Neonatal Resuscitation Program

EMC 420: Maternal & Child Emergency Care

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The next (2) presentations [L03, L04] on neonatal resuscitation for paramedics -- will be adapted, with minimal changes* , from material originating from:

American Academy of Pediatrics
American Heart Association
Neonatal Resuscitation Program

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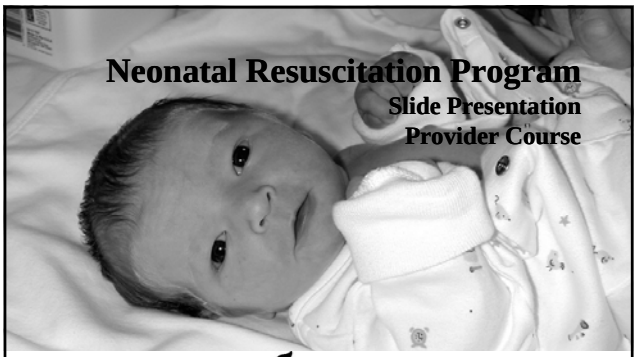


Objectives

L 03

Lesson 1: Principles of Resuscitation

- **Physiologic changes at birth**
- **Resuscitation flow diagram**
- **Resuscitation risk factors**

Lesson 2: initial steps of resuscitation
Lesson 3: BVM indications and use
Lesson 4 : Chest compressions; indications and technique
Lesson 5 : ET Intubation; indications and technique

L 04

Lesson 6 : Medications; indications and technique
Lesson 7 : Problems that can complicate resuscitation
Other non-NRP discussion of epidemiology of newborn risk factors

Lesson 1: Lungs and Circulation

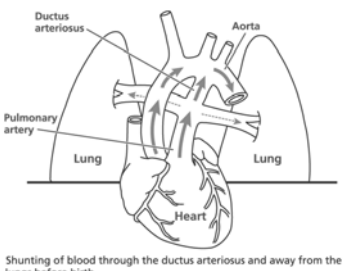
In the fetus

- **In utero, the fetus is dependent on the placenta as the organ of gas exchange**
- **Air sacs are filled with fetal lung fluid**

Lesson 1: Lungs and Circulation

In the fetus

- **Arterioles are constricted**
- **Pulmonary blood flow is diminished**
- **Blood flow is diverted across ductus arteriosus**

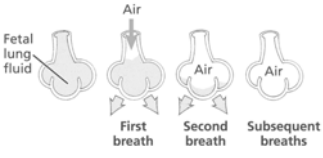


Shunting of blood through the ductus arteriosus and away from the lungs before birth

Lesson 1: Lungs and Circulation

After delivery

- **Lungs expand with air**
- **Fetal lung fluid leaves alveoli**

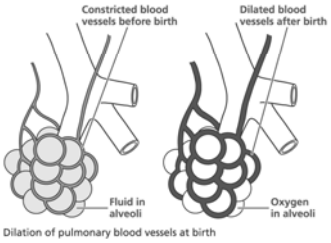


Fluid replaced by air in alveoli

Lesson 1: Lungs and Circulation

After delivery

- **Pulmonary arterioles dilate**
- **Pulmonary blood flow increases**

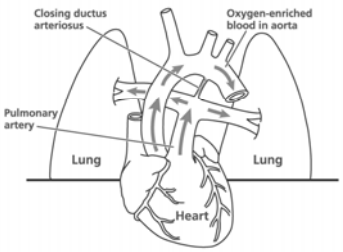


Dilation of pulmonary blood vessels at birth

Lesson 1: Lungs and Circulation

After delivery

- **Blood oxygen levels rise**
- **Ductus arteriosus constricts**
- **Blood flows through the lungs to pick up oxygen**



Cessation of shunt through ductus arteriosus after birth, as blood preferentially flows to the lungs

Lesson 1: Lungs and Circulation

Fetal lung fluid clearance

- **Improved with labor before delivery**
- **Facilitated with effective initial breaths**
- **Impaired by**
  - **Apnea at birth with no lung expansion**
  - **Shallow ineffective respirations**

Lesson 1: Lungs and Circulation

Pulmonary blood flow

- **Decreases with hypoxemia and acidosis due to vasoconstriction**
- **Increases with ventilation, oxygenation, and correction of acidosis**

Lesson 1: Lungs and Circulation

Cardiac function and compensatory mechanisms in asphyxia

- **Initial response**
  - **Constriction of vascular beds in lungs, intestines, kidneys, muscle, and skin to redistribute blood flow to heart and brain**
- **Late effects**
  - **Myocardial function may be impaired, cardiac output decreases, and organ damage may occur**

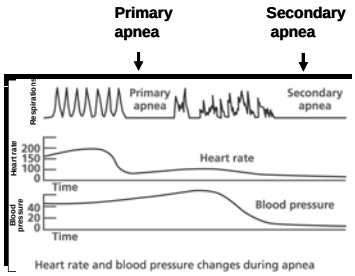
Lesson 1: What Can Go Wrong During Transition

