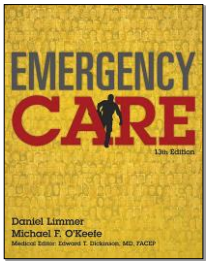
Emergency Care

THIRTEENTH EDITION



CHAPTER 10

Respiration and Artificial Ventilation

Topics

Mechanics of Breathing

- Ventilation
  - Process of moving air into and out of chest

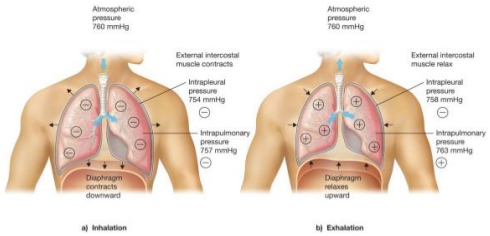
An open airway, adequate ventilation, and sufficient oxygenation are necessary to sustain life!

continued on next slide

Mechanics of Breathing

- Inhalation
  - Active process
  - External intercostal muscles and diaphragm contract
  - Size of chest increases
  - Pressure in the chest cavity decreases
  - Negative pressure pulls air into lungs
- Exhalation
  - Passive process
  - External intercostal muscles and diaphragm relax
  - Size of chest decreases
  - Positive pressure created; air pushed out through mouth and nose

Mechanics of Breathing



- Lungs are surrounded by the visceral and parietal pleura
- The diaphragm provides 60-70% of the effort of breathing

Control of Respiration

- Respiratory centers in the brainstem receive input from chemoreceptors about levels of O2, CO2, and pH.
- Primary stimulus to breathe is increased CO2 in arterial blood
- Some COPD patients must rely on a hypoxic drive to breathe

Respiration Terminology

- Tidal volume
  - Amount of air moved in one breath
- Minute volume
  - Amount of air moved into and out of lungs per minute

Physiology of Respiration

- Dead space air
  - Air moved in ventilation not reaching alveoli
- Alveolar ventilation
  - Air actually reaching alveoli
- Diffusion
  - Movement of gases from high concentration to low concentration

continued on next slide

Diffusion in Action

- CO_2 diffuses from the capillaries into the alveoli
- O_2 diffuses from the alveoli into the blood and is bound to the hemoglobin
- Blood entering capillaries is high in O_2, which diffuses into the cells
- Cells are high in CO_2, which diffuses into the blood

continued on next slide

Physiology of Respiration

- Respiration = gas exchange
- External respiration
  - Diffusion of oxygen and carbon dioxide (exchange of gases) between alveoli and circulating blood
- Internal respiration
  - Exchange of gases between blood and cells

continued on next slide

Physiology of Respiration

- Cellular respiration
  - Oxygen from blood diffused into cell
  - Carbon dioxide diffused from cell into blood

Pathophysiology of the Cardiopulmonary System

- Mechanics of breathing disrupted
  - Trauma, CNS, Bronchoconstriction
- Gas exchange interrupted
  - Confined space, CHF, COPD
- Circulation issues
  - Hypovolemia, Anemia

Respiration

Adequate and Inadequate Breathing

- Brain and body cells need a steady supply of oxygen.
  - Hypoxia
    - Low oxygen level in cells
- Carbon dioxide must be continuously removed.
  - Hypercapnea
    - High carbon dioxide level

continued on next slide

Adequate and Inadequate Breathing

- Compensation for hypoxia or hypercapnea is predictable.

Adequate > working hard to breathe = Respiratory Distress

Hypoxia Develops = Respiratory Failure

Brain Cells Die = Respiratory Arrest

Adequate and Inadequate Breathing

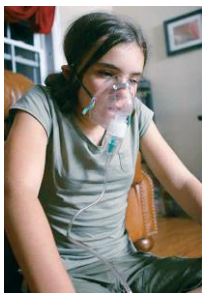
- Early on – our body can adjust
- Respiratory distress
  - Body compensating for a respiratory challenge and meeting metabolic needs

Inadequate Breathing

- Occurs when challenge are too great for body's compensation mechanisms
- Also known as respiratory failure
- Exceptionally important to recognize; often a precursor to respiratory arrest

Respiratory Distress

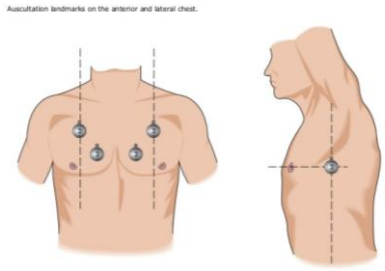
What signs do you see of respiratory distress?



