Chapter 14
Airway and Ventilation

Learning Objectives
- Explain primary objective of airway maintenance
- Identify commonly neglected prehospital skills related to airway
- Identify anatomy of upper, lower airway
- Describe functions of upper, lower airway

Learning Objectives (Cont'd)
- Define gag reflex
- Define atelectasis
- Explain differences between adult, pediatric airway anatomy
- Explain relation between pulmonary circulation, respiration
Learning Objectives (Cont’d)

- List concentration of gases that comprise atmospheric air
- Describe measurement of oxygen in blood
- Describe measurement of carbon dioxide in blood

Learning Objectives (Cont’d)

- List factors that cause decreased oxygen concentrations in blood
- List factors that increase, decrease carbon dioxide production in body
- Describe peak expiratory flow
- Define FiO₂

Learning Objectives (Cont’d)

- Describe voluntary, involuntary regulation of respiration
- List factors that affect respiratory rate, depth
- Define, differentiate hypoxia, hypoxemia
- Define normal respiratory rates, tidal volumes for adult, child, infant
Learning Objectives (Cont'd)

- Describe causes of respiratory distress
- Describe modified forms of respiration
- Identify types of oxygen cylinders, pressure regulators (including high-pressure regulator, therapy regulator)

Learning Objectives (Cont'd)

- List steps for delivering oxygen from cylinder, regulator
- Explain safety considerations of oxygen storage, delivery

Learning Objectives (Cont'd)

- Describe indications, contraindications, advantages, disadvantages, complications, liter flow range, concentration of delivered oxygen for supplemental oxygen delivery devices
- Describe use of oxygen humidifier
Learning Objectives (Cont’d)

- Define, explain implications of partial airway obstruction with good, poor air exchange
- Define complete airway obstruction
- Describe causes of upper airway obstruction
- Describe complete airway obstruction maneuvers

Learning Objectives (Cont’d)

- Describe manual airway maneuvers
- Explain purpose for suctioning upper airway
- Identify types of suction equipment
- Describe indications for suctioning upper airway

Learning Objectives (Cont’d)

- Identify types of suction catheters, including hard/rigid catheters, soft catheters
- Identify techniques of suctioning upper airway
- Identify special considerations of suctioning upper airway
Learning Objectives (Cont'd)

- Describe indications, contraindications, advantages, disadvantages, complications, equipment, technique of tracheobronchial suctioning in intubated patient
- Identify special considerations of tracheobronchial suctioning in intubated patient

Learning Objectives (Cont'd)

- Describe use of oral, nasal airway
- Describe indications, contraindications, advantages, disadvantages, complications, techniques for inserting oropharyngeal, nasopharyngeal airway
- Define gastric distention

Learning Objectives (Cont'd)

- Describe indications, contraindications, advantages, disadvantages, complications, techniques for ventilating patient by following resuscitation methods:
  - Mouth to mouth
  - Mouth to nose
  - Mouth to mask
  - One-person bag-mask
  - Two-person bag-mask
  - Three-person bag-mask
Learning Objectives (Cont’d)

- Describe indications, contraindications, advantages, disadvantages, complications, techniques for ventilating patient by following resuscitation methods:
  - Flow-restricted, oxygen-powered ventilation device
- Compare ventilation techniques used for adult patient with those used for pediatric patients

Learning Objectives (Cont’d)

- Explain advantage of 2-person method when ventilating with bag-mask
- Describe Sellick (cricoid pressure) maneuver
- Describe indications, contraindications, advantages, disadvantages, complications, technique for ventilating patient with automatic transport ventilator

Learning Objectives (Cont’d)

- Define, identify, describe tracheostomy, stoma, tracheostomy tube
- Define, identify, describe laryngectomy
- Define how to ventilate patient with stoma, including mouth-to-stoma, bag-mask-to-stoma ventilation
Learning Objectives (Cont’d)

• Describe indications, contraindications, advantages, disadvantages, complications, equipment, technique for inserting nasogastric tube, orogastric tube
• Identify special considerations of gastric decompression

Learning Objectives (Cont’d)

• Describe special considerations in airway management, ventilation for patients with facial injuries
• Describe special considerations in airway management, ventilation for pediatric patient
• Differentiate endotracheal intubation from other methods of advanced airway management

Learning Objectives (Cont’d)

• Describe indications, contraindications, advantages, disadvantages, complications, equipment, technique for using dual-lumen airway
• Describe indications, contraindications, advantages, disadvantages, complications of endotracheal intubation
Learning Objectives (Cont'd)

- Explain risk of infection to EMS providers associated with ventilation
- Describe laryngoscopy for removal of foreign body airway obstruction
- Describe indications, contraindications, advantages, disadvantages, complications, equipment, technique for direct laryngoscopy

Learning Objectives (Cont'd)

- Describe visual landmarks for direct laryngoscopy
- Describe methods of assessment for confirming correct placement of endotracheal tube
- Describe methods for securing endotracheal tube

Learning Objectives (Cont'd)

- Describe methods of endotracheal intubation in pediatric patient
- Describe indications, contraindications, advantages, disadvantages, complications, equipment, technique for nasotracheal intubation
Learning Objectives (Cont’d)

