Laryngotracheal Complications of Intubation

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Disclosure Statement

NONE 😞
Learning Objectives

• Laryngotracheal injuries following intubation

• Anesthetic management

• Surgical treatment

• Tracheostomy and airway safety practices
Lecture Outline

I. Case presentation

II. Background

III. Treatment of laryngotracheal complications
   • Posterior glottic stenosis

IV. Considerations post tracheostomy
Procedural Complications

I. Intubation

– Acute
  • Nasal complications
  • Oral cavity and oropharynx
  • Laryngeal: mucosal injury, arytenoid subluxation/dislocation

– Chronic
  • Laryngotracheal stenosis: glottic / posterior glottic, subglottic
  • Vocal process granuloma
  • Tracheal

II. Videolaryngoscopy

III. Airway exchange catheters
Uncommon Complications

Case Presentation

- 59 yo ASA III, male with posterior glottic stenosis (PGS) presenting for:
  - Elective awake tracheostomy
  - Microdirect laryngoscopy
  - CO₂ laser excision
  - Steroid injection
  - Mitomycin C application
Case - History

- Urgent aortic valve replacement and mitral valve repair 1 year prior
- Complicated post op course: 3 weeks of endotracheal intubation
- Presented several months later with dysphonia, dyspnea, & stridor
- Diagnosed with posterior glottic stenosis (PGS)
Laryngeal Videostroboscopy

Posterior

Anterior
History of Laryngotracheal Stenosis

- 1858-1900: laryngotracheal stenosis associated with croup, diphtheria, syphilis, leprosy, smallpox, measles, pertussis, & blastomycosis

- 1900s: trauma to trachea and larynx identified as a common cause

- 1900-1920s: Jackson associated stenosis with emergent tracheotomies

- 1940s: Endotracheal intubation became most common cause
Lefferts, 1890:

“The management of chronic laryngeal stenosis, so varying in its nature and indications for treatment, will always require patience, perseverance and ingenuity”
Weiser et al. 2008.

- Estimated 234.2 million surgeries each year worldwide.
- Countries spending < US $100 per person on health care: 295 per 100,000.
- Those spending > US $1,000: 11,110 per 100,000.
- Estimated > 30 million surgeries per year in the U.S.
Intubation Injury: Epidemiology

Airway Injury during Anesthesia
A Closed Claims Analysis
Karen B. Domino, M.D., M.P.H.,* Karen L. Posner, Ph.D.,† Robert A. Caplan, M.D.,‡ Frederick W. Cheney, M.D.§

Domino et al. 1999.
• ASA Closed Claims database

– 1961-1996:
– 4460 claims
– 6% for airway injury (n=266)

– Most frequent sites of injury:
  • Larynx (33%)
  • Pharynx (19%)
  • Esophagus (18%)
  • Trachea (15%)
- **Laryngeal injury** (n=87)
  - Vocal fold paralysis (n=30, 34%)
  - Granuloma (n=15, 17%)
  - Cricoarytenoid dislocation (n=7, 8%)
  - Hematoma (n=3, 3%)

- **Tracheal injury** (n=39)
  - Surgical tracheotomy (n=25, 64%)
  - Tracheal perforation (n=13, 33%)
  - Infection (n=1, 3%)

- 21 of 25 tracheostomies were emergent

  *4 for subglottic or tracheal stenosis*
Epidemiology

• Injuries to TMJ & larynx → routine intubation

• Injuries to the esophagus were more severe

• Pharyngoesophageal perforation with:
  - Difficult intubation
  - Age > 60
  - Female gender
Epidemiology

• “80% of laryngeal claims were associated with routine (non-difficult) tracheal intubation”

• “Most (85%) of laryngeal injuries were associated with short-term tracheal intubation”
Anesthesia Patient Safety Foundation

Section Editor: Sorin J. Brull

The Epidemiology of Upper Airway Injury in Patients Undergoing Major Surgical Procedures

May Hua, MD,* Joanne Brady, SM,† and Guohua Li, MD, DrPH†

Hua et al. 2012.
American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database