Patient Assessment – Is it Adequate Breathing?

Look	Listen	Feel
Normal breathing patterns	Speaking full sentences	Air movement against your cheek
Observe general appearance	Air movement during exhalation	Chest movement – shallow, deep, irregular
Inspect the chest	Tidal volume	
Any nasal flaring or retractions	Breath sounds that are diminished or absent	
Rate too fast, or too slow	Wheezing, crowing, stridor, snoring, gurgling, or gasping	
Abdominal breathing		
Skin condition	Low oxygen saturation	

Patient Assessment



Patient Assessment

- Hypoxia
  - Major causes
    - A patient is trapped in a fire.
    - A patient has emphysema.
    - A patient overdoses on a drug that has a depressing effect on the respiratory system.
    - A patient has a heart attack.

You Decide…..How and When Do I Intervene

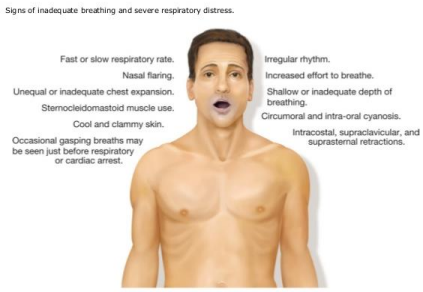
Condition	Signs/Symptoms	Treatment
Respiratory Distress "Adequate Breathing"		
Respiratory Failure "Inadequate Breathing"		
Respiratory Arrest "Cease of Breathing"		

Patient Care

- Inadequate breathing
  - Supplemental oxygen > breathing patient
  - Artificial ventilation > non-breathing or patient with inadequate breathing.

a) conjunctiva, b) mucosa, c) fingernail beds, d) circumoral area

Patient Care



Pediatric Considerations

- In children, hypoxia may present as bradycardia instead of tachycardia
- Children have limited oxygen reserves
- High metabolic rate and oxygen needs
- Hypoxia is the most common cause of cardiac arrest

Positive Pressure Ventilation

Positive Pressure Ventilation

- Forcing air or oxygen into lungs when a patient has stopped breathing or has inadequate breathing
- Uses force exactly opposite of how the body normally draws air into the lungs
- PPV is much different than spontaneous breathing (no negative pressure)

continued on next slide

Positive Pressure Ventilation

- Negative side effects of positive pressure ventilation
  - Decreasing cardiac output - dropping blood pressure
  - Gastric distention
  - Hyperventilation

Techniques of Artificial Ventilation

- Do not ventilate patient who is vomiting or has vomitus in airway
  - PPV will force vomitus into patient's lungs
- Watch chest rise and fall with each ventilation
- Ensure rate of ventilation is sufficient

continued on next slide

Techniques of Artificial Ventilation

- Carefully assess the adequacy of respiration
- Explain procedure to patient
- Place the mask over the patient's mouth and nose
- After sealing mask on patient's face, squeeze bag with patient's inhalation

CPAP/BiPAP

- Form of noninvasive positive pressure ventilation (NPPV)
- Positive pressure helps inflate alveoli and improve O2
- Decreases work of breathing
- Helps displace fluid in alveoli

- CPAP
  - Continuous positive airway pressure
- BiPAP
  - Biphasic positive airway pressure

CPAP/BiPAP

- Used in awake, spontaneously breathing patients
- CHF, COPD, Pulmonary edema, Asthma, and Pneumonia patients
- Can hopefully avoid the need for ET intubation in patients
- Oxygen should be titrated to SpO2 readings, and signs

Mouth-to-Mouth Ventilation

- 16% oxygenation
- Consideration for a barrier device

- Mouth to nose ventilation?
- Seal around mouth, pinch nose

Mouth-to-Mask Ventilation

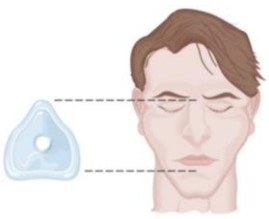
- Single EMT can maintain good seal
- Eliminate direct contact
- One-way valve

Oxygen?