- Describe indications, contraindications, advantages, disadvantages, complications, equipment, technique for digital endotracheal intubation
- Describe indications, contraindications, advantages, disadvantages, complications, equipment for rapidsequence intubation with neuromuscular blockade

Learning Objectives (Cont’d)

- Identify neuromuscular blocking drugs, other agents used in rapid-sequence intubation
- Describe indications, contraindications, advantages, disadvantages, complications, equipment for sedation during intubation
- Identify sedative agents used in airway management

Learning Objectives (Cont’d)

- Describe indications, contraindications, advantages, disadvantages, complications, equipment, technique for needle cricothyrotomy
- Describe indications, contraindications, advantages, disadvantages, complications for performing surgical cricothyrotomy
Learning Objectives (Cont’d)

• Describe equipment, technique for performing surgical cricothyrotomy

Introduction

• Primary objective
  ➢ Ensure optimal ventilation

• Basics neglected
  ➢ Maintain good seal with bag-mask device
  ➢ Proper position of head, neck
  ➢ Reassess patient

Anatomy & Physiology

• Upper airway anatomy
  ➢ Pharynx
    • Nasal cavity & mouth meet
    • Nasopharynx
    • Oropharynx
    • Laryngopharynx
Anatomy & Physiology (Cont’d)

• Upper airway anatomy
  - Larynx
    - Thyroid cartilage
    - Cricoid cartilage
    - Glottis
    - Cricothyroid membrane

Anatomy & Physiology (Cont’d)

• Lower airway anatomy
  - Trachea
  - Bronchi
  - Alveoli
  - Lungs
Anatomy & Physiology (Cont’d)

Lower Airway Structures

- Cellular Structures of Lower Airway

- Differences in pediatric airway
  - Airway flexes when supine
  - Tongue uses more space in oral cavity, obstructs airway
  - Epiglottis large, long, u-shaped, extends vertically beyond opening of cords
Anatomy & Physiology (Cont’d)

• Differences in pediatric airway
  ➢ Larynx
  ➢ Trachea
  ➢ Diaphragm
  ➢ Chest wall

Anatomy & Physiology (Cont’d)

• Respiratory system physiology
  ➢ Ventilation
    ➢ Inspiration
    ➢ Expiration
    ➢ Hering-Breuer reflex
Anatomy & Physiology (Cont’d)

- Respiratory system physiology
  - Respiration
    - External
    - Internal
    - Hemoglobin
    - Partial pressure

- Decreased O₂ concentrations in blood causes:
  - Decreased hemoglobin concentration
  - Lower oxygen partial pressure in atmosphere
  - Pneumothorax, hemothorax
  - Decreased respiration mechanics
  - Low inspired oxygen concentrations
  - Impaired diffusion across pulmonary membrane
  - Impaired pulmonary blood flow

Anatomy & Physiology (Cont’d)

- Respiratory system physiology
  - Blood gas concentrations
    - Hypoxemia
      - Decreased amount of O₂ saturated hemoglobin in blood stream
      - Treatment includes ventilation, supplemental oxygen
    - Hypoxia
      - Decreased O₂ amount in tissues
      - Treatment includes ventilation, supplemental oxygen
Anatomy & Physiology (Cont’d)

● Respiratory system physiology
  ➢ Blood gas concentrations
    ➢ Hypoventilation
    ➢ Hypercarbia
    ➢ Hyperventilation
    ➢ Hypocarbia

Anatomy & Physiology (Cont’d)

● Respiratory system physiology
  ➢ Lung, respiratory volumes
    ➢ Total lung volume
    ➢ Tidal volume
    ➢ Dead air space
    ➢ Alveolar
    ➢ Minute, residual volume
    ➢ Functional reserve capacity
    ➢ Residual volume

Anatomy & Physiology (Cont’d)

● Respiratory system physiology
  ➢ Lung, respiratory volumes
    ➢ Total lung volume
    ➢ Inspiratory reserve volume
    ➢ Expiratory reserve volume
    ➢ PaO2
    ➢ Peak expiratory flow
Anatomy & Physiology (Cont'd)

- Control of respiration
  - Brainstem
  - Chemoreceptors
  - Increased PCO₂
  - Decreased PCO₂
  - Decreased PO₂

Anatomy & Physiology (Cont’d)

- Neurochemical Respiratory Control System

Anatomy & Physiology (Cont’d)

- Functional Components of Respiratory System
Respiratory Assessment

- Respiratory rate
  - Normal
- Semi-Fowler's position

Respiratory Assessment (Cont'd)

- Respiratory distress
  - Upper/lower airway obstruction
  - Inadequate ventilation
  - Respiratory muscle impairment
  - Nervous system impairment

Respiratory Assessment (Cont'd)

- Dyspnea
  - Upper/lower airway obstruction
  - Tripod positioning
  - Orthopnea
Respiratory Assessment (Cont’d)

• Physical exam landmarks
  ➢ Angle of Louis
  ➢ Suprasternal notch
  ➢ Costal angle
  ➢ Chest wall diameter

Respiratory Assessment (Cont’d)

