Chapter 6

Airway

Learning Objectives

- Identify and label major structures of the respiratory system on a diagram
- List signs of adequate & inadequate breathing
- Describe steps in performing a head-tilt/chin lift
- Relate MOI to opening the airway
- Describe steps in performing a jaw thrust

Learning Objectives

- State the importance of having a suction unit ready for immediate use when providing emergency care
- Describe techniques of suctioning
- Describe how to measure and insert an OPA & an NPA
- Describe how to ventilate with a pocket mask
Learning Objectives

- List steps in performing mouth-to-mouth artificial ventilation
- Describe steps in ventilating a patient with a bag-mask device while using the jaw thrust
- List parts of a bag-mask system
- Describe steps in artificially ventilating a patient with a bag-mask device

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Learning Objectives

- Describe signs of adequate & inadequate ventilation using the bag-mask device
- Describe the steps in ventilating with a flow-restricted, oxygen-powered ventilation device
- Define components of an O₂ delivery system
- Identify nonrebreather face mask; state the O₂ flow requirements for its use

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Learning Objectives

- Indicate when to use nasal cannula vs. nonrebreather face mask
- Identify nasal cannula; state flow requirements
- List steps in performing mouth-to-stoma artificial ventilation for adult, child, infant
- Demonstrate O₂ delivery for infant & child
- Describe signs of FBAO
Introduction

- Assess ABCs on every call
- Airway, ventilation, oxygenation management
  - First priority
- Must be able to clear, maintain airway via:
  - Manual techniques
  - Suctioning
  - Mechanical techniques

- Inadequate breathing
  - Assist with positive-pressure ventilation
    - Mouth-to-mask device
    - Bag-mask device
    - Flow-restricted, O₂-powered ventilator
  - Give supplemental O₂ via:
    - Nasal cannula
    - Nonrebreather masks
    - Positive-pressure ventilation devices

- Inadequate breathing
  - Get a general impression
    - Respiratory distress
    - Supplemental O₂
    - Possible medication
    - Patient positioning
    - Rapid transport
    - Ongoing assessment for signs of respiratory failure
  - Respiratory failure:
    - Ensure open airway
    - Provide positive-pressure ventilations
Anatomy & Physiology

- Respiratory system - 3 main functions:
  - O₂ from atmosphere to blood
  - CO₂ from blood
  - Voice creation

Anatomy & Physiology

- Airway & alveoli
  - Nose
    - Nasal passage – 1st portion of airway
    - Divided into 2 compartments by nasal septum
    - Functions:
      - Filtering
      - Moistening
      - Warming air before it enters lungs
Anatomy & Physiology

Airway & alveoli
- Pharynx
  - Passage extending from back of nasal airway down to esophagus, larynx
  - Nasopharynx
  - Oropharynx
  - Laryngopharynx

Epiglottis & larynx
- Epiglottis - flap of cartilage that covers larynx during swallowing
- Larynx - contains vocal cords
  - Thyroid cartilage
  - Cricoid cartilage
Anatomy & Physiology

- Airway & alveoli
  - Trachea
    - Extends down from larynx
    - Hollow tube with horseshoe-shaped cartilage rings anteriorly that give support
    - Posterior surface - muscular wall

- Bronchi & bronchioles
  - Bronchi
    - Trachea subdivides into 2 tubes
    - Bronchi subdivide into smaller bronchi
  - Bronchioles
    - Smallest type of airway tube
    - Tubes change diameter as muscle constrict/dilate
Alveoli
- Microscopic air sacs within lung where gas exchange takes place

Lungs & muscles of breathing
- Lungs
  - Formed by bronchi, bronchioles, alveoli
  - Suspended in thoracic cavity
  - Separated by mediastinum
  - Rib, thoracic spine, scapula, muscles surround & provide protection, function
  - Clavicle, neck - superior
  - Diaphragm – inferior
  - Pleurae

Muscles of respiration
- Change diameter of chest cavity as they contract, relax & cause air to move in/out of lungs
- Diaphragm - main muscle of respiration, aided by external intercostals muscles
Anatomy & Physiology

Lungs & muscles of breathing
- Accessory muscles of respiration
  - When more air exchange needed, gives added volume with each breath
  - Muscles of inspiration
  - Muscles of expiration