Disadvantages?

Mouth-to-Mask Ventilation

- Use a E-C technique
- Careful not to over-ventilate

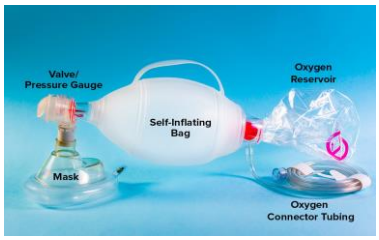


Bag-Valve Mask

- Handheld ventilation device
- Two-person technique preferred
- Can deliver close to 100% oxygen

Bag-Valve Mask

- Standard features



Bag-Valve Mask

- Mechanics of BVM
  - Supply of 15 liters per minute of oxygen attached and enters reservoir
  - When squeezed, air inlet closed and oxygen delivered to patient
  - When released, passive expiration by patient occurs

continued on next slide

Bag-Valve Mask

- Two-rescuer BVM ventilation—no trauma suspected
  - Strongly recommended by AHA
  - Most difficult part of BVM ventilation is obtaining adequate mask seal
  - Hard to maintain seal while squeezing bag
  - One rescuer squeezes bag; other rescuer maintains seal.

continued on next slide

Bag-Valve Mask (no trauma)

Two-Rescuer BVM Ventilation: Trauma Suspected

Delivering two-rescuer BVM ventilation while providing manual stabilization of the head and neck when trauma is suspected in the patient.

1 Person Bag-Valve Mask

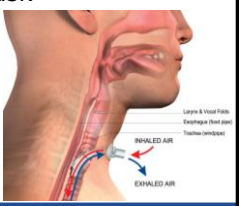
Bag-Valve Mask

- If the chest does not rise and fall during BVM ventilation, you should:
  1. Reposition head
  2. Check for escape of air around mask; reposition fingers and mask
  3. Check for airway obstruction or obstruction in BVM system
  4. Use alternative method

Stoma Ventilation

Ventilation through Stoma

- Clear mucus plugs or secretions
- Leave head and neck in neutral position
- Use a pediatric-sized mask
- If unable to ventilate through stoma site, assure site is closed and ventilate through mouth and nose



Artificial Ventilation

- Adequate ventilation
  - Sufficient rate (patients with a pulse)
    - Newborns
      - 40 to 60 times per minute
    - Infants and children
      - 12 to 20 times per minute, or once every 3 to 5 seconds
    - Adults
      - 10 to 12 times per minute, or once every 5 seconds

1 breath over 1 second – ALL AGES

Flow-Restricted, Oxygen-Powered Ventilation Device

- Also called *manually triggered ventilation device*
- Uses oxygen under pressure to deliver artificial ventilations through a mask placed over the patient's face
- Used on ADULTS only

Flow-Restricted, Oxygen-Powered Ventilation Device

- Follow same procedures for mask seal as for BVM.
- Trigger device until chest rises.

Automatic Transport Ventilator

An automatic transport ventilator. The coin is shown for scale.
© *Edward T. Dickinson, MD*

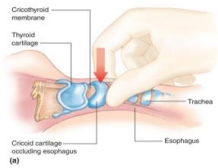
Automatic Transport Ventilator

- Provides positive pressure ventilations
- Can adjust ventilation rate and volume
- Provider must assure appropriate respiratory rate and volume for patient's size and condition.
- Lower risk for gastric distention

  - ❑ Advantages/Disadvantages
  - ❑ Technique

Considerations

- How do we know the ventilations provided are adequate?
- What are signs of inadequate ventilation?
- Cricoid pressure?



