NRP 2021- LESSON 4

POSITIVE- PRESSURE VENTILATION

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What we will talk about together

- The characteristics of self-inflating bags, flow-inflating bags, and T-piece resuscitators
- When to give positive-pressure ventilation
- How to position the newborn's head for positive-pressure ventilation
- How to place a resuscitation mask on the newborn's face
- How to administer positive-pressure ventilation and assess effectiveness
- How to use ventilation corrective steps
- How to administer continuous positive airway pressure
- How to insert an orogastric tube

Why does the NRP focus on PPV?

- Ventilation of the newborn's lungs is the single most important and effective step in neonatal resuscitation

- Learning how to provide PPV is the foundation of neonatal resuscitation

Case:

Resuscitation with PPV

The case …

- Your team is called to attend the birth for a woman at 36 weeks‘ gestation whose pregnancy and labor are complicated by preeclampsia, IUGR and a category II fetal heart rate pattern. The amniotic fluid is clear

- You complete a pre-resuscitation team briefing and prepare your supplies and equipment

The case …

- After birth, the obstetrician dries and stimulates the baby, but the baby remains limp and apneic
- The umbilical cord is clamped and cut and the baby is moved to the radiant warmer
- You finish drying the baby, provide brief additional stimulation and position and clear secretions from the airway

The baby is still not breathing

The case ...

- Within 1 minute of birth, you start PPV with 21% oxygen (room air)

What are the indications for PPV?

- After completing the initial steps, PPV is indicated if:
  - The baby is not breathing (apneic)
  - The baby is gasping
  - HR< 100 bpm/min even with breathing

- ***When indicated, PPV should be started within 1 minute of birth***

- *In addition,* a trial of PPV may be considered if the baby is breathing and the heart rate is greater than or equal to 100 bpm, but the baby's oxygen saturation cannot be maintained within the target range despite free-flow oxygen or CPAP

How do you prepare to begin PPV?

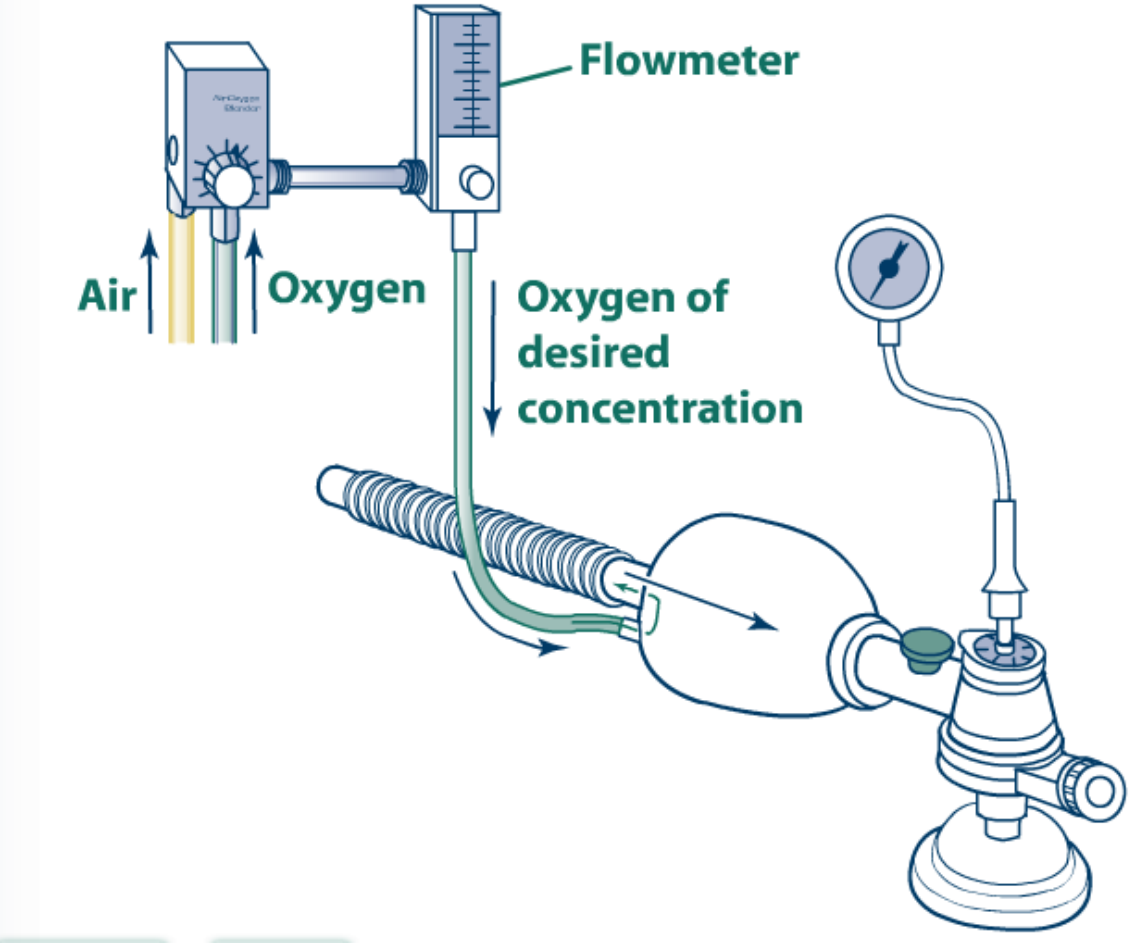
- Immediately call for help if you are alone

- Your assistant(s) will:
  - monitor the heart rate response to PPV
  - watch for chest movement
  - monitor the baby's oxygen saturation with pulse oximetry
  - document events as they occur

Different types of resuscitation devices used to ventilate newborns

- A ***self-inflating bag*** fills spontaneously with gas (air, oxygen or a blend of both) after it has been squeezed and released

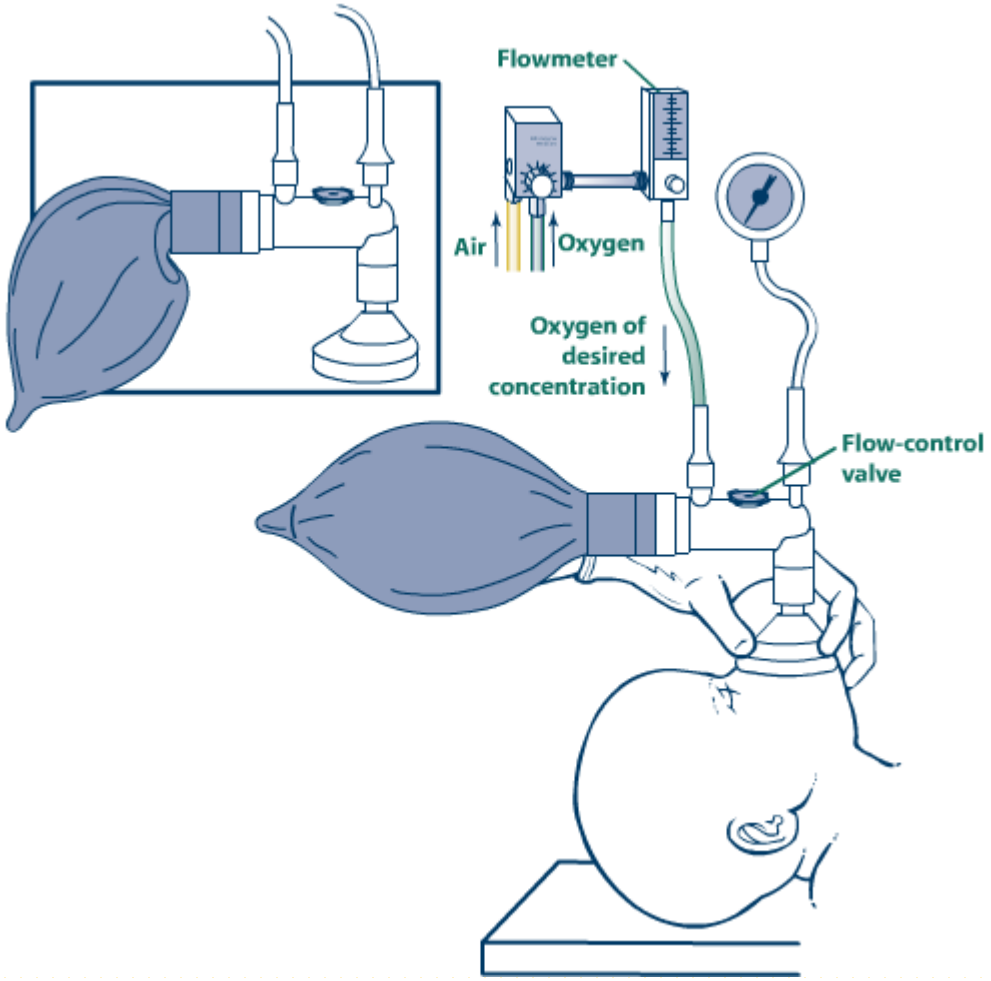
Self-inflating bags



Different types of resuscitation devices used to ventilate newborns

- A ***flow-inflating bag (also called an anesthesia bag)*** only fills when gas from a compressed source flows into it and the outlet is sealed

