Respiration and Artificial Ventilation
OBJECTIVES

9.1 Define key terms introduced in this chapter. Slides 15–16, 18, 20–22, 25, 29, 39, 60, 95

9.2 Explain the physiological relationship between assessing and maintaining an open airway, assessing and ensuring adequate ventilation, and assessing and maintaining adequate circulation. Slides 14–22

9.3 Describe the mechanics of ventilation. Slides 15–19

continued
OBJECTIVES

9.4 Explain mechanisms that control the depth and rate of ventilation. Slides 15–19

9.5 Explain the relationships between tidal volume, respiratory rate, minute volume, dead air space, and alveolar ventilation. Slides 20–21

9.6 Describe the physiology of external and internal respiration. Slides 21–22

continued
OBJECTIVES

9.7 Recognize patients at risk for failure of the cardiopulmonary system. Slides 25–35

9.8 Differentiate between adequate breathing, inadequate breathing (respiratory failure), and respiratory arrest. Slides 25–33

9.9 Use information from the scene size-up and patient assessment to anticipate hypoxia. Slides 29–35
OBJECTIVES

9.10 Given a variety of scenarios, differentiate between patients who require artificial ventilation and those who do not. Slides 30–36, 41

9.11 Identify patients who require administration of supplemental oxygen. Slides 30–36, 41

continued
OBJECTIVES

9.12 Discuss the potential negative effects of positive pressure ventilation, and how to minimize complications from positive pressure ventilation. Slides 39–40
OBJECTIVES

9.13 Demonstrate the following techniques of artificial respiration for pediatric (as applicable) and adult medical and trauma patients: Mouth-to-mask, Two-rescuer bag-valve mask (BVM), Flow-restricted, oxygen-powered ventilation device, One-rescuer BVM, Automatic transport ventilator (as permitted by local protocol). Slides 43–59, 62–65

continued
OBJECTIVES

9.14 Assess the adequacy of artificial ventilations. Slides 56, 61

9.15 Demonstrate the application of cricoid pressure. Slide 57

9.16 Modify artificial ventilation and oxygen techniques for patients with stomas. Slides 60–61

continued
OBJECTIVES

9.17 Discuss considerations for selecting the best device for delivering oxygen for a variety of patient scenarios. Slides 76–85

9.18 Demonstrate administration of oxygen by: Nonrebreather mask, nasal cannula. Slides 76–80

continued
OBJECTIVES

9.19 Describe the purpose and use of partial rebreather masks, Venturi masks, and tracheostomy masks. Slides 81–85

9.20 Demonstrate safe transport, storage, and use of oxygen. Slides 69–75

9.21 Describe the purpose of each part of an oxygen delivery system. Slides 69–71, 74–85

9.22 Describe the use of humidified oxygen. Slide 86
• Slide 87   Oxygen Delivery—Simple Mask Video
• Slide 99   In-Hospital Endotracheal Intubation Video
CORE CONCEPTS

- Physiology and pathophysiology of the respiratory system
- How to recognize adequate and inadequate breathing
- Principles and techniques of positive pressure ventilation
- Principles and techniques of oxygen administration
Topics

- Physiology and Pathophysiology
- Respiration
- Positive Pressure Ventilation
- Oxygen Therapy
- Special Considerations
- Assisting with Advanced Airway Devices
Physiology and Pathophysiology
Ventilation

• Process of moving air into and out of chest
Inhalation

- Active process
- Negative pressure pulls air into lungs
Internal Pressure
Decreases, air rushes in
Exhalation

- Passive process
- Muscles relax; size of chest decreases
- Positive pressure created; air pushed out

continued
Internal pressure increases, air rushes out
Respiration Terminology

- Tidal volume—amount of air moved in one breath
- Dead space air—air moved in ventilation not reaching alveoli
- Alveolar ventilation—air actually reaching alveoli
- Ventilation—both inhaling and exhaling

continued
Respiration Terminology

- Diffusion—movement of gases from high concentration to low concentration
- 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
In the Cells

- Oxygen from blood diffused into cell
- Carbon dioxide diffused from cell into blood
Categories of Respiratory System Failure

- Mechanics of breathing disrupted
- Gas exchange interrupted
- Circulation problems
Respiration
Evaluating Respiration

- 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
Evaluating Respiration

- Assesses how well cardiopulmonary system is accomplishing oxygenation and carbon dioxide removal
Respiratory Compensation

• Compensation for hypoxia or hypercapnea is predictable

• Signs
  – Shortness of breath (symptom)
  – Increased respiratory rate and depth
  – Increased heart rate
Respiratory Compensation

• Early on, steps of compensation can meet the needs of the body despite respiratory challenge
Respiratory Distress

- Body compensating for a respiratory challenge and meeting metabolic needs
Patient Assessment: Signs of Respiratory Distress

