Chapter 12
Resuscitation of the Newly Born
Outside the Delivery Room

Objectives

Discuss the physiologic changes that occur in the transition from intrauterine life to extrauterine life.

Discuss antepartum and intrapartum factors associated with an increased risk for neonatal resuscitation.

Objectives

Discuss the assessment findings associated with primary and secondary apnea in the neonate.

Discuss the treatment plan for apnea in the neonate.

Differentiate when a woman in labor should be transported and when to prepare for delivery in the field.
Objectives

- Describe the steps for performing a vaginal delivery and the steps performed immediately post-delivery for every newborn.
- Identify equipment that should be readily available for resuscitation of the newly born.
- Identify the primary signs used for evaluating a newborn during resuscitation.
- Formulate an appropriate treatment plan for providing initial care to a newborn.

Objectives

- Determine when the following interventions are appropriate for a newborn:
  - Blow-by oxygen delivery
  - Ventilatory assistance
  - Chest compressions
  - Tracheal intubation
  - Vascular access

- Discuss the routes of medication administration for a newborn.

Principles of Resuscitation of the Newly Born
Newborn Transitional Physiology

- In utero, oxygen used by the fetus diffuses across the placenta from the mother’s blood to the baby’s blood
- Fetal alveoli are open and filled with fetal lung liquid instead of air
- Pulmonary blood vessels are constricted

Newborn Transitional Physiology

- Before labor, production of fetal lung fluid decreases dramatically
  - Volume decreases by about 1/3

Newborn Transitional Physiology

- During vaginal delivery, the baby’s thorax is squeezed
  - Further reduces volume of fetal lung fluid by approximately 1/3
**Newborn Transitional Physiology**

- The newborn’s initial cries and deep breaths help move the fetal lung fluid out of the airways.
- The skin turns from gray/blue to pink as oxygen-enriched blood enters the newborn’s systemic circulation.

**Problems That May Disrupt The Normal Transition To Extrauterine Life**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn does not breathe sufficiently to force fluid from alveoli</td>
<td>Lungs do not fill with air</td>
</tr>
<tr>
<td>Meconium blocks air from entering alveoli</td>
<td>Oxygen is not available to blood circulating through the lungs → hypoxia, cyanosis</td>
</tr>
<tr>
<td>Problem</td>
<td>Possible Result</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Insufficient blood return from placenta before or during birth</td>
<td>Systemic hypotension</td>
</tr>
<tr>
<td>Poor cardiac contractility</td>
<td></td>
</tr>
<tr>
<td>Bradycardia due to insufficient delivery of oxygen to heart or brainstem</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of oxygen or failure to distend lungs with air may result in sustained constriction of pulmonary arterioles</td>
<td>Persistent pulmonary hypertension</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient oxygen delivery to brain</td>
<td>Depressed respiratory drive</td>
</tr>
<tr>
<td>Insufficient oxygen delivery to brain and muscles</td>
<td>Poor muscle tone</td>
</tr>
</tbody>
</table>
Factors Associated with Increased Risk for Neonatal Resuscitation

Antepartum Risk Factors
- Maternal age >35 years or <16 years
- Maternal diabetes
- Maternal bleeding in second or third trimester
- Maternal drug therapy (e.g., magnesium, adrenergic blocking drugs, lithium carbonate)
- Maternal substance abuse (e.g., heroin, methadone)
- Chronic or pregnancy-induced hypertension
- Chronic maternal illness (e.g., cardiovascular, thyroid, neurological, pulmonary, renal)
- Maternal anemia or isoimmunization
- Maternal infection
- Polyhydramnios
- Oligohydramnios
- Premature rupture of membranes
- Previous fetal or neonatal death
- Post-term gestation
- Multiple gestation
- Size-dates discrepancy
- No prenatal care
- Diminished fetal activity
- Fetal malformation