- **Insufficient ventilation, airway blockage, or both**
- **Excessive blood loss or poor cardiac contractility**
- **Sustained constriction of pulmonary arterioles**

Lesson 1: Secondary Apnea

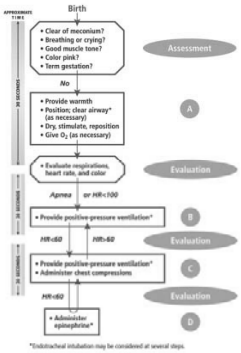
Secondary Apnea

- Respirations cease
- Heart rate decreases
- Blood pressure decreases
- No response to stimulation



Heart rate and blood pressure changes during apnea

Lesson 1: Provider Responses: Resuscitation Flow Diagram



Lesson 1: Initial Steps (Block A)

- Provide warmth
- Position; clear airway* (as necessary)
- Dry, stimulate, reposition
- Give O_2 (as necessary)

A

*Endotracheal intubation may be considered at several steps.

Lesson 1: Evaluation

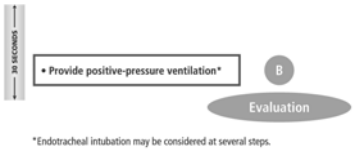
After these initial steps, further actions are based on evaluation of:

- Respirations
- Heart Rate
- Color

Lesson 1: Breathing (Block B)

If Apnea or HR <100 bpm:

- Assist newborn by providing positive-pressure ventilation with a bag and mask for 30 seconds.

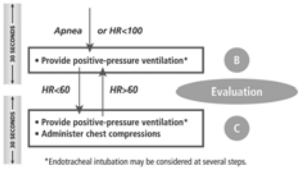


- Then, evaluate again

Lesson 1: Circulation (Block C)

If HR <60 bpm despite adequate ventilation:

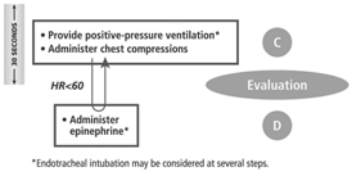
- Support circulation by starting chest compressions while continuing ventilation.
- Then, evaluate again. If heart rate <60, proceed to D.



Lesson 1: Drug (Block D)

If HR <60 bpm despite adequate ventilations and chest compressions:

- **Administer epinephrine as ventilation and chest compressions continue**



Lesson 1: Important Points in the Neonatal Resuscitation Flow Diagram

- **Heart rate < 60 ⟶ additional steps needed**
- **Heart rate > 60 ⟶ chest compressions can be stopped**
- **Heart rate > 100 ⟶ positive-pressure ventilation can be stopped**
- **Asterisk (*) endotracheal intubation may be considered at several steps**
- **Timeline – 30 seconds if no improvement, then proceed to next step**

Lesson 1: Preparation for Resuscitation Risk Factors

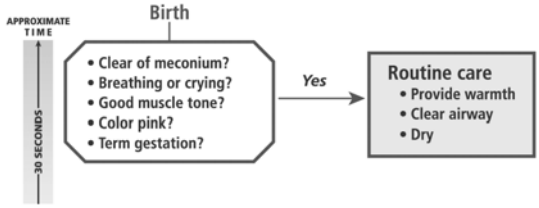
- **Antepartum factors**
- **Intrapartum factors**

Lesson 1: Why are Premature Newborns at Higher Risk?

- **Possible surfactant deficiency**
- **Increased heat loss, poor temperature control**
- **Possible infection**
- **Susceptible to intracranial hemorrhage**

Lesson 2: Evaluating the Newborn

Immediately after birth, the following questions must be asked:



Lesson 2: Initial Steps

- Provide warmth
- Position; clear airway* (as necessary)
- Dry, stimulate, reposition
- Give O_2 (as necessary)

*Endotracheal intubation may be considered at several steps.

Lesson 2: Provide Warmth

Prevent heat loss by

- ◆Placing newborn under radiant warmer
- ◆Drying thoroughly
- ◆Removing wet towel

Radiant warmer for resuscitating newborns

Lesson 2: Preventing Heat Loss

Premature newborns

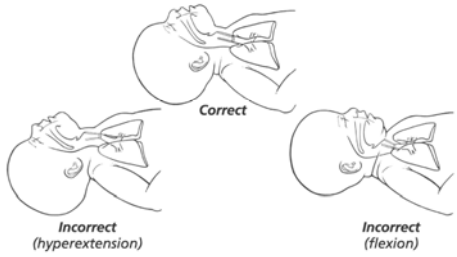
- ◆Special problems
  - – Thin skin
  - – Decreased subcutaneous tissue
  - – Large surface area
- ◆Additional steps
  - – Raise environment temperature
  - – Cover with clear plastic sheeting

