the lungs is the single most important and most effective step in cardiopulmonary resuscitation of the compromised infant.

General Characteristics of Resuscitation Devices

- Appropriate-sized mask (cushioned, anatomically shaped mask preferred)
- Size of bag (200-750 mL)
- Capability of blended oxygen, to control delivery
- Control of peak inspiratory pressure and inspiratory time
- Safety features to prevent high pressure delivery
  - A pressure gauge and a flow-control valve and/or
  - A pressure-release (pop-off) valve

Important Concerns when Ventilating Newborns

- Peak inspiratory pressure – how much pressure is needed to inflate the newborn lung. Initial 20-25 cm H2O
- Positive End Expiratory Pressure (PEEP) – the gas remaining in the system between breaths. Needed in the newborn to prevent collapse of the alveoli, 5cm H2O
- Rate – the number of assisted breaths 40-60/min
Bag and Mask: Equipment

- Rims - Cushioned
- Shape can be round, most are now anatomically shaped
- Size: Small and Large
- Mask must cover Tip of Chin, Mouth AND Nose

Resuscitation Devices Available to Ventilate Newborns

- The “self-inflating bag” – fills spontaneously after being squeezed (MOST COMMON)
- The “flow inflating bag” – also called the anesthesia bag
- The “T-piece resuscitator” newer technology most practical for in hospital use

Inflation Pressure

If the baby appears to be receiving very deep breaths

- Too much pressure is being used
- Most likely there is over-inflation of lungs
- Danger of producing a pneumothorax
### Signs of adequate ventilation

**Improved heart rate, color, muscle tone**

---

### Newborn Not Improving

- Check oxygen supply, bag, seal, and pressure
- Is chest movement adequate?
- Is adequate oxygen being administered?
- Then,
  - Consider endotracheal intubation
  - Check breath sounds; pneumothorax possible even from Positive Pressure Ventilation or Spontaneous in a Newborn

---

### Endotracheal Intubation: Indications

- To improve efficacy of ventilation after several minutes of PPV and not good chest movement
- If PPV lasts for more than a few minutes intubation may improve the efficacy and ease of ventilation
- To facilitate coordination of chest compressions and ventilation – intubate prior to chest compressions
- Special indications, extreme prematurity, surfactant
Endotracheal Tube Size
- Select tube size based on weight and gestational age
- Consider shortening tube to 13 to 15 cm to decrease dead space (? Practical)
- Stylet optional, use with caution

<table>
<thead>
<tr>
<th>Tube Size (mm)</th>
<th>Weight (gm)</th>
<th>Gestational Age (wks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>Below 1,000</td>
<td>Below 28</td>
</tr>
<tr>
<td>3.0</td>
<td>1,000 - 2,000</td>
<td>28 - 34</td>
</tr>
<tr>
<td>3.5</td>
<td>2,000 - 3,000</td>
<td>&gt; 34</td>
</tr>
</tbody>
</table>

Preparation of Laryngoscope:
- The correct-sized laryngoscope blade:
  - No. 00 for Extremely low birthweight infants < 1kg
  - No. 0 for preterm newborns
  - No. 1 for term newborns (in reality a 0 will work unless the infant is very large > 4 kg)
- Check laryngoscope light
- Adjust suction source to 80 - 100 mm Hg
- Use large suction catheter (greater than or equal to 10F) for oral secretions
- Have small catheter for suctioning endotracheal tube

Preparation for Intubation
- Stethoscope or CO₂ detector for confirmation of placement
- Tape or endotracheal tube stabilizer prepared
Assisting During Intubation

The assistant for the procedure should
- Ensure equipment available and prepared
- Provide free-flow oxygen
- Provide suction
- Hand endotracheal tube to intubator
- Apply cricoid pressure if requested

Assisting During Intubation

The assistant for the procedure should
- Provide positive-pressure ventilation between attempts
- Connect endotracheal tube to resuscitation device
- Auscultate breath sounds and observe chest movement
- Connect CO₂ detector if available, Note CO₂ detector color change
- Auscultate heart rate to assess improvement
- Help secure tube

