Management of the Emergent Airway

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The Difficult Airway

- Problematic ventilation using a face mask
  - Inability to deliver necessary tidal volume via face mask utilizing nasal or oral airway
- Incomplete laryngoscopic visualization
  - Cormack and Lehane grade 3 or 4
- Difficult Intubation with standard airway equipment
  - Requiring external laryngeal manipulation
  - Greater than 3 attempts at intubation
  - Requiring nonstandard equipment
Evaluation of the Airway

- Elective Versus Urgent
- Adult Versus Pediatric
- Patient Status
Predictors of Significantly Difficult or Impossible Intubation in Adults

- Interincisor distance 3 cm or less
- Thyro-mental distance 6 cm or less
- Maxillary dentition interfering with jaw thrust
- Mallampati classification
- Neck in fixed flexion
- Extreme head and neck radiation changes, scarring, or large masses
Airway Management Team

- Anesthesiologist
- Otolaryngologist
- Emergency Physician
- Respiratory Therapist
OR vs. Emergency Room: Difficult Intubations

- Incidence of difficult intubation in OR: 1.15% to 3.80%
  - Failed attempts occur in 0.05% to 0.35%
- Incidence of difficult intubations in ED: 3.0% to 5.3%
  - Failure rates ranging from 0.5% to 1.1%
The difficult airway in the emergency department. Wong et al

- Prospective Observational Study from 1 January 2000 to 31 December 2006
- 2,343 patients who underwent advanced airway management, 93 (4.0%) were deemed difficult
- Difficult airway defined as difficulty with mask ventilation or at least 3 attempts at orotracheal intubation or failed intubation or cricothyroidotomy was difficult
- Failed airway defined as tracheal intubation cannot be achieved after multiple attempts by orotracheal, nasotracheal or transtracheal (cricothyroidotomy or tracheostomy) route, or if intubation abandoned
### Diagnoses Encountered

#### Table 1 Primary diagnoses

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<th>Diagnoses</th>
<th>Difficult cases</th>
<th>Total</th>
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<td>Burns</td>
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<tr>
<td>Total</td>
<td>93</td>
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</table>

*CV A cerebrovascular accident*
### Table 2: Reasons for difficult intubation

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<tr>
<th>Reasons for difficulty</th>
<th>No.</th>
<th>%</th>
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<tbody>
<tr>
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<tr>
<td>Neck immobility</td>
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<tr>
<td>Secretions and blood</td>
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<td>15.1</td>
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<td>Small mouth &lt; 3 fingerbreadths</td>
<td>13</td>
<td>14.0</td>
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<tr>
<td>Obesity</td>
<td>10</td>
<td>10.8</td>
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<tr>
<td>Incomplete frontal dentition</td>
<td>8</td>
<td>8.6</td>
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<tr>
<td>Airway oedema</td>
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<td>8.6</td>
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<tr>
<td>Oral obstruction (tumour, mechanical obstruction)</td>
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<td>Maxillofacial trauma</td>
<td>4</td>
<td>4.3</td>
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<td>Combative presence</td>
<td>2</td>
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Results (continued)

- Mean number of attempts at intubation for difficult airway group was 3.6 compared to 1.2 for all patients
- Surgical airway rate was 0.3%
- Difficult intubation rate: 4%
- Failed intubation rate: 0.7%
Causes of a Difficult Airway

- Trauma
  - Midface
  - Mandible
  - Neck
- Bleeding into airway
- Caustic ingestion
- Thermal burns
Causes of a Difficult Airway

- Disease
  - Obstructive Sleep Apnea
  - Malignancy, mucosal
    - Oral
    - Pharyngeal
    - Laryngotracheal
Causes of a Difficult Airway

• Malignancy, extrinsic
  • Thyroid
  • Lymphoma
  • Esophageal
Causes of a Difficult Airway

- Foreign Body
- Degenerative cervical spine disease
- Infection
  - Deep Neck Space Abscess
  - Ludwig’s angina
- Trismus
- Anaphylaxis
- Angioedema
- Previous head and neck surgery
- Vocal cord paralysis
Causes of a Difficult Airway