- Relatively normal mental status
- Relatively normal oxygen saturation and end tidal carbon dioxide
- Relatively normal skin color
- Shortness of breath
- Increased respiratory rate and heart rate
- Accessory muscle use and position changes
Respiratory Failure

- Occurs when challenge overcomes compensation or compensatory steps can no longer continue
- Also known as inadequate breathing
- Exceptionally important to recognize; often a precursor to respiratory arrest
Patient Assessment: Signs of Respiratory Failure

- Signs of respiratory distress
- Evidence that compensation is no longer effective
- Signs of poor oxygenation and/or poor removal of $\text{CO}_2$
- Signs of decompensation

continued
Patient Assessment: Signs of Respiratory Failure

• Signs of failed oxygenation and/or removal of CO$_2$
  – Altered mental status
  – Cyanosis
Patient Assessment: Signs of Decompensation

- No or poor air movement
- Diminished or absent breath sounds
- Breathing rate too rapid, too slow, or irregular
- Patient unable to speak
- Unusual noises (wheezing, crowing, stridor, snoring, gurgling, gasping)
Signs of Respiratory Failure: Pediatric Note

• In addition to other signs, look for retractions and nasal flaring
Critical Decisions: When to Intervene

• Often respiratory failure patients will be breathing and conscious
• Identify adequacy of breathing
  – If breathing is inadequate, immediate intervention is necessary
Think About It

• What signs might identify the need to intervene in a breathing patient?
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
Negative Side Effects of Positive Pressure Ventilation

- Decreasing cardiac output/dropping blood pressure
- Gastric distention
- Hyperventilation
Key Concerns with PPV

- 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
Ventilating a Breathing Patient

- Explain procedure to patient
- After sealing mask on patient’s face, squeeze bag with patient’s inhalation
Mouth to Mask Ventilation

- Performed using a pocket face mask
Performing Mouth to Mask Ventilation

1. Open airway
2. Connect oxygen and run at 15 Lpm
3. Position mask on patient’s face
   - Apex over bridge of nose
   - Base between lower lip and prominence of chin

continued
Performing Mouth to Mask Ventilation

4. Hold mask firmly in place; maintain head tilt
5. Exhale into mask port
6. Allow passive exhalation
Achieving Tight Mask Seal

- Position thumbs over top of mask, index fingers over bottom of mask, and remaining fingers under patient’s jaw.
- Position thumbs along side of mask and remaining fingers under patient’s jaw.
Bag-Valve Mask (BVM)

- Handheld ventilation device
- Used to ventilate nonbreathing patient and/or patient in respiratory failure
Standard Features of BVM

- Self-refilling shell that is easily cleaned and sterilized
- Non-jam valve that allows an oxygen inlet flow of 15 Lpm
- Nonrebreathing valve

continued
Standard Features of BVM

- Ventilation bag
- Nonrebreathing valve
- Exhalation port
- Face mask
- Oxygen supply tubing
- Oxygen supply inlet connection
- Air/oxygen intake valve
- Oxygen reservoir
Mechanics of BVM

• Supply of 15 Lpm O$_2$ attached and enters reservoir
• When squeezed, air inlet closed and oxygen delivered to patient
• When released, passive expiration by patient occurs
Two-Rescuer BVM Ventilation

- 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
Two-Rescuer BVM Ventilation: No Trauma Suspected

1. Open airway with head-tilt, chin-lift maneuver
2. Select correct bag-valve mask size
3. Kneel at patient’s head; position thumbs over top half of mask, index fingers over bottom half
Two-Rescuer BVM Ventilation: No Trauma Suspected

4. Place apex of triangular mask over bridge of nose; lower mask over mouth and upper chin
Two-Rescuer BVM Ventilation: No Trauma Suspected

5. Use middle, ring, and little fingers to bring patient’s jaw up to mask
   – Maintain head-tilt, chin-lift maneuver

continued
Two-Rescuer BVM Ventilation: No Trauma Suspected

6. Second rescuer connects and squeezes bag
7. Second rescuer releases bag; patient exhales passively
Two-Rescuer BVM Ventilation: Trauma Suspected

1. Open airway using jaw-thrust maneuver
2. Select correct bag-valve mask size
3. Kneel at patient’s head; place thumb sides of your hands along mask to hold it firmly on patient’s face

continued
Two-Rescuer BVM Ventilation: Trauma Suspected

4. Use remaining fingers to bring jaw upward toward mask, without tilting head or neck
One-Rescuer BVM Ventilation

1. Open airway
2. Select correct size mask
3. Position mask on patient’s face
4. Squeeze bag
5. Release pressure on bag and let patient exhale passively
If Chest Does Not Rise During BVM Ventilation

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
Artificial Ventilation of a Stoma Breather

