**Neonatal Tracheotomy – Indications, Management and Outcomes**

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**Definitions**

- Tracheotomy – typically used to refer to act of incising the trachea
- Tracheostomy – refers to the opening into the trachea itself, sometimes implies that there is a tract
- Often these terms are used interchangeably

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**Tracheostomy History**

- Most tracheostomies performed for life risking, acute infectious airway obstruction
- Diphtheria
- Tend to be short term tracheostomies
- Tend to be older than neonates

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**Tracheostomy History**

- Goes back to ancient times
  - Hieroglyphic slabs
  - Rig Veda, Hindu text
  - Ebers Papyrus, 1550 BC
  - Homer, 800BC
  - George Washington
    - Died of upper airway obstruction
    - Tracheostomy debated

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**Tracheostomy History**

- Neonatal survival changes landscape – 1960s
  - Increases
    - Survival rate of medically complex infants
    - Long term mechanical ventilation increase
    - Acquired subglottic stenosis
  - Decreases the average age of pediatric tracheostomy
  - Increased duration of pediatric tracheostomy
Indications for Tracheostomy in the NICU

- Pulmonary disease
- Airway Obstruction
  - Congenital
  - Acquired
- Neurologic disease
- Cardiac disease
- Many patients have multisystem disease

Indications for Neonatal Tracheostomy

- Prolonged ventilation secondary to broncho-pulmonary dysplasia
- Most common associated diagnosis
- Although, may not be only reason

Timing of when to perform or recommend tracheostomy is variable

Indications for Neonatal Tracheostomy

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Tracheostomy for Infants Requiring Prolonged Mechanical Ventilation: 10 Years’ Experience

- Compare ELBW (extreme low birth weight < 1000g) and VLBW (very low birth weight) neonates who underwent tracheostomy
- Outcomes
  - ELBW 6.9% underwent tracheostomy
  - VLBW 0.9% underwent tracheostomy

ELBW Tracheostomies

- Associated with
  - Chronic lung disease
  - Multiple intubation events and attempts
  - Longer duration of ventilation
  - Non-congenital upper airway obstruction

Outcomes

- ELBW 6.9% underwent tracheostomy
- VLBW 0.9% underwent tracheostomy

Comparing ELBW (extreme low birth weight < 1000g) and VLBW (very low birth weight) neonates who underwent tracheostomy
Laryngotracheal Anomalies

- Subglottic stenosis
  - Congenital or acquired
  - Most commonly acquired
  - May occur along with BPD
  - Modern incidence is approximately 0 – 2%

Severe Tracheobronchomalacia

- Usually treat with medical therapy
- Tracheostomy may be necessary in severe cases

Bilateral Vocal Cord Paralysis

- Bilateral paralysis presents as stridor and dyspnea
- 2nd commonest cause of neonatal stridor
- MRI needed to assess for neurologic abnormality
- 1/3 to 2/3 may require tracheostomy

Bilateral Vocal Cord Paralysis

- Who gets tracheostomy?
  - More likely
    - Vocal cords are paramedian
    - Secondary airway lesion
- Who gets decannulated?
  - More likely
    - Idiopathic vs. neurogenic cause (80 vs. 40%)
    - Spontaneous resolution vs. not (95% vs. 55%)

Laryngomalacia

- Most common cause of noisy breathing in infancy
  - Inspiratory stridor
  - 90% resolution by 12-18 months
  - Dysphagia and reflux
  - Association with reflux

Laryngomalacia

- Surgical Treatments
  - Tracheotomy
  - Less common now
  - Supraglottoplasty
  - Incision of aryepiglottic folds +/- removal of redundant tissue cuneiform cartilage
  - Epiglottopexy

Laryngotracheal Anomalies

- Congenital High Airway Obstruction Syndrome (CHAOS)
  - Laryngeal atresia
  - Prenatal US will likely see polyhydramnios
  - Tracheostomy could be performed as part of ex utero intrapartum treatment (EXIT)

- Mortality rate remains high


Upper Airway Obstruction

- Pierre Robin Sequence
  - Clinical triad
    - Micrognathia
    - Glossoptosis
    - Airway obstruction

Craniofacial Syndromes

- Crouzon’s syndrome
- Treacher Collins syndrome
- Pfeiffer's syndrome
- Apert’s syndrome

- All cause midface hypoplasia and can create OSA and challenging unsafe airways

Vascular Malformation

- Large cervicofacial vascular malformation
- Prenatal ultrasound
- EXIT Procedure
  - At time of EXIT
  - Subsequent to intubation at EXIT

Hypotonia

- Often related to underlying neurologic disease
- OSA related symptoms not amenable to upper airway surgery
- Chronic aspiration
Indications

- Now that we have cleared up some of the indications for tracheostomy, shall we move onto the procedure itself?
- Not quite…

The Family Perspective

- Families are often not excited for tracheostomy
- “The family enters a long tunnel of fear and apprehension, mixed with episodes of panic, isolation, militancy, and despair”
- “Seldom can a small being provide such large problems for so many people for so long a period of time”

The Family Perspective

- “It is important not to underestimate how it feels to be responsible for removing your child’s only way of breathing, and register, however briefly, his color change and desperate struggle for breath. The emotional turmoil is awful?”
  - Gillinson, P. J. Laryngol. Otol. Suppl. 1988

“This is Not the Life I planned”

- Families have difficulty accepting tracheostomy
- Things that add to the trouble
  - Not understanding what “bronch” means
  - Not understanding what a “trach” is
- Major disruption to home and family life
- Confident nurses create confident families