Endotracheal Intubation: Upper Airway Anatomy

1. Epiglottis
2. Thymus membrane
3. Cricoid cartilage
4. Vocal cords (inside)
5. Sputum
6. Trachea
7. Left Main Bronchus
8. Carina
Endotracheal Intubation: Anatomic Landmarks

Endotracheal Intubation
Step 4 Visualize Landmarks

- Look for landmarks. Vocal cords should appear as vertical stripes on each side of the glottis or as an inverted letter "V".
- Applying downward pressure on cricoid may help bring glottis into view.
- Suction, if necessary, for visualization.

Endotracheal Intubation
Checking Tube Position

Signs of correct tube position
- Improved vital signs (heart rate, color, and activity)
- Presence of exhaled CO2 as determined by CO2 detector.
- Breath sounds over both lung fields but decreased or absent over stomach.
- No gastric distention with ventilation.
**Initial Endotracheal Tube insertion (“tip to Lip”)**

<table>
<thead>
<tr>
<th>Gestation (weeks)</th>
<th>Tube insertion depth at lips (cm)</th>
<th>Baby’s weight in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>23-24</td>
<td>5.5</td>
<td>500-600</td>
</tr>
<tr>
<td>25-26</td>
<td>6.0</td>
<td>700-800</td>
</tr>
<tr>
<td>27-29</td>
<td>6.5</td>
<td>900-1000</td>
</tr>
<tr>
<td>30-32</td>
<td>7.0</td>
<td>1100-1400</td>
</tr>
<tr>
<td>33-34</td>
<td>7.5</td>
<td>1500-1800</td>
</tr>
<tr>
<td>35-37</td>
<td>8.0</td>
<td>1900-2400</td>
</tr>
<tr>
<td>38-40</td>
<td>8.5</td>
<td>2500-3100</td>
</tr>
<tr>
<td>41-43</td>
<td>9.0</td>
<td>3200-4200</td>
</tr>
</tbody>
</table>

**Circulation**

If heart rate <60 bpm despite adequate ventilation for 30 seconds:

- Provide chest compressions as you continue assisted ventilation*

- Then evaluate again. If heart rate <60 bpm, use of medications must be considered.

*Consider intubation of the trachea at this point

**Chest Compressions**

- Temporarily increase circulation

- Must be accompanied by ventilation

- Should use 100% oxygen because your baby is not improving
Chest Compressions: Positioning of Thumbs or Fingers

- Run your fingers along the lower edge of the rib cage until you locate the xyphoid
- Place your thumbs or fingers on the sternum, above the xyphoid and on a line connecting the nipples

Chest Compressions: Thumb Technique

Apply pressure during compression on the sternum, releasing pressure to allow chest recoil and ventilation

Chest Compressions: Compression Pressure and Depth

- Depress sternum one third of the anterior-posterior diameter of chest
- Duration of downward stroke shorter than duration of release
Chest Compressions: Complications

- Laceration of liver
- Broken ribs

Chest Compressions: Coordination With Ventilation

- One cycle of 3 compressions and 1 breath takes 2 seconds
- One-and-two-and-three-and-breathe
- The breathing rate is 30 breaths per minute and the compression rate is 90 compressions per minute. This equals 120 “events” per minute

When to Discontinue Chest Compressions

- After 30 seconds of compressions and ventilation, reevaluate the heart rate
- If the HR is > 60 only ventilation is needed
- If HR is > 100 and infant is breathing, PPV is discontinued.
What to do if infant is “Not improving”

- Ensure adequacy of ventilation
- Is supplemental oxygen being given
- Is the depth of compressions adequate?
- Are compressions and ventilation well coordinated?
- Consider intubation if not already done

- If the HR still remains below 60 bpm, Insert an umbilical catheter to give epinephrine

Chest compressions

- It is now recommended that when there is a need for chest compressions a cardiac monitor is the preferred method for assessing heart rate.