Anatomy & Physiology

Physiology of respiration
- Minute volume
  - Adequate air amount inhaled/exhaled each minute
  - Normal adult: 6 to 10 L/min
- Alveolar, capillary, cellular exchange
  - Diffusion - movement of molecules from area of higher concentration to area of lower concentration
  - O₂ → alveoli → capillaries
  - CO₂ → capillaries → alveoli

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Adequate vs. Inadequate Breathing

- **Dyspnea**
  - Difficulty breathing, shortness of breath
  - Common symptom with respiratory emergency

- **Brain most O$_2$-dependent organ**
  - Change in mental status needs positive-pressure ventilation, high O$_2$ concentration

Adequate vs. Inadequate Breathing

- **Respiratory emergencies**
  - Require O$_2$
  - Positive-pressure ventilation

Adequate vs. Inadequate Breathing

- **Respiratory distress**
  - Patient works harder to breathe
  - Signs:
    - ↑ respiratory rate
    - ↑ accessory muscle use
    - Nasal flaring
    - Tripod or bolt upright position
    - Difficulty speaking in complete sentences
    - Agitation or restlessness
Adequate vs. Inadequate Breathing

- Respiratory failure
  - Inadequate ventilation to support life
  - Not able to maintain mental status, display muscle tone
  - Inadequate amount of air to lungs
Adequate vs. Inadequate Breathing

- Respiratory arrest
  - Complete cessation of breathing
  - Can progress to cardiac arrest
  - Can occur from
    - Electrocution
    - Lightning strikes
    - Spinal cord injury

- Signs of adequate & inadequate breathing
  - Determine whether respiratory distress or respiratory failure
  - Treatment differs
    - All patients need supplemental O₂
    - Patients in respiratory failure/arrest need positive-pressure ventilation
Adequate vs. Inadequate Breathing

- Signs of adequate & inadequate breathing
  - Rate of breathing
    - Normal
      - Adult: 12 to 20 breaths/min
      - Child: 15 to 30 breaths/min
      - Infant: 25 to 50 breaths/min
  - Rhythm of breathing
    - Regular
      - Consistent rise & fall of chest
    - Irregular
      - Increasing & decreasing rates, tidal volumes interspersed with periods of no breathing
Adequate vs. Inadequate Breathing

- Signs of adequate & inadequate breathing
  - Quality of breathing
    - Assessment
      - Look for chest/abdominal movements
      - Look for use of accessory muscles
      - Listen for breath sounds
      - Feel air movement through mouth, nose
      - Inspect skin
      - Evaluate mental status

Opening the Airway

- Airway management goals
  - Establish, maintain patent airway
  - Ensure adequate ventilation
  - Ensure adequate oxygenation
Opening the Airway

- Manual techniques
  - 1st step in opening airway
  - Use in conjunction with mechanical techniques
  - Techniques routinely used
    - Head-tilt/chin-lift
    - Jaw thrust

Relaxed tongue causes airway obstruction
Opening the Airway

- Suctioning
  - General considerations
    - Act of introducing soft, rigid catheter into airway to vacuum out liquid and small, solid secretions
    - Check suction equipment regularly
      - Should be capable of removing thick secretions, provide negative pressure of at least 300 mm Hg (80 to 120 mm Hg for children; 100 mm Hg for infants)
Skill 6-1: Suctioning—Rigid Catheter

- Connect rigid catheter to suction line
- Turn on suction unit; ensure presence of negative pressure

Skill 6-1: Suctioning—Rigid Catheter

- Open mouth by cross-finger technique
- Place catheter tip into posterior pharynx

Skill 6-1: Suctioning—Rigid Catheter

- Initiate suctioning by closing hole of rigid catheter or turning on suction device
- Suction from side to side no more than 15 seconds
Skill 6-1: Suctioning—Soft Catheter

- Attach soft catheter
- Measure from corner of mouth to earlobe

Skill 6-1: Suctioning—Soft Catheter

- Insert catheter into oral cavity without suction
- Insert only to base of tongue

Skill 6-1: Suctioning—Soft Catheter

- Apply suction
- Move catheter tip from side to side with twisting motion
- Suction no more than 15 seconds
Opening the Airway