563,190 patients included (n = 1202 injured, 0.20%)

- Lip laceration / hematoma (61.4%)
- Tooth injury (26.1%)
- Tongue laceration (5.7%)
- Pharyngeal laceration (4.7%)
- Laryngeal laceration (2.1%)
• Increased risk with Mallampati III and Mallampati IV

• Increased risk in patients > 80 years

• 1 in 500 for patients undergoing major surgery
• 4.9 cases per million per year using greater London population

Nouraei et al. 2007
Retrospective cohort: Johns Hopkins University 34 patients

Mean cost $4,080.09 annually

Intubation-related stenosis significantly greater cost
- $5,286.56 intubation related
- $2,873.62 idiopathic

Yin et al. 2018.
Review Methods: We compared rates of injury between videolaryngoscopy to direct laryngoscopy at our institution by searching anesthesia records to identify laryngoscopy procedures that resulted in injury to the soft palate or oropharynx. We also identified 19 published cases in the literature, in addition to our cases, that we reviewed for patient characteristics (e.g., body mass index, age and sex, Mallampati grade), type of videolaryngoscope, location of injury, and type of repair (if any) required.

Results: At our institution, we have a statistically higher rate of injury using videolaryngoscopy compared to direct laryngoscopy. Our data also indicate that women are more commonly injured during videolaryngoscope intubation than men. The right tonsillar pillars and soft palate are the most frequently injured, with through-and-through perforation of the soft tissues being the most common type of injury. The most common repair of injuries required simple closures, and long-term harm was very rare.

Conclusion: Our data suggests that using video-assisted laryngoscopy for intubation puts a patient at significantly greater risk for injury compared to direct laryngoscopy.
Prolonged Intubation Injuries Of The Larynx: Endoscopic Diagnosis, Classification, And Treatment*

Bruce Benjamin, FRACS, FAAP

Factors in Intubation Injury

- Abnormal larynx
- Emergency intubation
- Impairment of mucocilliary clearing
- Gastric aspiration
- Bacterial infection
- Acute or chronic disease states
- Duration of intubation
- Endotracheal tube size
- Endotracheal tube cuff pressure
Specific Injuries

- Tongues of granulation tissue
- Ulcerated troughs
- Healed furrows
- Healed fibrous nodule
- Intubation granuloma
- Interarytenoid adhesion
- **Posterior glottic stenosis**
- Subglottic stenosis
- Ductal retention cysts
- Vocal fold paralysis
- Arytenoid dislocation
Figure 4. Miscellaneous changes due to intubation, some not classified. A) Protrusion of edematous mucosa from laryngeal ventricles. B) Close-up of healed fibrous nodules just posterior to vocal process of arytenoid on left side. C) Dislocation of left arytenoid cartilage. D) Ulceration in postcricoid region caused by nasogastric tube. E) Subglottic ductal retention cyst and posterior glottic stenosis in infant. F) Irregular scarred central part of left vocal cord, probably healed laceration caused during intubation. G) Large, left subglottic intubation granuloma and anterior acquired subglottic stenosis following prolonged intubation in 10-year-old boy with head injury. H) Large defect of right vocal cord in child who was intubated as neonate. After one difficult intubation, it was said vocal cord had been “scrapped.” I) Chronic edema, congestion, and diffuse scarring of both vocal cords in 2-year-old with weak, hoarse voice. Result of prolonged intubation as premature infant.
Fig 12. Flow chart showing consequences of granulation tissue forming during prolonged intubation and three distinct chronic changes that can occur: intubation granuloma, healed fibrous nodule, and interarytenoid adhesion.
Figure 13. Flow chart showing consequences of ulceration following prolonged intubation: healed furrows, posterior glottic stenosis, and subglottic stenosis.
### Table 1: Etiologies of Glottic Stenosis

