Airway Management

Lesson Goal

- Learn fundamental principles of airway management and quickly recognize and decisively manage patients whose breathing is threatened

Lesson Objectives

- Identify major structures of respiratory system & explain basic mechanics and physiology of breathing
- Recognize and explain signs of adequate & inadequate breathing in pediatric & adult patients
Lesson Objectives

- Define indications for airway adjuncts and explain correct insertion
- Deliver assisted ventilations effectively to patients with compromised breathing by mouth-to-mask, bag-mask, and flow-restricted ventilator techniques

Lesson Objectives

- Explain different oxygen delivery systems along with advantages & disadvantages of each
- List special anatomic & physiologic considerations in evaluating and treating special populations, such as infants & children with airway compromise

Introduction

- Proper management of patient’s airway & breathing is the difference between life and death
Anatomy & Physiology

• Purpose of breathing
  ➢ Supply O₂
  ➢ Eliminate CO₂

• Understanding airway anatomy & physiology is essential to proper evaluation & management of patients whose breathing is compromised

Respiration & Ventilation

• Respiration
  ➢ Physiologic process
  ➢ O₂ drawn into lungs & delivered via erythrocytes
  ➢ O₂ exchanged for waste products of cellular metabolism

• Ventilation
  ➢ Mechanical process
  ➢ O₂ inspired deep into lungs & CO₂ exhaled
Normal Respiratory Tract Anatomy

- Upper respiratory tract
  - Nose
  - Mouth
  - Pharynx
    - Nasopharynx
    - Oropharynx
  - Larynx
    - Thyroid cartilage
  - Trachea
    - Cricoid cartilage
    - Cricothyroid membrane

Upper Airway
Larynx & Upper Trachea

Normal Respiratory Tract Anatomy

- Lower respiratory tract
  - Bronchi
  - Carina
  - Bronchioles
  - Alveoli

Lower Airway
Breathing

- Normal inspiration
  - Diaphragm contracts downward
  - Volume of thoracic cavity increases, resulting in lower pressure within chest relative to outside atmosphere
  - Air is drawn through respiratory tract into lungs

Inspiration

- When greater volumes of air are required for breathing, additional expansion of thoracic cavity is necessary
  - Heavy exercise
  - Airway obstruction

- Accessory muscles
  - Further expand rib cage up and out
  - Generate added intrathoracic volume
Muscles of Respiration

Muscles of Breathing

Breathing

- Exhalation
  - Simple, passive relaxation of diaphragm & accessory muscles
  - Reducing volume of thoracic cavity generates positive intrathoracic pressure, reversing airflow
Exhalation

Breathing

- Tidal volume
  - Amount of air taken into lungs with single inspiration and subsequently exhaled
  - ~500 mL in average healthy adult

- Minute ventilation
  - Tidal volume of average breath x number of times individual breathes over 1 min

Assessment

- Focused evaluation
  - Adequate breathing & ventilation

- Dyspnea
  - Patient usually anxious & breathing at abnormally high rate
  - Assessment
    - Determine patency of airway
    - Determine effectiveness of breathing
Airway

- Patients with open airway
  - Responsive
  - Speaking

- Patient with major or total airway obstruction
  - Initially may show obvious signs of panic & agitation
  - Progress to lethargy & unconsciousness—↓ O₂ delivery to brain

Airway

- Apnea
  - Absence of respirations
  - Skin possibly cyanotic, cool, diaphoretic

- Cyanosis
  - Dusky blue appearance that reflects inadequate oxygen delivery to tissues
  - Late sign of ↓ O₂ in conscious patient

Airway

- Responsive airway-compromised patient may
  - Be cyanotic
  - Have distorted speech, shortened to 1- or 2-word gasps
  - Will try to maintain position that maximizes patency of airway
Airway

- Unconscious, supine patient
  - Tongue may fall back & block airway
  - Sonorous, snoring respirations
  - Potential apnea

- Other signs of potential airway compromise
  - Stridor
  - Changes in pitch or volume of patient’s voice
  - Drooling
  - Mild increases in respiratory rate & work of breathing

Breathing

- Assessment of respirations
  - Rate
  - Depth
  - Quality
  - Rhythm
Rate of Breathing