- Anatomic/congenital factors
  - Retrognathia
  - Thick/Short neck
  - Macroglossia
  - Small mouth opening
  - Kyphosis
 Evaluation of the Airway

- Mallampati Classification: used to estimate ease of viewing patient’s glottis
Cormack Lehane scale

- Visualization of glottis with Macintosh blade
Questions I Need to Ask Myself

- Can I perform effective mask ventilation?
  - Incidence of difficult mask ventilation in adult patients in OR is 1.4-5%
  - Defined as inability to maintain O2 sat >90% with 100% inspired O2 or to prevent or reverse signs of hypoventilation with positive-pressure mask ventilation

- Can I safely intubate this patient?

- Although tracheal intubation is the ultimate goal in airway management, the ability to provide effective mask-ventilation is life-saving (1)
Kheterpal et al. reviewed 50,000 patients undergoing airway management in the operating room. Impossible mask ventilation occurred in 0.15% of cases. Predictors included previous neck radiation, male sex, OSA, Mallampati class III or IV, and presence of a beard. 25% (19/77) of patients with impossible mask ventilation were difficult to intubate. 2 of those patients required surgical airways.
Pre-oxygenation

- Healthy adults breathing room air will develop oxygen desaturation (SpO2 <90%) with 2 minutes of apnea
- Preoxygenation with 100% oxygen can maintain oxygen saturation above 90% for more than 6 minutes
- 4 vital-capacity breaths in 30 seconds or 8 vital capacity breaths in 60 seconds provide adequate pre-oxygenation
Monitoring During Anesthesia

- American Society of Anesthesiology Standards for Basic Anesthetic Monitoring released in 1986
- Continual monitoring of oxygen, ventilation, circulation, temperature
- Intermittent (no less frequent than every 5 minutes) measurement of arterial blood pressure and heart rate
Anesthetic Pharmacology
Induction Agents

- IV induction agents have quick onset, produce unconsciousness within 1-2 minutes
- Thiopental and Propofol: negative inotropic effect and produces apnea along with unconsciousness
- Etomidate: less effects on hemodynamics, potential adrenal suppression and myoclonic activity
- Ketamine: does not produce apnea with administration, can give IM, can cause tachycardia and hypertension along with exaggerated secretions
Volatile Anesthetic Agents

- Used for maintenance in most instances
- Halothane - nonflammable, alkane, lacks bronchoirritant effects, highly soluble in blood and fatty tissues, negative inotropic effects on cardiac muscles
- Enflurane and Isoflurane: nonflammable, pungent odor, produce more intrinsic respiratory depression, less cardiac effects (Enflurane now rarely used due to risk of renal toxicity and seizure)
- Sevoflurane and Desflurane: low lipid solubility, cause little myocardial depression, Desflurane has bronchoirritative properties
Nitrous Oxide

- Not potent enough as single agent,
- Used in conjunction with volatile agents to decrease the requirements
- Can support combustion with oxygen
- Quickly diffuses into closed, air-filled body cavities
  - Avoid in obstructive ileus, pulmonary bullae, unrelieved pneumothorax
  - Useful in PE tube placement but not during tympanoplasty
Neuromuscular Blocking Drugs

- **Competitive Inhibitors**
  - **Pancuronium**
    - Metabolized in the Liver, Excreted by Kidneys
    - CV Effects: Tachycardia
    - Onset: < 3 min
    - Duration: 60-90 min
  - **Vecuronium**
    - Metabolized in Liver, Excreted by Kidneys
    - CV Effects: None
    - Onset: < 3 min
    - Duration: 45-60 min
  - **Rocuronium**
    - Metabolized in Liver, Excreted by Kidneys
    - CV effects: None
    - Onset: < 1 min
    - Duration: 45-60 min

- **Non-competitive Inhibitors**
  - **Succinylcholine**
    - Metabolized by plasma cholinesterase, Excreted by Kidneys
    - CV Effects: Bradycardia in children or in repetitive bolus to adults
    - Onset: < 1 min
    - Duration: < 10 minutes
Rapid Sequence Intubation