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Examples</th>
<th>Pathogenesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traumatic – external</td>
<td>Blunt or penetrating</td>
<td>Cartilaginous fractures and mucosal tears</td>
</tr>
<tr>
<td>Traumatic – internal</td>
<td>Chemical/thermal burn</td>
<td>Supraglottic and posterior glottic scars</td>
</tr>
<tr>
<td>Traumatic – iatrogenic</td>
<td>After intubation</td>
<td>Pressure necrosis over interarytenoid mucosa, arytenoids, and cricoid</td>
</tr>
<tr>
<td></td>
<td>After laryngeal surgery</td>
<td>Circular surgical scar</td>
</tr>
<tr>
<td></td>
<td>After irradiation</td>
<td>Edema, necrosis, fusion of subunits</td>
</tr>
<tr>
<td>Infectious</td>
<td>Syphilis, diphtheria</td>
<td>Scar maturation after granuloma formation</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>Wegener’s</td>
<td>Granuloma and scarring</td>
</tr>
</tbody>
</table>

Keys to Prevention

- Endotracheal tube (ETT) choice
- Treatment of reflux
- Minimize secretions
- Antibiotic treatment with tracheostomy
- Minimize intubation time
- Manage comorbidities
Prevention (back to basics)

• Monitor ETT cuff pressures

• Caution with blind procedures (AFOI, AECs) – McLean et al. 2013.

• Optimize intubating conditions
  • Neuromuscular blockade (Pacheco-Lopez et al. 2014)
  • Positioning

• Lubricated ETT
Laryngotracheal Anatomy

• Larynx - vital component of respiratory system
  – Swallowing
  – Breathing coordination
  – Intrathoracic pressure regulation
  – Vocalization

• Laryngotracheal stenosis
  – Anterior or posterior glottic stenosis (PGS)
  – Subglottic stenosis or tracheal stenosis (SGS/TS)
Anatomy of posterior glottis

- Posterior 1/3 of vocal folds
- Posterior commissure and interarytenoid muscle
- Cricoid lamina
- Cricoarytenoid joints
- Arytenoids
- Overlying mucosae
Posterior glottis susceptibility

• Anatomy
  – Posterior & subglottis: respiratory vs squamous epithelium

• ETTs displaced by base of tongue onto posterior glottis

• Proliferative fibrotic process

• Arytenoid contracture, possible ankylosis
  Impairment of glottic airflow
Perfectly positioned ETT

Right in the posterior glottis
PGS: Development

Initial mucosal ulceration and inflammation (A)
Posterior laryngeal granulation tissue (B)
Contracts the arytenoids forcing the vocal folds into a bilateral midline position (C)

From Hillel et al. 2016
Posterior Glottic Stenosis

Posterior vocal folds

Vocal processes of the arytenoids

Interarytenoid region

Cricoarytenoid Joints

SGS & PGS – Location Matters

Hatcher et al. 2015.
Surgical Management Goals

- Balance airway & voice

- ↑Airway → ↓voice

- Tracheostomy placement may be best

- No surgery can correct fixed cricoarytenoid joints

- PGS can permanently alter QOL

Hatcher et al. 2015.
PGS: Risk Factors

- 28 PGS patients (14 ♂, 14 ♀) ≥ 24hrs intubated in ICU

- PGS risk factors included:
  - Ischemic condition (374% ↑ OR)
  - Diabetes (888% ↑ OR)
  - Length of intubation (21% ↑ OR/day)
  - ETT (≥ 8)  

Hillel et al. 2016.
Posterior Glottic Stenosis

• As high as 14% in patients intubated > 10 days

• Increased risk:
  - Traumatic intubation
  - Prolonged intubation
  - Multiple management maneuvers - motion
  - Large ETT size
  - Local infection

• Can present with co-existing subglottic stenosis
Other Etiologies of PGS

• Radiation

• Autoimmune disease

• External laryngeal trauma

• Caustic ingestion
PGS: Typical Presentation

- Complex patient & prolonged intubation
- Progressive dyspnea and noisy breathing
- May be mistaken as COPD or asthma
- Inspiratory vs biphasic stridor

- Cummings
Flexible Laryngoscopy - PGS

I: Vocal Process Adhesion
II. Posterior Commissure or interarytenoid scar
III: Unilateral CA fixation
IV: Bilateral CA fixation