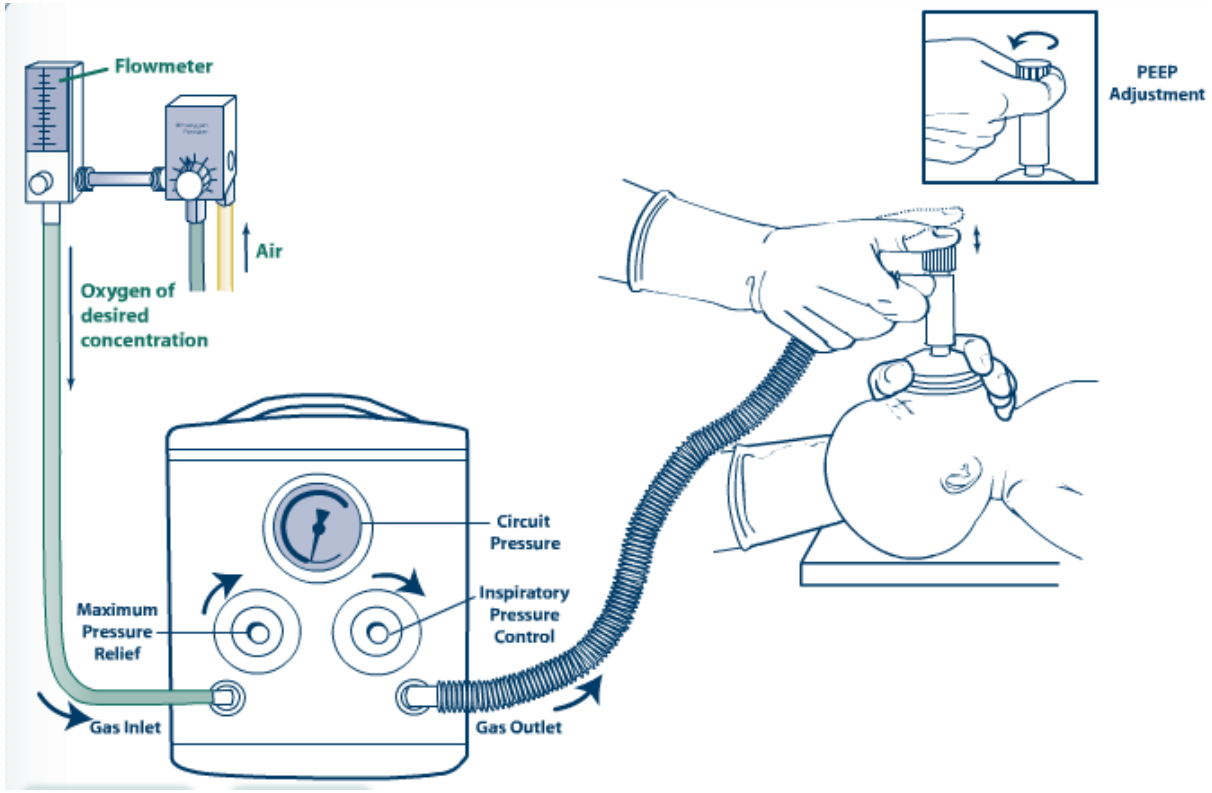
Flow-inflating bags



Different types of resuscitation devices used to ventilate newborns

- A ***T-piece resuscitator*** continuously directs compressed gas toward the baby
- Pressure increases when an opening on the top of the T-shaped device is occluded

T- piece resuscitator



Different types of resuscitation devices used to ventilate newborns

- Find out what kind of resuscitation device is used in your hospital
- If your hospital uses flow-inflating bags or T-piece resuscitators, you should still learn how to use a self-inflating bag
- A self-inflating bag should be readily available as a backup wherever resuscitation may be needed in case compressed gas is not available

How do you prepare to begin PPV?

Position yourself at the radiant warmer

- The person responsible for positioning the airway and holding the mask on the baby's face is positioned at the baby's head
- It is difficult to maintain the head, neck, and mask in the correct position when standing at the side or foot of the bed
- Team members at the side of the bed are better positioned to assess chest movement, listen to heart rate and breath sounds and assist with pulse oximeter and cardiac monitor placement

How do you prepare to begin PPV?

Complete the initial steps of newborn care

- If not done already, suction the mouth and nose to be certain that secretions will not obstruct PPV

How do you prepare to begin PPV?

Position the baby's head and neck for PPV

- The baby's head and neck should be positioned midline and neutral or slightly extended, in the sniffing position so that the baby's eyes are directed straight upward toward the ceiling

- **Improper positioning is one of the most common reasons for ineffective mask ventilation**

- The airway will be obstructed if the neck is excessively flexed or extended

- Because the back of a newborn's head (occiput) is prominent, it may be helpful to lift the shoulders slightly by placing a rolled towel or small blanket under the baby's shoulders

How do you position the mask on the baby's face?

Select the correct mask

- A variety of mask sizes should be available at every birth
- Neonatal masks have a cushioned or soft pliable rim and come in 2 shapes:
  - round
  - Anatomically shaped
    - ✓Anatomically shaped masks are placed with the pointed part of the mask over the nose
- The mask should rest on the chin and cover the mouth and nose, but not the eyes
- The correct mask will create a tight seal on the face
- If the rim of a cushioned mask is improperly inflated, it may be difficult to achieve a good seal

How do you position the mask on the baby's face?

Place the mask on the baby's face

- An airtight seal between the rim of the mask and the face is necessary to achieve the pressure that will inflate the lungs

- Ventilation will not be successful if there is a large air leak from an improperly placed mask

How do you position the mask on the baby's face?

Place the mask on the baby's face: One- Hand Hold

- Begin by cupping the chin in the bottom of an anatomic mask and then bring the mask over the mouth and nose

- The bottom of the mask should rest on the chin, not below it

- The tip of the mask should rest at or just below the nasal bridge to avoid putting pressure on the baby's eyes or causing a large leak around the eyes

How do you position the mask on the baby's face?

Place the mask on the baby's face: One- Hand Hold

- Hold the mask on the face with the thumb and index finger encircling the rim
- Place the other 3 fingers under the bony angle of the jaw and gently lift the jaw upward toward the mask
- Once the mask is positioned, an airtight seal can be formed by using even, downward pressure on the rim of the mask while holding the head in the sniffing position

How do you position the mask on the baby's face?

Place the mask on the baby's face: One- Hand Hold

- Some round masks are designed to be placed directly over the nose and mouth and held in place by the stem rather than the rim

- If you apply pressure to the rim of this type of mask, the mask shape will be deformed and will leak

How do you position the mask on the baby's face?

Place the mask on the baby's face: Two-Hand Hold With Jaw Thrust

- It can be difficult to maintain a good seal and the correct head position with one hand

- If you cannot achieve a good seal, use both hands to hold the mask and lift the jaw

How do you position the mask on the baby's face?

Place the mask on the baby's face: Two-Hand Hold With Jaw Thrust

- Use the thumb and first finger of both hands to hold the mask against the face
- Place the other 3 fingers of each hand under the bony angle of the jaw and gently lift the jaw upward, toward the mask
- While you concentrate on making a good seal and maintaining the correct midline head position, another team member stands at the baby's side and squeezes the bag or occludes the T-piece cap
- A third person monitors the baby's response

How do you position the mask on the baby's face?

Place the mask on the baby's face: PRECAUTIONS

- Do not "jam " the mask down on the face or occlude the nasal passages

  ✓Too much pressure can:
  - obstruct the mask
  - cause air to leak around the side of the mask
  - inadvertently flex the baby's neck
  - or bruise the face

- Be careful not to rest your hand on the baby's eyes
- Be careful not to compress the soft tissue of the baby's neck
- Recheck the position of the mask and the baby's head at intervals to make sure they are still correctly positioned

What concentration of oxygen should be used to start PPV?

- Studies have shown that resuscitation started with 21% oxygen in term and late preterm newborns and 21% to 30% oxygen in preterm newborns, is just *as effective as* resuscitation started with 100% oxygen

What concentration of oxygen should be used to start PPV?

- To balance the hazards possibly associated with extremes of oxygenation, this program recommends attempting to maintain an oxygen saturation, measured with pulse oximetry, close to the saturation measured in healthy babies born at term

- Before birth: the fetus has a blood oxygen saturation of approximately 60%

- After birth: the oxygen saturation gradually increases above 90%

  - Even healthy term newborns may take *10 minutes or longer* to reach this saturation

What concentration of oxygen should be used to start PPV?

- For the initial resuscitation of newborns:
  - ≥ 35 weeks' gestation: set the blender to 21% oxygen
  - < 35 weeks‘ gestation: set the blender to 21% to 30% oxygen
- Set the flow meter to 10 L/minute
- An assistant should place a pulse oximeter sensor on the right hand or wrist as soon as possible after PPV is started
- Once the pulse oximeter is reading reliably, compare the baby's pre-ductal oxygen saturation with the range of target values summarized in the table and adjust the FiO_2 as needed

Target Oxygen Saturation Table	
1 min	60%-65%
2 min	65%-70%
3 min	70%-75%
4 min	75%-80%
5 min	80%-85%
10 min	85%-95%

Why not routinely use 100% oxygen during all neonatal resuscitations?

- Multiple studies in both animals and humans have raised concerns about the safety of routinely using 100% oxygen during neonatal resuscitation
- A series of human randomized and quasi-randomized studies over the last 2 decades have demonstrated that resuscitation with 21% oxygen, is at least as effective as resuscitation with 100% oxygen
- In meta-analyses of these studies, mortality was decreased among term and late-preterm babies resuscitated with 21% oxygen compared with 100% oxygen
- Intermediate initial oxygen concentrations, between 21% and 100%, have not been studied

Why not routinely use 100% oxygen during all neonatal resuscitations?

- Because oxygen relaxes pulmonary blood vessels, some have expressed concern that babies resuscitated with lower oxygen concentrations will be more likely to develop pulmonary hypertension

- Animal studies have shown that pulmonary vascular resistance decreases appropriately with 21% oxygen and that resuscitation with 21% oxygen may actually prevent rebound pulmonary hypertension and preserve the response to inhaled nitric oxide if pulmonary hypertension develops

Why not routinely use 100% oxygen during all neonatal resuscitations?