Lesson 2: Opening the Airway

Open the airway by

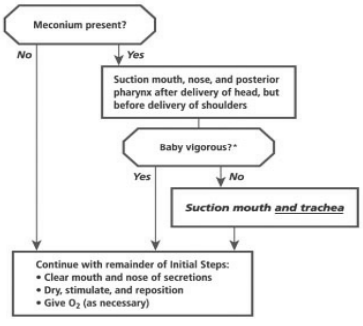
- ◆Positioning on back or side
- ◆Slightly extending neck
- ◆"Sniffing" position
- ◆Aligning posterior pharynx, larynx and trachea

Lesson 2: Opening the Airway



Correct and incorrect head positions for resuscitation

Lesson 2: Management of Meconium



*"Vigorous" is defined as strong respiratory efforts, good muscle tone, and a heart rate greater than 100 bpm.

Lesson 2: Meconium Present and Newborn Vigorous

If:
- ◆Respiratory effort is strong, *and*
- ◆Muscle tone is good, *and*
- ◆Heart rate is greater than 100 bpm

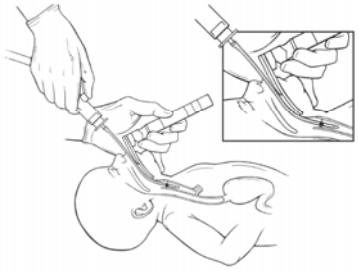
Then:
- ◆Use bulb syringe or large-bore suction catheter to clear mouth and nose

Lesson 2: Meconium Present and Newborn Not Vigorous

Tracheal suction

- **Administer oxygen**
- **Insert laryngoscope, use 12F or 14F suction catheter to clear mouth**
- **Insert endotracheal tube**
- **Attach endotracheal tube to suction source**
- **Apply suction as tube is withdrawn**
- **Repeat as necessary**

Lesson 2: Suctioning Meconium



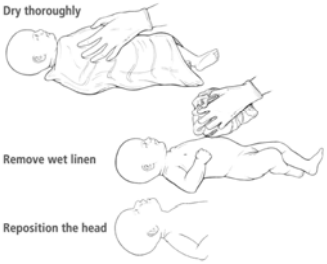
Visualizing the glottis and suctioning meconium from the trachea using a laryngoscope and endotracheal tube

Lesson 2: Clear Airway: No Meconium Present

Suction mouth first, then nose

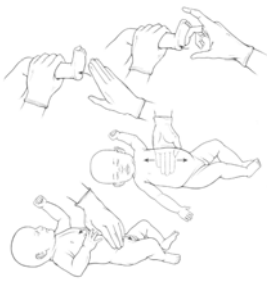
Suctioning the mouth and nose; "M" before "N"

Lesson 2: Dry, Stimulate to Breathe, Reposition



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

Lesson 2: Tactile Stimulation



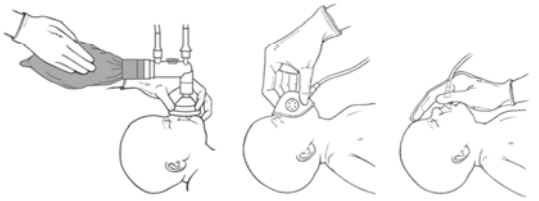
Acceptable methods of stimulating a baby to breathe

Lesson 2: Potentially Hazardous Forms of Stimulation

- **Slapping the back**
- **Squeezing the rib cage**
- **Forcing thighs into abdomen**
- **Dilating anal sphincter**
- **Hot or cold compresses or baths**
- **Shaking**

Lesson 2: Free-flow Oxygen

If the newborn is breathing but central cyanosis is present, give free-flow oxygen.

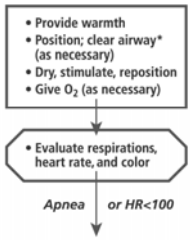


flow-inflating bag oxygen mask oxygen tubing

Lesson 2: Delivering Free-flow Oxygen

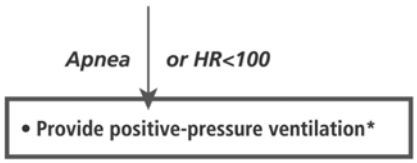
- **Heated and humidified (if given for longer than a few minutes)**
- **Flow rate at approximately 5 L/min**
- **Enough oxygen for newborn to become pink**

Lesson 2: Evaluation: Respirations, Heart Rate, Color



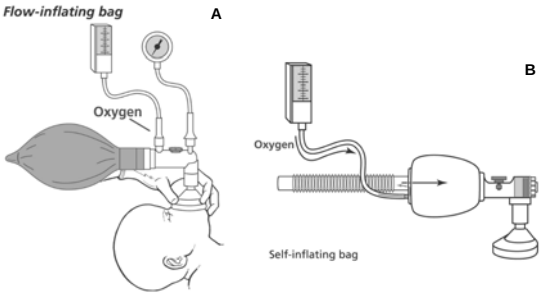
*Endotracheal intubation may be considered at several steps.