Bogdasarian Grades of PGS

May mimic bilateral true vocal fold paralysis, depending on degree of CA joint fixation

Surgical Management of Posterior Glottic Stenosis
Preoperative Evaluation

- Subjective/objective impairment

- Goals of preoperative examination:
  - Anatomic location(s)
  - Dimensions
  - Quality
  - Vocal fold / cricoarytenoid joint mobility

Evaluation

- Indirect laryngotracehoinsicopy/stroboscopy
- Direct laryngoscopy
- Laryngeal EMG
  - Equivocal cases VF motion impairment
- CT Scan with 2 mm cuts +/- 3D renderings

Surgical Management

- **Elective**: Non-critical lesions

- **Urgent**: Acute distress

SECURE AIRWAY

- Temporizing measures
  - Elevate head of bed
  - Cool humidified air
  - Racemic epinephrine
  - Corticosteroids
  - Heliox

Goals of Definitive Operations

• Establish SAFE airway

• Eventual decannulation with tracheostomy

• Preserve other laryngeal functions
  – Airway protection
  – Phonation
  – Swallowing

PGS: Surgical Management

- Difficult to manage
- Success difficult to predict
- No definitive therapy for cricoarytenoid mobility after fixation
Surgical Techniques

- Endoscopic laser excision and adjuncts
- Posterior cricoid split with cartilage grafting
  - Open
  - Endoscopic
- Arytenoidectomy for grade IV
CO$_2$ Laser Excision

- CO$_2$ laser excision of synechiae/scar tissue
- Injection of Kenalog and topical mitomycin application

Suspension Laryngoscopy

• May be difficult without tracheostomy

• University of Michigan:
  – High frequency high pressure jet ventilation without tracheostomy
  – Low threshold for tracheostomy

Anesthetic Considerations

- Preoperative evaluation
- Awake tracheostomy is common
- Shared, unprotected airway
- Bed 90 degrees
- Total intravenous anesthesia with NMB
- COMMUNICATION AND TEAMWORK
THE TEAM
THE TEAM
THE TEAM
BO SCHEMBECHLER
# Anesthetic Management: Ventilation Methods

<table>
<thead>
<tr>
<th>Technique</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous ventilation</td>
<td>- Ideal surgical access</td>
<td>- No airway protection</td>
</tr>
<tr>
<td>Intermittent apnea</td>
<td>- Unobstructed view of larynx</td>
<td>- ETCO₂ measurement inaccurate</td>
</tr>
<tr>
<td>Positive-pressure ventilation via MLT</td>
<td>- Familiar to all anesthesiologists</td>
<td>- Vocal cords may move unexpectedly</td>
</tr>
<tr>
<td></td>
<td>- Control of ventilation</td>
<td>- Difficult to control depth of anesthesia</td>
</tr>
<tr>
<td></td>
<td>- Protection against aspiration</td>
<td>- Risk of laryngospasm</td>
</tr>
<tr>
<td></td>
<td>- ETCO₂ measurement</td>
<td>- Trauma from repeated intubations</td>
</tr>
<tr>
<td></td>
<td>- Ability to use volatile anesthesia without OR pollution</td>
<td>- Interrupted ventilation and surgery</td>
</tr>
<tr>
<td>Supraglottic jet ventilation</td>
<td>- Optimal access for the surgeon – especially for posterior commissure lesions</td>
<td>- Hindered surgical access</td>
</tr>
<tr>
<td>Subglottic jet ventilation</td>
<td>- Some ability to monitor ETCO₂</td>
<td>- Risk of airway fire if laser used</td>
</tr>
<tr>
<td></td>
<td>- More efficient than supraglottic ventilation</td>
<td>- May obscure a glottic lesion</td>
</tr>
<tr>
<td></td>
<td>- Minimal vocal cord movement</td>
<td></td>
</tr>
<tr>
<td>Transtracheal jet ventilation</td>
<td>- Assists in management of difficult airway if placed prior to induction</td>
<td></td>
</tr>
<tr>
<td>High-frequency jet ventilation</td>
<td>- Lower peak airway pressure</td>
<td>- Inability to measure ETCO₂</td>
</tr>
<tr>
<td></td>
<td>- Less hemodynamic compromise than IPPV</td>
<td>- Vocal cord movement with each jet</td>
</tr>
<tr>
<td></td>
<td>- Minimal movement of surgical field</td>
<td>- Risk of aspiration and barotrauma</td>
</tr>
<tr>
<td></td>
<td>- Excellent surgical conditions</td>
<td>- Potential for tumor seeding</td>
</tr>
<tr>
<td></td>
<td>- Laser compatible</td>
<td>- Need for TIVA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Greater risk of barotrauma compared to supraglottic technique</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Need for TIVA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Catheter may kink, block or dislodge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Bleeding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Barotrauma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tumor seeding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Requires specialized ventilators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Risk of gas trapping and barotrauma</td>
</tr>
</tbody>
</table>