Spontaneously Breathing

- Recognize the need to ventilation
- Explain the procedure
- Ventilate to achieve normal rate and tidal volume
- Be aware of the complications
  - Uncooperative patient
  - Inadequate mask seal
  - Overinflation

Oxygen Therapy

Importance of Supplemental Oxygen

- Issues to consider when making decisions about oxygen administration
  - Oxygen is a drug.
  - Oxygen can cause harm.
  - Oxygen should be administered based on your overall evaluation of the patient's presentation and possible underlying conditions.

Indications for Oxygen Use – Why?

- Arrest
- Hypoxic
- Shock
- SpO2 < 94%
- Altered level of consciousness
- Receiving PPV
- CNS Injuries
- Multiple fractures
- Severe bleeding
- Toxin exposure

- When in doubt, give O2
  - Never withhold O2

Oxygen Systems

Portable
- In the field
- Lightweight, safe, dependable

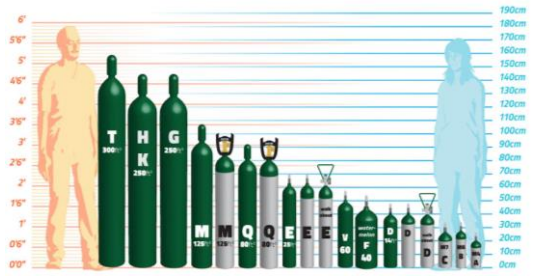
For safety, oxygen tanks should be placed in horizontal position or secured.

Installed
- In the truck

Oxygen Cylinder Sizes

- *D cylinder*
  - About 350 liters of oxygen
- *E cylinder*
  - About 625 liters of oxygen
- *M cylinder*
  - About 3,000 liters of oxygen
- *G cylinder*
  - About 5,300 liters of oxygen
- *H cylinder*
  - About 6,900 liters of oxygen

Oxygen Cylinders



Oxygen Cylinders

- A full tank is assumed to be 2,000 psi

Cylinder Constant

D = 0.16	G = 2.41
E = 0.28	H = 3.14
M = 1.56	K = 3.14

As an example, to determine how long the full (2,000 psi) E cylinder will last with a patient on a nonrebreather mask at 15 lpm, you would calculate the following:

$$\frac{(2{,}000 - 200) \times 0.28}{15} = \frac{504}{15} = 33.6 \text{ minutes}$$

The oxygen tank will provide oxygen at 15 lpm to the patient for a period of 33.6 minutes.

psi x constant
liter flow per minute

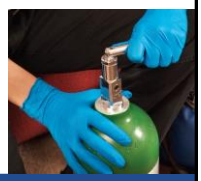
Oxygen Cylinders

- Use pressure gauges, regulators, and tubing intended for use with oxygen.
- Use nonferrous wrenches.
- Ensure valve seat inserts and gaskets are in good condition.
- Use medical-grade oxygen.
- Have oxygen cylinders hydrostatically tested every five years.

continued on next slide

Oxygen Cylinders

- Open the valve of an oxygen cylinder fully then close it half a turn to prevent someone else from thinking the valve is closed and trying to force it open.
- Store reserve oxygen cylinders in cool, ventilated room, properly secured in place.



Oxygen Cylinders

- Never drop a cylinder or let it fall against any object.
- Never leave an oxygen cylinder standing in an upright position without being secured.
- Never allow smoking around oxygen equipment in use.

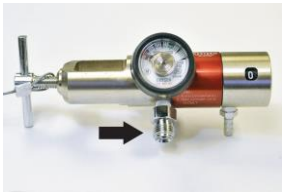
continued on next slide

Oxygen Cylinders

- Never use oxygen equipment around open flame.
- Never use grease, oil, or fat-based soaps on devices that will be attached to an oxygen supply cylinder.
- Never use adhesive tape on a cylinder.
- Never try to move an oxygen cylinder by dragging it or rolling it on its side or bottom.