Lesson 2: Evaluation: Vital Signs Abnormal



*Endotracheal intubation may be considered at several steps.

Lesson 3: Types of Resuscitation Bags



Lesson 3: Flow-inflating Bag

Advantages

- **Delivers 100% oxygen**
- **"Good seal" easily determined**
- **Feel stiffness of lungs**
- **Can be used for free-flow oxygen**

Disadvantages

- **Requires tight seal**
- **Requires gas source to inflate**
- **May not have safety "pop-off" valve**

Lesson 3: Self-inflating Bag

Advantages

- Refills even with no compressed gas source
- Pressure-release valve

Disadvantages

- Will inflate without good seal
- Requires reservoir
- Not reliable for providing free-flow oxygen thru a mask

Lesson 3: General Characteristics of Neonatal Resuscitation Bags and Masks

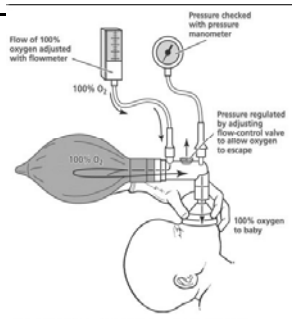
- Size of bag (200 to 750 mL)
- Oxygen capability 90%-100%
- Capable of avoiding excessive pressures
- Appropriate-sized mask (cushioned, anatomically shaped masks preferred)

Lesson 3: Flow-inflating Bag: Potential Problems

The bag will not inflate if

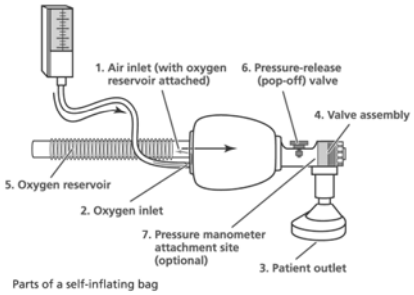
- Mask is not properly sealed
- Bag is torn
- Flow-control valve opened too wide
- Pressure manometer not attached
- Oxygen is disconnected or occluded

Lesson 3: Flow-inflating Bag: Adjusting Oxygen Flow and Pressure



Regulation of oxygen and pressure in flow-inflating bag

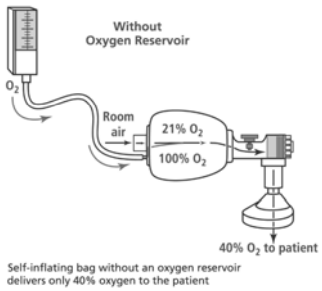
Lesson 3: Self-inflating Bag: Basic Parts



Parts of a self-inflating bag

Lesson 3: Self-inflating Bag: Control of Oxygen

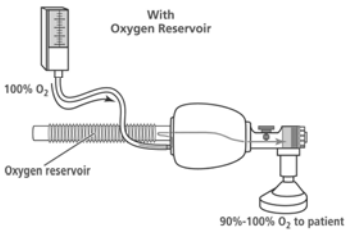
Without reservoir: Delivers only 40% oxygen to the patient



Self-inflating bag without an oxygen reservoir delivers only 40% oxygen to the patient

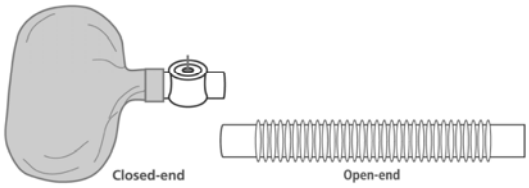
Lesson 3: Self-inflating Bag: Control of Oxygen

With reservoir: 90%-100% oxygen delivered to patient



Self-inflating bag with oxygen reservoir delivers 90% to 100% oxygen to the patient

Lesson 3: Self-inflating Bag: Types of Oxygen Reservoirs



Different types of oxygen reservoirs for self-inflating bags

Lesson 3: Self-inflating Bag: Pressure

Amount of pressure delivered depends on the following three factors:

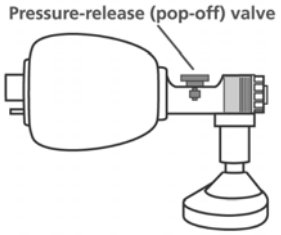
- **How hard the bag is squeezed**
- **Any leak between mask and newborn's face**
- **Set point of pressure-release valve**

Lesson 3: Resuscitation Bags: Safety Features

Every bag should have at least 1 safety feature to prevent excessive pressure.

