CHAPTER 37

Advanced Airway Management
Airway Anatomy and Physiology Review
Respiratory System: The Airway
Physiology: Factors of Adequate Breathing

- Functioning brainstem
- Open airway
- Intact chest wall
- Alveolar gas exchange
- Changes in any of these may result in inadequate breathing!
Adequate Breathing: Normal Breath Rates

Adults  12-20/min

Children  15-30/min

Infants  25-50/min
## Adequate Breathing

<table>
<thead>
<tr>
<th>Rhythm</th>
<th>Usually regular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>Breath sounds audible with stethoscope</td>
</tr>
<tr>
<td></td>
<td>Minimal effort</td>
</tr>
<tr>
<td>Depth</td>
<td>Chest expands normally</td>
</tr>
</tbody>
</table>
Signs of Inadequate Breathing

Rate: Outside normal range (too fast or slow)
Rhythm: Irregular pattern
Depth: Chest expansion shallow
Signs of Inadequate Breathing

Quality

- Abnormal breath sounds (unequal, diminished, or absent)
- Chest expansion unequal
- Increased breathing effort
- Use of accessory muscles
- Inability to speak full sentences
<table>
<thead>
<tr>
<th>Signs of Inadequate Breathing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skin</strong></td>
</tr>
<tr>
<td><strong>Retractions</strong></td>
</tr>
<tr>
<td><strong>Agonal Respirations</strong></td>
</tr>
</tbody>
</table>
Airway Differences between Adults and Children

- Child has smaller nose and mouth.
- In child, more space is taken up by tongue.
- Child’s trachea is narrower.
- Cricoid cartilage is less rigid and less developed.
- Airway structures are more easily obstructed.
Differences between the Airways of Children & Adults

- Mouth and nose smaller
- Tongue is proportionally larger
- Trachea is softer & narrow
- Cricoid cartilage is narrowest opening
- Diaphragm performs most work
Signs of Inadequate Breathing In Infants and Children

- Slow heart rates
- Weak/absent peripheral pulse
- Retractions
- Nasal flaring
- “Seesaw” breathing
Suctioning

- Always be prepared for the need to suction the patient’s airway as needed.
- Have suction equipment ready for use!
Advanced Airway Management
Orotracheal Intubation

Advantages

- Complete control of the airway
- Allows direct ventilation of the lungs
- Minimizes risk of aspiration
- Better oxygen delivery
- Allows deep suctioning
Orotracheal Intubation

Complications

- Stimulation of airway can cause bradycardia
- Trauma to lips, teeth, tongue, gums, airway structures

Continued…
Orotracheal Intubation

Complications

- Hypoxia from prolonged attempts
- Right mainstem intubation

Continued…
Orotracheal Intubation

Complications

- Esophageal intubation
- Vomiting
- Self-extubation
- Movement of tube out of trachea when patient moves
Equipment: Body Substance Isolation
Orotracheal Intubation

**Equipment**

- Laryngoscope handle
- Laryngoscope blades
- Assorted sizes (0-4)
- Curved or straight
  - Straight preferred for infants/children
Laryngoscope Blades
Assembly of Laryngoscope Handle and Blade

Align identification with bar, press-forward to lock

Press to lock
Assembly of Laryngoscope Handle and Blade

Elevate blade to a right angle
Straight blade brings vocal cords into view by lifting the epiglottis.
Curved blade brings vocal cords into view by lifting vallecula and indirectly lifting epiglottis.
Endotracheal Tubes

- Range in size (inner diameter) from 2.0 (smallest) to 10.0 (largest)
- Have a standard 15mm bag valve connection
Endotracheal Tubes

Average Sizes (inner diameter)

Adult Female: 7.0-8.0 mm

Adult Male: 8.0-8.5 mm
Endotracheal Tube
Endotracheal Tubes

Emergency Rule:

* 7.5 fits most adults.
* Have available one size larger and one size smaller.
Endotracheal Intubation