Intrapartum Risk Factors
- Abruptio placentae
- Placenta previa
- Premature labor
- Precipitous labor
- Chorioamnionitis
- Prolonged rupture of membranes (>18 hours before delivery)
- Prolonged labor (>24 hours)
- Prolonged second stage of labor (>2 hours)
- Use of general anesthesia
- Emergency cesarean section
- Forceps or vacuum-assisted delivery
- Uterine tetany
- Narcotics administered to mother within 4 hours of delivery
- Breech or other abnormal presentation
- Fetal bradycardia
- Nonreassuring fetal heart rate patterns
- Prolapsed cord
- Meconium-stained amniotic fluid
# Focused Maternal History

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Question</th>
<th>Possible Risk</th>
<th>Preparation/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate gestational age</td>
<td>When is your baby due?</td>
<td>Prematurity</td>
<td>Assisted ventilation Ensure availability of size-appropriate equipment</td>
</tr>
<tr>
<td>Multiple gestation</td>
<td>How many babies are there?</td>
<td>If more than one, newborns at greater risk for prematurity</td>
<td>Additional personnel and equipment needed</td>
</tr>
<tr>
<td>Meconium in amniotic fluid</td>
<td>Did your bag of waters rupture? What was the color of the water?</td>
<td>Respiratory distress Hypoxemia Aspiration pneumonia</td>
<td>Immediate suction Possible tracheal intubation</td>
</tr>
<tr>
<td>Maternal medications</td>
<td>Have you taken any medications or drugs?</td>
<td>Narcotic use within 4 hours of delivery may result in neonatal respiratory depression</td>
<td>Assisted ventilation</td>
</tr>
<tr>
<td>Maternal diabetes</td>
<td>Do you have high blood sugar or diabetes?</td>
<td>Neonatal hypoglycemia Congenital anomalies Large for gestational age</td>
<td>Assisted ventilation Vascular access</td>
</tr>
<tr>
<td>Breech position</td>
<td>Has your doctor told you if the baby is coming head first or feet first?</td>
<td>Birth trauma Prematurity Umbilical cord prolapse</td>
<td>Assisted ventilation Additional personnel and equipment needed</td>
</tr>
</tbody>
</table>
### Focused Maternal History

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Question</th>
<th>Possible Risk</th>
<th>Preparation/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginal bleeding</td>
<td>Have you experienced any vaginal bleeding? How long ago? Did you have any pain with the bleeding?</td>
<td>Maternal/placental hemorrhage - increased likelihood of hypovolemic shock and respiratory distress in neonate</td>
<td>Vascular access fluid/blood administration</td>
</tr>
<tr>
<td>Fetal movement</td>
<td>When was the last time you felt the baby move?</td>
<td>Fetal distress</td>
<td>Assisted ventilation</td>
</tr>
</tbody>
</table>

### Prematurity

- Premature babies are at higher risk of needing resuscitative efforts:
  - Lungs may lack sufficient surfactant and be more difficult to ventilate
  - Brain substance is soft, gelatinous, easily torn
    - Fragile capillaries may bleed during stress

- More likely to be born with an infection

- Predisposed to problems with temperature regulation
  - Thin skin
  - Large surface area to body mass ratio
  - Lack of subcutaneous fat
Primary Apnea

- Initial response to asphyxia
  - Breathes faster
  - Attempt to maintain perfusion and oxygen delivery to vital organs
  - Heart rate drops abruptly
  - Skin color becomes progressively cyanotic, then blotchy
    - Vasoconstriction occurs to maintain BP
  - If oxygen levels do not improve:
    - Respiratory efforts slow and eventually cease

- This is called primary apnea

Primary Apnea

- Newborn will respond to gentle stimulation by resuming spontaneous breathing
  - Drying
  - Gently rubbing the back

Secondary Apnea

- Oxygen deprivation continues
- Newborn takes several gasping respirations
- Skin is cyanotic
- Bradycardia ensues
- Blood pressure falls
- Gasping ventilations become weaker and slower and then stop (secondary apnea)
Secondary Apnea

- Newborn will not respond to stimulation
- Death will ensue without immediate resuscitation
- Bag-mask ventilation with supplemental oxygen required