- In preterm newborns, there was no difference in outcomes between those resuscitated with low oxygen (21%-30%) and high oxygen (60%-100%)

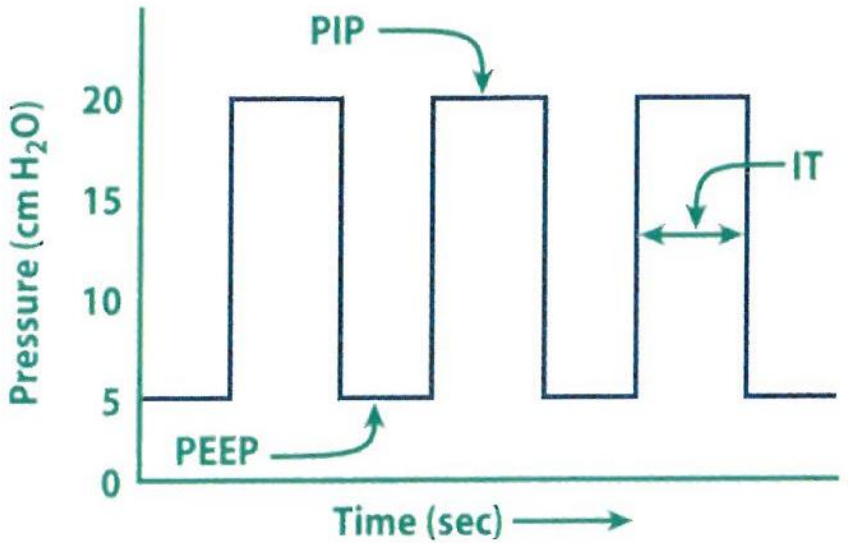
- Although no difference was found, the recommendation to start with low oxygen and titrate upward as needed using pulse oximetry reflects a preference to avoid exposing preterm newborns to additional oxygen without evidence demonstrating a benefit for important outcomes

- The ideal initial FiO_2 for resuscitating preterm newborns is still unknown, but the majority of preterm newborns enrolled in studies required some oxygen supplementation during the first minutes of life

How do you administer PPV and assess effectiveness?

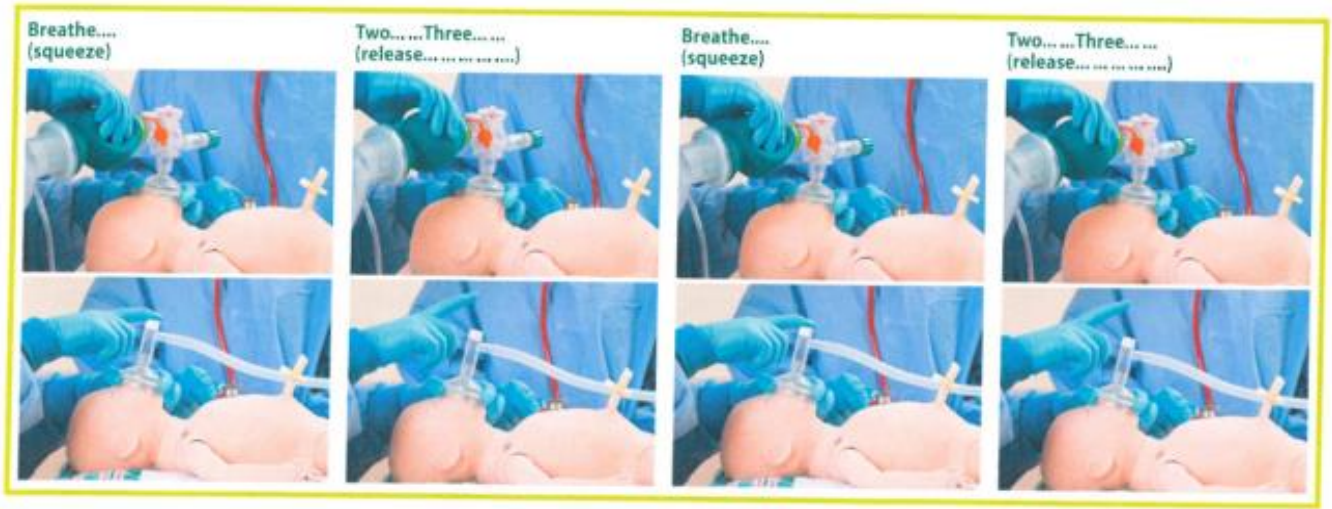
Common terminology used to describe PPV

- **Peak inflation pressure (PIP):** The highest pressure administered with each breath
- **Positive end-expiratory pressure (PEEP):** The gas pressure maintained in the lungs between breaths when the baby is receiving *assisted breaths*
- **Continuous positive airway pressure (CPAP):** The gas pressure maintained in the lungs between breaths when a baby is *breathing spontaneously*
- **Rate:** The number of assisted breaths administered per minute
- **Inflation time (IT):** The time duration (seconds) of the inflation phase of each positive-pressure breath
- **Manometer:** A gauge used to measure gas pressure



What ventilation rate should be used during PPV?

- Breaths should be given at a rate of *40 to 60 breaths per minute*
- Count out loud to help maintain the correct rate
- Use the rhythm: "Breathe, *two, three;* breathe, *two, three;* breathe, *two, three*"
- Say "Breathe" as you squeeze the bag or occlude the T-piece cap and release while you say *"two, three"*



How much pressure should be used to start PPV?

- After birth, fetal lung fluid within the alveoli must be replaced with air for gas exchange to occur

- If the baby has not taken a spontaneous breath, the first few assisted breaths may require higher than usual pressure to move fluid out of the air spaces and inflate the alveoli

- However, excessively high lung volumes and airway pressures can cause lung injury

    - The goal is to use just enough pressure to inflate and aerate the lungs so that the heart rate and oxygen saturation increase

How much pressure should be used to start PPV?

- Start with a PIP of 20 to 25 cm H_2O
  - Full-term babies may require a higher inflation pressure for the first few breaths to inflate their lungs
- After the initial inflating breaths, you may be able to decrease the inflation pressure

How much pressure should be used to start PPV?

- Administering PEEP with the initial inflating breaths helps to:
  - achieve stable lung inflation more quickly
  - remove fluid
  - prevent the air spaces from collapsing during exhalation
- When PEEP is used, the suggested initial setting is 5 cm H_2O

How much pressure should be used to start PPV?

- Once you inflate the lungs, you should see a gentle rise and fall of the chest with each breath

- If the baby appears to be taking very deep breaths during PPV, you are probably using too much pressure and the lungs may become overinflated

  - This increases the risk of producing an air leak within the lung (pneumothorax)

- Remember that the volume of a normal breath is much smaller than the amount of gas in a typical resuscitation bag

How much pressure should be used to start PPV?

- If the baby is preterm, visual assessment of chest movement may be less reliable and there may be a greater risk of injury from overinflation

- It is possible to achieve successful ventilation without apparent chest movement

Initial settings for PPV

COMPONENT		INITIAL SETTING
oxygen concentration	≥ 35 weeks' gestation < 35 weeks' gestation	21% 21- 30%
gas flow		10 LPM
Rate		40- 60 bpm
PIP		20- 25 cmH_2O
PEEP		5 cmH_2O

How do you evaluate the baby's response to PPV?

- The most important indicator of successful PPV is a rising heart rate
- When you start PPV, an assistant will monitor the baby's heart rate response
- The initial heart rate assessment may be made with a stethoscope
- Once PPV begins, an assistant should apply a pulse oximeter sensor to continuously assess the baby's oxygen saturation and heart rate
- Continuous monitoring with a cardiac monitor may be considered

How do you evaluate the baby's response to PPV?

- If PPV was started because the baby had a low HR, it should improve rapidly
- **Within 15 seconds of starting PPV:** the baby's heart rate should be increasing
- **Within 30 seconds of starting PPV:** the baby's heart rate should be greater than 100 bpm

How do you evaluate the baby's response to PPV?

- If the baby's heart rate *is increasing* after the first 15 seconds:
  - continue PPV
  - You will check the response again 30 seconds from the start of PPV

The case …

- After 15 seconds of starting PPV, an assistant reports that the baby's HR is 70 bpm, not increasing and the chest is not moving

- Another team member places a pulse oximeter sensor on the baby's right hand, places cardiac monitor leads on the baby's chest and attaches the sensor and leads to the monitors

- Another team member documents the events as they occur

How do you evaluate the baby's response to PPV?

- If the baby's heart rate *is not increasing* after the first 15 seconds:

  ask your assistant *"if the chest is moving"*

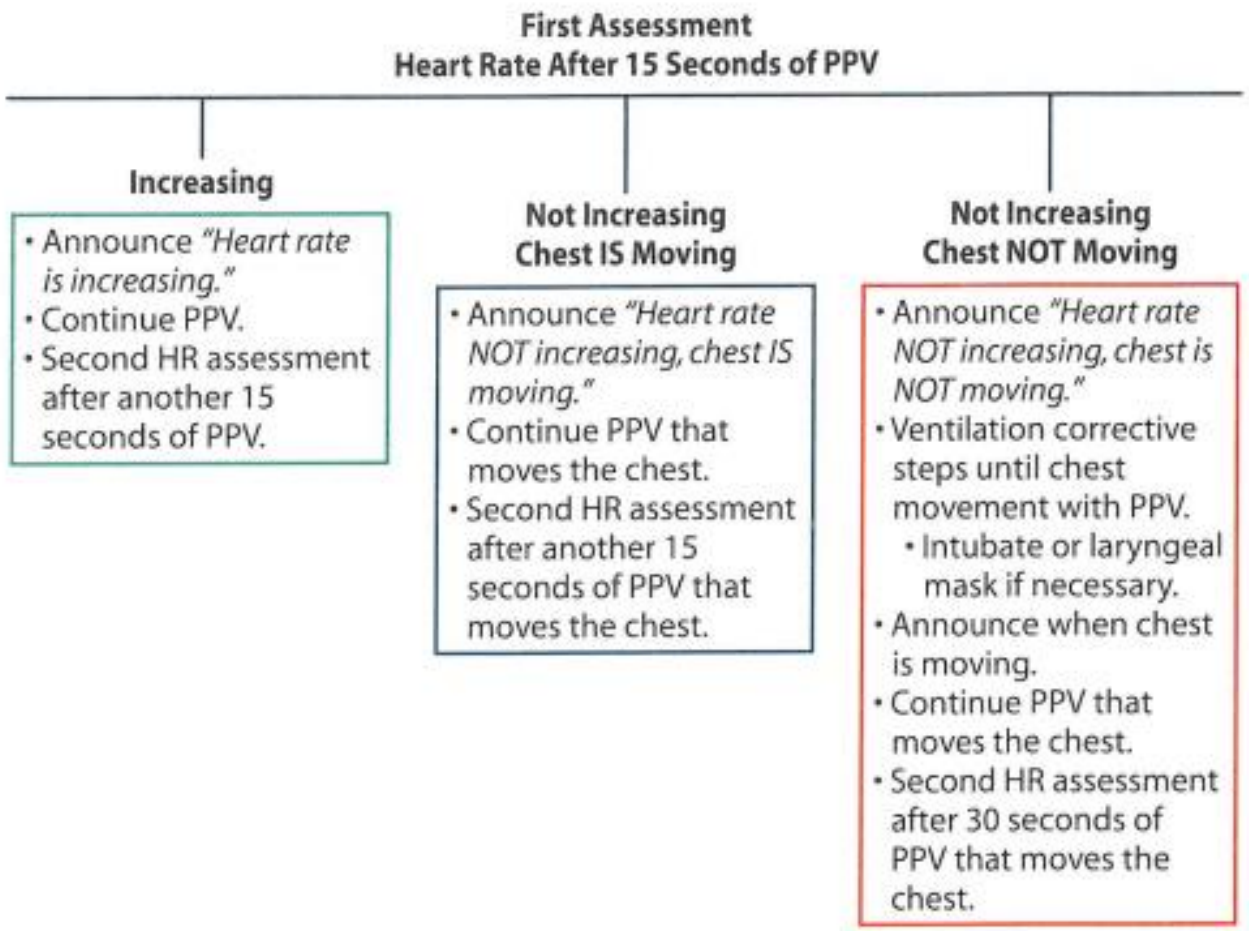
  - If the chest is moving:

    ✓continue PPV while you monitor your ventilation technique
    ✓You will check the baby's response again 30 seconds from the start of PPV

  - If the chest is NOT moving:

    ✓you may not be ventilating the baby's lungs
    ✓Perform the ventilation corrective steps until you achieve chest movement with PPV

How do you evaluate the baby's response to PPV?