- Most common approach to securing airway in ER, ICU, and OR with concerns for aspiration
- Pre-oxygenation, administration of induction agent with muscle relaxant in rapid succession, Wait 45-60 s without mask ventilation then intubation with cricoid pressure
- Controversy over cricoid pressure:
  - Studies show it lies over the hypopharynx that can only be compressed 35% in diameter, Smith et al used MRI to demonstrate greater than 50% of patients have esophagus displaced laterally with cricoid pressure and is not compressible
Adult Evaluation

- Evaluate for:
  - Facial or Neck Masses
  - Deformities, scars, quality of dentition, Maxillary and Mandibular position, pharyngeal structures, and Neck Mobility
- Flexible fiber-optic endoscopy is the most important factor in determining the status of the upper airway and cause of impairment; however, when do we have the time?
- Controversy whether increased age, male sex, OSA, high BMI, Pretracheal soft tissue increase challenge
Pediatric Evaluation

- Noisy breathing during exercise, at rest or when feeding
- Previous surgeries or Intubations
- Neck pain, fever, recent upper respiratory infections
- Birth Trauma
- Congenital Anomalies
Difficult Airway Algorithm

- Accepted by the American Society of Anesthesiologists
- 4 main steps in the process of developing the strategy for acquiring control of the airway
- (1) Assess the likelihood and clinical impact of basic management problems
  - Difficult ventilation
  - Difficult intubation
  - Difficulty with Patient Cooperation or Consent
  - Difficult Tracheostomy
Algorithm continued

- (2) Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management
- (3) Consider the relative merits and feasibility of basic management choices
  - Awake intubation vs. Intubation Attempts After Induction of General Anesthesia
  - Non-invasive Technique for Initial Approach to Intubation vs. Invasive Technique for Initial Approach to Intubation
  - Preservation of Spontaneous Ventilation vs. Ablation of Spontaneous Ventilation
- (4) Develop primary and alternative strategies
Scenario 1

- You decide that the best approach is an awake intubation
- Decision is between approaching the airway by non-invasive intubation or invasive airway access (tracheostomy vs. cricothyroidotomy)
You succeed !!!

- Hooray, you have confirmed ventilation, tracheal intubation, or LMA placement with exhaled CO2
Or -- You Have Failed

- (1) Consider cancelling the case
- (2) Consider feasibility of other options: face mask or LMA, local anesthesia infiltration or regional nerve block (not really an option for many of our cases)
- (3) Invasive Airway Access
Scenario 2

- Intubation Attempts After Induction of General Anesthesia
- Major decision tree based on ability to adequately ventilate through face mask
Tube is in the trachea

- Congrats, you are done. Go on your coffee break then 20 minutes later, go on your lunch break, then read the paper for 30 minutes while various beeps go off. Take out a syringe and then push some saline into the IV. Complain for a while about the length of the OR case and why you wish your stocks were doing better. Flirt with the scrub nurse.
Initial Intubation Attempt Unsuccessful

• From here on out consider:
  Calling for Help,
  Return to Spontaneous Ventilation,
  Awakening the Patient

• Attempt Face Mask Ventilation
  • If adequate, head toward non-emergent pathway
Alternative Approaches to Intubation

- Using different laryngoscope blades
- LMA as an intubation conduit (with or without fiberoptic guidance)
- Fiberoptic Intubation
- Intubating stylet or tube changer
- Light wand
- Retrograde Intubation
- Blind oral or nasal intubation
Failing after Multiple Attempts

- Invasive Airway Access
- Consider other options
- Awaken the patient
If Face Mask Ventilation Not Adequate

- First Consider or Attempt to place LMA
- If the LMA is adequate then you can attempt alternative approaches to intubation
- If LMA is not adequate or not feasible:
  - Call for Help
- Emergency Non-Invasive Airway Ventilation
  - Rigid Bronchoscopy
  - Esophageal-Tracheal Combitube
  - Transtracheal jet ventilation
Laryngeal Mask

Courtesy Cummings
Esophageal Combitube

Courtesy Cummings
Rigid Bronchoscope
If Emergency Non-invasive Ventilation is Successful

- Consider invasive airway access
- Consider feasibility of other options as discussed before
- Awaken the Patient
If Emergency Non-Invasive Ventilation is Unsuccessful

- Emergency Invasive Airway Access
- That would be us.
ASA Difficult Airway Algorithm

DIFFICULT AIRWAY ALGORITHM

1. Assess the likelihood and clinical impact of basic management problems:
   A. Difficult Ventilation
   B. Difficult Intubation
   C. Difficulty with Patient Cooperation or Consent
   D. Difficult Tracheostomy

2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management.