• Physical exam findings
  ➢ Barrel chest
  ➢ Paradoxical motion
  ➢ Accessory muscle use
  ➢ Pursed lip breathing
  ➢ Subcutaneous emphysema
  ➢ Crepitation
  ➢ 1-2 word dyspnea
Respiratory Assessment (Cont’d)

- Auscultation
  - Airway compromise
    - Snoring
    - Gurgling
    - Stridor
    - Wheezes
    - Crackles
    - Rattles

Respiratory Assessment (Cont’d)

- Common abnormal patterns
  - Bradypnea
  - Tachypnea
  - Hyperpnea
  - Air trapping
Respiratory Assessment (Cont’d)

- Common abnormal problems
  - Cheyne-Stokes respirations
  - Kussmaul respirations
  - Biot’s respirations
  - Central neurogenic hyperventilation
  - Agonal respirations

Respiratory Assessment (Cont’d)

- High priority patients
  - Severe dyspnea
  - Altered mental status
  - Cyanosis
  - Absent breath sounds
  - Stridor
  - 1-2-word dyspnea
  - Accessory muscle use

Supplemental Oxygenation

- Oxygen supply
Supplemental Oxygenation (Cont'd)

- Delivery devices
  - Nasal cannula
    - Advantages
    - Disadvantages

Supplemental Oxygenation (Cont'd)

- Delivery devices
  - Simple face mask
    - Advantages
    - Disadvantages

Supplemental Oxygenation (Cont'd)

- Delivery devices
  - Partial rebreather mask
    - Advantages
    - Disadvantages
Supplemental Oxygenation (Cont'd)

- Delivery devices
  - Nonrebreather mask
    - Advantages
    - Disadvantages

Supplemental Oxygenation (Cont'd)

- Delivery devices
  - Venturi mask
    - Advantages
    - Disadvantages

Supplemental Oxygenation (Cont'd)

- Delivery devices
  - Small-volume nebulizer
  - Oxygen humidifier
Airway Obstruction

- Tongue
  - Most common cause
  - Head tilt/chin lift
- Foreign bodies
  - Food, dentures, broken teeth, toys
  - Choking symptoms
  - Treatment

Airway Obstruction (Cont’d)

- Laryngeal spasm, edema
  - Constrict airway
  - Epiglottis, anaphylaxis, burns, toxic inhalation, trauma
- Trauma
- Aspiration
  - Destroy bronchiolar tissues

Opening the Airway

- Manual maneuvers
  - Head tilt/chin lift
  - Indications
    - Unresponsive patient, no mechanism for correct spine injury, unable to protect airway
Manual maneuvers

Head tilt/chin lift
- Contraindications
  - Awake patient, possible cervical spine injury
- Advantages
  - Simple to perform, no equipment required, noninvasive
- Disadvantages
  - Does not protect lower airway from aspiration, may cause spinal movement

Jaw thrust maneuver
- With/without head tilt

Jaw thrust without head tilt
- Indications
  - Unresponsive patient, possible cervical spine injury, unable to protect own airway
Opening the Airway (Cont'd)

- Manual maneuvers
  - Jaw thrust without head tilt
    - Contraindications
    - Awake patient
    - Advantages
    - No equipment required, noninvasive
    - Disadvantages
    - Difficult to maintain, 2nd rescuer needed for bag-mask, does not protect lower airway, spinal movement

Opening the Airway (Cont'd)

- Suctioning
  - Purpose
    - Removing vomitus, saliva, blood, other
  - Suction devices
    - Hand powered
    - Portable oxygen powered
    - Portable battery operated
    - Mounted vacuum powered

Opening the Airway (Cont'd)

- Suctioning
  - Suction catheters
    - Hard
    - Soft
  - Technique
    - Upper Airway
    - Lower Airway
Skill 14-1 Upper Airway Suctioning

- Put on appropriate PPE, assemble necessary equipment, including suction unit, tubing, suction catheter
  - Preoxygenate patient before suctioning if possible

Skill 14-1 Upper Airway Suctioning (Cont’d)

- Turn suction unit power on, test for adequate suction by sealing side port of catheter with 1 finger, remove finger from port or turn off suction unit

Skill 14-1 Upper Airway Suctioning (Cont’d)

- Determine appropriate depth for catheter insertion
- Insert catheter into patient’s mouth to proper depth without applying suction
Skill 14-1 Upper Airway Suctioning (Cont’d)

- To begin suctioning, turn power on to suction unit or cover catheter side port with 1 finger
- Withdraw catheter while applying suction

Skill 14-2 Lower Airway Suctioning (Cont’d)

- Put on appropriate PPE, assemble necessary equipment, including suction unit, tubing, suction catheter
  - Preoxygenate patient before suctioning if possible
- Turn suction unit power on, test for adequate suction by sealing side port of catheter with 1 finger, remove finger from port or turn off suction unit
Skill 14-2 Lower Airway Suctioning (Cont’d)

- Determine appropriate depth for catheter insertion
- Insert catheter into ET tube to proper depth without applying suction

Skill 14-2 Lower Airway Suctioning (Cont’d)

- To begin suctioning, turn power on to suction unit or cover catheter side port with 1 finger
- Withdraw catheter while applying suction