How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

- The ventilation corrective steps are a series of adjustments that you will make if the baby's heart rate is not improving and the chest is not moving

- The most likely reasons for ineffective mask ventilation are:
  - leak around the mask
  - airway obstruction
  - insufficient ventilating pressure

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

- You may use the MR. SOPA mnemonic to remember the 6 steps in order:
  - Mask adjustment
  - Reposition the head and neck
  - Suction the mouth and nose
  - Open the mouth
  - Pressure increase
  - Alternative airway
- You will perform the corrective steps sequentially until you achieve chest movement with assisted breaths

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

	Corrective Step	Actions
M	Mask adjustment.	Reapply the mask and lift the jaw forward. Consider the 2-hand hold.
R	Reposition the head and neck.	Place head neutral or slightly extended.
Give 5 breaths and assess chest movement. If no chest movement, do the next steps.		
S	Suction the mouth and nose.	Use a bulb syringe or suction catheter.
O	Open the mouth.	Use a finger to gently open the mouth.
Give 5 breaths and assess chest movement. If no chest movement, do the next step.		
P	Pressure increase.	Increase in 5-1 O cm H_20 increments to maximum recommended pressure. • Max 40 cm H_20 term • Max 30 cm H_20 preterm
Give 5 breaths and assess chest movement. If no chest movement, do the next step.		
A	Alternative airway.	Insert a laryngeal mask or endotracheal tube.
Try PPV and assess chest movement and breath sounds.		

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

Mask adjustment

- Reapply the mask to the face to form a better seal

- Indicators of a good seal while using a T-piece resuscitator and flow-inflating bag include:

  - achieving the desired PIP

  - maintaining the desired PEEP on the manometer

  - rapid re- inflation of a flow- inflating bag between breaths

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

Mask adjustment

- If a leak is present, lift the jaw upward but do not press down hard on the baby's face
- You may need to use a little more pressure on the rim of an anatomic mask
- The most common place for a leak to occur is between the cheek and bridge of the nose
- If you continue to have difficulty achieving a tight seal, use *the 2-hand hold technique*

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

Reposition the head and neck

- The airway may be obstructed because the neck is flexed too far forward or is overextended

- Reposition the baby's head and neck to ensure that it is midline and neutral or slightly extended *(the sniffing position)*

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

- Once you have adjusted the mask and repositioned the head and neck, try PPV again and assess chest movement

- If the chest is not moving, proceed to the next 2 corrective steps

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

Suction the mouth and nose

- Suction the mouth and nose with a bulb syringe

- The airway may be blocked by thick secretions

- In unusual situations, thick secretions may be blocking the trachea, and tracheal intubation for suction may be required

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

Open the mouth

- Opening the baby's mouth may decrease the resistance to airflow during PPV

- Use your finger to open the baby's mouth and reapply the mask

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

- After suctioning the mouth and nose and opening the mouth, try PPV again and assess chest movement

- If the chest is still not moving, proceed to the next step

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

Pressure increase

- Although you have an adequate seal and an open airway, inflating the baby's lungs may require a higher inflation pressure
- Use the manometer to guide adjustments of the inflation pressure
- Increase the pressure by 5 to 10 cm H_2O increments until you achieve chest movement
- The maximum recommended pressure with face-mask ventilation is:
  - 40 cm H_2O for a term newborn
  - 30 cm H_2O for a preterm newborn

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

- After each pressure increase, try PPV again and assess the chest movement

- If the chest is not moving with the maximum recommended pressure, proceed to the next step

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

Alternative airway

- Mask ventilation is not always sufficient to inflate the lungs

- If you have completed the first 5 corrective steps and you still cannot achieve chest movement, you should insert an alternative airway such as a laryngeal mask or endotracheal tube

How do you evaluate the baby's response to PPV?

MR. SOPA ventilation corrective steps

- Once an alternative airway is inserted, begin PPV and evaluate the baby's chest movement and breath sounds

While performing the ventilation corrective steps

can a carbon dioxide detector help assess the effectiveness of ventilation?

- Using a carbon dioxide (CO_2) detector during the ventilation corrective steps can provide a visual cue that helps you and your team identify when you have achieved ventilation that inflates and aerates the lungs

- Place a CO_2 detector between the PPV device and mask

- If the lungs are being effectively ventilated and gas exchange is occurring, CO_2 should be exhaled through the mask

While performing the ventilation corrective steps

can a carbon dioxide detector help assess the effectiveness of ventilation?

- If you are effectively ventilating the lungs, you should see the detector turn yellow during each exhalation
- If the CO_2 detector is purple and turns yellow after a corrective step, the step was effective and the baby's heart rate will likely improve quickly
- If the CO_2 detector does not turn yellow, your face-mask ventilation attempts may not be ventilating the lungs
- If the detector remains purple after the first 5 corrective steps and the heart rate has not improved, it may be another indication that you have not achieved effective ventilation and an alternative airway is needed

- Caution: If the baby's heart rate is very low or not pumping blood, the detector may not change color because CO_2 is not being carried to the lungs even though you are ventilating the lungs

The case ...

- You initiate the ventilation corrective steps:
  - First, you reapply the mask to the face and reposition the baby's head and neck
  - *You restart PPV while your assistant watches the newborn's chest*
  - *After several breaths, the assistant reports that there is still no chest movement*
  - You suction the mouth and nose and open the baby's mouth
  - *Again, you start PPV, but there is still no chest movement*
  - You gradually increase the inflation pressure and **the assistant calls out, "The chest is moving now"**

The baby's chest started moving after one of the ventilation corrective steps

Now what do you do?

- Once you achieve chest movement with each assisted breath, announce, ***"The chest is moving NOW"***

- This ensures that your team is aware of your assessment and knows that additional MR. SOPA steps are not necessary

- Continue PPV that moves the chest for 30 seconds while you monitor your ventilation rate, pressure, and the baby's heart rate response

The baby's chest started moving after one of the ventilation corrective steps

Now what do you do?

- If you have difficulty maintaining chest movement during this time, repeat the ventilation corrective steps as needed

- Insert an alternative airway if you have persistent difficulty maintaining effective ventilation with a face mask

What do you do after 30 seconds of PPV that ventilates the lungs?

- After 30 seconds of PPV that ventilates the lungs, as indicated by an increasing heart rate or chest movement:
  - *you will check the baby's heart rate response again*

What do you do after 30 seconds of PPV that ventilates the lungs?

The heart rate is greater than or equal to 100 bpm

- It means that assisted ventilation has been successful
- Continue ventilating at a rate of 40 to 60 breaths per minute
- Monitor the baby's chest movement, heart rate, and respiratory effort
- Adjust the FiO_2 as needed based on pulse oximetry

What do you do after 30 seconds of PPV that ventilates the lungs?

The heart rate is greater than or equal to 100 bpm

- When the heart rate is *consistently* greater than 100 bpm:
  - gradually reduce the rate of PPV
  - observe for effective spontaneous respirations
  - gently stimulate the baby to breathe
- PPV may be discontinued when the baby has a heart rate continuously greater than 100 bpm and sustained spontaneous breathing

What do you do after 30 seconds of PPV that ventilates the lungs?

The heart rate is at least 60 bpm but less than 100 bpm

- If the heart rate *is improving*:
  - continue to administer PPV as long as the baby is showing steady improvement
  - Monitor the oxygen saturation and adjust the FiO_2 to meet the target saturation range

What do you do after 30 seconds of PPV that ventilates the lungs?

The heart rate is at least 60 bpm but less than 100 bpm

- If the heart rate ***is not*** *improving*: consider each of the following:
  - Quickly reassess your ventilation technique:
    - ✓Is the chest moving?
    - ✓Are you ventilating at a rate of 40 to 60 breaths/minute?
    - ✓Do you hear breath sounds?
  - If necessary, perform the ventilation corrective steps
  - Adjust the FiO_2 to meet the target saturation
  - If not already done, consider placing cardiac monitor leads for continuous monitoring
  - If not already done, consider inserting a laryngeal mask or endotracheal tube
  - If available, call for additional expertise to help problem solve this situation

What do you do after 30 seconds of PPV that ventilates the lungs?

The heart rate is less than 60 bpm

- This ***uncommon*** situation occurs when the heart cannot respond to ventilation alone and requires additional support to bring oxygenated blood to the coronary arteries

What do you do after 30 seconds of PPV that ventilates the lungs?

The heart rate is less than 60 bpm

- Consider each of the following:
  - Quickly reassess your ventilation technique
    - ✓Is the chest moving?
    - ✓Are you ventilating at a rate of 40 to 60 breaths/minute?
    - ✓Do you hear breath sounds?
  - If necessary, perform ventilation corrective steps
  - If the pulse oximeter has a reliable signal, adjust the FiO_2 to meet the target saturation
  - If not already done, place cardiac monitor leads and begin continuous monitoring
  - If not already done, insert a laryngeal mask or endotracheal tube
  - If available, call for additional expertise to help problem solve this situation

What do you do after 30 seconds of PPV that ventilates the lungs?