From Abdelmalak B and Doyle JD (Eds). 2013.
High Frequency Jet Ventilation (HFJV)
## High Frequency Jet Ventilation (HFJV)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspiratory Time</td>
<td>%IT</td>
<td>40%</td>
</tr>
<tr>
<td>Driving pressure</td>
<td>DP</td>
<td>24 PSI</td>
</tr>
<tr>
<td>Rate (frequency)</td>
<td>F</td>
<td>120 cpm*</td>
</tr>
<tr>
<td>Peak Inspiratory Pressure</td>
<td>PIP</td>
<td>28 cmH2O</td>
</tr>
<tr>
<td>Peak Pause Pressure</td>
<td>PP</td>
<td>24 cmH2O</td>
</tr>
</tbody>
</table>
Subglottic Jet Ventilation
Microlaryngeal ETT & Intermittent Apnea
- Adequate oxygenation/ventilation in 1512
- 623 ABGs
  - Mean PaO$_2$ 133.8 mmHg
  - Mean PaCO$_2$ of 42.3 mmHg
- No barotrauma
- 312 laser treatment – no complication

Rezaie-Majd et al. 2006.
### Table 2. Methods of Surgery Used in the Studied Cases

<table>
<thead>
<tr>
<th>Surgical procedures</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endoscopic resection of the stenosis</td>
<td></td>
</tr>
<tr>
<td>Laser</td>
<td>16 (10.1)</td>
</tr>
<tr>
<td>Dilation</td>
<td>92 (57.9)</td>
</tr>
<tr>
<td>Laser and dilation</td>
<td>32 (20.1)</td>
</tr>
<tr>
<td>Open resection</td>
<td>6 (3.8)</td>
</tr>
<tr>
<td>Tracheostomy only</td>
<td>2 (1.3)</td>
</tr>
<tr>
<td>Diagnostic only</td>
<td>11 (6.9)</td>
</tr>
<tr>
<td>Total</td>
<td>159 (100)</td>
</tr>
</tbody>
</table>

### Table 3. A List of the Established Airway Management Techniques Used and the Incidence of Hypoxemia

<table>
<thead>
<tr>
<th>Technique</th>
<th>N</th>
<th>Hypoxemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jet ventilation via Hunsaker\textsuperscript{a}</td>
<td>41</td>
<td>10 (24.4)</td>
</tr>
<tr>
<td>Jet ventilation via a rigid bronchoscope\textsuperscript{a} (from above legen)</td>
<td>35</td>
<td>9 (25.7)</td>
</tr>
<tr>
<td>Intermittent apnea technique</td>
<td>35</td>
<td>8 (22.9)</td>
</tr>
<tr>
<td>(Small) endotracheal tube\textsuperscript{b}</td>
<td>21</td>
<td>8 (38.1)</td>
</tr>
<tr>
<td>Intermittent facemask ventilation</td>
<td>11</td>
<td>7 (63.6)</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>10</td>
<td>7 (70)</td>
</tr>
<tr>
<td>Spontaneous ventilation via bronchoscope</td>
<td>5</td>
<td>3 (60)</td>
</tr>
<tr>
<td>Laryngeal mask airway</td>
<td>1</td>
<td>1 (100)</td>
</tr>
<tr>
<td>Total</td>
<td>159</td>
<td>53 (33.3)</td>
</tr>
</tbody>
</table>
Table 4. Pairwise Comparisons Between the Incidence of Hypoxemia in the Most Common 4 Airway Techniques, Expressed as Difference in Proportion (95% CI), Corrected for Familywise Error Rate