- Normal respiratory rates vary by age
  - Infants: 25-50 breaths per minute
  - Children: 15-30 breaths per minute
  - Adults: 12-20 breaths per minute

Depth of Breathing

- Dead space
  - Volume of gas that stays in upper airway, bronchi & bronchioles at end of inspiration
  - Does not reach alveoli for gas exchange
  - Each breath must be > dead space for fresh air to reach alveoli

- Hypoventilation
  - Failure to exchange enough air with each respiration

Quality of Breathing

- Symmetry of chest wall
- Accessory muscle use
  - May not be obvious in infants & children
- Paradoxical breathing
- Wheezing
- Rales
Rhythm of Breathing

- Regular or irregular
- Agonal respirations

Management

- Opening airway
- Suctioning
- Airway adjuncts
- Assisted ventilation
- Supplemental O₂

Opening Airway

- Jaw muscles relax in unresponsive patient, allowing tongue to obstruct airway
- Head-tilt/chin-lift maneuver elevates jaw, pulling tongue forward, out of hypopharynx
- Head-tilt/chin-lift not used for patients with suspected cervical spine injury
  - Use jaw thrust
Skill 7-1: Head-Tilt/Chin-Lift

1. Place patient in supine position
2. Kneel at patient’s side
3. Place palm of one hand on patient's forehead and fingers of other hand on bony underside of patient’s chin

4. Gently tilt head backward and lift chin to pull tongue forward and open airway
Skill 7-2: Jaw Thrust

1. Place patient in supine position while maintaining inline c-spine stabilization
2. Stand or kneel behind patient’s head
3. Place hands on either side of patient’s head
4. With thumbs of each hand positioned on patient’s cheeks, place ring fingers of each hand behind angle of patient’s mandible

Skill 7-2: Jaw Thrust

5. While maintaining inline C-spine stabilization, push mandible forward to pull tongue forward and open airway
Suctioning

- Indications
  - When attempts to open airway fail
  - When gurgling or stridor heard
  - When liquids or solids visible in oropharynx
- Wear appropriate BSI when suctioning

Suctioning

- Suction units
  - Wall-mounted
  - Portable
- Catheters
  - Rigid
    - Suction visible matter
  - Soft
    - Do not insert past base of tongue

Skill 7-3: Suctioning

1. Assemble proper equipment
2. Rigid catheter:
   Measure length equal to distance from tip of nose to top of ear
Skill 7-3: Suctioning

3. Test assembly by turning on suction device. Suctioning may be tested by sealing side port on catheter with 1 finger. Once proper function confirmed, remove finger from port or turn off device.

Skill 7-3: Suctioning

4. Insert suction catheter into patient’s mouth or nose to maximal depth (as far as direct visualization allows for tip of rigid catheter or as far as base of tongue for soft catheter).

Skill 7-3: Suctioning

5. Turn on suction device or cover catheter side port with 1 finger to initiate suctioning.
Skill 7-3: Suctioning

6. Slowly withdraw catheter while sweeping from side to side to clear airway. Do not suction for >15 sec (less for infant or small child). Ventilate patient for ≥2 min before any repeat suction attempt.

Airway Adjuncts

- Oropharyngeal airway (OPA)
  - Provides channel for airflow between tongue & posterior pharynx.
  - May not be used if gag reflex present.
Skill 7-4: OPA Insertion

1. Select properly sized OPA (length should match distance from corner of mouth to angle of mandible)

2. Open patient’s mouth and insert airway with its curve opposite to curve of patient’s tongue

3. When tip of device is positioned in posterior pharynx, rotate OPA 180° so that curve of device is parallel to curve of patient’s tongue and phalange is resting at patient’s front teeth
Skill 7-4: OPA Insertion

4. Alternatively, use tongue depressor to pull tongue forward and down. Insert OPA, with its curve parallel to patient's tongue, until tip of device rests in posterior pharynx and phalange is against patient's front teeth. Suction as necessary and initiate assisted ventilations.