- **Pressure manometer and flow-control valve**
- **Pressure-release valve**

Lesson 3: Self-inflating Bags With Pressure-release Valve



Self-inflating bag with pressure-release (pop-off) valve

Lesson 3: Resuscitation Bags: Free-flow Oxygen

Free-flow oxygen

- **Can be given with a flow-inflating bag**
- **Cannot be given reliably through a mask with a self-inflating bag**

Lesson 3: Bag and Mask: Equipment

Masks

- **Rims**
  - **Cushioned**
  - **Non-cushioned**
- **Shape**
  - **Round**
  - **Anatomic shape**
- **Size**
  - **Small**
  - **Large**

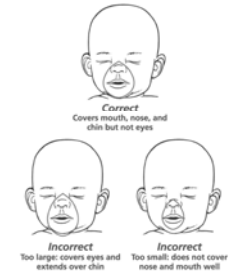
Face masks with cushioned rims

Round (left) and anatomically shaped (right) face masks

Lesson 3: Bag and Mask: Equipment

Mask should cover

- **Tip of chin**
- **Mouth**
- **Nose**



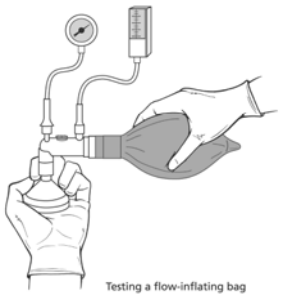
Correct (top) and incorrect (bottom) mask sizes

Lesson 3: Preparation for Resuscitation

- **Assemble equipment**
- **Test equipment**

Lesson 3: Testing a Flow-inflating Bag

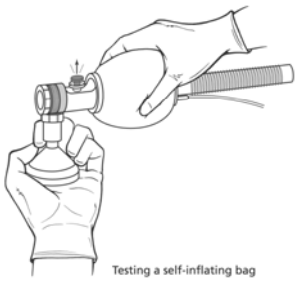
- **Does bag fill properly?**
- **Exert pressure against your hand?**
- **Pressure manometer working?**



Testing a flow-inflating bag

Lesson 3: Testing a Self-inflating Bag

- **Pressure against your hand?**
- **Pressure manometer working?**
- **Pressure-release valve opens?**



Testing a self-inflating bag

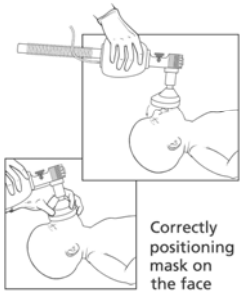
Lesson 3: Checklist

Before assisting ventilation with bag,

- **Select appropriate-sized mask**
- **Clear airway**
- **Position newborn's head**
- **Position yourself at the side or head of the baby**

Lesson 3: Positioning Bag and Mask on Face

- **Do not jam the mask down on the face**
- **Do not allow your fingers or parts of the hands to rest on the newborn's eyes**
- **Do not put pressure on the throat (trachea)**



Correctly positioning mask on the face

Lesson 3: Face-mask Seal

Airtight seal is essential to achieve positive pressure.

- **Tight seal required for flow-inflating bag to inflate**
- **Tight seal required to inflate lungs when bag squeezed**

Lesson 3: How Hard to Squeeze the Bag

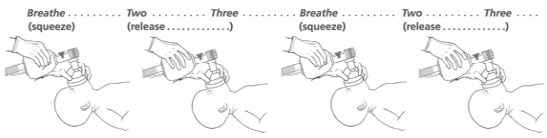
- **Noticeable rise and fall of chest**
- **Bilateral breath sounds**
- **Improvement of color and heart rate**

Lesson 3: Overinflation of Lungs

If the baby appears to be taking a very deep breath,

- **Too much pressure is being used**
- **Danger of producing a pneumothorax**

Lesson 3: Frequency of Ventilation: 40 to 60 breaths per minute

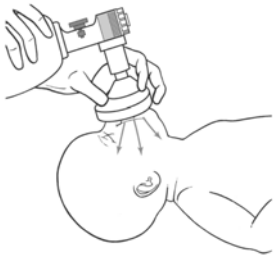


Counting out loud to maintain a rate of 40 to 60 breaths per minute

Lesson 3: Chest Not Expanding Adequately

Possible causes

- **Seal inadequate**
- **Airway blocked**
- **Not enough pressure given**



Inadequate seal of mask on face may result in poor chest rise

Lesson 3: Causes of and Solutions for Inadequate Chest Expansion

Condition	Actions
1. Inadequate seal	Reapply mask to face.
2. Blocked airway	Reposition the head. Check for secretions; suction if present. Ventilate with newborn's mouth slightly open.
3. Not enough pressure	Increase pressure until there is an easy rise and fall of the chest. Consider endotracheal intubation.
4. Malfunctioning equipment	Check or replace bag.

Lesson 3: Signs of Improvement

- Increasing heart rate
- Improving color
- Spontaneous breathing

Lesson 3: Continued Bag-and-Mask Ventilation

Orogastric tube should be inserted to relieve gastric distention.