3. Consider the relative merits and feasibility of basic management choices:
   A. Awake Intubation
   B. Non-Invasive Technique for Initial Approach to Intubation
   C. Preservation of Spontaneous Ventilation

4. Develop primary and alternative strategies:

   A. AWAKE INTUBATION
      - Airway Approached by Non-Invasive Intubation
        - Invasive Airway Access
          - Succeed
            - Cancel Case
          - FAIL
            - Consider Feasibility of Other Options
              - Invasive Airway Access

   B. INTUBATION ATTEMPTS AFTER INDUCTION OF GENERAL ANESTHESIA
      - Initial Intubation Attempts Successful
        - ONWARDS CONSIDER:
          1. Calling for Help
          2. Returning to Spontaneous Ventilation
          3. Awakening the Patient
      - Initial Intubation Attempts UNSUCCESSFUL
        - FACE MASK VENTILATION NOT ADEQUATE
          - CONSIDER / ATTEMPT LMA
            - LMA ADEQUATE
              - EMERGENCY PATHWAY
                - Ventilation Not Adequate, Intubation Unsuccessful
                  - Call for Help
                  - Emergency Non-Invasive Airway Ventilation
                  - Emergency Invasive Airway Access
                  - FAIL
                  - LMA NOT ADEQUATE OR NOT FEASIBLE
                    - Alternative Approaches to Intubation
                      - Successful Intubation
                        - Invasive Airway Access
                      - FAIL After Multiple Attempts
                        - Consider Feasibility of Other Options
                          - Ablation of Spontaneous Ventilation

   * Confirm ventilation, tracheal intubation, or LMA placement with exhaled CO₂
     a. Other options include (but are not limited to): surgery utilizing face mask or LMA anesthesia, local anesthesia infiltration or regional nerve blocks. Pursuit of these options usually implies that mask ventilation will not be problematic. Therefore, these options may be of limited value if this step in the algorithm has been reached via the Emergency Pathway.
     b. Invasive airway access includes surgical or percutaneous tracheostomy or cricothyrotomy.
     c. Alternative non-invasive approaches to difficult intubation include (but are not limited to): use of different laryngoscope blades, LMA as an intubation conduit (with or without fiberoptic guidance), fiberoptic intubation, intubating stylet or tube changer, light wand, retrograde intubation, and blind oral or nasal intubation.
     d. Consider re-preparation of the patient for awake intubation or canceling surgery.
     e. Options for emergency non-invasive airway ventilation include (but are not limited to): rigid bronchoscope, esophageal-tracheal combitube ventilation, or translaryngeal jet ventilation.
DIFFICULT AIRWAY ALGORITHM

1. Assess the likelihood and clinical impact of basic management problems:
   A. Difficult Ventilation
   B. Difficult Intubation
   C. Difficulty with Patient Cooperation or Consent
   D. Difficult Tracheostomy

2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management.

3. Consider the relative merits and feasibility of basic management choices:
   
   A. Awake Intubation vs. Intubation Attempts After Induction of General Anesthesia
   B. Non-Invasive Technique for Initial Approach to Intubation vs. Invasive Technique for Initial Approach to Intubation
   C. Preservation of Spontaneous Ventilation vs. Ablation of Spontaneous Ventilation

4. Develop primary and alternative strategies:

   A. AWAKE INTUBATION
   - Airway Approached by Non-Invasive Intubation
     - Succeed
     - FAIL
     - Cancel Case
     - Consider Feasibility of Other Options
     - Invasive Airway Access