Airway Adjuncts

- Nasopharyngeal airway (NPA)
  - May be tolerated by patients with gag reflex
  - Should not be used in patients with significant midfacial trauma
Skill 7-5: NPA Insertion

1. Select properly sized NPA (length should match distance from end of patient’s nose to tip of ear)

Skill 7-5: NPA Insertion

2. Apply water-soluble lubricant to tip of NPA

Skill 7-5: NPA Insertion

3. Select larger of patient’s two nares as place of insertion. Insert tip of NPA with bevel oriented toward patient’s nasal septum or base of nose
Skill 7-5: NPA Insertion

4. Apply gentle, steady pressure until device is inserted to its full length with phalange resting at opening of naris. Suction and begin assisted ventilation as necessary.

Assisted Ventilation

- For responsive or unresponsive patients with absent or inadequate breathing:
  - Mouth-to-barrier
  - Mouth-to-mask
  - Bag-mask device
  - Flow-restricted ventilator
Skill 7-6: Mouth-to-Barrier Ventilation

1. Put on appropriate PPE; position yourself at patient’s head; maintain open airway through use of manual or mechanical techniques.

2. Place barrier device over patient’s mouth.

Skill 7-6: Mouth-to-Barrier Ventilation

3. Place your mouth over mouthpiece, pinch nostrils, and breathe slowly into patient’s mouth over 1 1/2 - 2 sec (adult) or 1-2 sec (infant or child). Delivery of your breath should cause patient’s chest to visibly rise.

Skill 7-6: Mouth-to-Barrier Ventilation

4. Remove your mouth from mouthpiece and release patient’s nose to allow patient to exhale; continue rescue breathing at a rate of 1 breath every 5-6 sec (adult or older child) or 1 breath every 3-5 sec (child or infant).

5. Continue to maintain open airway and watch for signs that patient has vomited or has started breathing on his/her own.
Assisted Ventilation

- Mouth to mask
  - Easy to carry
  - Can deliver adequate volume
  - Requires supplemental O₂
  - Can fatigue EMT quickly

Skill 7-7: Mouth-to-Mask Ventilation

1. Assemble face mask with one-way breathing valve
2. Designate 1 EMT to stand or kneel behind supine patient
3. If trauma is suspected, immobilize head and neck
4. Insert oral or nasal airway

Skill 7-7: Mouth-to-Mask Ventilation

5. EMT positioned at patient’s head applies mask to patient’s face with apex over nose and base over mouth. Airtight seal is obtained by applying pressure to upper, nasal portion of mask with both thumbs and to lower segment of device with each forefinger. Remaining fingers of each hand are placed along length of jaw until small fingers rest behind each angle of mandible
Skill 7-7: Mouth-to-Mask Ventilation

6. Perform head-tilt/chin-lift (if no trauma is suspected) or jaw thrust maneuver (if trauma is suspected) as needed

7. 2nd EMT delivers breaths by squeezing bag with both hands at rate and depth appropriate for age

Assisted Ventilation

- Bag-mask device
  - May require 2 EMTs for adequate mask seal & volume
  - Can deliver high-flow O₂
Skill 7-8: Bag-Mask Ventilation (2-Person)

1. Assemble bag-mask apparatus (face mask with one-way, self-inflating bag, oxygen reservoir, supplemental oxygen tank with regulator and oxygen tubing)

2. Designate 1 EMT to stand or kneel behind supine patient

3. If trauma is suspected, immobilize head and neck

4. Insert oral or nasal airway

5. EMT positioned at patient’s head applies mask to patient’s face with apex over nose and base over mouth. Airtight seal is obtained by applying pressure to upper, nasal portion of mask with both thumbs and to lower segment of device with each forefinger. Remaining fingers of each hand are placed along length of jaw until small fingers rest behind each angle of mandible

6. Perform head-tilt/chin-lift (if no trauma is suspected) or jaw thrust maneuver (if trauma is suspected) as needed

7. 2nd EMT delivers breaths by squeezing bag with both hands at rate and depth appropriate for age
Skill 7-8: Bag-Mask Ventilation
(2-Person)

Skill 7-9: Bag-Mask Ventilation
(1-Person)

1. Assemble bag-mask apparatus (face mask with one-way, self-inflating bag, oxygen reservoir, supplemental oxygen tank with regulator and oxygen tubing)
2. Stand or kneel behind supine patient
3. If trauma is suspected, immobilize head and neck
4. Insert oral or nasal airway

Skill 7-9: Bag-Mask Ventilation
(1-Person)