The heart rate is less than 60 bpm

- If the baby's heart rate remains less than 60 bpm after at least 30 seconds of PPV that moves the chest, **preferably through an alternative airway**, increase the FiO_2 to 100% and begin chest compressions

The case ...

- Within 30 seconds of achieving ventilation that inflates the baby's lungs, the baby's heart rate is greater than 100 bpm and oxygen saturation is 64%

- The assistant adjusts the oxygen concentration (Fi02) to maintain the baby's oxygen saturation within the target range

- You continue PPV while monitoring the baby's respiratory effort

- The baby begins to breathe and you gradually decrease the ventilation rate

The case …
spontaneously breathe, no labored respirations

- When the baby is 4 minutes of age, there is good spontaneous breathing effort, the HR is 140 bpm, and oxygen saturation is 85%

- You discontinue PPV and monitor the baby's oxygen saturation

- While your team prepares to move the baby to the nursery for post-resuscitation care, you explain the next steps to the mother

- Shortly afterward, you meet with your team and conduct a debriefing to evaluate your preparation, teamwork, and communication

The case …
spontaneously breathe, labored respirations

- Within 4 minutes of birth, the baby is spontaneously breathing, the HR is 140 bpm and oxygen saturation is 85%

- You discontinue PPV, but the baby has grunting and labored respirations

What do you do if the baby is breathing spontaneously and has a HR of at least 100 bpm, but has labored or grunting respirations or low oxygen saturation despite free-flow oxygen?

- CPAP may be considered
- CPAP is a technique for maintaining pressure within the lungs of a *spontaneously breathing* baby
- CPAP is **NOT** appropriate if:
  - the baby is apneic or gasping
  - the baby's heart rate is less than 100 bpm

What do you do if the baby is breathing spontaneously and has a HR of at least 100 bpm, but has labored or grunting respirations or low oxygen saturation despite free-flow oxygen?

- CPAP keeps the lungs slightly inflated at all times and may be helpful for preterm babies whose lungs are surfactant deficient, causing the alveoli to collapse at the end of each exhalation

- When CPAP is provided, the baby does not have to work as hard to inflate the lungs with each breath

- Using early CPAP for preterm newborns may avoid the need for intubation and mechanical ventilation

What do you do if the baby is breathing spontaneously and has a HR of at least 100 bpm, but has labored or grunting respirations or low oxygen saturation despite free-flow oxygen?

- Administering CPAP may increase the chance of developing a pneumothorax (air leak)

- Providers should be aware of this potential complication and be prepared to address it

How do you administer CPAP during the initial stabilization period?

- CPAP is administered by making a seal between the baby's face and a mask attached to either a T-piece resuscitator or a flow-inflating bag

- CPAP ***can not*** be administered with a self-inflating bag even if a PEEP valve has been placed

How do you administer CPAP during the initial stabilization period?

- The desired CPAP is achieved by adjusting the PEEP dial on the cap of the T-piece resuscitator or the flow-control valve on the flow-inflating bag
- Test the amount of CPAP before applying the mask to the baby's face by holding the mask tightly against your hand and reading the pressure on the manometer (pressure gauge)
- Adjust the PEEP cap or the flow-control valve so that the manometer reads 5 to 6 cm H_2O pressure

How do you administer CPAP during the initial stabilization period?

- After you have adjusted the CPAP to the desired pressure, place it firmly against the baby's face using the 2-hand hold with jaw thrust
- Lift the baby's jaw into the mask instead of pushing the baby's head down into the mattress
- Check that the pressure is still at the selected level
  - If it is lower, you may not have an airtight seal of the mask on the baby's face
- You may adjust the CPAP depending on how hard the baby is working to breathe
  - Do not use more than 8 cm H_2O

How do you administer CPAP during the initial stabilization period?

- During CPAP, you do NOT occlude the T-piece cap or squeeze the flow-inflating bag

- If the baby cannot maintain a heart rate of at least 100 bpm with spontaneous respirations, you need to give PPV breaths instead of CPAP

The case …
spontaneous breathe, labored respirations

- Using T-piece resuscitator, you administer CPAP via face mask
- The baby steadily has spontaneous breathing, the HR is 145 bpm and oxygen saturation is 93%
- You gradually decrease the oxygen concentration (Fi02)
- The baby still needs to continue the CPAP

How do you administer CPAP during the initial stabilization period?

- If CPAP will be administered for a prolonged period, you will use nasal prongs or a nasal mask

- After the initial stabilization, CPAP can be administered with:
  - a bubbling water system
  - a dedicated CPAP device
  - a mechanical ventilator

When should you insert an orogastric tube?

- During CPAP or PPV using a face mask or laryngeal mask, gas enters the esophagus and stomach
- Gas in the stomach may interfere with ventilation
- If a newborn requires CPAP or PPV for longer than several minutes, consider placing an orogastric tube and leaving it uncapped to act as a vent for the stomach

How do you insert an orogastric tube?

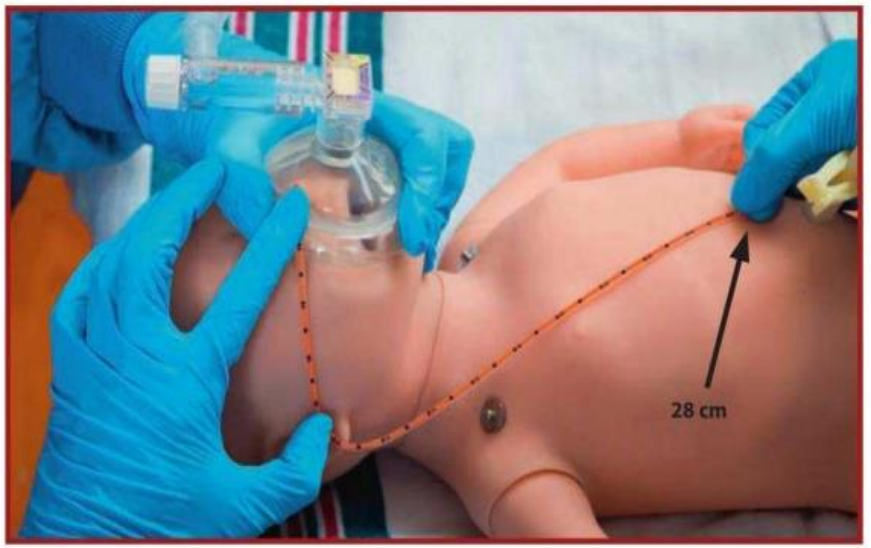
Equipment needed

- 8F orogastric tube
- 20-mL syringe
- Tape

How do you insert an orogastric tube?

Insertion steps

- Measure the distance from the bridge of the nose to the earlobe and from the earlobe to a point halfway between the xiphoid process (the lower tip of the sternum) and the umbilicus



- Note the centimeter mark at this place on the tube

- To minimize interruption of ventilation, measurement of the orogastric tube can be approximated with the mask in place

How do you insert an orogastric tube?

Insertion steps

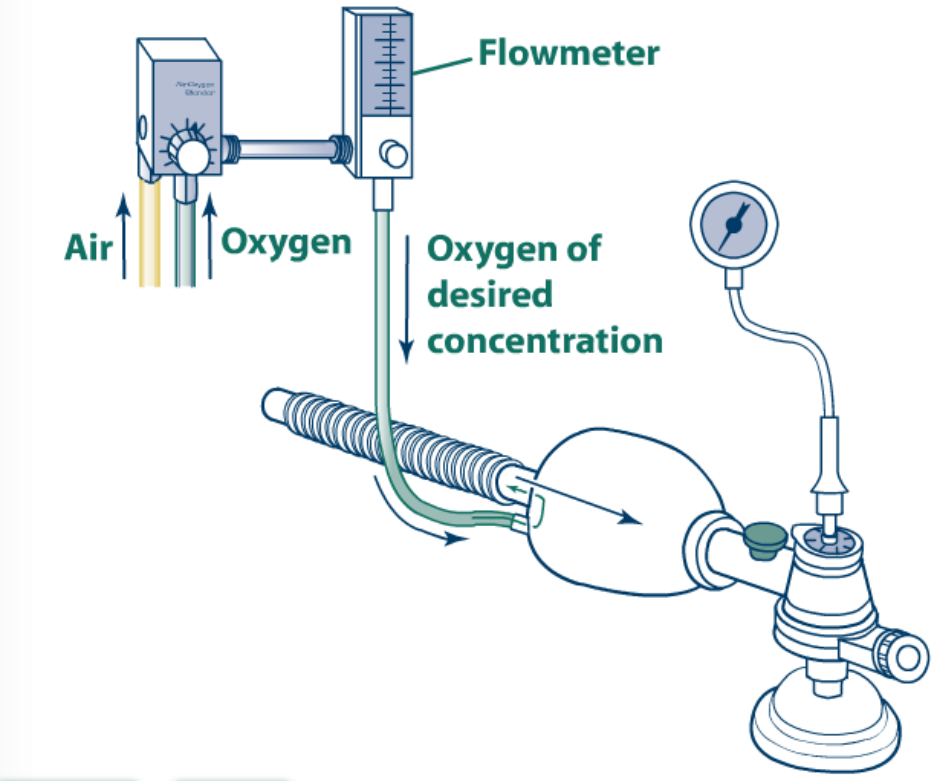
- Insert the tube through the mouth
- Ventilation can be resumed as soon as the tube has been inserted
- Reassess the face-mask seal
- Once the tube is inserted the desired distance, attach a syringe and remove the gastric contents
- Remove the syringe from the tube and leave the end of the tube open to provide a vent for air entering the stomach
- Tape the tube to the baby's cheek

The case …
spontaneously breathe, labored respirations

- You insert an orogastric tube, while continuing CPAP
- The baby is transferred to NICU to receive additional care
- While your team prepares to move the baby to the NICU, you explain the next steps to the mother
- Shortly afterward, you meet with your team and conduct a debriefing to evaluate your preparation, teamwork, and communication