Opening the Airway

- Possible complications
  - Hypoxia
  - Dysrhythmias
  - Increased intracranial pressure
  - Local swelling
  - Hemorrhage
  - Tracheal ulceration
  - Tracheal infection
  - Bronchospasm
  - Vagal stimulation
  - Tachycardia
  - Hypertension
Airway Adjuncts

- Oral airway adjuncts
  - Indications
    - Maintain open airway for patient not intubated, no gag reflex, ventilated with PPV device
  - Contraindications
    - Patient responsive, gag reflex
  - Sizing

Airway Adjuncts (Cont’d)

- Oral airway adjuncts
  - Advantages
    - Positions tongue forward, away from back of throat
  - Disadvantages
    - Does not protect lower airway from aspiration
    - May produce vomiting
  - Cautions
    - Does not eliminate need for maintaining proper head position

Skill 14-3 Oral Airway Insertion

- Oral airways available in variety of sizes (infant, child, adult)
  - Size of airway
    - Based on distance, in millimeters, from flange to distal tip
Skill 14-3 Oral Airway Insertion (Cont'd)

- Take appropriate standard precautions, select oral airway of appropriate size by measuring from corner of mouth to angle of jaw.

Skill 14-3 Oral Airway Insertion (Cont'd)

- Open patient's mouth, hold oral airway at its flange end, insert into mouth, with tip pointing toward roof of patient's mouth.

Skill 14-3 Oral Airway Insertion (Cont'd)

- Slide airway along roof of mouth:
  - When distal end nears back of throat, rotate airway 180 degrees so is positioned over tongue.
Skill 14-3 Oral Airway Insertion (Cont'd)

- When oral airway inserted properly, device flange should rest comfortably on patient’s lips/teeth
  - Confirmed by ventilating patient

Skill 14-3 Oral Airway Insertion (Cont'd)

- Another method of oral airway insertion requires use of tongue blade to depress tongue

Airway Adjuncts

- Nasal airway adjuncts
  - Indications
    - Maintain airway when oral contraindicated, trismus, biting, clenched jaws/teeth
  - Contraindications
    - Severe cranial trauma, patient intolerance
    - contraindicated
Airway Adjuncts (Cont'd)

- Nasal airway adjuncts
  - Advantages
    - Provides airway, tolerated by responsive patients
  - Disadvantages
    - No protection from aspiration, bleeding, suctioning difficult, may stimulate gag reflex
  - Caution
    - Must maintain proper head position

Skill 14-4 Nasal Airway Insertion

- Nasal airways available in many sizes varying in length, internal diameter

Skill 14-4 Nasal Airway Insertion (Cont'd)

- Take appropriate standard precautions, determine proper airway size by holding nasal airway against side of patient's face
Skill 14-4 Nasal Airway Insertion (Cont’d)
- Lubricate distal tip of device liberally with water-soluble lubricant to minimize resistance, decrease irritation to nasal passage.

Skill 14-4 Nasal Airway Insertion (Cont’d)
- Hold nasal airway at flange end like pencil, slowly insert into larger of patient’s 2 nares with bevel pointing toward nasal septum.

Skill 14-4 Nasal Airway Insertion (Cont’d)
- Advance airway along floor of nostril, following natural curvature of nasal passage until flange is flush with nostril.
Artificial Ventilation Techniques

- Mouth-to-mouth ventilation
- Mouth-to-nose ventilation
- Mouth-to-barrier device ventilation

Skill 14-5 Mouth-to-Barrier Device

- Put on appropriate PPE, open patient’s airway, place barrier device over patient’s mouth

Skill 14-5 Mouth-to-Barrier Device (Cont’d)

- Place your mouth over mouthpiece of barrier device, breathe into device with enough force to cause patient’s chest to rise gently
Artificial Ventilation Techniques

- Mouth-to-mask ventilation
  - Inspired oxygen concentration
  - Advantages
  - Disadvantages

Skill 14-6 Mouth-to-Mask

- Put on appropriate PPE, connect 1-way valve to ventilation port on mask
  - If oxygen inlet present on mask & oxygen available, connect oxygen tubing to oxygen inlet

Skill 14-6 Mouth-to-Mask (Cont’d)

- Position yourself at patient’s head, open patient airway
  - Clear airway of secretions, vomitus
  - If unresponsive, insert oral airway
  - Select appropriate sized mask, place on patient’s face
Skill 14-6 Mouth-to-Mask (Cont’d)

- Apply apex of mask over bridge of nose, stabilize with thumbs
  - Lower mask over face, mouth
  - Use index fingers to stabilize base of mask over groove between lower lip, chin

Skill 14-6 Mouth-to-Mask (Cont’d)

- Ventilate lungs through 1-way valve on top of mask at age-appropriate rate

Artificial Ventilation Techniques

- Bag-mask ventilation
  - Advantages
    - Oxygen-enriched mixture
    - Compliance of patient’s lungs
    - Immediate ventilatory support
    - Spontaneously breathing patient & nonbreathing
  - Disadvantages
    - Requires practice
    - Inadequate tidal volume
    - Rescuer fatigue
    - Gastric distention
Artificial Ventilation Techniques (Cont’d)

- Bag-mask without supplemental oxygen: 21% oxygen delivered
- Bag-mask with supplemental oxygen at 15 L/min: 40%-60% oxygen delivered
- Bag-mask with reservoir and supplemental oxygen 15 L/min: 90%-100% oxygen delivered