- Gastric distention may elevate diaphragm, preventing full lung expansion
- Possible regurgitation and aspiration

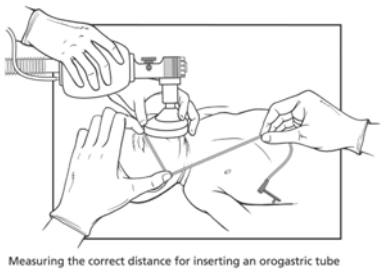
Lesson 3: Insertion of Orogastric Tube

Equipment

- 8F feeding tube
- 20-mL syringe

Lesson 3: Insertion of Orogastric Tube

Measuring correct length



Measuring the correct distance for inserting an orogastric tube

Lesson 3: Insertion of Orogastric Tube: Technique

- Insert through mouth, rather than through nose (resume ventilation)
- Attach 20-mL syringe and aspirate gently
- Remove syringe and leave tube end open to air
- Tape tube to newborn's cheek

Lesson 3: Newborn Not Improving

- **Check oxygen, bag, seal, and pressure**
- **Is chest movement adequate?**
- **Is 100% oxygen being administered?**

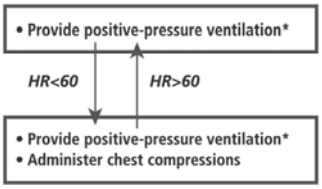
Then

– **Consider endotracheal intubation**

– **Check breath sounds; pneumothorax is possible**

Lesson 3: Newborn Not Improving

Heart Rate less than 60 despite 30 seconds of Positive-pressure Ventilation



*Endotracheal intubation may be considered at several steps.

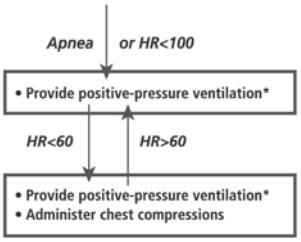
Lesson 4: Chest Compressions

Chest Compressions

- **Temporarily increase circulation**
- **Must be accompanied by ventilation**

Lesson 4: Chest Compressions: Indications

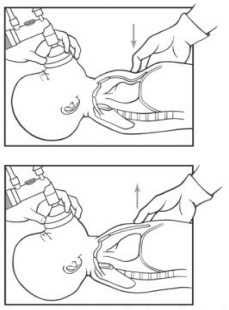
- **HR less than 60 despite 30 seconds of effective positive-pressure ventilation**



*Endotracheal intubation may be considered at several steps.

Lesson 4: Chest Compressions

- **Compress heart against spine**
- **Increase intrathoracic pressure**
- **Circulate blood to vital organs**



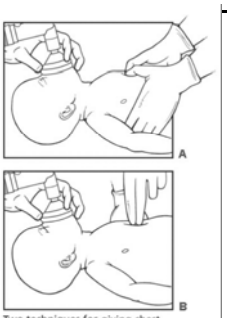
Compression (top) and release (bottom) phases of chest compressions

Lesson 4: Chest Compressions: 2 People Needed

- **One person compresses chest**
- **One person continues ventilation**

Two people are required when chest compressions are given.

Lesson 4: Chest Compressions: Techniques



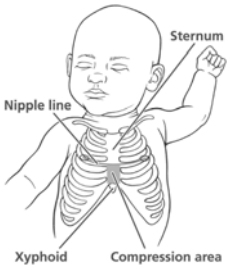
Two techniques for giving chest compressions: thumb (A) and two-finger (B)

Lesson 4: Comparison of Chest Compression Techniques

- **Thumb Technique *(Preferred)***
  - **Less tiring**
  - **Better control of compression depth**
- **Two-Finger Technique**
  - **More convenient with only one rescuer**
  - **Better for small hands**
  - **Provides access to umbilicus for medications**

Lesson 4: Chest Compressions: Positioning of Thumb or Fingers

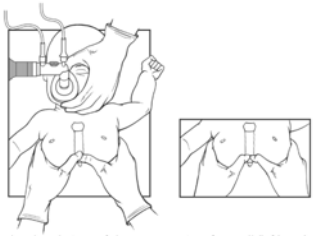
- **Apply pressure to lower third of sternum**
- **Avoid xyphoid process**



Landmarks for chest compressions

Lesson 4: Chest Compressions: Thumb Technique

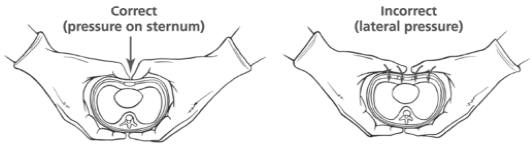
- **Thumbs compress sternum**
- **Fingers support back**


Thumb technique of chest compressions for small (left) and large (right) babies

Lesson 4: Chest Compressions

Thumb technique - *preferred*

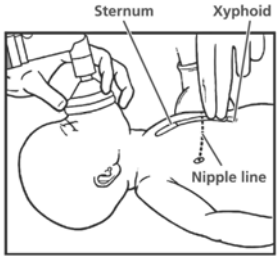
- **Pressure must remain on sternum**



Correct and incorrect application of pressure with thumb technique of chest compressions