CHARACTERISTICS OF EACH VENTILATION DEVICE

Self-inflating resuscitation bag



Self-inflating resuscitation bag

Eight basic parts

1. Gas outlet
2. Positive end-expiratory pressure (PEEP) valve (optional)
3. Manometer
4. Pressure-release valve
5. Gas inlet
6. Gas tubing
7. (A) Oxygen reservoir (closed type), (B) Oxygen reservoir (open type)
8. Valve assembly

Self-inflating resuscitation bag

- The self-inflating bag remains fully inflated unless it is being squeezed
- The bag re- expands after being squeezed and fills with gas from 3 locations
  - As the bag re- inflates, air from the room is drawn in from openings in the back of the bag
  - Gas from the blender and flow meter travels through gas tubing and enters the bag at the gas inlet
  - Gas from the blender collects in the oxygen reservoir and provides a third source for gas to fill the bag

Self-inflating resuscitation bag

- Oxygen tubing does not need to be attached for the bag to provide PPV with 21% oxygen
  - It fills by drawing room air (21% oxygen) into the bag
- If the bag is attached to a compressed gas source, it fills with gas at the supplied FiO_2

Self-inflating resuscitation bag

- The gas outlet is where gas exits from the bag to the baby and where a face mask, laryngeal mask, or endotracheal tube is attached
- To ensure that the appropriate pressure is used, a manometer (pressure gauge) should always be used
- Some bags will have a built-in manometer and others will need one attached
- The attachment site is usually close to the patient outlet
- If the manometer attachment site is left open, without a manometer attached, air will leak out and prevent you from achieving inflation pressure
- Do not attach the oxygen inflow tubing to the manometer attachment site
  - This could generate undesired high pressure

Self-inflating resuscitation bag

- Most self-inflating bags have *a pressure-release valve, also called a pop-off valve*, which limits the peak pressure

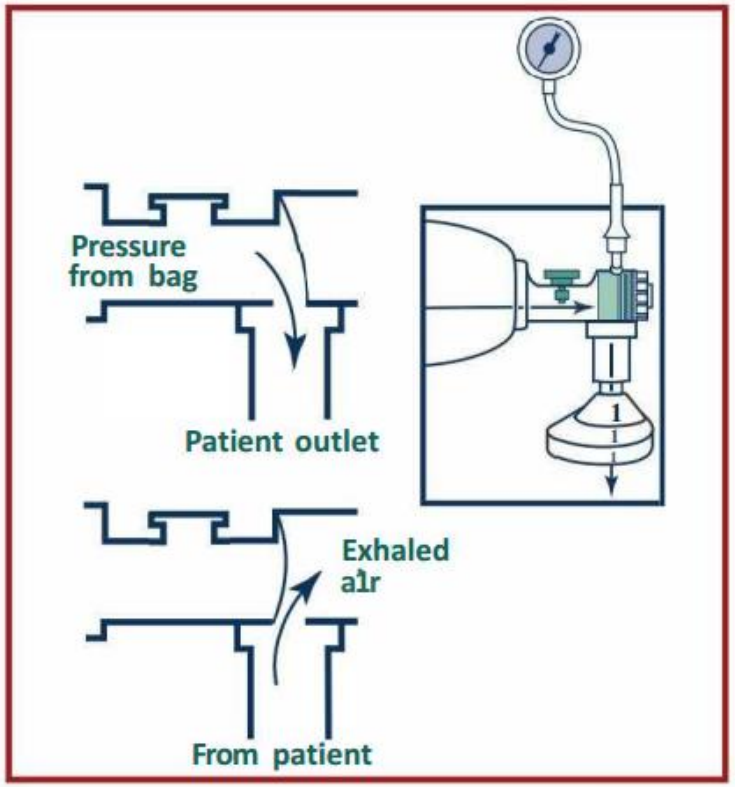
- These valves are usually set to release at 30 to 40 cm H_2O pressure, but they are not reliable and may not release until higher pressures are achieved

- Some self-inflating bags have a device that allows the pressure-release valve to be temporarily occluded, allowing higher pressures to be administered

- Occluding the pop-off valve should be an unusual occurrence and care must be taken not to use excessive pressure

Self-inflating resuscitation bag

- Self-inflating bags have a *valve assembly* positioned between the bag and the patient outlet
  - When the bag is squeezed during ventilation, the valve opens and directs gas to the patient
  - When the bag re- inflates, the valve is closed
    - ✓This prevents the patient's exhaled air from entering the bag and being rebreathed
- Some self-inflating bags also have an *adjustable PEEP valve*



Self-inflating resuscitation bag

Why is an oxygen reservoir used on a self-inflating bag?

- An oxygen reservoir is an appliance that can be placed over the bag's air inlet
- Gas from the blender collects in the reservoir
- At very low flow rates, the reservoir prevents blended gas from being diluted with room air
- Several different types of oxygen reservoirs are available, but they all perform the same function
  - Some have open ends ("tails") and others look like a bag covering the air inlet

Self-inflating resuscitation bag

A closed reservoir

An open "tail" reservoir

Self-inflating resuscitation bag

- Because the bag self-inflates, it does not require compressed gas or a tight seal at the outlet to remain inflated
- The ventilation rate is determined by how often you squeeze the bag and the inflation time is determined by how quickly you squeeze the bag
- PIP is controlled by how hard the bag is squeezed
- PEEP may be administered if an additional valve is attached to the bag

Self-inflating resuscitation bag

- Because gas does not flow out of the mask unless the bag is being squeezed, a self- inflating bag and mask cannot be used to administer CPAP or free-flow oxygen

- Free-flow oxygen may be administered through the open reservoir (tail) on some self-inflating bags

Testing a self-inflating bag during the equipment check and before use

Testing a self-inflating bag

Block the mask or gas outlet and squeeze the bag.

- Do you feel pressure against your hand?
- Does the manometer register pressure?
- Does the pressure-release valve open when the manometer registers 30 to 40 cm H_2O pressure?
- Does the bag reinflate quickly when you release your grip?

If no,

- Is there a crack or leak in the bag?
- Is the manometer missing, resulting in an open attachment site?
- Is the pressure-release valve missing or blocked?

What are the advantages and disadvantages of Self-inflating bags?

Advantages:

- The *self-inflating bag* is often considered easier to use than the other devices and requires little time to set up

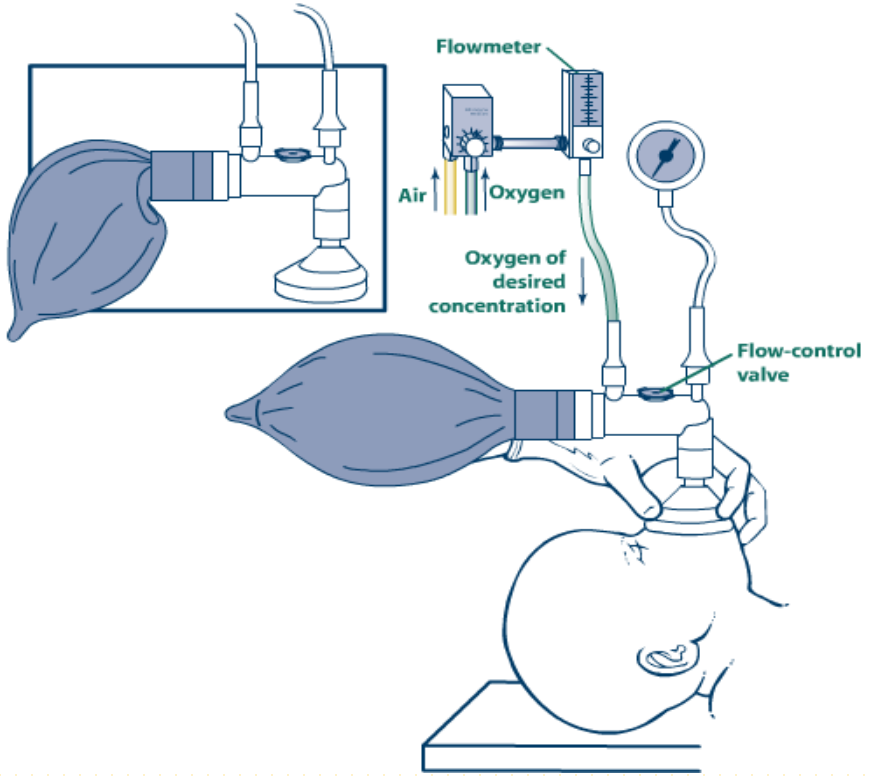
- It does not require a compressed gas source and can be used in an emergency setting when compressed gas may not be readily available

What are the advantages and disadvantages of Self-inflating bags?

Disadvantages:

- Because it fully re- inflates even without a seal, you will be less likely to know if you have a large leak between the mask and the baby's face
- It is difficult to control the inflation time with a self-inflating bag
- As previously mentioned, the mask cannot be used to administer free-flow oxygen or CPAP to a baby