Skill 14-7 Bag-Mask Ventilation

- Put on PPE, position yourself at top of supine patient’s head, open airway
  - Clear airway of secretions/vomit
  - If unresponsive, insert oral airway
Skill 14-7 Bag-Mask Ventilation (Cont'd)

- Select appropriate-sized mask, connect bag to mask, connect bag to oxygen at 15 L/min, attach reservoir

Skill 14-7 Bag-Mask Ventilation (Cont'd)

- Place mask on patient, apply apex over bridge of nose, base over groove between lower lip, chin
  - If large, round cuff surrounding ventilation port, center port over mouth

Skill 14-7 Bag-Mask Ventilation (Cont'd)

- If alone, squeeze bag with 1 hand or with 1 hand & arm/chest
Skill 14-7 Bag-Mask Ventilation (Cont'd)

• Ask partner to squeeze bag until chest rises while you press mask firmly against face with both hands, simultaneously maintain proper head position.

Artificial Ventilation Techniques

Landmarks of Cricoid Pressure

Artificial Ventilation Techniques (Cont'd)

• Cricoid pressure
Artificial Ventilation Techniques (Cont'd)

- Troubleshooting bag-mask ventilation
  - Avoid over-inflation
  - Allow for adequate exhalation

Artificial Ventilation Techniques (Cont'd)

- Automatic transport ventilator
  - Indications
    - Decreased LOC
    - Apnea
    - Extended ventilation

Artificial Ventilation Techniques (Cont'd)

- Automatic transport ventilator
  - Contraindications
    - Airway obstruction
    - Resistance
    - Poor lung compliance
    - Pulmonary over-pressurization
  - Advantages
  - Disadvantages
Artificial Ventilation Techniques (Cont’d)

- Flow-restricted, oxygen-powered ventilation devices
  - Indications
    - Decreased ventilation
    - Apnea
  - Contraindications
    - Pediatric patients

Skill 14-8 Flow-Restricted, Oxygen-Powered Ventilation Device

- Appropriate PPE, open patient’s airway
  - If unresponsive, insert oral airway
  - Attach FROPVD to mask

Skill 14-8 Flow-Restricted, Oxygen-Powered Ventilation Device (Cont’d)

- Apply mask, ensure good seal
  - Trigger device until patient’s chest rises
  - Allow patient to exhale passively
  - Repeat once every 5-6 seconds
Artificial Ventilation Techniques

Tracheostomy Tube in Position

Artificial Ventilation Techniques (Cont'd)

• Special considerations
  • Tracheostomy
    • Permanent or temporary

Artificial Ventilation Techniques (Cont'd)

• Special considerations
  • Stoma sites
Artificial Ventilation Techniques (Cont'd)

- Gastric distention
  - Common in ventilated nonintubated patient
  - Regurgitation, aspiration
  - Affect ability to ventilate adequately
  - Cricoid pressure
  - Gastric tube may be needed

Artificial Ventilation Techniques (Cont'd)

- Ventilation of pediatric patients
  - Consider anatomical differences
    - Opening airway
    - Mask seal
  - Choose appropriate bag size

Advanced Airways

- Dual lumen airway devices
  - Esophageal-tracheal combitube
    - Indications
      - Difficult face mask fit or difficult bag-mask ventilation
      - Intubation unsuccessful
      - Airway management necessary but untrained for visualized orotracheal intubation
Advanced Airways (Cont’d)

- Dual lumen airway devices
  - Esophageal-tracheal combitube
    - Contraindications
      - Intact gag reflex, upper airway obstruction
      - Esophageal disease (varices or cancers)
      - Caustic substance ingestion
      - Less than 4 ft tall

Advanced Airways (Cont’d)

- Pharyngeal tracheal lumen airway
  - Indications
    - Unconscious over 14 y/o
    - Height between 5 & 7 feet tall
    - Absent gag reflex, unable to intubate
    - Failure of less invasive measures

Advanced Airways (Cont’d)

- Pharyngeal tracheal lumen airway
  - Contraindications
    - Less than 14 years old
    - Gag reflex intact
    - Esophageal disease (varices or cancers)
    - Chronic alcohol abuse
    - Suspected caustic ingestion
Advanced Airways (Cont’d)

Skill 14-9 Combitube Insertion

- PPE, open mouth, suction
  - If oral airway inserted, remove
  - Auscultate bilateral breath sounds for baseline
  - Oxygenate with 100%

Skill 14-9 Combitube Insertion (Cont’d)

- Assemble equipment, check cuffs for leaks, lubricate distal tip of tube with water-soluble jelly
• Insert Combitube in same direction as natural curvature of pharynx
  ➢ Insert tip into mouth in midline, advance gently along base of tongue, into airway until line of teeth between 2 black lines on tube

• Inflate proximal (pharyngeal) cuff with 100 mL of air through blue pilot tube marked #1

• Inflate distal (esophageal) cuff with 15 mL of air through white pilot tube marked #2
Skill 14-9 Combitube Insertion
(Cont'd)
● Attach bag-mask device to longer (blue) connecting tube marked #1, begin ventilation
  ➢ Continue to ventilate
  ➢ When placement verified, short tube (#2) used for gastric suction