   B. INTUBATION ATTEMPTS AFTER INDUCTION OF GENERAL ANESTHESIA
   - Initial Intubation Attempts Successful
   - Initial Intubation Attempts UNSUCCESSFUL
     - FROM THIS POINT ONWARDS CONSIDER:
       1. Calling for Help
       2. Returning to Spontaneous Ventilation
       3. Awakening the Patient

   FACE MASK VENTILATION ADEQUATE
   - Ventilation Adequate, Intubation Unsuccessful
     - Alternative Approaches to Intubation

   FACE MASK VENTILATION NOT ADEQUATE
   - Consider / Attempt LMA
     - LMA ADEQUATE
     - LMA NOT ADEQUATE OR NOT FEASIBLE
     - Emergency Pathway:
       - Ventilation Not Adequate, Intubation Unsuccessful
       - Call for Help
       - Emergency Non-Invasive Airway Ventilation

   * Confirm ventilation, tracheal intubation, or LMA placement with exhaled CO₂
   a. Other options include (but are not limited to): surgery utilizing face mask or LMA anaesthesia, local anaesthesia infiltration or regional nerve blockade. Pursuit of these options usually implies that mask ventilation will not be problematic. Therefore, these options may be of limited value if this step in the algorithm has been reached via the Emergency Pathway.
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   d. Consider re-preparation of the patient for awake intubation or canceling surgery.
   e. Options for emergency non-invasive airway ventilation include (but are not limited to): rigid bronchoscope, esophageal-tracheal combitube ventilation, or transtracheal jet ventilation.
Non-surgical Options

• Face Mask Ventilation
• Endotracheal Intubation
• LMA
• Combitube
• Fiberoptic Nasotracheal Intubation
Face Mask Ventilation

- Essential element to airway management
- Used during induction and as a rescue technique during failed attempts
- More difficult in bearded patients
- Using a nasal trumpet or oral airway may assist in ventilation
Anesthesiologist establishing mask ventilation

Courtesy Cummings
Endotracheal Intubation

- First accounts of oro-tracheal intubation in 1000 AD by Avicenna *

* Avicenna was middle eastern physician and philosopher.
Oroendotracheal intubation

- Utilizes either Macintosh or Miller Blade
- Macintosh is a curved laryngoscope that slides under the vallecula and lifts the entire larynx anteriorly or ventrally to expose the glottis
- Miller is a straight laryngoscope and is placed under the epiglottis where it sits in the petiole of the epiglottis lifting the larynx anteriorly to view the glottis
- If not successful on initial attempt, 3 maneuvers are helpful
  - Place patient in modified Jackson’s position
  - Apply external laryngeal pressure
  - Maneuver Laryngoscope
- After 3 failed attempts, proceed with alternative procedures
Incidence of Endotracheal Intubation Complications

- Severe Hypoxemia
- Severe Collapse
- Cardiac Arrest
- Death
- Difficult Intubation
- Cardiac Arrhythmia
- Esophageal Intubation
- Agitation
- Aspiration
- Dental Injury
LMA

- Initially introduced in the U.S in early 1990s
- First utilized for elective face mask cases requiring general anesthesia
- Has revolutionized the algorithm for difficult airway management
- Is fast and easy to place, even by inexperienced personnel
- Does not offer full protection of airway from aspiration
- Can intubate patient through LMA
Inserting the LMA

Miller: Miller’s Anesthesia. 7th ed.
Combitube

- Widely used in prehospital care
- Closed distal end designed for passage into esophagus with inflatable cuff providing seal
- Proximal seal achieved with facemask or oropharyngeal cuff
- Holes in tube between proximal seal and distal cuff deliver gases to laryngopharynx
- Has second open-ended tube that can function as tracheal tube if inserted into trachea
Semi-rigid Gum Elastic Bougie

- Anterior Commissure laryngoscope used to view larynx
- Semi-rigid gum elastic bougie introduced under direct visualization then endotracheal tube may be inserted
Hollinger Laryngoscope with Eschmann stylet and endotracheal tube
Nasotracheal Intubation

- Fiberoptic flexible bronchoscope is passed transnasally after passing through endotracheal tube
- Endoscope introduced into the subglottic trachea then endotracheal tube passed over the endoscope
- Contraindications include history or possible basal skull fracture
- Can cause damage to nasal mucosa creating epistaxis and can tear mucosa of posterior nasopharynx passing submucosally
Retrograde Intubation