Pressure Regulators

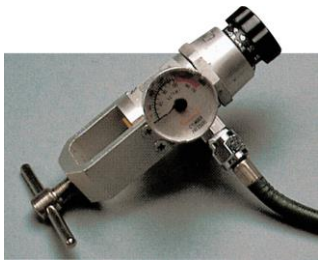
- Connected to the oxygen cylinder to provide a safe working pressure of 30 to 70 psi.



Flowmeters

- Allow control of the flow of oxygen in liters per minute
- Low-pressure flowmeters
  - Pressure-compensated flowmeter
  - Constant flow selector valve
- High-pressure flowmeters
  - Thumper™ CPR device
  - Respirators and ventilators such as CPAP and BiPAP devices

Flowmeters



Low-pressure flowmeters: (Left) A pressure-compensated flowmeter; (Right) a constant flow selector valve.

Humidifiers

- Connected to flowmeter
- Provide moisture to dry oxygen from supply cylinder

Hazards of Oxygen Therapy

- Common hazards of oxygen and oxygen equipment
  - If the tank is punctured or a valve breaks off, the supply tank can become a missile.
  - Oxygen supports combustion.
    - Can saturate towels, sheets, clothing
  - Oxygen and oil do not mix under pressure.

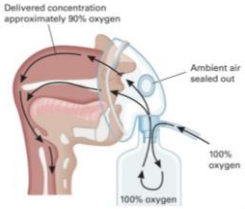
continued on next slide

Hazards of Oxygen Therapy

- Rare medical situations
  - Oxygen toxicity or air sac collapse
  - Infant eye damage
  - Respiratory depression or respiratory arrest
- Caution with ischemic stroke and acute coronary syndrome patients

Nonrebreather Mask

- Best way to deliver high concentrations of oxygen to a breathing patient



Nonrebreather Mask

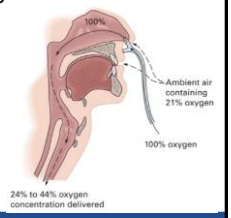
- Provides oxygen concentrations of 80 to 100 percent
- Optimum flow rate is 12 to 15 liters per minute.
- A new design feature allows for one emergency port in the mask to the patient can still receive atmospheric air should the oxygen supply fail.

Nasal Cannula

- Best choice for a patient who refuses to wear an oxygen face mask

Nasal Cannula

- Oxygen is delivered to patient by two prongs that rest in patient's nostrils.
  - Flow rate is 1 to 6 liters per minute and should never exceed 6 liters per minute



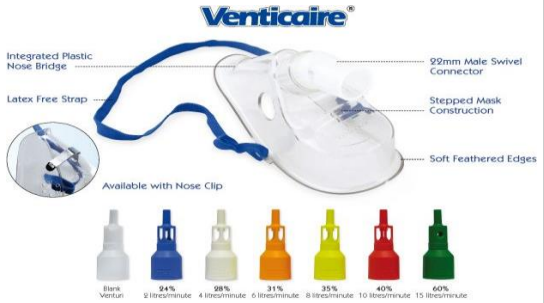
Partial Rebreather Mask

- Very similar to nonrebreather mask
- No one-way valve in opening to reservoir bag
- Delivers 40 to 60 percent oxygen at 9–10 liters per minute

Delivery Devices: Venturi Mask

- Delivers specific concentrations of oxygen by mixing oxygen with inhaled air
- Not as applicable in EMS setting

Venturi Mask



Tracheostomy Mask

- Placed over stoma or tracheostomy tube to provide supplemental oxygen
- Connected to 8 to 10 liters per minute of oxygen via supply tubing

Special Considerations

Special Considerations

- Facial injuries
  - Bleeding and swelling can disrupt movement of air.
  - Aggressive suction and advanced airway maneuvers may be necessary.

continued on next slide

Special Considerations

- Obstructions
  - Foreign bodies can impede ventilation of patients.
  - If unable to ventilate, always consider the possibility of obstruction.

continued on next slide

Special Considerations

- Dental appliances
  - Dentures should ordinarily be left in place during airway procedures.
  - Partial dentures may become dislodged during an emergency.
  - Leave a partial denture in place if possible, but be prepared to remove it if it endangers the airway.