5. Apply mask to patient’s face with apex over nose and base over mouth. Obtain airtight seal using 1 hand by applying pressure to upper, nasal portion of mask with thumb and to lower segment of mask with forefinger while remaining fingers grip length and angle of jaw
Skill 7-9: Bag-Mask Ventilation (1-Person)

6. Perform head-tilt/chin-lift (if no trauma is suspected) or jaw thrust maneuver (if trauma is suspected) as needed.

7. Use other hand to squeeze bag and ventilate patient at rate and depth appropriate for age.

Special populations

- Patients with:
  - Tracheostomy tube
  - Stoma
Skill 7-10: Mouth to Mask to Stoma

1. Place 1 hand under patient’s neck; use other hand to obtain seal using pediatric mask over opening in neck

2. Provide ventilation as you would in mouth-to-mask ventilation

Supplemental Oxygen

- Flow-restricted $O_2$-powered ventilator
  - Delivers 100% $O_2$ at rates $\leq$40 L/min
  - Can be used by single EMT
  - Not appropriate for children & infants

Skill 7-11: Flow-Restricted $O_2$-Powered Ventilation Device

1. Position yourself at top of patient’s head. Manually open patient’s airway. Size and insert oral or nasal airway. Attach device to mask
Skill 7-11: Flow-Restricted O₂-Powered Ventilation Device

2. Apply mask to patient’s face with apex over nose and base of mouth. Obtain airtight seal using 1 hand. Trigger device until chest rises. Release trigger to allow passive exhalation. Adult patient should be ventilated every 5-6 sec

Supplemental Oxygen

- O₂ tanks come in variety of sizes

- Make sure tank contains O₂
  - Green tank or labeling
  - Labeled “oxygen”
  - Unique pin index system for regulator

Supplemental Oxygen Delivery

- O₂ cylinders store O₂ under pressure too high for patient use

- Regulator decreases pressure to safe level

- Flow meter (often attached to regulator) allows control of O₂ delivery in L/min

NOTE FROM EDITOR: PLEASE INSERT FIG 7-16
Skill 7-12: Oxygen Tank/Regulator/Tubing Assembly

1. Remove protective seal from valve on tank
   - Don’t lose washer attached to seal; it provides airtight seal between regulator and tank

2. Turn valve away from yourself or anyone else and quickly open and close valve to blow any dirt or contaminants out of tank opening

3. Place washer over inlet port on regulator

Skill 7-12: Oxygen Tank/Regulator/Tubing Assembly

4. Line up regulator port and pins with tank opening and holes in tank valve

5. Check flow meter to ensure it is turned off

6. Tighten screw by hand

Skill 7-12: Oxygen Tank/Regulator/Tubing Assembly

7. Open tank to test for airtight seal. If there is leakage, tighten screw until leak stops. Once you have made sure there are no leaks, tank valve must be completely open or completely closed

8. Adjust flow meter to desired setting; when finished, turn off flow meter and close tank valve

9. Open flow meter momentarily to release pressure from regulator
Skill 7-12: Oxygen Tank/Regulator/Tubing Assembly

Supplemental Oxygen Delivery

- For patients with adequate spontaneous breathing:
  - Nasal cannula
  - Nonrebreather mask

Supplemental Oxygen Delivery

- Nasal cannula
  - Cannot be used at >6 L/min
  - Delivers 24%-28% O₂

- Nonrebreather mask
  - Preferred device
  - Inflates reservoir
  - Requires 12-15 L/min
  - Delivers >90% O₂
Skill 7-13: Applying Nonrebreather Mask

1. Attach nonrebreather mask to oxygen tank with regulator using connective tubing

2. Adjust regulator to deliver O₂ at 15 L/min

3. Insert finger into face mask; occlude port connecting face mask with O₂ reservoir; maintain occlusion long enough (~3-5 sec) for reservoir bag to inflate fully

4. Place mask over patient’s nose and mouth; secure behind patient’s head with attached elastic strap
Nasal Cannula Application

Summary

- Both oxygenation & ventilation are critical to life
- Important to recognize inadequate oxygenation and ventilation and to intervene to correct problems with airway and ventilation
- These are critical skills that require regular practice for proficiency