Pulmonary Diseases & Advanced Management of the Tracheostomy/Ventilator-Dependent Patient

Friday, November 20  8:00 AM - 10:00 AM

Session Number/Code: 1980
Room:  Ernest N. Morial Convention Center – 383-385  CC/

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This session was developed by the Convention Program Committee. It is intended to provide clinicians with intermediate to advanced knowledge regarding the anatomy and physiology of the respiratory system, interrelations between respiration and swallowing, interpretation of medical test data as they relate to dysphagia, and information about frequently encountered clinical interventions with patients on ventilators. Current evidence in both areas will be presented.

Benefits and Learning Objectives

- describe normal and abnormal pulmonary functions.
- understand differences among common pulmonary diseases and pneumonias.
- list advanced assessment techniques for patients on ventilation.
Respiratory Function & Common Pulmonary Diseases in Adults
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ASHA Convention, 11/20/2009, New Orleans

Financial Disclosure
- I have a job and they pay me monthly
- My family spends the money and I keep going to work
- Presenter has no financial interests in any product

Dysphagia is Not a Disease

Disease, Condition:
- Neurologic
- Traumatic
- Neoplastic
- Structural
- Iatrogenic
- “Deconditioning”
- Pulmonary
- Others

Dysphagia:
- Pulmonary
- Nutritional
- Community-Acquired
- Social
- Psychological
- Others
Mechanical Ventilation

- Replaces workload of breathing
- Manipulates gases in inhaled air
- Alters volume and pressure if inhaled air to maximize gas exchange

- All above can be damaged by diseases...

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Mechanical Ventilation

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- Alters volume and pressure if inhaled air to maximize gas exchange

- All above can be damaged by diseases...
Breathing and Swallowing

- Exhale swallow exhale
  - Subglottic pressure during swallow

- Inspiration
  - Swallow apnea 1.5 – 2.5 seconds

- Expiration
  - Respiratory Rate = 16/min
Abnormalities: Tachypnea

TACHYPIEA

Seconds →

Respiratory Rate = 36/min

Pleural coupling

Parietal pleura
Visceral pleura
Lung outer surface
Diaphragm

Pleural coupling

Parietal pleura
Visceral pleura
lung
rib

P<atm
• Compliance and Elastance

- Compliance:
  - “ease of stretchability”
  - Increases when “stretched”

- Elastance: (surface tension)
  - Resistance to stretchability
  - Increases when “unstretched”

Disrupt Pleural Linkage—Lungs Collapse
Resting Expiratory Level

Diaphragm
**Compliance & Elastance**

- Surfactant

Water droplet with surface tension  \[\rightarrow\]  Surface tension is eliminated

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**Compliance & Elastance**

- When alveolar compliance is very low...
  - Lungs tough and rubbery
- ... workload of breathing increases
  - Segments, entire lungs
  - Patient effort cannot “pull alveoli open”
- Mechanical ventilation may be necessary
  - Tracheostomy if prolonged dependence
Diseases that reduce pulmonary compliance

- Diseases that thicken alveolar “walls”
  - Mechanically increase alveolar “rubberiness”
- Diseases that reduce surfactant
  - Chemically reduce alveolar compliance
- Diseases that compromise pleural links
  - Alveolar diameter too small to “pull open”

Conditions that reduce pulmonary compliance

- Pneumothorax
  - Pleural linkages are disrupted
  - Lung collapses
  - Patient cannot “pull lungs open”
  - Atelectasis – partial “collapse”

Pneumothorax

Collapse caused by compromised pleural linkage (perforated pleura)
Pneumothorax

Atelectasis

- Atelectasis
  - collapsed alveoli
  - Rate increases to accommodate reduced surface area
Causes of ARDS

- Massive aspiration – chemical pneumonitis
  - Trauma to epithelium, inflammation
- Septicemia
  - Bloodborne pathogen traumatizes alveoli
- Both reduce surfactant, “toughen” alveoli
Chemical Pneumonitis

Septicemia

ARDS (bilaterally) with (R) Pneumothorax
Other conditions impairing self-ventilation

- Paralysis
  - Phrenic nerve, C3,4,5
  - Some cardiothoracic procedures
- Sedation (CNS depression)
- Congestive heart failure

CHF

- Heart muscle weakened by disease
  - Produces pulmonary hypertension
  - Fluid leaks into alveoli, partially filling them
    - Pulmonary edema
  - Fluid leaks into pleural space
    - Pleural effusion
Hydrostatic pressure pushes “water” into alveoli

PULMONARY EDEMA

CHF: clear chest (L); pulmonary edema in same patient on (R)
Pleural Effusion

CHF (transudative), Inflammatory (exudative)

Pneumonia

• An inflammation of pulmonary parenchyma (alveoli, airways, both)...
• ...Caused by infectious pathogens
• Treatment:
  – Infection must be treated
  – Respiratory distress, failure must be treated

