Difficult Airways

- Difficulties with airway management after induction of anesthesia are the commonest cause of mortality or morbidity with anesthesia

Difficult Airway Society UK
Overview

- Bronchoscopy Equipment
  - Rigid
  - Flexible
- Anatomy & Anesthetic Considerations
  - Pediatric v. Adult
- Indications for Bronchoscopy
  - Urgent Airways
Objectives

1. Improve knowledge of the components of the bronchoscope and how to put it all together

2. Identify the correct airway instruments for the patient and the medical situation

3. Improve identification and management of impending airway compromise
Bronchoscope Components

- Bronchoscope
- Hopkins Rod
  - 0, 30, 70 degree
- Prism
- Bridge
- Suction Port & Plastic Cover
- Light Cord

Bronchoscope Sizing

- Children > 1 year old
  - \( \frac{(Age + 16)}{4} \)
- Endotracheal Tube (ETT) Depth
  - \( (Normal\ Tube\ Size\ for\ Age) \times 3 \)
# Bronchoscope Sizes

<table>
<thead>
<tr>
<th>Size</th>
<th>Length</th>
<th>ID (mm)</th>
<th>OD (mm)</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>20</td>
<td>3.5</td>
<td>4.2</td>
<td>Premature</td>
</tr>
<tr>
<td>3.0</td>
<td>20, 26</td>
<td>4.3</td>
<td>5.0</td>
<td>Premature, newborn</td>
</tr>
<tr>
<td>3.5</td>
<td>20, 26, 30</td>
<td>5.0</td>
<td>5.7</td>
<td>Newborn-6 mo</td>
</tr>
<tr>
<td>3.7</td>
<td>26, 30</td>
<td>5.7</td>
<td>6.4</td>
<td>6 mo-1 yr</td>
</tr>
<tr>
<td>4.0</td>
<td>26, 30</td>
<td>6.0</td>
<td>6.7</td>
<td>1-2 yr</td>
</tr>
<tr>
<td>5.0</td>
<td>30</td>
<td>7.1</td>
<td>7.8</td>
<td>3-4 yr</td>
</tr>
<tr>
<td>6.0</td>
<td>30, 40</td>
<td>7.5</td>
<td>8.2</td>
<td>5-7 yr</td>
</tr>
<tr>
<td>6.5</td>
<td>43</td>
<td>8.5</td>
<td>9.2</td>
<td>Adult</td>
</tr>
</tbody>
</table>

*ID*, Internal diameter; *OD*, outer diameter.

Camera & Video

http://matulyasurgical.com/endoscopy-set-refurbished/
Accessories

- Tooth Guard
- Defogging Solution
- Suction
  - Rigid
  - Flexible
  - Luki Trap
- Graspers
  - Peanut
  - Alligator
  - Cup

## Pediatric v. Adult Airway

<table>
<thead>
<tr>
<th>Location</th>
<th>Pediatric (&lt; 8 y.o.)</th>
<th>Needed Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>Proportionately Larger, Less Stable</td>
<td>Natural Sniffing Position, Use Donut</td>
</tr>
<tr>
<td>Teeth</td>
<td>Deciduous Teeth</td>
<td>Aspiration Risk</td>
</tr>
<tr>
<td>Adenotonsillar Tissue</td>
<td>Larger, Friable</td>
<td>Bleeding Risk; Blind Nasal ETT Contraindicated</td>
</tr>
<tr>
<td>Tongue</td>
<td>Larger</td>
<td>Use Straight dL Blade</td>
</tr>
<tr>
<td>Larynx</td>
<td>Higher (C2-4) More Anterior</td>
<td>Shoulder Roll, Gentle Cricoid Pressure</td>
</tr>
<tr>
<td>Epiglottis</td>
<td>Omega shaped, Prolapsing</td>
<td>Use Straight dL Blade</td>
</tr>
</tbody>
</table>

http://clinicalgate.com/tracheal-intubation/  
http://www.slideshare.net/sot462004/emergency-lectures-pediatric-resuscitation
Pediatric v. Adult Airway

- Smaller nasopharynx, easily occluded during infection.
- Lymph tissue (tonsils, adenoids) grows rapidly in early childhood; atrophies after age 12.
- Smaller nares, easily occluded.
- Small oral cavity and large tongue increase risk of obstruction.
- Long, floppy epiglottis vulnerable to swelling with resulting obstruction.
- Larynx and glottis are higher in neck, increasing risk of aspiration.
- Because thyroid, cricoid, and tracheal cartilages are immature, they may easily collapse when neck is flexed.
- Because fewer muscles are functional in airway, it is less able to compensate for edema, spasm, and trauma.
- The large amounts of soft tissue and loosely anchored mucous membranes lining the airway increase risk of edema and obstruction.
## Pediatric v. Adult Airway