<table>
<thead>
<tr>
<th>Difference in proportion (95% CI)</th>
<th>Jet ventilation via a rigid bronchoscope(^a) (from above legen)</th>
<th>Intermittent apnea technique</th>
<th>(Small) Endotracheal tube(^a)</th>
<th>Intermittent facemask ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jet ventilation via Hunsaker(^a)</td>
<td>-1.3 (-33.9 to 31.3)</td>
<td>1.5 (-30.6 to 33.7)</td>
<td>-13.7 (-56.6 to 29.2)</td>
<td>-39.2 (-95.1 to 16.6)</td>
</tr>
<tr>
<td>Jet ventilation via a rigid bronchoscope(^a) (from above legion)</td>
<td>-1.3 (-33.9 to 31.3)</td>
<td>1.5 (-30.6 to 33.7)</td>
<td>-13.7 (-56.6 to 29.2)</td>
<td>-39.2 (-95.1 to 16.6)</td>
</tr>
<tr>
<td>Intermittent apnea technique</td>
<td>2.9 (-32.1 to 37.8)</td>
<td>2.9 (-32.1 to 37.8)</td>
<td>-12.4 (-56.7 to 31.9)</td>
<td>-37.9 (-94.9 to 19.1)</td>
</tr>
<tr>
<td>(Small) endotracheal tube(^a)</td>
<td>2.9 (-32.1 to 37.8)</td>
<td>2.9 (-32.1 to 37.8)</td>
<td>-12.4 (-56.7 to 31.9)</td>
<td>-37.9 (-94.9 to 19.1)</td>
</tr>
</tbody>
</table>

\(^a\)Jet ventilation at our institution was always automatic low frequency jet ventilation.

Endotracheal tube size range from internal diameter of 5 to 7 mm, mean size 5.8 mm.

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Table 5. Ease of Facemask Ventilation (Han Grade) According to Severity of Subglottic Stenosis (Myer-Cotton Grade)

<table>
<thead>
<tr>
<th>Myer-Cotton grade</th>
<th>Not recorded</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Han Grade</td>
<td>10</td>
<td>69</td>
<td>40</td>
<td>40</td>
<td>159</td>
</tr>
<tr>
<td>Not recorded</td>
<td>1</td>
<td>28</td>
<td>14</td>
<td>25</td>
<td>68</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>25</td>
<td>21</td>
<td>10</td>
<td>61</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>11</td>
<td>5</td>
<td>5</td>
<td>23</td>
</tr>
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<td>3</td>
<td>1</td>
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<td>0</td>
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<td>6</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>69</td>
<td>40</td>
<td>40</td>
<td>159</td>
</tr>
</tbody>
</table>
Philips et al. 2018

- 46 patients - 70 procedures
- 29 obese
- Jet ventilation successful in 28/29 of obese cases
- No significant differences in chest rise, need for intubation, and length of surgery or ventilation
A New Use for an Old Technology
Transnasal Humidified Rapid Insufflation Ventilatory Exchange (THRIVE): a physiological method of increasing apnoea time in patients with difficult airways

A. Patel¹,² and S. A. R. Nouraei³

¹ Consultant Anaesthetist, The Royal National Throat Nose and Ear Hospital, London, UK
² Consultant Anaesthetist, 3 Specialist Registrar in Academic Otolaryngology, University College Hospital NHS Foundation Trust, London, UK
Fisher & Paykel Healthcare

Optiflow THRIVE

A wide range of applications in the peri-anaesthesia period

General anaesthesia

https://www.fphcare.com/
Dhillon et al. 2018.