Medications

If heart rate <60 bpm despite adequate ventilation and chest compressions:

- Administer epinephrine as you continue assisted ventilation and chest compressions
MEDICATIONS

There are few medications which are needed in newborn resuscitation.

Medication Administration via Umbilical Vein

Easiest access in a compromised newborn

Placing catheter in umbilical vein

- Preferred route for intravenous access
- 3.5F or 5F end-hole catheter
- Sterile technique
Medication Administration via Umbilical Vein

- Insert catheter 2 to 4 cm for resuscitation to avoid insertion into the liver
- Note free flow of blood when aspirated
- Preterm infants generally 2-3 cm
- Term infants 4-5 cm

Epinephrine

Epinephrine, a cardiac stimulant, is indicated when the heart rate remains below 60 beats per minute despite

- 30 seconds of assisted ventilation followed by
- 60 seconds of coordinated compressions and ventilation
- Coordinated with PPV using 100% oxygen

Note: Epinephrine is not indicated before adequate ventilation is established.

Epinephrine Administration

Recommended concentration = 1:10,000
Recommended route = Intravenously (consider endotracheal route while intravenous access being obtained)

Recommended dose = 0.1 to 0.3 mL/kg of 1:10,000 solution (consider 0.3 to 1 mL/kg if giving endotracheally)
Recommended preparation = 1:10,000 solution in 1-mL syringe (or larger syringe if giving endotracheally)
Recommended rate of administration = Rapidly—as quickly as possible
**Epinephrine**

Effects, Repeated Dosing

- One dose may be given down the ET tube while a line is being placed.
- Repeat doses should be given via umbilical vein

**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)

Is there a history of a condition associated with fetal blood loss, eg, extensive vaginal bleeding, abruptio placentae, placenta previa, twin-to-twin transfusion, cord clamped not soon enough, infant delivered and lifted above the level of the mother.

**Blood Volume Expansion**

<table>
<thead>
<tr>
<th>Solution</th>
<th>Normal saline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose</td>
<td>10mL/kg</td>
</tr>
<tr>
<td>Route</td>
<td>IV → Umbilical vein</td>
</tr>
<tr>
<td>Preparation</td>
<td>Correct volume drawn into large syringe</td>
</tr>
<tr>
<td>Rate</td>
<td>Over 5-10 minutes for resuscitation</td>
</tr>
</tbody>
</table>
Volume Expanders
- O - unmatched blood might be of assistance in the Delivery room
- Ringer’s lactate no longer recommended
- Preferred route is UVC
- No evidence for sodium bicarbonate in neonate
- No evidence that naloxone is safe or effective

Why Are Premature Newborns at Higher Risk?
- Possible surfactant deficiency
- Decreased drive to breathe
- Rapid heat loss, poor temperature control
- Possible infection
- Susceptible to brain hemorrhage
- Susceptible to hypovolemia secondary to blood loss
- Weak muscles make spontaneous breathing difficult
- Immature tissues may be damaged by excessive oxygen

Decreasing Brain Injury (Risk of IVH)
- Handle the baby gently
- Avoid the Trendelenburg position
- Avoid high airway pressures when possible
- Adjust ventilation gradually based on physical examination and pulse oximetry
- Avoid rapid intravenous fluid boluses and hypertonic solutions
Important Points in the Neonatal Resuscitation Flow Diagram

- The most important and effective action in neonatal resuscitation is to ventilate the baby's lungs.
- Effective positive-pressure ventilation when the infant is not breathing usually results in rapid improvement of heart rate.
- If heart rate does not increase, ventilation may be inadequate and/or chest compressions and epinephrine may be necessary.

Heart rate <60 bpm → Additional steps needed
Heart rate >60 bpm → Chest compressions can be stopped
Heart rate >100 bpm and breathing → Positive-pressure ventilation can be stopped
THANK YOU!