<table>
<thead>
<tr>
<th>Location</th>
<th>Pediatric (&lt;8 y.o.)</th>
<th>Needed Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocal Folds</td>
<td>More Reactive</td>
<td>Positive Pressure to Break Spasm</td>
</tr>
<tr>
<td>Thyroid, Cricoid, &amp; Tracheal Cartilages</td>
<td>Immature, More Pliable</td>
<td>Collapse more easily with compression</td>
</tr>
<tr>
<td>Cricoid</td>
<td>Narrowest Portion</td>
<td>May need to downsize ETT</td>
</tr>
<tr>
<td>Trachea</td>
<td>Shorter</td>
<td>Easier to Main Stem ETT</td>
</tr>
<tr>
<td>Airway Diameter</td>
<td>Narrower</td>
<td>Aspiration Risk</td>
</tr>
<tr>
<td>Residual Lung Capacity</td>
<td>Smaller</td>
<td>Hypoxic more rapidly</td>
</tr>
</tbody>
</table>

http://www.slideshare.net/sot462004/emergency-lectures-pediatric-resuscitation
http://clinicalgate.com/tracheal-intubation/
Pediatric Airway Anatomy

- Tongue is larger in proportion to mouth
- Pharynx is smaller
- Epiglottis is larger and floppier
- Larynx is more anterior and superior
- Narrowest at cricoid
- Trachea narrow and less rigid

Adult’s Upper Airway

Child’s Upper Airway

Copyright 2008 EMT-National-Training.com

Infant Airway Diameter

The diameter of an infant’s airway is approximately 4 mm, in contrast to an adult’s airway diameter of 20 mm.
Pediatric Respiratory Physiology

- More Rapid Desaturation Tendency
  - Basal Oxygen Consumption 2x Adult
  - Proportionately smaller Functional Residual Capacity to Body Weight Ratio
Bronchoscopy Indications

- Foreign Body
- Relief of airway obstruction -> Establishment of airway
- Airway evaluation and intervention
  - Stenosis, Balloon Dilation, Surgical Planning
- Pulmonary hemorrhage
- Pulmonary toilet
- Tumor Ablation
Contraindications

- Uncontrolled coagulopathy
- Extreme ventilation demands
- Patient instability
Complications

- Dental damage
- Airway compromise
- Perforation: Pneumothorax, Pneumomediastinum
- Bleeding
- Complication rates should be < 0.1%
- Rare procedure related mortality
Anesthetic Considerations

- **Rigid Bronchoscopy Challenges**
  - Increased airway resistance
  - Increased air leak
  - Suctioning rapidly depletes oxygen

- **Management Options**
  - Hyperventilate prior to start
  - Increase gas flow rate
  - Slow, Larger Volume, Manual Ventilation
Neonatal Anesthesia

- Risk of adverse events is inversely proportional to age
  - Greatest risk < 60 wks gestational age

- Respiratory control is immature
  - CO2 response curve is flatter & shifted right
  - Hypoxia may induce apnea

- Immature Cardiovascular Responses
  - Poorly compliant myocardium
  - Cardiac output is rate dependent
  - Bradycardia with hypoxemia
Spontaneous v. Paralyzed Ventilation

- **Spontaneous Ventilation**
  - Dynamic assessment
  - Severe airway obstruction

- **Paralyzed Ventilation**
  - No cough or spasm
  - Operator entirely responsible for respiration
    - Use slow, larger than normal volume, manual ventilation
Premature Infants

- Premature Infants <1 kg

- 2.5 bronchoscope is too big -> Hopkins Rod (OD 2.7 mm) Alone
  - Apneic Technique
  - Spontaneous ventilation with NP Sevoflurane
  - IV Propofol with/without remifentanil
Premature Infants

- Premature infants 1–2 kg

- 2.5 bronchoscope
  - Very high intrapulmonary pressure
    - Risks barotrauma -> Pneumothorax risk
    - Prevents adequate gas exchange
  - Apneic technique may be safer
    - Bradycardia risk
Head Positioning

A. Neutral

B. Head elevated

C. Sniffing position

D. Ramped position

http://clinicalgate.com/tracheal-intubation/
Rigid Bronchoscopy Procedure

- Mask Ventilation
  - Oral Airway
  - Jaw Thrust
  - Pre-Oxygenate

- Direct Laryngoscopy
  - Straight dL if < 2 y.o.