- **Suctioning**
  - Infants & children
    - Use rigid catheter to suction upper airway
    - Do not touch back of airway
    - Become hypoxic with prolonged suctioning
    - Nasal suctioning, use bulb suction device/small, soft catheter with low to medium vacuum

Opening the Airway

- **Mechanical techniques**
  - OPA
    - Elevates tongue away from oropharynx in unconscious patients without gag reflex
    - Curved plastic extends just anterior to lips down to tongue base in oropharynx
Opening the Airway

Skill 6-2: Inserting an OPA

- Measure airway from corner of mouth to angle of jaw

Skill 6-2: Inserting an OPA

- Place index finger of one hand on top teeth, thumb on lower teeth
- Apply pressure in opposite directions
- Insert device into mouth with tip pointing toward roof
Skill 6-2: Inserting an OPA

- Advance OPA along hard palate until you reach soft palate, then rotate into position
- Insert without interruption of ventilation

Once in place, test patency by ventilating or look, listen, feel for breathing

Can also be inserted by restraining tongue with tongue blade
- Insert OPA following normal curvature of mouth & pharynx
Opening the Airway

Mechanical techniques
- NPA
  - Same purpose as OPA, used when OPA not tolerated
  - Gag reflex present
  - Mouth cannot open from trauma/clenching teeth
  - Do not use with severe, direct facial injury, possible skull fracture
  - Extends from nares down to oropharynx

Skill 6-3: Inserting an NPA
- Measure airway from nose to angle of jaw
- Lubricate outside of tube with water soluble gel
Skill 6-3: Inserting an NPA

- Insert with bevel facing toward septum
- Test patency by ventilating patient or look, listen, feel for breathing

Positive-Pressure Ventilation

- Mouth-to-mouth/mouth-to-barrier device
  - Barrier device protects EMT
  - Mouth-to-mask, pocket mask, seals around patients mouth & nose with an air-filled bladder
  - One-way valve prevents exhaled air from reaching EMT
  - Use 2 hands to create mask seal, lung compliance while delivering rescue breath

Positive-pressure Ventilation

- Mouth-to-mask/mouth-to-barrier device
  - Breathe until chest rise over a 1-second period
  - O₂ can be delivered through port on top of mask
  - Pinch patient’s nose, deliver slow breath over 2-seconds through valve filter
  - Pocket mask preferred over face shield
Skill 6-4:
Mouth-to-Mask – No Suspected Spinal Injury

- Position adjacent to head
- Apply mask to face using nose bridge as guide

Skill 6-4:
Mouth-to-Mask – No Suspected Spinal Injury

- Place index finger, thumb of hand closer to top of head along mask border
  - Place thumb of other hand along lower mask margin
  - Place remaining fingers along bony margin of jaw
Skill 6-4:
Mouth-to-Mask – Suspected Spinal Injury

- Position directly above head
- Apply mask to face using nose bridge as guide
- Use thumb, heel to make complete seal

Skill 6-4:
Mouth-to-Mask – Suspected Spinal Injury

- While lifting jaw, squeeze mask with thumbs, hand heels
- Give slow breaths by blowing exhaled air into valve attached to mask

Positive-Pressure Ventilation

- Bag-mask
  - Most common
  - Most unreliable if used improperly
  - O₂ inlet provides increased concentration to patient
  - O₂-collecting reservoir delivers 90% to 100% O₂
Positive-pressure Ventilation

- Bag-mask

- Features
  - Self-refilling disposable bag
  - Non-jamming valve, allows maximum O₂ inlet flow of 15 L/min
  - Standardized fittings of 15 & 22 mm
  - True nonrebreather valve
  - Performs in all environmental extremes

Positive-Pressure Ventilation

Skill 6-5: Bag-Mask Ventilation

- After opening airway, insert oral/nasal device, attach mask
- EMT at head places hand on each side of mask
Skill 6-5: Bag-Mask Ventilation

- Maintaining head-tilt/chin-lift position, EMT at head places mask on patient’s face
  - Creating a seal around nose & mouth

- Connect bag-mask to high-flow O₂
- 2nd EMT squeezes bag, watching for chest rise
- If neck injury, use jaw thrust