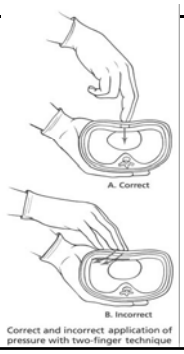
Lesson 4: Chest Compressions: Two-finger Technique

- **Tips of middle finger and index or ring finger of one hand compress sternum**
- **Other hand supports back**



Correct finger position for chest compressions

Lesson 4: Chest Compressions: Two-finger Technique

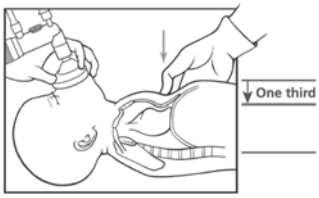


Correct and incorrect application of pressure with two-finger technique

Lesson 4: Chest Compressions: Compression Pressure and Depth

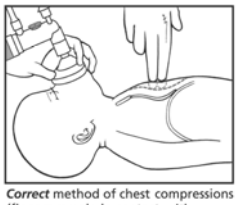
- **Depress sternum one third of the anterior-posterior diameter of chest**

Compression depth should be approximately one third of the anterior-posterior diameter of the chest.

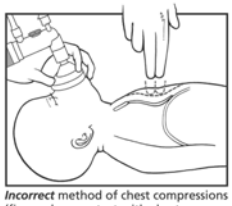


Lesson 4: Chest Compressions: Technique

- **Duration of downward stroke shorter than duration of release**

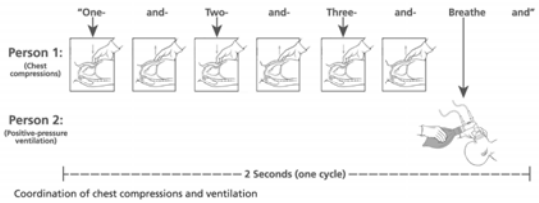


Correct method of chest compressions (fingers remain in contact with chest on release)



Incorrect method of chest compressions (fingers lose contact with chest on release)

Lesson 4: Chest Compressions: Coordination With Ventilation



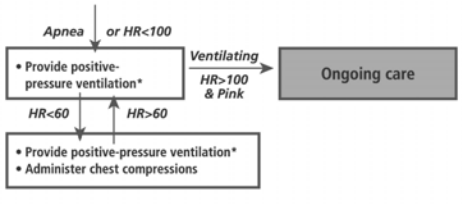
Coordination of chest compressions and ventilation

Lesson 4: Chest Compressions: Coordination With Ventilation

- **A four event cycle should take approximately 2 seconds**
- **Approximately 120 "events" per minute (30 breaths and 90 compressions)**

Lesson 4: Chest Compressions: Stopping Compressions

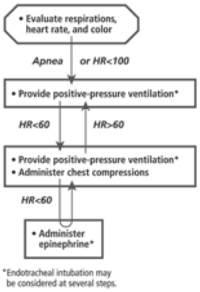
After 30 seconds of compressions and ventilation, stop and check the heart rate for 6 seconds



*Endotracheal intubation may be considered at several steps.

Lesson 4: Chest Compressions: Newborn Not Improving

- **If heart rate less than 60 bpm despite adequate ventilation and chest compressions for 30 seconds, administer epinephrine.**

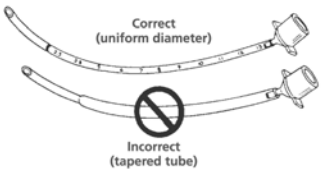


Lesson 5: Endotracheal Intubation: Indications

- **Meconium present and baby is not vigorous**
- **Prolonged positive-pressure ventilation required**
- **Bag-and-mask ventilation ineffective**
- **Chest compressions necessary**
- **Epinephrine administration necessary**
- **Special indications: prematurity, surfactant administration, diaphragmatic hernia**

Lesson 5: Characteristics of ET Tube

- **Sterile, disposable**
- **Uniform diameter**
- **Centimeter marks and vocal cord guides helpful**
- **Uncuffed**



Endotracheal tubes with uniform diameter are preferred for newborns.