Useful Dimensions

Teeth to vocal cords: 15 cm
Teeth to suprasternal notch: 20 cm
Teeth to carina: 25 cm
Teeth to tip: 22 cm
Endotracheal Intubation

Stylet

- Provides stiffness/shape.
- Lubricant may ease removal.
- Use to shape tube like hockey stick.
- Do not let stylet go past the proximal end of the Murphy eye.
Stylet

Stylet in Place

Limmer et al., *Emergency Care Update, 10th Edition*
Endotracheal Intubation

Other Equipment

- Water-soluble lubricant
- 10 cc syringe
- Securing devices
- Suction unit
- Towels
Endotracheal Intubation

Indications

- Inability to ventilate apneic patient
- Protect airway when no cough or gag reflex
- Protect airway of patient unresponsive to painful stimuli
- Cardiac arrest

Limiter et al., Emergency Care Update, 10th Edition
Ensure proper ventilation of the patient.
Assemble, prepare, and test equipment.
Position patient’s head.

If trauma is suspected, have a rescuer hold the head in a neutral position.
Insert laryngoscope blade into mouth, avoiding contact with teeth.
Lift tongue up and sweep to the left.
Lift mandible; do not use a fulcrum motion.
Have rescuer apply Sellick’s maneuver (bring vocal cords into view).
Visualize glottic opening between vocal cords.
Gently insert ET tube (with stylet in place) until cuff passes between vocal cords.
Make sure airway structures are aligned.
Remove laryngoscope and stylet without moving tube. Inflate cuff with 5-10 cc of air.
Attach bag-valve resuscitator and ventilate. Observe rise of chest.
Confirm placement by auscultating epigastrium and lungs.
Confirm Correct Tube Placement

- Visualize tube passing through vocal cords.
- Observe chest rise and fall.
Confirm Correct Tube Placement

* Observe for signs of deterioration, such as cyanosis.

* As protocols direct, use pulse oximeter or CO₂ detector.
If correct placement is confirmed, secure tube and continue to ventilate.
Incorrect Tube Placement

If breath sounds present only on right:

* Deflate cuff.
* Ventilate, and while auscultating over lungs,
  * Withdraw tube slightly until breath sounds are equal.
* Secure tube and ventilate.
Incorrect Tube Placement

If sounds present only in epigastrium:

* Deflate cuff.
* Remove tube.
* Ventilate for at least 1 minute.
* Reattempt intubation.
Tube Placement

Reassess breath sounds after every major move:

- From scene to ambulance
- From ambulance to hospital
Sellick’s Maneuver
(Cricoid Pressure)
Sellick’s Maneuver

Purpose

To help prevent regurgitation and aspiration during endotracheal intubation
**Key Term**

**Cricoid Cartilage**

Surrounds entire trachea; it is inferior to cricothyroid membrane (depression below thyroid cartilage or Adam’s apple).
Location of Cricoid Cartilage
Perform Sellick’s maneuver by exerting posterior pressure on cricoid cartilage.
Sellick’s Maneuver

- Verify correct position to avoid damaging other structures.
- Cricoid more difficult to find in infants/children.
Infant and Child Intubation
Anatomic and Physiologic Considerations

- Smaller mouth and nose
- Tongue larger proportionally
- Floppier epiglottis
- Smaller glottic opening
Anatomic and Physiologic Considerations

- Harder to see vocal cords
- Narrower trachea
- Less rigid cricoid cartilage
- Increased reliance on diaphragm for breathing
Child and Adult Airways

Cricoid Cartilage
Infant and Child Intubation

Special Considerations

Since cricoid ring narrowest part of child’s airway:

- Pediatric tube has no cuff
- Tube size depends on size of cricoid ring
Infant and Child Intubation

Purpose

- Most effective means of controlling airway.
- In apneic patients, it also allows deeper suctioning.
Infant and Child Intubation

Indications

- Prolonged artificial ventilation required
- Inability to ventilate by other means
Indications