- If only 1 EMT, use 1 hand to grasp mask, with thumb & index finger, place mask on patient’s face
  - Use other fingers to bring jaw up to mask
- With other hand, squeeze bag
Positive-Pressure Ventilation

- Cricoid pressure
  - Air can enter esophagus and cause gastric inflation, increase vomiting/aspiration risk
  - Use Sellick maneuver
    - Compress esophagus between cricoid cartilage & thoracic spine

Positive-Pressure Ventilation

- Flow-restricted, O₂-powered ventilation device
  - Provides highest delivered O₂ concentration
    - 100%
Positive-Pressure Ventilation

O₂ Therapy

- O₂, colorless, odorless gas plentiful in environment
- Anyone in respiratory distress/failure receives supplemental O₂
- EMTs carry in tanks/cylinders

O₂ Therapy

- O₂ cylinders
  - Large gas quantity, stored at very high pressure
  - Color-coded green
  - Pin index safety system
O₂ Therapy

- O₂ cylinders
  - Cylinder sizes
    - Smaller - D or E
    - Larger - M, G, H

- Regulators
  - Reduces high gas pressure in cylinder
  - Single-staged
  - Double-staged
  - Pressure gauge
  - Flowmeter records flow rate
O₂ Therapy

- O₂ cylinders
  - Cylinder calculations

  \[
  \text{Time (min)} = \left( \text{Tank pressure [psi]} - 200 \text{ psi} \right) \times \text{Constant} \\
  \text{Flow rate (L/min)}
  \]

Skill 6-6: Setting Up O₂ System

- Confirm cylinder contains O₂
  - Identify color & pin index grouping

- Ensure rubber washer in place at cylinder opening or regulator opening
Skill 6-6: Setting Up O₂ System

- Open main valve at cylinder top slowly until gas comes out; then immediately close valve

Skill 6-6: Setting Up O₂ System

- Attach regulator
  - Align pin index from regulator into cylinder holes
- Tighten clamp

Skill 6-6: Setting Up O₂ System

- Open valve 2 full turns
- Check pressure gauge – should read approximately 2000 psi
- If cylinder leaks, turn off main valve
Skill 6-6: Setting Up $O_2$ System

- Attach tubing or delivery device to regulator
- Adjust liter flow

Skill 6-6: Setting Up $O_2$ System

- Attach delivery device to patient

Skill 6-7: Discontinuing $O_2$ System

- Remove $O_2$ delivery device from patient
- Turn off $O_2$ flow
Skill 6-7: Discontinuing O₂ System

- Turn off main valve at top of cylinder

Skill 6-7: Discontinuing O₂ System

- Open flowmeter valve to bleed O₂
- Detach regulator by loosening clamp
- Mark cylinder as empty

O₂ Therapy

- O₂ administration devices
  - When patients are ventilating adequately but in need of supplemental O₂
    - Nasal cannula
      - Low-flow, low-concentration
      - 24% to 40% concentration
      - 2 to 6 L/min flow rate
    - Indications:
      - COPD
      - Asthma
      - Uncomplicated chest pain
      - Dyspnea, hypoxia

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Skill 6-8: Applying a Nasal Cannula

- Place nasal cannula prongs into nares
- Guide tubing around ears, under chin
- Adjust fit under chin

O₂ Therapy

- O₂ administration devices
  - Nonrebreather mask
    - High-flow, high-concentration
    - Up to 90% concentration
    - 10-15 L/min
    - Indications:
      - Respiratory distress
      - Shock
      - Poor tissue oxygenation
Skill 6-9: Applying a Nonrebreather Mask

- Prefill reservoir bag with O₂ by placing 2 fingers inside mask and closing off valve

Skill 6-9: Applying a Nonrebreather Mask

- Extend elastic strap
- Place mask over patient’s head
- Cinch metal band on nose, adjust strap

O₂ Therapy

- O₂ administration devices
  - Pulse oximetry
    - Monitors O₂ saturation
    - Colorimeter
    - Normal hemoglobin saturation: 93% to 100%
    - More than 95% - good saturation
    - Less than 95% - hypoxia
O₂ Therapy

- O₂ administration devices
  - Pulse oximetry
    - Accuracy affected by:
      - Excessive ambient light
      - Conditions that reduce circulation to peripheral arteries:
        - Cardiac arrest
        - Hypotension
        - Hypothermia
        - Vasodilation drugs
        - CO poisoning