- Percutaneously passing narrow flexible guide into the trachea from site below the vocal cords, advancing guide out of mouth or nose

- Endotracheal tube then passed over the guide into the upper part of the trachea

- Can perform either oral or nasal intubation
Retrograde Intubation (continued)

Diagram on left shows stylet passed through CTM while diagram on right shows stylet from below CTM.
Retrograde Intubation

- Invasive and takes time

- Complications:
  - Minor bleeding
  - Subcutaneous emphysema
  - Pneumomediastinum
  - Infection

- Contraindications:
  - Coagulopathy
  - Inability to identify landmarks
  - Laryngeal disease
  - Local infection
Surgical Management of the Difficult Airway

- Awake Tracheostomy
- Emergency Cricothyroidotomy
- Transtracheal Needle Ventilation
- Emergency Tracheostomy
Awake Tracheostomy

- When intubation is deemed impractical
- Best performed in a controlled environment
- Requires clear communication among surgeon, anesthesiologist, nurses, and technicians
- Place patient where anesthesia can have ready access to airway and to improve primary and accessory respiratory muscle function
- Under local anesthesia with minimal sedation to keep patient comfortable
Emergency Cricothyroidototomy

- Relatively simple, fast and with lower perioperative complication rate
- Cricothyroid Membrane only separated from skin by subcutaneous fat, anterior cervical fascia and strap muscles laterally
- Vocal cords are approximately 1 cm above Cricothyroid membrane
Contraindications to Cricothyroidotomy

- Age less than 10 years of age
- Severe neck trauma with inability to palpate landmarks
- Expanding neck hematoma
- Preexisting laryngeal disease with subglottic extension
  - Planned urgent awake tracheostomy preferred
Procedure

- Palpate the landmarks
- Stabilize upper airway with nondominant hand is single most important factor in successful outcome
- Perform midline vertical skin incision
- Palpate membrane through incision and enter with a horizontal incision at lower edge of membrane
- Dilate with a hemostat or Kelly clamp
- Place small (5.0) endotracheal tube or tracheostomy tube
Transtracheal Needle Ventilation

• **Equipment:**
  - 100% oxygen at 50 psi
  - Large-bore needle and cannula (14 G)
  - Luer-lok connector

• Puncture either trachea or Cricothyroid Membrane with saline-filled syringe in midline at 30-degree caudal direction

• Patient can be oxygenated for 30 minutes to 2 hours
Emergency Tracheostomy

- “Slash Trach”
- Since anoxia causes death in 4-5 minutes, so must perform within 2 or 3 minutes
- Perform through a vertical incision
- Stabilize the larynx with non-dominant hand
- Vertical incision through skin, platysma and subcutaneous tissue and thyroid isthmus
- Use index finger of non-dominant finger to help palpate and dissect
- Make vertical incision at second or third tracheal ring
- If available, use reinforced endotracheal tube
Outcomes of Emergency Surgical Airway Procedures in a Hospital-Wide Setting
Gillespie et al.

- Records of 35 adult patients receiving emergency tracheotomy or cricothyroidotomy
- From January 1, 1993 to December 31, 1998
- Patients with spontaneous ventilation and underwent urgent surgical airway access excluded
- Need for Emergent surgical airway:
  - Cardiac or pulmonary arrest in 13 patients (37%)
  - Head and neck cancer in 12 patients (34%)
  - Trauma in 10 patients (29%)
Outcomes (continued)

- Patients unable to be treated with mask ventilation or intubation:
  - Upper airway edema in 14 patients (40%)
  - Difficult anatomy with inability to visualize vocal cords in 8 patients (23%)
  - Obstructing lesion in oropharynx or larynx in 7 patients (20%)
  - Maxillofacial or neck trauma in 6 patients (17%)
Outcomes (continued)

- Surgical airway established in 34 patients in 37 attempts (92% success)
- Cricothyroidotomy established in 20 of 23 attempts (87%)
- Tracheostomy established in 14 patients (100%)
Complications