Preparation for Delivery

Prehospital Predelivery Considerations

Signs of imminent delivery
- Consider delivering at the scene when:
  - Delivery can be expected in a few minutes
  - Patient feels the urge to push, bear down, or have a bowel movement
  - Crowning is present
  - Contractions are regular, lasting 45 to 60 seconds, and are 1 to 2 minutes apart
  - No suitable transportation is available
  - The hospital cannot be reached
    - Heavy traffic, bad weather, natural disaster
Field Delivery

- If the decision is made to deliver on the scene:
  - Consider the need for additional personnel and equipment (e.g., multiple births)
  - Use personal protective equipment
  - Contact medical direction
    - If complications are anticipated
    - If delivery does not occur within 10 minutes
  - Do not attempt to delay or restrain delivery

Delivery Procedure

- Position the patient
Delivery Procedure

- When crowning occurs, apply gentle palm pressure to infant's head
- Examine the infant’s neck for the presence of a looped umbilical cord
- Support the infant’s head as it rotates from shoulder presentation

Delivery Procedure

- Once the head is delivered, suction mouth, then nose

Delivery Procedure

- Support baby’s head as it rotates to line up with shoulders
- Guide head downward to deliver anterior (top) shoulder
- Guide head upward to deliver posterior (bottom) shoulder
Delivery Procedure

- Dry, warm, and position the newborn
- Clamp and cut the umbilical cord after the cord stops pulsating

Delivery Procedure

- Observe for delivery of the placenta

Initial Steps of Resuscitation of the Newly Born
Initial Steps of Resuscitation of the Newly Born

Ask yourself three questions at the time of birth:
1. Term gestation?
2. Breathing or crying?
3. Good muscle tone?

- If the answer to all questions is “Yes,” proceed with routine newborn care
  - Provide warmth
  - Clear the airway
  - Dry
  - Stimulate

- If the answer to any question is “No,” begin initial steps of resuscitation

Copyright © 2013 by Jones & Bartlett Learning, LLC, an Ascend Learning Company
Provide Warmth

- Methods to minimize heat loss
  - Placing the newborn under a radiant warmer (ideal)
  - Rapidly drying the skin
  - Removing wet linens immediately from newborn
  - Wrapping in prewarmed blankets or towels, insulating film blankets, or using an infant chemical warming mattress
  - Covering newborn’s body and top of head
  - Placing dried newborn against mother’s chest
    - Skin-to-skin contact
    - Increasing room temperature

Positioning

- Quickly dry the newborn

- Place the infant supine with the head in a “sniffing” position

Suctioning

- If the amniotic fluid is clear of meconium and signs of infection:
  - Suctioning should be reserved for babies who have obvious obstruction to spontaneous breathing or who require positive-pressure ventilation
Suctioning

- Meconium stained fluid
  - If the newborn is vigorous (strong ventilatory effort, good muscle tone, heart rate above 100 beats/minute), proceed with routine newborn care (i.e., provide warmth, clear the airway, dry).

- Meconium stained fluid
  - If the newborn is depressed (poor ventilatory effort, decreased muscle tone, and/or a heart rate slower than 100 beats/minute):
    - Insert a tracheal tube into the trachea and attach the tracheal tube to suction
    - Apply suction as the tube is slowly withdrawn

Stimulate

- Stimulation may be tried for 5 to 10 seconds to stimulate breathing
Oxygen Administration

- Conflicting evidence regarding the use of room air versus supplemental oxygen during resuscitation

Supplemental oxygen should be available for use if resuscitation is begun with room air and there is no appreciable improvement within 90 seconds after birth.

If the infant’s heart rate is slower than 60 beats/min after 90 seconds of resuscitation with a lower concentration of oxygen, increase the oxygen concentration to 100% until recovery of a normal heart rate.
Oxygen Administration

- Blow-by oxygen can be delivered via:
  - Face mask and flow-inflating (anesthesia) bag
  - Simple face mask held firmly to newborn’s face
  - Hand cupped around oxygen tubing