Lesson 5: Endotracheal Tube: Appropriate Size

- **Select tube size based on weight and gestational age**
- **Consider shortening tube to 13-15 cm**
- **Stylet optional**

Tube Size (mm) (inside diameter)	Weight (g)	Gestational Age (wks)
2.5	Below 1,000	Below 28
3.0	1,000-2,000	28-34
3.5	2,000-3,000	34-38
3.5-4.0	Above 3,000	Above 38

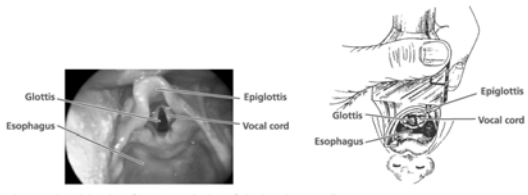
Lesson 5: Preparation of Laryngoscope: Supplies

Select blade size

- **No 0 for preterm newborns**
- **No 1 for term newborns**

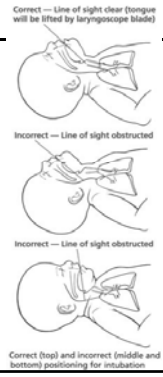
- **Check laryngoscope light**
- **Connect suction source to 100 mm Hg**
- **Use large suction catheter (greater than or equal to 10F) for secretions**
- **Small suction catheter for ET tube**

Lesson 5: Endotracheal Intubation: Anatomic Landmarks



Photograph and drawing of laryngoscopic view of glottis and surrounding structures

Lesson 5: Endotracheal Intubation: Positioning the Newborn



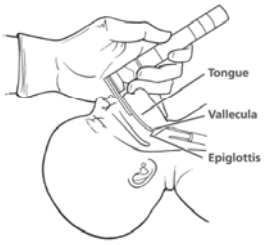
Correct (top) and incorrect (middle and bottom) positioning for intubation

Lesson 5: Endotracheal Intubation: Holding the Laryngoscope


Correct hand position when holding a laryngoscope for neonatal intubation

Lesson 5: Endotracheal Intubation Step 2: Insert Laryngoscope

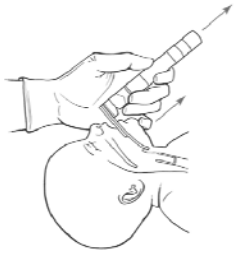
- **Slide blade over right side of tongue**
- **Push tongue to left side of mouth**
- **Advance blade tip to vallecula**



Landmarks for placement of the laryngoscope

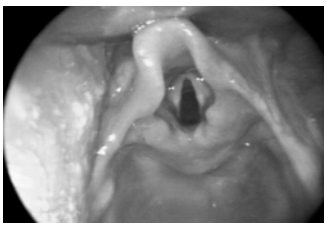
Lesson 5: Endotracheal Intubation Step 3: Lift Blade

- **Lift blade**
- **Visualize pharyngeal area**
- **Do not use rocking motion**


Lifting the laryngoscope blade to expose the opening of the larynx

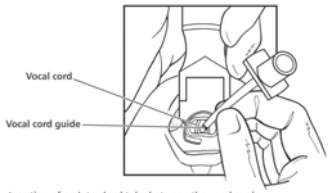
Lesson 5: Endotracheal Intubation Step 4: Visualize Landmarks

- **Vocal cords appear as vertical strips or as inverted letter "V"**
- **Downward pressure on cricoid may help bring glottis into view**
- **May need to suction secretions**



Lesson 5: Endotracheal Intubation Step 5: Inserting Tube

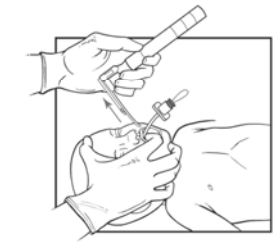
- ***Hold* tube in right hand**
- ***Wait* for cords to open**
- ***Insert* tube tip until vocal cord guide at level of cords**
- **Limit attempt to 20 seconds**



Insertion of endotracheal tube between the vocal cords

Lesson 5: Endotracheal Intubation Step 6: Remove Laryngoscope

- Use a finger to hold the tube against the hard palate
- Remove laryngoscope (and stylet, if used)



Stabilizing the tube while laryngoscope is withdrawn

Lesson 5: Suctioning Meconium Via Endotracheal Tube

- Connect endotracheal tube to meconium aspirator and suction source
- Occlude suction port to apply suction
- Gradually withdraw endotracheal tube
- Repeat intubation and suction as necessary

Lesson 5: Suctioning Meconium Via Endotracheal Tube

- Suction for only 3 to 5 seconds as tube is withdrawn
- If no meconium is recovered, proceed to resuscitation
- If meconium is recovered, check heart rate
  - Heart rate OK ⟶ Reintubate, suction again if indicated
  - Heart rate decreased ⟶ Administer positive-pressure ventilation

Lesson 5: Endotracheal Intubation: Checking Tube Position

The tube is likely not in trachea if

- No chest rise
- No breath sounds over lungs
- Noises over the stomach
- No mist in endotracheal tube
- Abdomen becomes distended
- CO_2 detector does not indicate exhaled CO_2
- Newborn remains cyanotic or bradycardic

Lesson 5: Endotracheal Intubation: Tube Location in Trachea

Tip-to-lip measurement

Weight (kg)	Depth of insertion (cm from upper lip)
1*	7
2	8
3	9
4	10

* Babies weighing less than 750 g may require only 6 cm insertion.