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<th>Cricothyroidotomy (N = 20)</th>
<th>Tracheotomy (N = 14)</th>
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<tr>
<td>Hemorrhage</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Cricoid cartilage injury</td>
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<tr>
<td>Wound infection</td>
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<td>0</td>
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<td>Operating room fire</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Subglottic stenosis</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>4 (20%)</td>
<td>3 (21%)</td>
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Complications (continued)

• Less known about role of tracheotomy in emergency situation
• In study, effective 100% of attempts
• Emergency cricothyroidotomy associated with 13% to 40% complication rate
• Elective Tracheostomy has complication rate of 15%, complication rate of emergent tracheostomy thought to be 2 to 5 times higher
• In present study, equivalent complication rates between both procedures
Controversy in Cricothyroidotomy

- Principal long-term morbidity is subglottic stenosis
- Intense debate since publication of Chevalier Jackson’s article on tracheostomy in 1921 discouraging the use of elective cricothyroidotomy due to high rate of subglottic stenosis
  - High rate in study secondary to use of metal tracheostomy tubes in pediatric patients with chronic inflammatory disease of laryngotracheal framework
- Elective cricothyroidotomy shown to have low rate of subglottic stenosis (<1%); Avoid in patients treated with intubation for more than 7 days
- True incidence of subglottic and tracheal stenosis is difficult to determine as many patients lost to follow-up
Converting from Cricothyroidotomy to Tracheostomy

- Controversy surrounds whether to expeditiously convert emergency cricothyroidotomy to tracheostomy
- Conversion advocated by many authors to decrease incidence of subglottic stenosis
- DeLaurier et al questioned need to convert, 0 of 11 patients they studied who underwent cricothyroidotomy developed stenosis
- 2 of the 9 patients who underwent conversion developed tracheal granulation tissue secondary to tracheostomy tube
- Conversion did not prevent the only case of cricothyroidotomy-related subglottic stenosis
- Trauma patients decannulated after average of 3 days and had lower rate of complication than patients undergoing conversion to tracheostomy
When to consider conversion

- Patients requiring operative exploration for hemorrhage or other complications including suspected laryngeal cartilage injury
- Patients requiring long-term airway maintenance or mechanical ventilation
Management of the Pediatric Patient

• **Anatomic Considerations**
  • Larynx closer to level of C3 leads to higher level of tongue and appearance of “anterior larynx”
  • Proportionally larger tongues
  • Larger, stiffer epiglottis
  • Angle of thyroid cartilage is broader
  • Narrowest part of airway is at level of cricoid (not true vocal cords as in adults)
  • Large occiput makes positioning more challenging
Anatomic Differences

- Narrow Nares
- Large Tongue
- High Glottis
- Slanting Vocal Cords
- Narrow Cricoid Ring
- LargeOcciput
Anatomic Differences

A: Adult Larynx, B: Pediatric Larynx
General Considerations in Pediatric Airway Management

- Resistance to flow is inversely proportional to radius of the lumen to the fourth power, makes similar changes in edema more substantial in pediatrics.

- Estimate endotracheal tubes using formula \((\text{Age} + 16)/4 = \text{ETT size}\).

- Pre-operative medications should be given that have minimal respiratory depressant effects, such as Midazolam.
Laryngeal Mask Airway

- Can be easily placed and removed while inflated in children
- Correct size is based on patient’s weight

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>LMA size</th>
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<tbody>
<tr>
<td>&lt;5</td>
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<tr>
<td>5–10</td>
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<tr>
<td>10–20</td>
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<td>35–55</td>
<td>3.0</td>
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<tr>
<td>&gt;55</td>
<td>4.0</td>
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</tbody>
</table>
Light Wand

- Rigid fiber optic stylet with light at its tip
- Blind Technique for intubation
- Does not depend on good mouth opening or extension of the neck
- Can be simpler and quicker than fiberoptic intubation, can succeed even with bleeding in airway
- Requires room lights dimmed
- Difficult to use when anatomy is distorted and laryngeal structures not midline
Light Wand

Light wand correctly positioned in trachea. Note the tear drop appearance as light tracks to sternum.
Flexible Fiberoptic Bronchoscope