- Humidification
  - Moisturizes inspired O₂
  - Loosens secretions, prevents airway drying
  - Useful in smoke inhalation
  - Prevent contamination of device
Special Patient Populations

- Patients with stomas
  - Permanent/temporary breathing tube or tracheostomy or laryngectomy
  - Obstructed stoma requires suctioning

- If positive-pressure ventilation required:
  - Breathe directly through opening/tube
  - Place infant/child mask directly over stoma
  - Extension of head, neck not necessary
  - Squeeze bag, observe chest rise
  - If you are unable to ventilate through stoma, attempt to breathe through upper airway
  - If patient has a tube coming out of stoma, attach bag-mask device directly to tube

Special Patient Populations
Special Patient Populations

- Infants & children
  - Airway differs from adults
    - Internal diameter - smaller at all levels
    - Tongue larger in relation to airway; greater obstruction risk
    - Narrowest part of airway - ring formed by cricoid cartilage
    - Larynx, trachea cartilage softer
    - Chest wall softer; diaphragmatic breathing

- Differences have practical implications
  - Infants - head placed in sniffing, neutral position
  - Toddlers, small children - neck extended slightly
  - Keep tongue from obstructing airway
  - Small obstructions may cause significant blockage
Special Patient Populations

- Patients with facial injuries
  - Because of rich blood supply to face, blunt injuries cause severe bleeding
  - Makes airway management difficult
  - Have suctioning readily available
  - Bleeding in cheek, mouth controlled with direct pressure
  - Turn head to aid drainage

Special Patient Populations

- Patients with dental appliances
  - Dentures remain in place during airway management
  - Give form to face, help create better seal with mask device
  - If loose, may obstruct airway
  - If dislodged, remove, continue ventilation

Special Patient Populations

- Patients with COPD
  - Ordinary control of ventilatory drive is CO₂ level in blood
  - Have chronic CO₂ buildup from lung disease, brain desensitized to CO₂
  - When patients are severely hypoxic, in shock, or respiratory arrest:
    - Administer high-concentration O₂, monitor for possible respiratory depression/arrest
Airway Obstruction

- Perform BLS procedures
- If unsuccessful × 3 - rapid transport, continue efforts en route

Airway Obstruction

- Choking
  - Death within minutes
  - Tongue obstructs pharynx from lower jaw muscle relaxation
  - Epiglottis blocks airway in unconscious patients
  - Head/facial injury bleeding, vomiting may cause obstruction

Skill 6-10: Adult Choking

- Ask, “Are you choking?”
Skill 6-10: Adult Choking

- Move behind choking victim, place 1 hand on abdomen above umbilicus, below ribs
- Reach around with other hand, grab 1st hand, hold firmly

Skill 6-10: Adult Choking

- Give abdominal thrusts
- Repeat until object expelled or victim becomes unresponsive

Skill 6-10: Adult Choking

- If victim becomes unconscious, help safely to ground
- Perform tongue-jaw lift
Skill 6-10: Adult Choking

- Ventilate patient
- If unsuccessful, start CPR
- Repeat tongue-jaw lift, ventilation, CPR

Airway Obstruction

- Recognition of airway obstruction
  - Mild obstruction
    - Responsive patients cough forcefully with wheezing between coughs
    - Encourage coughing, monitor patient
  - Severe obstruction
    - Weak, ineffective cough
    - High-pitched noises while inhaling
    - ↑ respiratory difficulty
    - Inability to talk
    - Possible cyanosis
    - May clutch neck
    - Provide abdominal thrusts
Airway Obstruction

- Relief of choking
  - Abdominal thrust with victim standing/sitting
    - Stand behind victim, wrap around waist
    - Make fist with 1 hand
    - Grasp fist with other hand
    - Press into victim’s abdomen with quick upward thrusts

Airway Obstruction

- Relief of obstruction
  - Abdominal thrusts with responsive victim lying down
    - Kneel astride thighs
    - Place heel of hand against abdomen, midline slightly above navel, below tip of xiphoid
    - Place other hand directly on top of fist
    - Press with quick upward thrusts