- Maintain airway clearance and support tracheal wall
- 13 patients with laryngotracheal stenosis and aphonia/dysphonia
- Significant improvement in VRQOL after T tube placement
- Most common complication: granulation tissue
T - Tube Management

- Under GA
  - Remove and an armored ETT placed
  - Small 4.0 ETT placed through T - tube
  - Connector from ETT fit into end of T - tube

- If ETT through T - tube, must be directed downward

- Manipulations WITH surgical service
T – Tube Removal

- Clamp with a hemostat - pull with firm pressure

- Only replaced with DL & bronchoscopy

- Standard tracheostomy tube used temporarily
PGS Highlights

- Common and costly
- Complication of airway management
- Difficult to diagnose
- Challenging to treat
System Based Practices

Guidelines

Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies

B. A. McGrath,¹ L. Bates,²* D. Atkinson³ and J. A. Moore³

McGrath et al. 2012.
National Tracheostomy Safety Project (NTSP)

• Several airway management specialties & governing societies

• In England in 2009-2010:
  - 5700 surgical tracheostomies
  - 5000-8000 percutaneous tracheostomies
  - 570 laryngectomies

• Guidelines developed for tracheostomy-related emergencies:
  – Training
  – Distinct bedside signs and algorithms
  – Emergency equipment
Specialized Airway Algorithms

Tracheostomy

Emergency tracheostomy management - Patent upper airway

- Call for airway expert help
- Look, listen & feel at the mouth and tracheostomy
  - A Mapleson C system (e.g., Waters circuit) may help assessment if available
  - Use waveform capnography when available - exhaled carbon dioxide indicates a patent or partially patent airway

Is the patient breathing?

No

- Call Resuscitation Team
  - CPR if no pulse / signs of life
- Apply high-flow oxygen to BOTH face and the tracheostomy

Yes

- Assess tracheostomy patency
- Remove speaking valve or cap (if present)
- Remove inner tube
  - Some inner tubes need reinserting to connect to breathing circuits

Can you pass a suction catheter?

No

- Deflate the cuff (if present)
- Look, listen & feel at the mouth and tracheostomy
  - Use waveform capnography or Mapleson C if available
- Laryngoscopy
- The tracheostomy tube is patent
  - Perform tracheal suction
  - Consider partial obstruction
  - Ventilate via tracheostomy tube if not breathing
  - Continue ABCDE assessment
- Tracheostomy tube partially obstructed or dislodged
  - Continue ABCDE assessment

Yes

The patient stable or improving?

No

- Call Resuscitation Team
  - CPR if no pulse / signs of life
- Use waveform capnography or Mapleson C if available

Yes

Secondary emergency oxygenation

- Standard ORAL airway maneuvers
  - Cover the stoma (mouth / hand)
  - Use bag-valve mask
  - Oral or nasal airway adjuncts
  - Supraglottic airway device e.g. LMA

- Tracheostomy STOMA ventilation
  - Pneumatic face mask applied to stoma
  - LMA applied to stoma

Laryngectomy

Emergency laryngectomy management

- Call for airway expert help
- Look, listen & feel at the mouth and laryngectomy stoma
  - A Mapleson C system (e.g., Waters circuit) may help assessment if available
  - Use waveform capnography when available - exhaled carbon dioxide indicates a patent or partially patent airway

Is the patient breathing?

No

- Call Resuscitation Team
  - CPR if no pulse / signs of life
- Apply high-flow oxygen to laryngectomy stoma
  - If any doubt whether patient has a laryngectomy, apply oxygen to face also*

Yes

- Assess laryngectomy stoma patency
- Remove stoma cover (if present)
- Remove inner tube
  - Some inner tubes need reinserting to connect to breathing circuits
  - Do not remove a tracheocutaneous puncture (TEP) prosthes

Can you pass a suction catheter?

No

- Deflate the cuff (if present)
- Look, listen & feel at the laryngectomy stoma or tube
  - Use waveform capnography or Mapleson C if available
- Laryngectomy tube is patent
  - Perform tracheal suction
  - Consider partial obstruction
  - Ventilate via stoma if not breathing
  - Continue ABCDE assessment

Yes

The laryngectomy stoma is patent
- Perform tracheal suction
- Consider partial obstruction
- Ventilate via stoma if not breathing
  - Continue ABCDE assessment

Is the patient stable or improving?