- Allows operator to see around corners
- Advantageous in patients with poor mouth opening, limited neck movement or other conditions that make direct laryngoscopy difficult
- Bleeding and secretions can make it difficult to use
- Keep child anesthetized but breathing spontaneously at 100% oxygen
- LMA is good adjunct in difficult intubation
Craniofacial Dysmorphologies

- Pierre-Robin Sequence
- Treacher-Collins Syndrome (mandibulofacial dysostosis)
- Goldenhar Syndrome (oculoauriculovertebral dysplasia)
- Hallerman-Streiff Syndrome (oculomanidbulodyscephaly)
- Mobius Syndrome
- Cornelia de Lange Syndrome
- Macroglossia with glycogen storage disease
- Cystic Hygroma of the tongue
- Fetal Alcohol Syndrome
- Cherubism (familial osseous dysplasia)
- Carpenter Syndrome
- Crouzon disease
- Freeman-Sheldon Syndrome
Treacher-Collins Syndrome

- Patients have maxillary, mandibular, and zygomatic hypoplasia
- Mask ventilation and tracheal intubation are difficult, impossible if there are TMJ abnormalities
- Sedated fiberoptic intubation or laryngeal mask placement is helpful
- Generally intubation improves as patients grow older
- Many patients require surgical airway
Cornelia de Lange Syndrome

Courtesy Emedicine
Cornelia De Lange Syndrome

- Microcephaly
- Confluent eyebrows
- Underdeveloped orbital arches
- Long philtrum
- High arched palate and overt or submucous cleft palate
- Micrognathia
microcephaly, malar hypoplasia, micrognathia, thin small pointed nose with hypoplasia of the cartilage (becoming parrot like), narrow and high arched palate, thin and light hair with hypotrichosis, especially of the eyebrows and eyelashes, and low set ears
Hallerman-Streif Syndrome

- Microcephaly,
- Malar hypoplasia,
- Micrognathia,
- Thin small pointed nose with hypoplasia of the cartilage (becoming parrot like),
- Narrow and high arched palate
- Thin and light hair with hypotrichosis, especially of the eyebrows and eyelashes
- Low set ears
Carpenter Syndrome

Courtesy:
Carpenter Syndrome

- Autosomal Recessive Condition
- Craniosynostosis
- Many fusions of sutures
- Soft tissue syndactyly of hands and feet always present
Crouzon Disease

Crouzon Disease

- Craniosynostosis with midface hypoplasia, hypertelorism, and proptosis
- Patients are primarily mouth breathers
- Many have obstructive apnea
- Can have vertebral abnormalities causing limited neck mobility
- Can have tracheal abnormalities requiring smaller endotracheal tube
- Mask ventilation can be difficult
Freeman-Sheldon Syndrome

http://www.fspsg.org/Characteristics.htm
Freeman-Sheldon Syndrome

- Rare myopathic dysplasia
- Patients have mask-like facies with circumoral fibrosis and microstomia
- Inhalational agents are contraindicated in these patients due to increased risk of malignant hyperthermia
Inflexibility or Instability of Larynx

- Down Syndrome
- Juvenile Rheumatoid Arthritis
- Goldenhar Syndrome
- Klippel-Feil Syndrome
Laryngeal Anomalies

- **Congenital Lesions**
  - Cricoid Ring Stenosis
  - Subglottic Stenosis
  - Laryngeal Webs
  - Laryngeal Cysts
  - Laryngoceles
  - Subglottic Hemangiomas
  - Bilateral True Vocal Cord Paralysis

- **Infectious Disease**
  - Epiglottitis
  - Respiratory Papillomatosis
  - Croup

- **Traumatic Injuries**
  - Foreign Bodies
  - Chemical or Thermal Burns
Conclusions

- Very few difficult airway scenarios require a surgical airway
- It is best to have several back-up plans and then back-up plans for those back-up plans
- Know where your equipment is and how to use it
- The LMA has revolutionized airway management and can create time for more permanent solutions
- Pediatric patients have differing anatomy from adults that can be more challenging
- Otolaryngologists have many special skills and tools that are invaluable in the management of the difficult and emergent airway
References

References