Blow-by Oxygen Administration

- Set oxygen source to deliver at least 5 L/min

Evaluate Breathing

- Ventilatory rate and effort
  - Crying
  - Adequate
  - Gasping
  - Apneic
- Term newborn’s normal ventilatory rate
  - Between 30 and 60 breaths/minute in first 12 hours of life
- Gasping breathing or apnea
  - Requires positive-pressure ventilation
Evaluate Heart Rate

- Heart rate
  - Term newborn’s normal heart rate
    - Between 100 and 180 beats/minute in first 12 hours of life
  - If heart rate slower than 100, begin positive-pressure ventilation
  - If heart rate slower than 60, additional resuscitative measures are needed

Evaluate Color

- Color
  - Assess for central cyanosis
    - Face, trunk, and mucous membranes
  - Acrocyanosis
    - Common finding immediately after delivery
    - Not a reliable indicator of hypoxemia
    - May be an indicator of cold stress

Evaluate Color

- Color
  - Pallor may indicate:
    - Decreased cardiac output
    - Severe anemia
    - Hypothermia
    - Acidosis
    - Hypovolemia
Evaluate Color

- It is normal for the oxygen saturation level to remain in the 70% to 80% range for several minutes following birth with the appearance of cyanosis during this period.

Apgar Scoring System

<table>
<thead>
<tr>
<th>Item</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Blue, pale</td>
<td>Body pink</td>
<td>Completely pink</td>
</tr>
<tr>
<td>Extremities blue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse</td>
<td>Absent</td>
<td>Slower than 100</td>
<td>100 or higher</td>
</tr>
<tr>
<td>Grimace/reflex irritability</td>
<td>No response</td>
<td>Grimaces, cries</td>
<td>Cough, sneeze, vigorous cry</td>
</tr>
<tr>
<td>Activity/muscle tone</td>
<td>Limp, flaccid</td>
<td>Some flexion of extremities</td>
<td>Active motion</td>
</tr>
<tr>
<td>Respiratory effort</td>
<td>Absent</td>
<td>Slow, irregular</td>
<td>Good, crying</td>
</tr>
</tbody>
</table>

Apgar Scoring System

- 7 to 10
  - Newborn in mild distress or one with no distress
  - No assistance needed other than nasopharyngeal suctioning
- 4 to 6
  - Newborn in moderate distress (i.e., depressed respirations, flaccidity, and pallor or cyanosis)
- 0 to 3
  - Newborn in severe distress
  - Immediate resuscitation necessary
Ventilation

- Indications for positive-pressure ventilation
  - Apnea or gasping ventilations
  - Heart rate less than 100 beats/min despite initial steps of resuscitation

- Select a properly sized face mask

- Term newborn
  - Select resuscitation bag with minimum volume of 450 to 500 mL, maximum volume 750 mL

- Assisting ventilation
  - Ventilate at a rate of 40 to 60 breaths/min to achieve or maintain a heart rate above 100/min
    - Slightly less than 1 breath/sec
    - Rate is 30 breaths/min when chest compressions are also being delivered
  - Breathe, two, three = Squeeze, release, release
Ventilation

- Signs of adequate ventilation
  - Gentle chest rise
  - Presence of bilateral breath sounds
  - Improvement in color and heart rate

A poor response to ventilation efforts may be the result of:
  - Poor seal between newborn’s face and the mask
  - Poor alignment of the head and neck
  - Insufficient ventilation pressure
  - Improper tracheal tube position (if intubated)
  - Blocked airway
  - Gastric distention

After ventilating for 30 seconds, reassess heart rate, color, and ventilations.
Chest Compressions

- Begin chest compressions if the newborn’s heart rate is less than 60 beats/min despite adequate ventilation with supplemental oxygen for 30 seconds

Chest Compressions

- Thumb technique (preferred)

Chest Compressions

- Two-finger method
Chest Compressions

- Compress approximately 1/3 depth of the chest
- Compression to ventilation ratio is 3 to 1
- One complete cycle (3 compressions and 1 ventilation) every 2 sec
  - Results in 90 compressions and 30 breaths (approximately 120 events) per minute

Chest Compressions

- Consider using a compression to ventilation ratio of 15:2 if the arrest is believed to be of cardiac origin