Skill 14-9 Combitube Insertion
(Cont'd)
● If chest does not rise/sounds only heard over epigastrium, attach bag-mask device to 2nd tube, begin ventilation to determine if Combitube entered trachea

Skill 14-9 Combitube Insertion
(Cont'd)
● Confirm placement by: observing chest rise, auscultation over epigastrium and bilaterally over each lung
  ● If ventilation confirmed, continue ventilation through second tube
  ● Secure tube with commercial tube holder or tape
Advanced Airways

- Supraglottic airway devices
  - Laryngeal mask airway
    - Indications
      - Difficult face mask fit
      - Intubation unsuccessful or ventilation difficult
      - Airway management necessary but untrained for visualized orotracheal intubation
    - Contraindications
      - Provider untrained
      - Risk of aspiration exists

Advanced Airways (Cont’d)

Laryngeal Mask Airway
Advanced Airways (Cont’d)

- Endotracheal intubation
  - Indications
    - Patient inability to protect airway
    - Inability to ventilate
    - Airway obstruction
    - Prolonged ventilatory support required
  - Contraindications
    - Untrained

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Advanced Airways (Cont’d)

![Laryngoscope Blade](image)

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Advanced Airways (Cont’d)

![Foreign Body Obstruction Removal](image)
Advanced Airways (Cont’d)

- Endotracheal intubation
  - Equipment
    - Laryngoscope

Advanced Airways (Cont’d)

Laryngoscope Insertion

Advanced Airways (Cont’d)

- Endotracheal intubation
  - Equipment
    - Laryngoscope
Advanced Airways (Cont’d)

- **Endotracheal intubation**
  - **Equipment**
    - Endotracheal tubes

Advanced Airways (Cont’d)

- **Endotracheal intubation**
  - **Equipment**
    - Stylet
    - Suction

Advanced Airways (Cont’d)

- **Endotracheal intubation**
  - **Equipment**
    - Placement confirmation devices
    - Securing devices
Skill 14-10 Orotracheal Intubation

- PPE; open patient’s mouth; suction; auscultate bilateral breath sounds to establish baseline

Skill 14-10 Orotracheal Intubation (Cont’d)

- Prepare equipment
  - Proper size blade
  - Assemble laryngoscope
  - Attach blade to handle, check blade for white bright light
  - Unlock blade

Skill 14-10 Orotracheal Intubation (Cont’d)

- Proper size ET tube
  - Insert stylet into ET tube
  - Bend proximal end of stylet over tube, prevent from sliding
  - Test tube for cuff leaks, deflate cuff
  - Lubricate distal end of tube
Skill 14-10 Orotracheal Intubation (Cont'd)

- Head in sniffing position, open mouth & inspect

Skill 14-10 Orotracheal Intubation (Cont'd)

- Stop ventilations, apply cricoid pressure
  - Laryngoscope left hand, blade tip away from you, insert right side between teeth, sweeping tongue to left, advance until distal end reaches base of tongue

Skill 14-10 Orotracheal Intubation (Cont'd)

- Lift laryngoscope to elevate mandible without pressure on front teeth, visualize epiglottis, identify vocal cords, place blade in proper position
Skill 14-10 Orotracheal Intubation (Cont'd)

- Grasp ET tube with right hand, into right corner of mouth

Skill 14-10 Orotracheal Intubation (Cont'd)

- Advance tube through glottic opening until distal cuff disappears past vocal cords
  - Firmly hold ET tube, gently withdraw laryngoscope

Skill 14-10 Orotracheal Intubation (Cont'd)

- If using EDD to confirm placement, do now
Skill 14-10 Orotracheal Intubation (Cont'd)

- If using exhaled CO₂ detector to verify placement, lungs must be ventilated 6 x before

Skill 14-10 Orotracheal Intubation (Cont'd)

- Attach ventilation device to ET tube, ventilate patient, confirm placement of tube, observe chest for full movement

Skill 14-10 Orotracheal Intubation (Cont'd)

- Attach exhaled CO₂ detector to verify tube placement
- Note, record depth of tube at patient's teeth
Skill 14-10 Orotracheal Intubation (Cont’d)

- Secure with tube holder/tape, provide ventilatory support, supplemental oxygen, recheck tube depth

Advanced Airways

Head Positioning for Endotracheal Intubation

Advanced Airways (Cont’d)

- Endotracheal intubation
  - Complications:
    - Bleeding, mucosal necrosis, barotrauma
    - Laryngospasm, laryngeal/tracheal edema
    - Vocal cord damage
    - Aspiration, cuff leak
    - Esophageal intubation, right bronchus intubation
    - Tube occlusion, hypoxia, dysrhythmias
    - Trauma to lips, teeth, tongue, soft tissues
    - Increased intracranial pressure
Skill 14-11 Pediatric Intubation

- Open airway, insert oropharyngeal airway
- Ventilate lungs 12-20 x/min, using bag-mask, oxygen

Skill 14-11 Pediatric Intubation (Cont’d)

- Preoxygenate
- Prepare equipment
- Place patient in neutral/sniffing position

Skill 14-11 Pediatric Intubation (Cont’d)