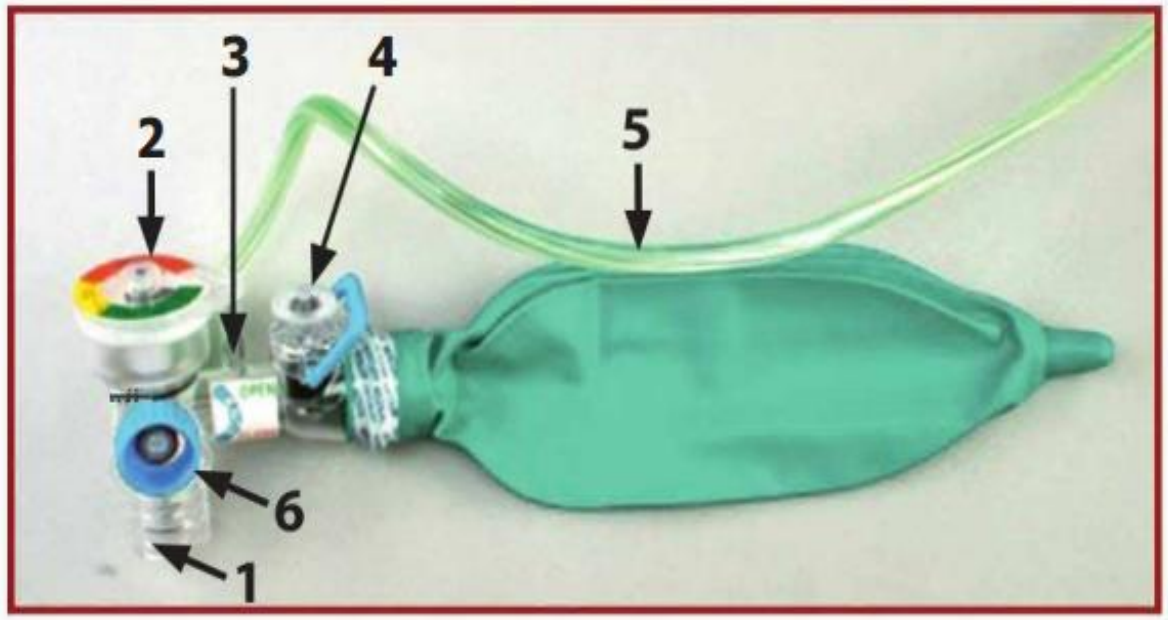
Flow-inflating resuscitation bag



Flow-inflating resuscitation bag

Six parts

1. Gas outlet
2. Manometer
3. Gas inlet
4. Pressure-release valve (optional)
5. Gas tubing
6. Flow-control valve



Flow-inflating resuscitation bag

- Compressed gas from the blender and flow meter enters the bag through oxygen tubing attached to the *gas inlet*
- The *gas outlet* is where gas exits from the bag to the baby and where a face mask, laryngeal mask or endotracheal tube is attached
- Even if you plan to use 21% oxygen for PPV, you must have a compressed gas source to fill the flow-inflating bag

Flow-inflating resuscitation bag

- The *flow-control valve* provides an adjustable leak that allows you to regulate the pressure in the bag
- The adjustable leak allows excess gas to escape rather than overinflate the bag or be forced into the patient
- The flow-control valve adjusts both the peak inflation pressure (PIP) and the PEEP

Flow-inflating resuscitation bag

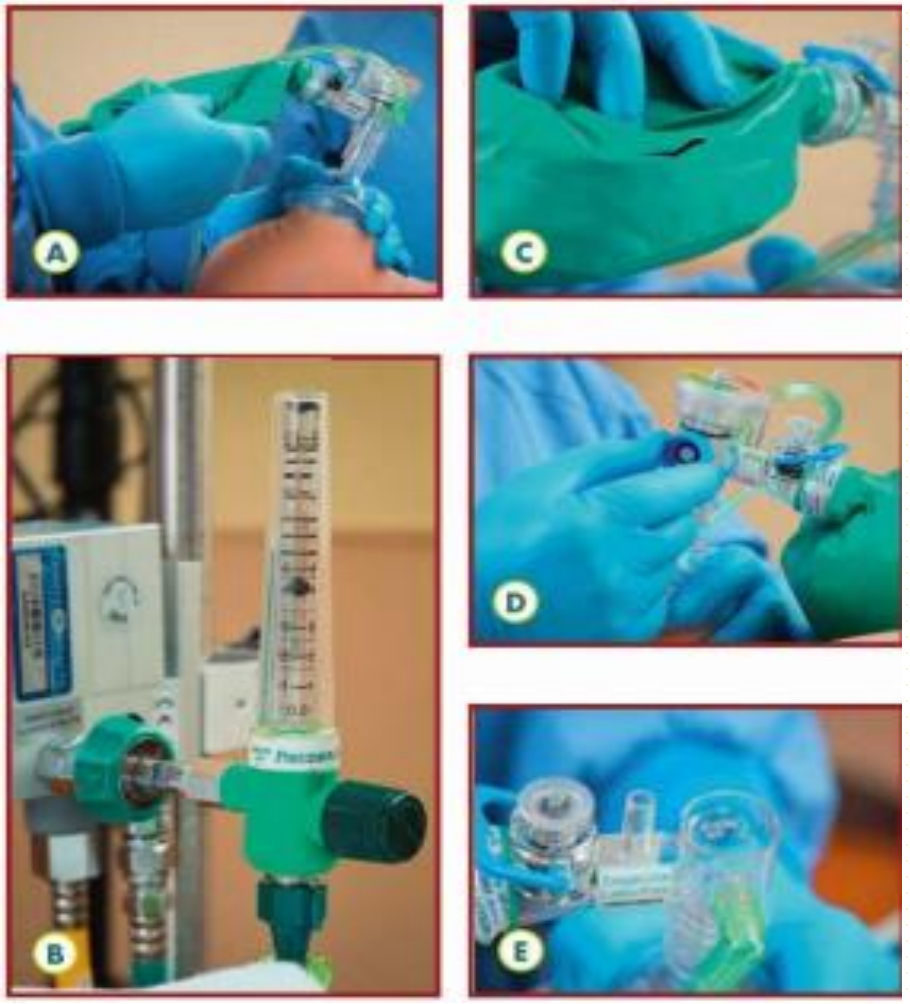
- Flow-inflating bags have a site for attaching a *manometer*
- The attachment site usually is close to the patient outlet
- A manometer must be attached or the site will be a source of leak and the bag will not inflate properly
- A *pressure release (pop-off) valve* may also be present

Flow-inflating resuscitation bag

How does a flow-inflating bag work?

- For a flow-inflating bag to work properly, there must be adequate gas flow from the source and a sealed system

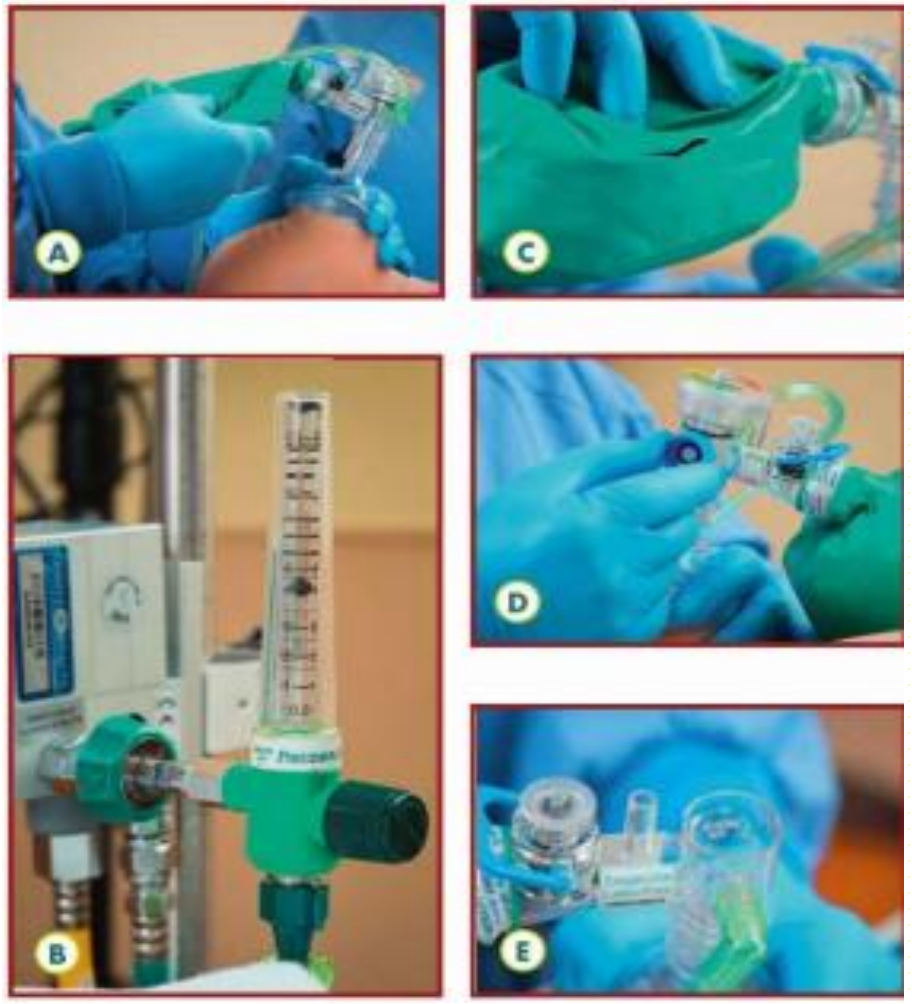
- The bag inflation is controlled by the balance between:
  - gas entering the bag
  - gas exiting the adjustable flow-control valve
  - gas exiting the gas outlet



Flow-inflating resuscitation bag

How does a flow-inflating bag work?

- A flow-inflating bag will not inflate adequately if:
  - the mask is not properly sealed
  - flow from the gas source is insufficient, disconnected, or occluded
  - there is a hole in the bag
  - the flow-control valve is open too far
  - the manometer attachment site has been left open



Flow-inflating resuscitation bag

How do you adjust the inflation of a flow-inflating bag?

- There are 2 ways that you can adjust the pressure in the bag and thus the amount of inflation of the bag:
  - By adjusting the incoming gas from the flow meter, you regulate how much gas enters the bag
  - By adjusting the flow-control valve on the bag, you regulate how much gas escapes from the bag

Flow-inflating resuscitation bag

How do you adjust the inflation of a flow-inflating bag?

- The flow meter and flow-control valve should be set so that the bag is inflated to the point where it is comfortable to handle and does not completely deflate with each assisted breath (A)
- An overinflated bag is difficult to manage and may deliver high pressure to the baby; a pneumothorax or other air leak may develop (B)
- An underinflated bag makes it difficult to achieve the desired inflation pressure (C)
- With practice, you will be able to make the necessary adjustments to achieve a balance
- If there is a good seal between the baby's face and the mask, you should be able to maintain the appropriate amount of inflation with the flow meter set at 8 to 10 L/min.