No

- REMOVE THE TUBE FROM THE LARYNGECTOMY STOMA if present
  - Look, listen & feel at the laryngectomy stoma
  - Ensure oxygen is re-applied to stoma
  - Use waveform capnography or Mapleson C if available

Yes

Continue ABCDE assessment

Secondary emergency oxygenation

- Laryngectomy stoma ventilation via either
  - Paediatric face mask applied to stoma
  - LMA applied to stoma
- Attempt intubation of laryngectomy stoma
  - Small tracheostomy tube / 6.0 cuffed ET
  - Consider Ambu catheter and fiberoptic scope / Bougie / Airway exchange catheter

Laryngectomy patients have an end stoma and cannot be oxygenated via the mouth or nose*

* Applying oxygen to the face and stoma is the default emergency action for all patients with a tracheostomy.

National Tracheostomy Safety Project. Further information at www.tracheostomy.org.uk
Reduction in harm from tracheostomy-related patient safety incidents following introduction of the National Tracheostomy Safety Project: Our experience from two hundred and eighty-seven incidents


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Keypoints

- Hospitals managing in patients with tracheostomies continue to report airway-related critical incidents, reflecting the high-risk nature of this cohort of patients.
- The National Tracheostomy Safety Project is a bundle of multidisciplinary initiatives and resources designed to reduce institutional harm.
- We performed retrospective uncontrolled case series analysis of 287 critical incidents from four major acute NHS hospital sites, before and after introduction of the project.
- Incidents in which patient harm occurred were reduced from 82% to 57% ($P < 0.0001$) with a relative risk reduction of 0.65 in the monthly rates of such incidents.
- Introducing the project into diverse clinical areas can reduce the nature, severity and rates of tracheostomy-related critical incidents.
Get Trach Ready

Movements forwards
patients and their at the heart of what

The gift of speech
Helping tracheostomy and laryngectomy patients to find a voice

Collaboration
Global collaboration to improve care

Algorithms and Bedheads
Emergency algorithms and bedhead signs

Are you ready
Educational
Michigan Medicine MiChart
Difficult Airway Navigator

Reason for Difficult Airway: Difficult Mask ventilation

Recommendations for intubation:
- Videolaryngoscopy (Glidescope/C-Mac)
- LMA
- Awake fiberoptic
- Operative laryngoscopy (otolaryngology present)
- Intubation over endoscope
- Tracheostomy

Special equipment to be at the bedside:
- Appropriate ETT (size and type) and size smaller
- Appropriate Tracheostomy tube and size smaller
- Video laryngoscope
- LMA

Date of last airway evaluation: 11/6/18

Mask Ventilation Grade: Grade 4 - Unable to mask ventilate

Can patient be bagged from above? No
Can patient be intubated from above? No

Laryngoscopy Grade: Unknown (no prior intubations or prior intubations with videolaryngoscope [glidescope/C-mac])

Difficulty encountered during tube passage:
- T3 - failed passage

Procedure Successfully Used for Intubation:
- LMA

Airway Tube Type: LMA: size 6

Service to Contact for Emergent Airway Issues: Anesthesiology and Otolaryngology

Airway evaluation performed by: Emmeline Gemma Almendras, MD

Graphic Airway Image
Enter Annotated Image below by clicking this icon on your toolbar.

LEGEND
- Tracheotomy Tube
- Laryngectomy - NOT INTUBATABLE FROM ABOVE
- Complete Obstruction
- Stenosis
- Airway Reconstruction
- Tumor
- Swelling
- Difficult Laryngoscopy
- Difficult Mask
- Cervical Spine Precautions
- Radiation Fibrosis
Summary

Intubation NOT WITHOUT RISK
Anesthetic considerations for management of laryngotracheal complications

*Cotton classification of posterior GS*
Importance of airway risk assessment and planning
Team communication
Optimizing safe airway management
THANK YOU
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Cummings


COCLIA Pediatrics: Glottic and Subglottic Stenosis Samuel Ostrower March 24, 2008


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