Technique of Tracheostomy

- Plan to have appropriate length and diameter of tracheostomy tube
- Is a cuff needed?
  - Based on current ventilator settings
  - Communicate with NICU
- Key facts
  - Trachea length in 0-2 yo is only 5.4 cm
  - Trachea’s lateral dimension is greater than anterior to posterior (until age 6)

Technique of Tracheostomy

- Skin landmarks identified
- Localize and infiltrate skin incision
  - Horizontal or vertical
- Incise skin
- Defat and stay midline
- Expose cricoid and proximal trachea
- Place stay sutures

Bluestone, et al. Surgical Atlas of Pediatric Otolaryngology

Wine, Todd, MD
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**Stay Sutures**

- Mature stoma if desired
- Vertically incise trachea
- Anesthesiologist withdraw endotracheal tube
- Place tracheostomy tube
- Confirm ET CO2
- Switch over circuit

Bluestone, et al. Surgical Atlas of Pediatric Otolaryngology

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**Stoma Maturation**

- May mature stoma
- Improves safety in the setting of early decannulation
- Does not lead to increased rate of complications


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**Tracheostomy Tie**

- Place tracheostomy tie
  - Very important part of procedure
  - Prevent accidental decannulation prior to stoma maturation
  - Prevent skin ulceration
  - Varying techniques

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First Tracheostomy Tube Change

- First trach change is safe at 3-4 days after tracheostomy, but most institutions prefer 5-7 days.
- Less wound break down
  - Related to tie
  - Related to shorter duration of first trach change

International Pediatric Otolaryngology Group (IPOG) consensus recommendations: Routine peri-operative pediatric tracheostomy care

- Recently, much more attention is being given to all aspects of tracheostomy care and guidelines surrounding it.
Sedation pathway

- Use algorithm
- Based upon State Behavioral Scale (SBS)
  - Scoring is based on response to noxious stimuli
    - Planned ETT suctioning
    - < 5 seconds of nail bed pressure
- Goal depends on clinical scenario of that patient
  - Critical airways and critical medical conditions
  - More heavily sedated or paralyzed

Study from CHCO that shows that creating standardized team approach can improve the length of stay, reduce patient cost and improve safety.

- Reduced LOS by 42%
- Direct costs reduced by 43%

A Standardized Discharge Process
Decreases Length of Stay for Ventilator-Dependent Children

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Pediatrics, 137, 4; April 2016.
Morbidity and Mortality of Neonatal Tracheostomy

- Morbidity and mortality is increased as it relates to neonates undergoing tracheostomy.
- Morbidity ranges 20 – 64%.
- Mortality not often due to tracheostomy itself.
- Range 15 – 25%.
- Depends on study.
- Worse than Pediatric tracheostomy.

Mortality of Infants versus other Children after tracheostomy

- Evaluated Medicaid only population.
- In hospital mortality 9%.
- Odds ratio of 7.3: Mortality associated with tracheostomy patients under 1 versus older children.
- Tracheostomy complication 39%.

Risk Factors and In-Hospital Outcomes following Tracheostomy in Infants

- Analysis of Pediatrix NICU database.
- 15 year.
- Tracheostomy is rare – 0.1% NICU infants.
- 885 of 887910 infants underwent tracheostomy.
- Range of 0.6% - 2.7% in the literature.
- Mortality is highly associated with tracheostomy - 14% vs. 2.5%.
- 16% - 25% in the literature.
- Moderate prematurity, SGA status, pulmonary diagnoses.

Tracheostomy Placement in Children Younger Than 2 Years 30-Day Outcomes Using the National Surgical Quality Improvement Program Pediatric

- National Surgical Quality Improvement Program (NSQIP) Pediatric.
- 61 participating institutions.
- Tracheostomy in children < 2.
- 24.3% experienced a complication < 30 days.
- Pneumonia (7.8%), sepsis (5.8%), death (5.8%).
- Neonates – OR 2.38, cardiac OR 2.9.

Skin – wound breakdown

- A never event.
- Pressure ulcer.
Morbidity and Mortality of Tracheostomy

- Late complications
  - Skin ulceration
  - Granuloma formation
    - Trachea
    - Distal
    - Suprastomal
    - Tracheostoma
  - Stomal infection
  - Tracheo-esophageal fistula
- Innominate artery hemorrhage
- Airway stenosis
- Accidental decannulation
- Need for revision

Granuloma Formation

- Granuloma formation
  - External stoma
  - Suprastomal
  - Does not always require surgical treatment
  - External may respond to medical therapy
    - Silver nitrate
    - Betadine
    - Antibiotic ointment

Granuloma Formation

- Secondary to cuff pressure and erosion of anterior tracheal wall
- Often presents with sentinel bleed
- 75% mortality
- Open repair or ligation vs. endovascular stenting

Tracheo-innominate Fistula
Tracheo-innominate Fistula

Outcomes
- Receptive and expressive delays in communication
- Feeding delays
- At 18-22 months, cognitive delays are more common in very preterm infants
- Increased incidence of constipation and reflux
- Higher incidence in tracheocutaneous fistula in neonatal tracheostomy

DeMauro SB, et al., Perspectives on neonatal and infant tracheostomy, Seminars in Fetal & Neonatal Medicine (2016)

Outcomes
- Healthcare utilization
  - all children, total spending was $53.3 million for 502 children over 2 year period.

Watters, et al. Laryngoscope, 00:000-000, 2016.

Thank You
- Questions