- Apnea
- Cardiac arrest
- Unresponsive with no cough or gag reflex
Infant and Child Intubation

Advantages

- Prevents gastric distention
- Minimizes risk of aspiration
- Permits suctioning of airway secretions
Infant and Child Intubation

Equipment

- Bag-valve mask with mask of correct size
- Laryngoscope handle & blades
Infant and Child Intubation

Equipment – Laryngoscope Blades

Straight blade allows:

- Greater displacement of tongue
- Better visualization of glottis (preferred in infants)
Infant and Child Intubation

Equipment – Laryngoscope Blades

Curved blade

* Inserted into vallecula to allow visualization of glottis, cords

* Preferred in older children
Consult chart or tape.

In general, use:
- 3.0-3.5 for newborns, small infants
- 4.0 up to 1 year old
Infant and Child Intubation

TUBE SIZE FORMULA

\[
\frac{16 + \text{Age (years)}}{4} = \text{Tube Size (mm)}
\]
Infant and Child Intubation

- Alternative tube size selection
  - Use tube same size as little finger or that will fit nostril.
- Have tubes one size larger and smaller available.
ET Tubes

- Use UNCUFFED tubes for children up to 8 years old (narrowing of cricoid acts as a cuff).
Uncuffed ET Tube for Child Under 8 Years Old
Infant and Child Intubation

ET Tubes

- Use CUFFED tubes for children older than 8 years.

- Tube should have marker for vocal cords, to assure proper insertion depth.
# Pediatric ET Tube Distances

<table>
<thead>
<tr>
<th>Age</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5-1 year</td>
<td>12 cm</td>
</tr>
<tr>
<td>2 years</td>
<td>14 cm</td>
</tr>
<tr>
<td>4-6 years</td>
<td>16 cm</td>
</tr>
<tr>
<td>6-10 years</td>
<td>18 cm</td>
</tr>
<tr>
<td>10-12 years</td>
<td>20 cm</td>
</tr>
</tbody>
</table>

Measured from teeth to mid-trachea
Endotracheal Intubation

Equipment

- Pediatric stylet
- Water-soluble lubricant
- 10 cc syringe
- Securing devices
- Suction unit
- Towels
Infant and Child Intubation
Techniques

- Ventilate appropriately.
- Assemble and test equipment.
- Take BSI precautions.
**Infant and Child Intubation Techniques**

- Monitor heart rate throughout.
- Stimulating airway may slow heart rate. If this happens, stop and ventilate.
Place head in “sniffing” position.

If trauma is suspected, have rescuer hold head in neutral position.
Infant and Child Intubation Techniques

* Insert laryngoscope blade into right corner of mouth.
* Sweep tongue out of way.
Infant and Child Intubation

Techniques

* Insert end of blade into position.

* Lift mandible.
Infant and Child Intubation Techniques

- Consider using Sellick’s maneuver.
- Visualize glottic opening and vocal cords.
Infant and Child Intubation

Techniques

- Gently insert tube until glottic marker (if present) is at level of vocal cords.
- If using cuffed tube, insert cuff beyond vocal cords.
Infant and Child Intubation

Techniques

- Holding tube, remove laryngoscope blade and stylet.
- Attach bag-valve and ventilate.
- Confirm correct placement.
**Infant and Child Intubation**

**Confirming Placement**

- Observe chest rise and fall.
- Auscultate lung sounds.
- Auscultate epigastrium for absence of sounds.
- Assess for improving skin color & heart rate.
If correct placement confirmed, secure tube and continue to ventilate.
Infant and Child Intubation

Techniques

- Ventilate patient at a rate appropriate for age.
- Note tube's depth of insertion.
- May insert oral airway as a bite block.
Incorrect Tube Placement

If breath sounds present only on right:

- Deflate cuff (if used).
- Ventilate, and while auscultating over lung, withdraw tube slightly until breath sounds are equal.
- Secure tube and ventilate.
Incorrect Tube Placement