1. Clear mucus plugs or secretions from stoma
2. Leave head and neck in neutral position

continued
Artificial Ventilation of a Stoma Breather

3. Use pediatric-sized mask to establish seal around stoma

4. Ventilate at appropriate rate for patient’s age

5. If unable to artificially ventilate through stoma, seal stoma and attempt artificial ventilation through mouth and nose
Flow-Restricted, Oxygen-Powered Ventilation Device
Using Flow-Restricted, Oxygen-Powered Ventilation Device

• Use on adults only
• Follow same procedures for mask seal as for BVM
• Trigger device until chest rises
Using Flow-Restricted, Oxygen-Powered Ventilation Device
Automatic Transport Ventilator (ATV)

- Provides automated ventilations
- Can adjust ventilation rate and volume
- Provider must assure appropriate respiratory rate and volume for patient’s size and condition
Think About It

• How would you decide which positive pressure delivery method to use for your patient?
Oxygen Therapy
Conditions Requiring Supplemental Oxygen

• Respiratory or cardiac arrest
• Heart attacks and strokes
• Shock
• Respiratory distress and lung diseases
• Head injuries
• Other serious injuries
Oxygen Systems

- Portable or installed
Oxygen System Components

Main valve
Pressure regulator
O₂ source
Flow meter
Tubing
O₂ delivery device
Oxygen Cylinders

- Come in various sizes
  - D—about 350 L of \( \text{O}_2 \)
  - E—about 625 L of \( \text{O}_2 \)
  - M—about 3,000 L of \( \text{O}_2 \)
  - G—about 5,300 L of \( \text{O}_2 \)
  - H—about 6,900 L of \( \text{O}_2 \)
Oxygen Safety

- Use pressure gauges, regulators, and tubing intended for use with oxygen
- Use non-sparking wrenches
- Replace disposable gaskets each time a cylinder is changed
- Properly secure oxygen cylinders in a cool, ventilated space
- Never drop cylinder or move by dragging
Oxygen Safety

• Never leave cylinder in upright position without being secured
• Never allow smoking around oxygen or use oxygen equipment around open flame
• Never use grease or adhesive tape on a cylinder
• Test cylinders hydrostatically every 5 years
Pressure Regulator

continued
Pressure Regulator
Delivery Devices: Nonrebreather Mask

• Best way to deliver high concentrations of oxygen to a breathing patient
Delivery Devices: Nonrebreather Mask

continued
Delivery Devices: Nonrebreather Mask

- Provides oxygen concentrations of 80%–100%
- Minimum flow rate 8 Lpm
- Maximum flow rate 12–15 Lpm
Delivery Devices: Nasal Cannula

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

continued
Delivery Devices: Nasal Cannula

- Provides oxygen concentrations of 24%–44%
- Should deliver no more than 4–6 liters per minute
Delivery Devices: Partial Rebreather Mask

- Very similar to nonrebreather mask
- No one-way valve in opening to reservoir bag
- Delivers 40%–60% oxygen at 9–10 Lpm
Delivery Devices: Venturi Mask

- Delivers specific concentrations of oxygen by mixing oxygen with inhaled air
- Some have set percentage and flow rate; others have adjustable Venturi port
Delivery Devices: Venturi Mask
Delivery Devices: Tracheostomy Mask

- Placed over stoma or tracheostomy tube to provide supplemental oxygen
- Connected to 8–10 Lpm

continued
Delivery Devices: Tracheostomy Mask
Humidifier

- Connected to flowmeter
- Provides moisture to dry oxygen from supply cylinder
Oxygen Delivery—Simple Mask Video

Click [here](#) to view a video on the subject of oxygen delivery using a simple mask.
Special Considerations
Facial Injuries

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

- Foreign bodies can impede ventilation of patients
- If unable to ventilate always consider the possibility of obstruction
Pediatric Notes

• Hypoxia often occurs rapidly
  – Children burn oxygen at twice the rate of adults
  – Account for many anatomical differences associated with airway
Ventilating Pediatric Patients

- Avoid excessive pressure and volume
- Use properly sized face masks
- Flow-restricted, oxygen-powered ventilation devices contraindicated
- Gastric distention may impair adequate ventilations
Assisting with Advanced Airway Devices
Types of Advanced Airway Devices

- Devices requiring direct visualization
- Devices inserted “blindly”
Assisting with 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
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 Devices

• Examples
  – King LT-D™ airway
  – Combitube®
  – Laryngeal Mask Airway (LMA™)

• Usually do not require head to be placed in sniffing position
In-Hospital Endotracheal Intubation Video

Click [here](#) to view a video on the subject of in-hospital endotracheal intubation.
Chapter Review

• Respiratory failure (inadequate breathing): breathing 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
Chapter Review

• Oxygen can also be administered as therapy to the breathing patient.
• Supplemental oxygen is indicated when breathing is inadequate or in patients that have a condition that would benefit from additional oxygen delivery.
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.
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
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?
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
Critical Thinking

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