- Insert laryngoscope blade while displacing tongue
- Insert ET tube to appropriate depth, ventilate, conform placement, secure, oxygen
Advanced Airways

- Nasotracheal Intubation
  - Blind procedure, breathing patient
  - Digital intubation
  - Transillumination technique
  - Gum elastic bougie

Advanced Airways (Cont’d)

- Rapid-sequence intubation
  - 7 P’s
    - Preparation (zero - 10 mins)
    - Prep-oxygenate (zero - 5 mins)
    - Premedicate (zero - 3 mins)
    - Paralysis with sedation (zero)
    - Protect the airway (zero + 15 secs)
    - Pass the tube/prove of placement (zero + 45 secs)
    - Postintubation management (zero + 60 secs)

Advanced Airways (Cont’d)

- Rapid-sequence intubation
  - Indications:
    - Excessive work of breathing
    - Comatose patients requiring airway control
    - Uncontrolled seizures
    - Airway obstruction
    - Head trauma
    - Severe asthma
    - Inadequate CNS control of ventilation
Advanced Airways (Cont’d)

- Rapid-sequence intubation
  - Complications
    - Prolonged apnea
    - Bradycardia
    - Fasciculations
    - Death from anoxia
    - Hypotension
    - Hyperkalemia
    - Increased intragastric pressure
    - Malignant hyperthermia

Advanced Airways (Cont’d)

- Rapid-sequence intubation
  - Preparation: Assess patient for difficult intubation
    - Evaluate mouth opening, neck mobility
    - Mallampati Airway Classification
      - Use alternative methods for class II
    - Apply cardiac monitor, pulse oximeter
    - Preoxygenate
    - Premedicate

Advanced Airways (Cont’d)

- Paralysis with sedation
- Protect airway
- Pass tube & prove placement
- Ventilate & verify placement
Advanced Airways (Cont’d)

- Secure tube
- Equipment
  - PPE
  - Oxygen, suction, antiseptic
  - Adapter from top of 3.0-mm ET tube
  - Bag-mask device
  - 14-gauge over-the-needle catheter
  - 10-mL syringe
  - Several 4 x 4 gauze pads

Cricothyrotomy

- Indications
  - Intubation difficult, impossible
  - Complete upper airway obstruction
  - Laryngeal fracture
  - Craniofacial abnormalities
  - Congenital laryngeal anomalies
  - Excessive oropharyngeal hemorrhage
  - Massive genetic, congenital deformities
  - Respiratory arrest

Cricothyrotomy (Cont’d)

- Contraindications
  - Ability to ventilate the patient by less aggressive means
  - Inability to identify landmarks
  - Primary laryngeal injury
  - Infrafararyngeal obstruction
Cricothyrotomy (Cont’d)

- Allows rapid entrance to airway for temporary oxygenation, ventilation
  - Insert needle into cricoid membrane
  - Create opening with scalpel
  - Between thyroid, cricothyroid membrane
  - Medical director

Skill 14-12 Needle Cricothyrotomy

- Supine position, hyperextend head & neck, manage airway, pulse oximeter, cardiac monitor, vital signs every 5 min

Skill 14-12 Needle Cricothyrotomy (Cont’d)

- Prepare equipment
- Palpate neck locating cricothyroid membrane, cleanse site
Skill 14-12 Needle Cricothyrotomy (Cont'd)

- With syringe & needle in dominant hand, stabilize laryngeal cartilages with other hand
  - Reconfirm cricothyroid membrane location
  - Direct needle, catheter at 45° angle

- Insert needle, catheter through cricothyroid membrane, negative pressure on syringe
  - Advance slowly while aspirating for air, signifies placement in tracheal lumen

- Advance catheter over needle until hub flush with skin
  - Hold catheter hub in place, prevent displacement, discard needle in sharps container
Skill 14-12 Needle Cricothyrotomy (Cont'd)

- Attach 3-mm ET tube adapter to bag-mask device
- Attach barrel of 3-mL syringe to IV catheter & 8-mm ET tube adaptor to syringe barrel
- Begin ventilation

- 4 x 4 gauze pads around catheter to stabilize, tape in place, monitor for chest rise, auscultate for adequate ventilation

Skill 14-13 Surgical Cricothyrotomy (Cont'd)

- Supine position, hyperextend head & neck, manage airway, pulse oximeter, cardiac monitor, vital signs every 5 min, prepare equipment
Skill 14-13 Surgical Cricothyrotomy (Cont’d)

- Palpate neck to locate cricothyroid membrane between thyroid, cricoid cartilages, cleanse

Skill 14-13 Surgical Cricothyrotomy (Cont’d)

- Stabilize laryngeal cartilages with thumb, fingers of nondominant hand, reconfirm cricothyroid membrane location
  - Make 1-2-cm midline & vertical incision

Skill 14-13 Surgical Cricothyrotomy (Cont’d)

- Some medical directors prefer incision be made vertically
Skill 14-13 Surgical Cricothyrotomy (Cont'd)

- Locate cricothyroid membrane, make 1-cm incision in horizontal plane of membrane

Skill 14-13 Surgical Cricothyrotomy (Cont'd)

- Use curved hemostate to maintain surgical opening, increase diameter for tube placement