Chest Compressions

- Periodically reassess oxygenation, ventilation, and heart rate
- Discontinue chest compressions when the heart rate reaches 60 beats/min or more
Tracheal Intubation

- Tracheal intubation may be indicated at several points during neonatal resuscitation
  - When tracheal suctioning for meconium is required
  - If bag-mask ventilation is ineffective or prolonged
  - When chest compressions are performed
  - Special resuscitation circumstances (e.g., congenital diaphragmatic hernia or extremely low birth weight)

- Intubation attempts should be limited to 20 seconds to minimize the risk of hypoxia

- Watch for symmetrical rise and fall of the chest
- Listen high in the axillae for equal breath sounds and for an absence of sounds over the stomach
- Confirm absence of gastric distention with ventilation
- Note improvement in color, heart rate, and activity of the newborn
**Tracheal Intubation**

- Detection of exhaled CO₂
  - Preferred method for confirmation of tracheal tube placement in intubated infants and children with a perfusing cardiac rhythm
- Chest radiograph

**Tracheal Intubation—Troubleshooting**

- **Dislodgement**
  - Tube is no longer in trachea (right primary bronchus or esophagus)

- **Obstruction**
  - Secretions are obstructing airflow through tube
  - Suspect tube obstruction when there is resistance to bagging and no chest wall movement

- **Pneumothorax**

- **Equipment**
  - Oxygen is not being delivered to the patient (check equipment)

**Medications and Fluids**
Tracheal Route

- In the past, recommended route for epinephrine administration during newborn resuscitation
  - Epinephrine has no effect when it is administered tracheally using the currently recommended intravenous (IV) dose
    - 0.01 to 0.03 mg/kg of 1:10,000 solution

Current recommendations

- Epinephrine should be administered IV as soon as venous access is available
- Tracheal administration epinephrine
  - Can be considered while attempting to obtain venous access
  - Safety and efficacy of this practice have not been evaluated
  - Tracheal dose: 0.05 to 0.1 mg/kg of 1:10,000 solution

Umbilical Vein

- Rarely used as a means of vascular access outside the delivery room
- Should only be attempted by those specially trained in this technique
Umbilical Vein

- Complications
  - Infection
  - Possible fatal air embolus if air enters umbilical venous catheter
  - Advancing catheter too far into umbilical vein may cause infusion of medications directly into liver
    • Potential for hepatic damage

Peripheral Vascular Access

- Veins of the scalp and extremities
  - Acceptable routes
  - Difficult to access during resuscitation

Volume Expanders

- Volume expanders should be considered when acute blood loss is known or suspected with signs of hypovolemia
  - Pallor that persists despite oxygenation
  - Poor perfusion
  - Weak pulses with a heart rate faster than 100 beats/min
  - Poor response to resuscitative efforts, including effective ventilation
Volume Expanders

- Fluid choice
  - Isotonic crystalloid solution
    - Normal saline
    - Ringer’s lactate

Volume Expanders

- Dosage
  - Initial dosage
    - 10 mL/kg slow IV push over 5 to 10 minutes
  - Boluses may be repeated several times, guided by patient assessment

Epinephrine

- Indications
  - Asystole
  - Heart rate remains less than 60 beats/minute despite adequate ventilation with 100% oxygen and chest compressions
Postresuscitation Care

- Monitor
  - Heart rate
  - Ventilatory rate
  - Blood pressure
  - Temperature
  - Oxygen saturation

- Determine blood sugar
  - Treat hypoglycemia

Postresuscitation Care

- Consider induced therapeutic hypothermia for infants born at 36 weeks gestation or longer with evolving moderate to severe hypoxic-ischemic encephalopathy

- Obtain a chest radiograph
Postresuscitation Care

- Treat hypotension with volume expanders, vasopressors, or both if indicated
- Treat infection, seizures
- Establish vascular access and administer appropriate fluid therapy
- Document observations and actions

Postresuscitation Care

- Transport the infant to the most appropriate unit for further care
  - Newborn nursery
  - Level II nursery
  - Neonatal intensive care unit
- Use a transport team with personnel skilled in neonatal resuscitation

Questions?