Airway Obstruction

- Relief of obstruction
  - Chest thrusts with victim standing/sitting
    - For late pregnancy, obese patient
    - Stand behind victim, arms directly under armpits, encircle chest
    - Place thumb side of 1 fist on lower half of sternum, avoid xiphoid process, margins of rib cage
    - Grasp fist with other hand, administer backwards thrusts
Airway Obstruction

- Relief of obstruction
  - Chest thrusts with responsive victim lying down
    - For late pregnancy, unconscious obese patient
    - Place patient on back, kneel close to side
    - Hand placement & technique same as CPR chest compressions

- Relief of obstruction
  - Finger sweep & tongue-jaw lift
    - Finger sweep not used with seizures
    - Open mouth, grasp tongue & lower jaw between thumb, fingers lifting mandible
    - Draw tongue/foreign body away from back of throat
    - If you see an object, insert index finger along side cheek deeply into throat to tongue base
    - Use hooking action to dislodge

Airway Obstruction

- Relief of foreign body airway obstruction in unresponsive victim
  - CPR
  - Open airway using tongue-jaw lift, look for object
  - If object seen, remove using finger sweep
  - If object not seen, give rescue breaths & chest compressions
  - If you feel resistance to airflow and have no chest rise:
    - Reopen airway, try again
    - If air does not go in, start CPR
    - Each time you open airway, look for object
Summary

- Respiratory system brings O₂ into body, rids CO₂

- Respiratory system composed of:
  - Nose
  - Mouth
  - Nasopharynx
  - Oropharynx
  - Larynx
  - Epiglottis
  - Trachea
  - Bronchi
  - Bronchioles
  - Alveoli
  - Lungs

Summary

- Diaphragm, chest muscles cause thoracic cavity to expand/contract, create airflow during ventilation
  - Inhalation when diaphragm, intercostal muscles contract, enlarge thoracic cavity
  - Exhalation when diaphragm, intercostals relax, decrease thoracic cavity size

- O₂ & CO₂ exchange occurs at alveoli & capillaries through diffusion

- Accessory muscles help increase respiratory volumes during exercise, respiratory disease

Summary

- Inadequate breathing - respiratory rate outside of normal, irregular rhythm, abnormal breathing quality
  - Pale, cool, cyanotic skin
  - Retractions
  - Nasal flaring
  - Seesaw breathing
  - Agonal respirations
Summary

- Respiratory distress requires increased work of breathing
  - Increased respiratory rate
  - Accessory muscle use
  - Nasal flaring
  - Position to aid breathing (tripod or bolt upright)

- Respiratory failure - inadequate ventilation to support life & cannot maintain mental status/muscle tone; needs positive-pressure ventilation

- Respiratory arrest - complex cessation of breathing
  - Can progress to respiratory/cardiac arrest

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Summary

- Airway opened by using head-tilt/chin-lift/jaw thrust

- Suctioning used to clear liquid, small solid secretions with soft/rigid catheter
  - Never suction >15 sec

- OPA used for unconscious patient with no gag reflex

- NPA for patients who will not tolerate OPA

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Summary

- Mouth-to-mask ventilation reliable, allows EMT to create mask seal with 2 hands, feel chest wall compliance, administer supplemental O₂

- Bag-mask ventilation most common

- Cricoid pressure used to compress esophagus, prevent gastric inflation during positive-pressure ventilation
Summary

- Positive-pressure ventilation provided using:
  - Mouth-to-mask
  - Bag-mask
  - Flow-restricted, O₂-powered ventilation device
- O₂ stored in green steel/aluminum cylinders, used with regulators
- 2 most common free-flow O₂ devices include nasal cannula & nonrebreather mask

Summary

- Pulse oximetry assesses O₂ saturation in blood
- When delivering O₂ with COPD, prepare to assist with ventilations
- Laryngectomy/stoma ventilated directly through opening in neck
- BLS airway obstruction procedures used to clear foreign object

Summary

- Choking in adults usually occurs during eating
- Severe airway obstruction signs:
  - Weak, ineffective cough
  - High-pitched noises while inhaling
  - Increased respiratory difficulty
  - Inability to talk
  - Possible cyanosis
Summary

- Abdominal thrusts recommend for choking relief
- When treating COPD patients, administer O₂; closely monitor ventilations

Questions?