Pediatric Note

- Hypoxia often occurs rapidly.
  - Children burn oxygen at twice the rate of adults
  - Accounted for by the many anatomical differences associated with airway

continued on next slide

Pediatric Note

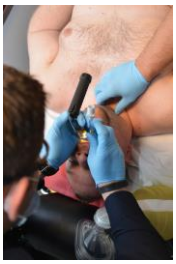
- Ventilating pediatric patients
  - Avoid excessive pressure and volume.
  - Use properly sized face masks.
  - Flow-restricted, oxygen-powered ventilation devices contraindicated
  - Use pediatric-sized nonrebreather masks and nasal cannulas.
  - Gastric distention may impair adequate ventilations.

Assisting with Advanced Airway Devices

Assisting with Advanced Airway Devices

- Devices requiring direct visualization of the glottic opening (endotracheal intubation)
- Devices inserted "blindly," meaning without having to look into the airway to insert the device.

Types of Advanced Airway Devices



In the BURP maneuver, press your thumb and index finger on either side of the throat over the cricoid cartilage and gently direct the throat upward and toward the patient's right. © *Edward T. Dickinson, MD*

Preparing the Patient for Intubation

- Maximize oxygenation prior to procedure.
- Position patient in sniffing position.
- Cricoid pressure
- Confirmation
- Securing tube in place

Ventilating the Intubated Patient

- Very little movement can displace an endotracheal tube.
- Pay attention to resistance to ventilations; report changes.
- If patient is defibrillated, carefully remove bag from tube.
- Watch for any change in patient's mental status.

Assisting with a Trauma Intubation

- Provide manual in-line stabilization throughout procedure.
- Position hands to hold stabilization, but allow for movement of jaw.

Blind-Insertion Airway Devices

- Examples
  - King LT™ airway
  - Laryngeal mask airway (LMA™)
- Usually do not require head to be placed in sniffing position

In-Hospital Endotracheal Intubation Video

Click on the screenshot to view a video on the subject of in-hospital endotracheal intubation.

Back to Directory

Chapter Review

Chapter Review

- Respiratory failure is the result of inadequate breathing, breathing that is insufficient to support life.
- A patient in respiratory failure or respiratory arrest must receive artificial ventilations.
- Oxygen can be delivered to the nonbreathing patient as a supplement to artificial ventilation.

continued on next slide

Chapter Review

- Oxygen can also be administered as therapy to the breathing patient whose breathing is inadequate or who is cyanotic, cool and clammy, short of breath, suffering chest pain, suffering severe injuries, or displaying an altered mental status.

Remember

- Always use proper personal protective equipment when managing an airway.
- Assessment of breathing must be an ongoing process. Respiratory status can change over time.
- Inadequate breathing requires immediate action.

continued on next slide

Remember

- Positive pressure ventilations are very different than normal breathing and can have negative side effects.
- Select the most appropriate method of positive pressure ventilations based upon the needs of the individual.

continued on next slide

Remember

- Always use appropriate safety measures when handling oxygen.
- Select the appropriate delivery device to provide supplemental oxygen.

Questions to Consider

- What are the signs of respiratory distress?
- What are the signs of respiratory failure?
- For BVM ventilation, what are recommended variations in technique for one or two rescuers?

continued on next slide

Questions to Consider

- How does the way positive pressure ventilation moves air differ from how the body normally moves air?
- Describe a patient problem that would benefit from administration of oxygen and explain how to decide what oxygen delivery device should be used.

Critical Thinking

- On arrival at the emergency scene, you find an adult female patient who is semiconscious. Her respiratory rate is 7 per minute. She appears pale and slightly blue around her lips

continued on next slide

Critical Thinking

- Is this patient in respiratory failure, and if so what signs and symptoms indicate this? Does this patient require artificial ventilations?