If sounds present only in epigastrium:

- Deflate cuff (if used).
- Remove tube.
- Ventilate for at least 1 minute.
- Reattempt intubation.
Once tube is secured, secure head to prevent movement that can dislodge tube.
Infant and Child Intubation

Techniques

Reassess breath sounds after every major move:

- Scene to ambulance
- Ambulance to hospital
If tube in proper place, but inadequate lung expansion:

- Tube may be too small.
  - Auscultate neck.
  - Replace with larger tube.
  - Consider cuffed tube if child is older than 8 years old.
Infant and Child Intubation

Complications

If tube is in proper place, but inadequate lung expansion:

- Check if pop-off valve on bag-valve device is activated.
- Check for a leak in bag-valve device.
Infant and Child Intubation

Complications

If tube in proper place, but inadequate lung expansion:

- Possible inadequate compression of bag.
- Check for tube blocked with secretions.

Continued...
Infant and Child Intubation

Complications

- Suction endotracheally;
- Replace tube.
Nasogastric Tubes
Nasogastric Tubes

Indications

- Inability to ventilate infant/child because of gastric distention
- Unresponsive infant/child with gastric distention
Nasogastric Tubes

Reasons for Use:
- Decompress stomach
- Gastric lavage
- Administration of medications/nutrition

Limmer et al., *Emergency Care Update, 10th Edition*
Nasogastric Tubes

Contraindications

- Presence of major face, head, or spine trauma.
- Use orogastric technique instead.
Nasogastric Tubes

Complications

- Tracheal intubation
- Nasal trauma
- Emesis
- Passage into cranium through basilar skull fracture

Limmer et al., *Emergency Care Update, 10th Edition*
### Nasogastric Tubes

#### Tube Sizes

<table>
<thead>
<tr>
<th>Age Group</th>
<th>French Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn/Infant</td>
<td>8.0</td>
</tr>
<tr>
<td>Toddler/Preschool</td>
<td>10.0</td>
</tr>
<tr>
<td>School-age</td>
<td>12.0</td>
</tr>
<tr>
<td>Adolescent</td>
<td>14-16</td>
</tr>
</tbody>
</table>
# Nasogastric Tubes

## Equipment

- 20 cc syringe
- Water-soluble lubricant
- Emesis basin
- Tape, stethoscope
- Suction unit and catheters
Nasogastric Intubation – Infant/Child:
Use BSI; oxygenate patient; prepare and assemble equipment.
Measure tube from tip of nose, around ear, to below xiphoid process.
Pass lubricated tube downward along nasal floor into stomach.
Confirm placement as you inject 10-20 cc air. Listen for bubbling.
Aspirate stomach contents.
Secure tube in place.
Orotracheal Suctioning

“Deep Tracheal Suctioning”
Orotracheal Suctioning

**Indications:**

- Obvious secretions in endotracheal tube
- Poor compliance with bag valve
Orotracheal Suctioning

Complications

- Hypoxia
- Cardiac dysrhythmias
- Trauma to airway
- Bronchospasm
- Laryngospasm
- Coughing
Preoxygenate and hyperventilate patient.
Carefully check equipment. Use BSI.
Approximate depth of insertion by measuring the suction catheter from lips, to the ear, to the nipple line.
Insert catheter without suction.
Use sterile technique.
Advance catheter no farther than carina.
Apply suction (no more than 15 seconds) and withdraw catheter in a twisting motion. Resume ventilations.

Combitubes®
A Dual Lumen Airway

- Esophageal tube
- Tracheal tube
- Pilot balloon
- Cuff inflation port
- Pharyngeal cuff
- Tracheal or esophageal cuff

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Indication

- Unconscious patient in need of airway management
Contraindications:

- Conscious patient
- Patient with gag reflex
- Under 5 feet tall
- Under 16 years old
- Ingestion of caustic substance
- Known esophageal disease
Combitubes®
Insertion Techniques

- Take BSI precautions.
- Ventilate with bag-valve mask.
- Prepare and check equipment.
- Have suction readily available.
- If patient becomes conscious, at any time, remove the tube!
Lubricate the Combitube®

Limmer et al., Emergency Care Update, 10th Edition
Combitube®
Insertion Techniques

* Insert device blindly along center of the mouth.