Mandell & Wunderink, 2007

Pneumonia

• Phase 1: Edema
  – Pathogen infiltrates, infects alveoli
    • Draws nourishment from alveolar epithelium
      – Damaging alveolar epithelium
    • Producing metabolic byproducts (toxins)
      – Irritants to alveoli
      – Inflammation

Mandell & Wunderink, 2007
Pneumonia

- Phase 2: Red hepatization phase.
  - Alveoli become excessively permeable
    - RBC, WBC, serum "leak" from capillaries
  - Immunological response
    - pneumonitis

Infectious debris
- Respiratory surface area is reduced by infiltrate
  - Dyspnea, hypoxemia
- Epithelium thickens
- Surfactant production is diminished
  - Reduces lung compliance
  - ...worsening dyspnea

Infiltrates
Respiratory Complications of Disease

1. Increased respiratory rate
2. Increased workload of breathing
3. Reduced surface area for gas exchange

These impairments often require management with mechanical ventilation.

Questions

Thank you.

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Ventilators & Tracheotomies: Advanced Issues

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2009 ASHA Convention, New Orleans, LA
November 20, 2009

Management

- Endotracheal Intubation for mechanical ventilation
- Mechanical Ventilation with subsequent tracheotomy
- Tracheotomy without mechanical ventilation

Acknowledgment / Speaker Disclosure

- The Dr. Ralph & Marian Falk Foundation provides funding for the swallowing center research
- Fellow members of the Marianjoy Swallowing Center Research Team
- Presenter has no financial interest in any of the products discussed during this presentation
Traditional Ventilation Modes – Positive Pressure

CMV – Control Mode Ventilation
Regular time intervals of machine volume control breaths

AC – Assist Control Ventilation
Negative inspiratory pressure triggers the assist control breathing

IMV – Intermittent Mandatory Ventilation: Spontaneous breathing (inspiration & expiration) occurs between each IMV breath

SIMV – Synchronized IMV
Spontaneous breathing (inspiration & expiration) occurs between each IMV breath. Negative pressure deflection, which initiates the SIMV, is triggered by the patient

Other Ventilation Modes & Setting

Modes
- CPAP – Continuous Positive Airway Pressure
- NAVA: Neuromechanically adjusted ventilator assist
- VAPS: Volume assured pressure support
- VSV: Volume support ventilation
- PRV-C: Pressure regulated volume control
- PAV: Proportional assist ventilation
- HFOV: High frequency oscillatory ventilation
- NIV: Noninvasive ventilation

Settings
- PEEP – Positive End Expiratory Pressure
- PS – Pressure Support
- Tidal Volume
- Rate: Minimum number of breath per minute delivered to patient
- FIO2: Fraction of inspired oxygen - % of oxygen delivered with each breath

Ventilator Weaning

Hemodynamic Variables
- Mean arterial pressure
- Systolic blood pressure
- Cardiac Output
- Ejection Fraction

Physiological Measures
- Gas exchange variables
- Oxygenation
- PaCO2
- Oxygen cost of breathing
- Arterial pH

Pulmonary Mechanics
- Vital Capacity
- Rapid shallow breathing index
- Negative inspiratory pressure
- Minute ventilation
- Mandatory minute ventilation
- Respiratory rate
- Tidal volume
- Maximum inspiratory pressure
- Maximum voluntary ventilation

Subjective Perceptions
- Dyspnea
- Anxiety
- Fatigue
- Anger
- Hopelessness
- Depression
- Hope
- Social support
- Sense of mastery
- Uncertainty
- Stress
- Weaning self-efficacy

Other
- Somnolence
- Patient’s age

Twibell et al., 2003
Potential Complication Following Endotracheal Tube (No Trach Tube)

- Sore throat
- Paranasal sinusitis
- Vocal cord paralysis
- Laryngeal tracheal ulceration
- Hoarseness (Yamanaka et al., 2009)
  - 49% - day of extubation
  - 29% - 1 day
  - 11% - 3 days
  - 0.8% - 7 days
- Arytenoid subluxation / dislocation (Yamanaka et al., 2009)
  - 0.097% (3 / 3093 adult patients)

Swallowing Following Prolonged Endotracheal Intubation (> 48 hours)

- Barker et al. (2009)
  - 254 patients – 51% demonstrated dysphagia
- Hafner et al. (2008)
  - 533 patients – silent aspiration 69.3%
- El Solh et al. (2003)
  - FEES within 48 hours of extubation
    - >65 years – 52% (2 week follow-up 13%)
    - <65 years - 36% (2 week follow-up 0%)
- Ajemian et al. (2001)
  - FEES within 48 hours of extubation
    - 56% aspiration; 25% silent aspiration
- Leder et al. (1998)
  - 45% aspiration; 20% silent aspiration