Flow-inflating resuscitation bag

- The ventilation rate is determined by how often you squeeze the bag and the inflation time is determined by how quickly you squeeze and release the bag

- PIP is controlled by how hard the bag is squeezed *and* the balance between the amount of gas flowing into the bag and the gas escaping through an adjustable flow-control valve

- PEEP, CPAP, and free-flow oxygen can be administered with a flow-inflating bag and are adjusted by the balance between the gas flow into the bag and the gas escaping through the flow-control valve

Flow-inflating resuscitation bag

A. Flow-inflating bag inflated with compressed gas and a seal against the baby's face

B. lf compressed gas is not flowing into the bag or the outlet is not sealed, the bag collapses

Testing a flow-inflating bag during the equipment check and before use

Testing a flow-inflating bag

Block the mask or gas outlet.

- Does the bag fill properly?
- Adjust the flow-control valve to read 5 cm H20 PEEP.

Squeeze the bag 40 to 60 times per minute.

- Does the bag reinflate quickly when you release your grip?
- Adjust the flow-control valve to read 30 to 40 cm H_20 when squeezed firmly.
- Check to be sure that the pressure still reads 5 cm H_2O when not being squeezed (PEEP).

If the bag does not fill correctly,

- Is there a crack or hole in the bag?
- Is the flow-control valve open too far?
- Is the manometer attached?
- Is the gas tubing connected securely?
- Is the gas outlet sufficiently blocked?

What are the advantages and disadvantages of Flow-inflating bags?

Advantages:

- You will know immediately if you lose gas pressure or have a leak between the bag and mask because the bag will deflate
  - Absent or partial inflation of the bag indicates that a tight seal has not been established or the bag has a leak
- An effective face-mask seal is indicated by observing stable PEEP/CPAP on the manometer
- The inflation time can be increased, if needed, by squeezing the bag for a longer period of time
- The flow-inflating bag can deliver CPAP, PEEP, and free-flow oxygen

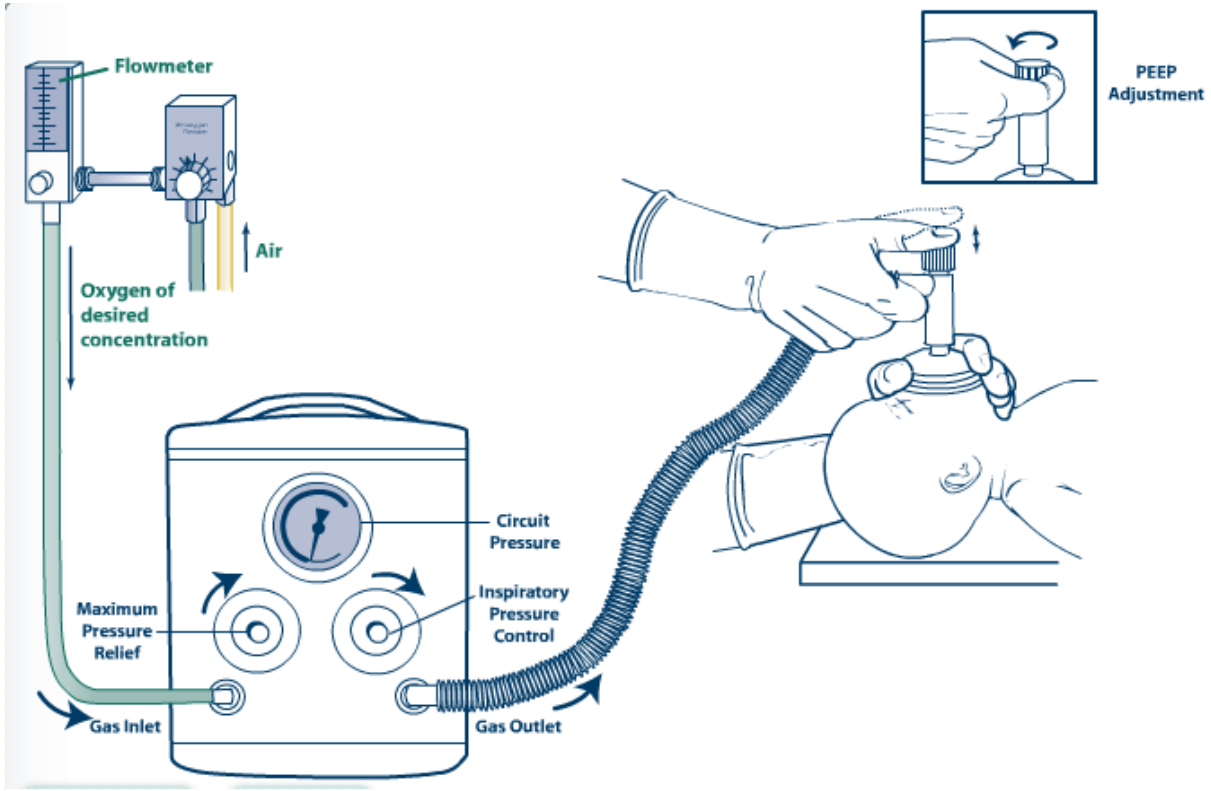
What are the advantages and disadvantages of Flow-inflating bags?

Disadvantages:

- It is more complicated to set up than the other devices and takes more practice to use effectively

- It requires a compressed gas source and adjustments to find the correct balance between gas inflow and outflow

T-piece Resuscitator



T-piece Resuscitator

- A T-piece resuscitator is a mechanical device that uses valves to regulate the flow of compressed gas directed toward the patient
- Similar to the flow-inflating bag, the device requires a compressed gas source
- A built-in manometer measures the inflation and expiratory pressure

T-piece Resuscitator

Nine parts

1. Gas tubing
2. Gas inlet
3. Maximum pressure-relief control
4. Manometer
5. Inflation pressure control
6. Gas outlet (proximal)
7. T-piece gas outlet (patient)
8. T-piece PEEP adjustment dial
9. Opening on T-piece cap

T-piece Resuscitator

- There are 2 control dials that are used to limit the inflation pressure
  - The *peak inflation pressure* control limits the peak pressure during each assisted breath
  - The *maximum pressure relief control* is a safety feature, similar to the pop-off valve on a self-inflating bag, which prevents the user from increasing the peak pressure beyond a preset value
    - ✓ This control dial may be covered by a removable shield
- An adjustable dial on the T-piece cap controls how much gas is allowed to escape between breaths and, therefore, adjusts the PEEP and CPAP

T-piece Resuscitator

How does a T-piece resuscitator work?

- Gas from a compressed source enters the T-piece resuscitator through *gas tubing* at the *gas inlet*
- Gas exits the control box from the *gas outlet (proximal)* and travels through corrugated tubing to the *T-piece gas outlet (patient),* where a face mask, laryngeal mask, or endotracheal tube attaches
- When the *opening on the T-piece cap* is occluded by the operator, the preset inflation pressure is delivered to the patient for as long as the T-piece opening is occluded
- The maximum pressure that can be used is regulated by the *maximum pressure relief control* valve
- PEEP is adjusted using a dial on the T-piece cap

T-piece Resuscitator

How do you prepare the T-piece resuscitator for use?

- Assemble the parts of the T-piece resuscitator as instructed by the manufacturer

- Occlude the patient outlet (using a test lung, outlet occluding cap, or palm)

- Connect the device to the compressed gas source using gas tubing

T-piece Resuscitator

How do you prepare the T-piece resuscitator for use?

- Adjust the pressure settings as follows:
  - Adjust the blended gas flow meter on the wall to regulate how much gas flows into the T-piece resuscitator
    - ✓ In most cases, 10 L/min is appropriate
  - Set the *maximum pressure-relief control* by occluding the T-piece cap with your finger and adjusting the maximum pressure relief dial to a selected value as discussed earlier
    - ✓ Some manufacturers recommend that the maximum relief control be adjusted to an institution-defined limit when the device is put into original service and not be readjusted during regular use
  - Set the desired peak inflation pressure (PIP) by occluding the T-piece cap with your finger and adjusting the *inflation pressure control* to the selected pressure
  - Set the PEEP by removing your finger from the T-piece cap and adjusting the dial on the cap to the desired setting as discussed earlier

T-piece Resuscitator

How do you prepare the T-piece resuscitator for use?

- When the device is used to ventilate the baby, either by applying the mask to the baby's face or by connecting the device to a laryngeal mask or endotracheal tube, you administer a breath by alternately covering and releasing the opening on the T-piece cap

- The ventilation rate is determined by how often you occlude the opening on the cap

- the inflation time is controlled by how long your finger covers the opening

- Be careful not to become distracted and inadvertently cover the opening on the T-piece cap with your finger for a prolonged time

T-piece Resuscitator

How do you adjust the concentration of oxygen in a T-piece resuscitator?

- The concentration of oxygen delivered by the T-piece resuscitator is controlled by the oxygen blender

T-piece Resuscitator

A. An example of a T-piece resuscitator. *The position and function of control dials on the T-piece resuscitator may vary by manufacturer*

B. The T-piece resuscitator's pressure is controlled by adjustable valves. PIP is adjusted by a dial on the machine

C. PEEP is controlled by a dial on the T-piece cap

Testing a T- piece resuscitator during the equipment check and before use

Testing a T-piece resuscitator

Block the mask or T-piece gas outlet without occluding the opening on the T-piece cap.

- Does the PEEP read 5 cm H_2O ?

Occlude the opening on the T-piece cap.

- Does the peak pressure read 20 to 25 cm H_2O ?

If the pressure is not correct,

- Is the T-piece gas outlet sealed?
- Is the gas tubing connected to the gas inlet?
- Is the gas flow set at 10 L/min?
- Is the gas outlet (proximal) disconnected?
- Is the maximum circuit pressure, PIP, or PEEP incorrectly set?

What are the advantages and disadvantages of T-piece resuscitators?

Advantages:

- The primary advantage of the T-piece resuscitator is that it provides more consistent pressure with each breath than either the self-inflating or flow-inflating bag
- An effective face-mask seal is indicated by observing stable PEEP/CPAP on the T-piece manometer
- In addition, the users may not become fatigued because they are not repeatedly squeezing a bag
- The inflation time can be increased, if needed, by occluding the hole on the T-piece cap for a longer period of time
- The T-piece can deliver CPAP, PEEP, and free-flow oxygen

What are the advantages and disadvantages of T-piece resuscitators?

Disadvantages:

- The T-piece resuscitator also requires some preparation time for setup prior to use
- Similar to the flow-inflating bag, it requires a compressed gas source and adjustment to the dials controlling the PIP and PEEP