- Bronchoscopy

https://iowaheadneckprotocols.oto.uiowa.edu/display/protocols/Pediatric+Direct+Laryngoscopy
Laryngoscopy Assessment
Pass Through Vocal Folds

Rigid Bronchoscopy
Pulmonary Take Offs
Tracheomalacia
Innominate Compression

Flexible Fiberoptic Bronchoscopy
Flexible Fiberoptic Bronchoscopy

- Airway Evaluation
  - Dynamic Assessment
  - More Distal Lesions
- Intubation Role
- Treatment
  - Pulmonary Toilet
Flexible Fiberoptic Bronchoscopy
Urgent Airways

- Foreign Bodies
- Airway Compromise
  - Stenosis/Atresia
- Airway Trauma
- Pulmonary Toilet
- Pulmonary Hemorrhage
Foreign Bodies

- Age 1 – 3 y.o.
- Peanut most common
- 80 – 90 % Bronchial
  - Right Main Stem Bronchus
  - Classic Symptom Triad
    - Cough
    - Unilateral Wheezing
    - Unilateral Decreased Breath Sounds

http://lifeinthefastlane.com/lower-airway-foreign-body/
Pediatric Carina Level

Bifurcation of trachea in children is at T3 level.

Right mainstem bronchus in children has a steeper slope than in adults.

Bifurcation in adults is at T6 level.

http://slideplayer.com/slide/5015262/
High Index of Suspicion

Foreign Body Localization

Foreign Body Localization in the Lower Airway
High Index of Suspicion
Where There is 1...
Foreign Bodies
Tracheal Foreign Body
Tracheal Foreign Body

Subglottis
Bronch Removal Through Stoma

Carina
Tracheal Foreign Body
Alternative Removal Options

Basket

Fogarty Catheter


Surgical Emergencies

Subglottic Stenosis (SGS)

Classification | From | To          
---             | ---  | ---         
Grade I        | No Obstruction | 50% Obstruction 
Grade II       | 51% Obstruction | 70% Obstruction 
Grade III      | 71% Obstruction | 69% Obstruction 
Grade IV       | No Detectable Lumen 

Copyright © The McGraw-Hill Companies, Inc. All rights reserved.
SGS – Endoscopic Management

• Balloon
  • Size selection
• Adjuvants
  • Radial Incisions
  • Steroid Injections


https://www.youtube.com/watch?v=3jEd4TuPiI4
Endoscopic Management of SGS

- Splits & Grafts
  - Best for Grade I – II SGS
  - Children < 1 y.o.
- Types
  - Posterior Cricoid Split with Graft
  - Anterior Cricoid Split

http://oto.sagepub.com.ezproxy.uthsc.edu/content/148/3/494.full.pdf+html
Airway Trauma

4 cm Tracheal Rupture
Pulmonary Toilet

- Pneumonia
- Plastic Bronchitis
Plastic Bronchitis

- **Etiology**
  - Congenital heart disease
  - Pneumonia
  - Asthma

- **Lymphatic Flow Disorder**

- **Tracheobronchial Casts**

- **Severe Airway Obstruction**
Plastic Bronchitis Management

- Bronchoscopic Removal
- Adjuvants
  - Fibrinolytics
    - T-PA
    - Heparin
    - Urokinase
  - Mucolytics
    - Acetylcysteine
    - Dornase alpha
Pulmonary Hemorrhage

- **Etiology**
  - Infectious
    - Tuberculosis
  - Traumatic
    - Iatrogenic
  - Neoplastic
  - Vascular
    - Arteriovenous Malformation
  - Medication
    - Bevacizumab

Left Main Stem Bronchus –
Left Lateral Decubitus Positioning
Pulmonary Hemorrhage – Diagnosis

- Secure Airway
- Flexible Fiberoptic Bronchoscopy
- Rigid Bronchoscopy
- Concurrent Catheterization
- CT Angio
Left Double Lumen ETT

A. Correct position
B. Tube too low (no cuff visible)
C. Tube too high (balloon covers carina)
Pulmonary Hemorrhage – Bronchoscopic Management

- Topical Vasoconstrictors
- Balloon Tamponade
- Fibrinogen-Thrombin
- Cauterization

Conclusion

- Verify Bronchoscopy Set Up prior to case
- Never Destabilize a Stable Airway
- Special Anesthetic Considerations for Premature Infants and Neonates
- Spontaneous Ventilation until airway established
- Use Side Ports for Adjuvants
The general who wins the battle makes many calculations in his temple before the battle is fought. The general who loses makes but few calculations beforehand.

- Sun Tzu, Art of War