* Advance device until the teeth are centered between the black rings on the Combitube®.
Insert the Combitube®.
Combitubes®
Insertion Techniques

- Inflate valve #1 cuff with 100 cc of air.
- Inflate valve #2 cuff with 15 cc of air.
Combitube® in place with cuffs inflated.
Ventilate through tube #1 (blue tube).
Auscultate for lung sounds and the absence of epigastric sounds.

If lung sounds are present and no epigastric sounds are heard, continue ventilating through the blue tube (tube #1).
If no lung sounds are present and epigastric sounds are heard, ventilate through the shorter tube (tube #2).
Laryngeal Mask Airway (LMA)
A Laryngeal Mask Airway
Laryngeal Mask Airway

Insertion Techniques

★ Take BSI precautions.
★ Ventilate with bag-valve mask.
★ Prepare and check equipment.
★ Have suction readily available.
★ Place patient in a sniffing position.
Laryngeal Mask Airway

Insertion Techniques

- Lubricate the posterior side of cuff.
- Insert tube with open side facing anteriorly.
- Stop when resistance is felt.
Inserting the LMA

(a)

(b)
Laryngeal Mask Airway

Insertion Techniques

- Inflate cuff with air based on size of LMA.
- Ventilate through the tube.
- Auscultate for lung sounds and the absence of epigastric sounds.
- Insert an oral airway as a bite block.
Automatic Transport Ventilators (ATVs)
An Automatic Transport Ventilator
Automatic Transport Ventilators

- Protocols may allow use in place of bag-valve mask.
- Controls set rate of ventilations and weight-based tidal volume.
1. Explain the differences between orotracheal and oropharyngeal suctioning.

2. Explain why nasogastric tubes are used in an infant or child.

3. Explain the purpose of Sellick’s maneuver.
Review Questions

4. Explain the purpose of orotracheal intubation and the complications that can arise during intubation.

5. Explain the procedures for assuring correct placement of an endotracheal tube.

6. Describe the differences between child and adult airways.
What priority would you assign the patient?

What definitive treatment do pulseless patients require?

What alternatives for managing the airway might you consider?
What assessment procedures should be performed at this time?

How often should this patient be reassessed?
### Sample Documentation

**Patient Name:** Rafael Gomez

#### Chief Complaint
- **Cardiac Arrest**

#### Past Medical History
- None
- Hypertension
- Seizures
- COPD
- Other (List)

#### Vital Signs

<table>
<thead>
<tr>
<th>TIME</th>
<th>RESP</th>
<th>PULSE</th>
<th>B.P.</th>
<th>Mental Status</th>
<th>R Pupils</th>
<th>L</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:05</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Alert</td>
<td>Normal</td>
<td>✔</td>
<td>Normal</td>
</tr>
<tr>
<td>10:10</td>
<td>80</td>
<td>46</td>
<td></td>
<td>Alert</td>
<td>Normal</td>
<td>✔</td>
<td>Unremarkable</td>
</tr>
</tbody>
</table>

#### Narrative

Patient was a bystander-witnessed cardiac arrest. Physician on scene stated patient had no pulse; verified by EMS crew. CPR ongoing while AED attached and detected shockable rhythm (see AED printout attached). One shock delivered with patient’s pulse returning. No respirations; airway secretions noted. Patient suctioned with rigid catheter and decision to intubate with #8.0 ET tube x 1 attempt = successful. Prior to intubation, patient oxygenated with BYM and OPA. Lung sounds equal bilaterally and negative findings over epigastric area. Patient reassessed throughout with no changes noted other than patient seemed to respond to verbal stimuli as we neared the hospital. On-line medical direction established.