Skill 14-13 Surgical Cricothyrotomy (Cont'd)

- Insert ET tube into tracheal opening, direct toward patient’s feet
Skill 14-13 Surgical Cricothyrotomy (Cont’d)

- Inflate cuff using 10-mL syringe so pilot balloon full
  - Detach syringe
  - Begin ventilation, supplement oxygen
  - Confirm placement

Skill 14-13 Surgical Cricothyrotomy (Cont’d)

- Secure tube, monitor for adequate ventilation

Pulse Oximetry

- Pulse oximeter
  - Limitations
    - False readings
Exhaled CO₂ Monitoring

- Uses
  - ET tube verification
  - Mechanical ventilation evaluation
  - Exhaled CO₂ level monitoring
  - Adequacy of ventilation assessment

Exhaled CO₂ Monitoring (Cont’d)

- Capnography
  - Continuous analysis, recording of CO₂ concentrations in respiratory gases

- Capnometer
  - Device used to measure concentration of CO₂ at end of exhalation
Exhaled CO₂ Monitoring (Cont’d)

• Capnography
  » Numeric reading of exhaled CO₂ concentrations without continuous written record, waveform

• Capnometry
  » Numeric reading of exhaled CO₂ concentrations, waveform
Exhaled CO₂ Monitoring (Cont’d)

- Exhaled CO₂ detector
- Colorimetric ETCO₂ detector
- Qualitative ETCO₂ monitor

Continuous Positive Airway Pressure

- Positive pressure airflow throughout entire respiratory cycle

Continuous Positive Airway Pressure (Cont’d)

- Bilevel positive airway pressure
- Indications
  - Chronic respiratory failure
  - CHF, pulmonary edema
Chapter Summary

- Upper airway consists of structures located outside chest cavity, including nose/nasal cavities, pharynx, larynx
  - Functions to filter, warm, humidify air, protecting surfaces of lower respiratory tract

Chapter Summary (Cont'd)

- Lower airway consists of trachea, bronchial tree (primary bronchi, secondary bronchi, bronchioles), alveoli, lungs, where gas exchange occurs
  - Functionally, oxygen diffuses from alveoli into pulmonary capillaries while carbon dioxide diffuses in opposite direction

Chapter Summary (Cont'd)

- Ventilation, mechanical process of moving air into, out of lungs in 2 separate phases: inspiration, expiration
- Respiration, exchange of gases between living organism, environment
- Bodies of human beings provide oxygen while removing carbon dioxide, chief metabolic pollutants within our system
Chapter Summary (Cont’d)

- Must identify respiratory problems quickly to provide appropriate, timely intervention
  - Assessment of age-appropriate respiratory rate, regularity, work of breathing essential parameters to evaluate early (repeatedly) on every patient
  - When possible, use topographic landmarks of chest to describe physical examination findings, including clavicles, nipples, angle of Louis, suprasternal notch, costal angle

Chapter Summary (Cont’d)

- Auscultating lung sounds essential for every patient with any type of respiratory symptom
  - Determine if lung sounds present, equal bilaterally
  - Compare sounds from side to side by listening to one lung, then other in same place
  - With each stethoscope placement, listen to at least one full inhalation, exhalation

Chapter Summary (Cont’d)

- Many supplemental oxygen delivery methods available
  - When administering supplemental oxygen, adequate rate, depth (minute volume) of ventilation necessary
  - If doubt exists regarding adequacy of ventilation, must support patient with both supplemental oxygen, positive pressure ventilation
• Many devices exist for delivering supplemental oxygen
  • Patient’s condition determines method of delivery, liter per minute flow rate

• Airway obstruction can have many causes
  • Partial blockage of airway may impair gas exchange, jeopardize patient’s life without quick corrective action
  • Classifications of airway obstruction include complete obstruction, partial obstruction with poor air exchange, partial obstruction with good air exchange
  • Common causes leading to obstruction include tongue, foreign bodies, laryngeal spasm & edema, trauma, aspiration

• Must be able to manually open patient’s airway, require no special equipment, noninvasive
• In unresponsive patient, secretions, blood, vomitus require removal with suction device before ventilating
• Several devices can help keep airway open
Chapter Summary (Cont’d)

- Apneic patients, inadequate ventilation require artificial ventilation
- Advanced airways include Combitube, LMA, ET tube

Chapter Summary (Cont’d)

- Nasotracheal intubation
  - Alternative for intubating trachea
  - Blind procedure, vocal cords not visualized
  - RSI, use of medications to sedate, paralyze patient to achieve rapid ET intubation
  - Capnography/capnometry should be used with all endotracheal intubations

Chapter Summary (Cont’d)

- Pulse oximetry
  - Noninvasive measurement of oxygen saturation of hemoglobin in peripheral tissues
- CPAP
  - Delivery of slight positive pressure to prevent airway collapse, reduce work of breathing, improve alveolar ventilation
Chapter Summary (Cont’d)

- Cricothyrotomy
  - Emergency procedure, allows rapid entrance to airway for temporary oxygenation, ventilation
  - Insert needle into cricothyroid membrane (needle cricothyrotomy), creating opening into cricothyroid membrane with scalpel (surgical cricothyrotomy)

Questions?