Swallowing: Ventilator Dependent & Trach

Swallowing Characteristics
- Davis & Stanton (2004)
  - Aspiration present in 41.4% of patients (silent 83.3%)
  - Compensatory strategies alleviated aspiration in 63.8% of the patients
- Leder (2002)
  - Aspiration present in 35% aspiration of patients (silent 82.3%)
  - Aspirators were older & fewer days post-trach
  - 73 years vs. 59 years
  - 14 days vs. 23 days
Swallow is improved on mechanical ventilation
- Terzi et al. (2007): 10 patients with neuromuscular disease & tracheotomy
  - Swallow off mechanical ventilation vs. Swallowing on mechanical ventilation
    - Reduced swallowing time per bolus & number of swallows per bolus
- Vitacca et al. (2005)
  - Swallow off mechanical ventilation may induced an increase in respiratory rate, end-tidal CO₂, & dyspnea
  - ventilation maintains a positive subglottic pressure to the risk of aspiration and prevent dyspnea
Marianjoy’s Trach Tube Studies

- Blue Dye
- Trach Effect?
- Secretions & Occlusion
- Occlusion & Swallowing Ability

Efficacy of Blue Dye with Trachs

- First described by Cameron et al., (1973)
  ➢ 5 case studies (not simultaneous exams)
- Blue Dye vs. the VFSS (Simultaneous exams)
  ➢ Brady et al., 1999
  ➢ Peruzzi et al., 2001
  ➢ O’Neill-Pirozzi et al., 2003
- Blue Dye vs. the FEES
  ➢ Donzelli et al., 2001 (simultaneous exams)
  ➢ Belafsky et al., 2003 (not simultaneous exams)
  ➢ Winklmaier et al., 2007 (not simultaneous exams)

Marianjoy Blue Dye Studies

- Brady et al. (1999)
  ➢ Simultaneous blue dye and VFSS examinations
  ➢ Tracheal suctioning provided after each incidence of aspiration as identified by the VFSS and at the end of each study
  ➢ 20 consecutive patients participated

- Donzelli et al. (2001)
  ➢ Simultaneous blue dye and FEES examinations
  ➢ Subglottal viewing and tracheal suctioning was provided after each incidence of aspiration as view by the FEES and at the end of the examination
  ➢ 15 consecutive patients participated
Blue Dye: Results

• Brady et al. (1999)
  ➢ Overall the blue dye test had a 50% false negative error rate when compared to the VFSS.
  ➢ The blue dye was 100% accurate with detecting aspiration in gross amounts (greater than trace)
  ➢ 0% accurate when detecting aspiration in small amounts (less than trace).
• Donzelli et al. (2001)
  ➢ Overall the blue dye had a 50% false negative error rate when compared to the FEES.
  ➢ The blue dye was 67% accurate with detecting aspiration in gross amounts (greater than trace)
  ➢ 0% accurate when detecting aspiration in small amounts (less than trace).
Blue Dye: Translation to Clinical Practice

• Blue dye test showed an overall false-negative error rate of 50% for the detection of aspiration when compared to the VFSS & FEES
• Blue dye test is not sensitive to detect microaspiration --- only sensitive to detect gross aspiration
• Current evidence suggest that the blue dye test should at best be viewed only as a screening tool for the presence of gross amounts of aspiration

Trach Effect? Pre & Post Trach

• Leder & Ross (2000)
  ➢ Investigated the relationship between a tracheotomy and incidence of aspiration pre and post tracheotomy in patients with head/neck cancer – 20 subjects
  ➢ 12 subjects who aspirated before the tracheotomy also aspirated after the tracheotomy
  ➢ 7/8 subjects who did not aspirate before the tracheotomy also did not aspirate after the tracheotomy
• Leder & Ross (2009)
  ➢ Confirmation of no causal relationship between tracheotomy and aspiration status- replication study
  ➢ 25 subjects – 88% (22/25) had the same aspiration status before and after the tracheotomy

Trach Effect? Removal of the Trach

• Leder et al. (2005)
  ➢ Investigated the effects of the presence of the trach tube on the aspiration status in patients after surgery for head/neck cancer
  ➢ No differences in aspiration status with the trach tube in, removed with the tracheostoma gently covered, or with an open tracheostoma.
• Terk, Leder, & Burrell (2007)
  ➢ Examined the biomechanical effects of the presence of a tracheotomy tube on aspiration status and hyoid bone movement in nondysphagic patients under fluoroscopy.
  ➢ Found no evidence to support that the tracheotomy tube tethers the larynx during the swallow under the following three conditions:
    • tracheotomy tube in with inflated cuff;
    • tracheotomy tube in with capped with deflated cuff;
    • tracheotomy tube out (decannulated).
Marianjoy: Trach Effect? Removal

- Purposes: (Donzelli et al. 2005)
  - To investigate the relationship between the presence of a trach tube and laryngeal penetration and/or aspiration in patients with a known or suspected dysphagia
  - When laryngeal penetration/aspiration occurs with the trach tube in place, what immediate effect, if any, does removing the tube have on eliminating the penetration/aspiration?

Subjects

- 46 consecutive patients were approached for consent
- 37 were able to successfully complete the study protocol
  - 4 patients – profound secretions – not safe
  - 3 patients – gross amounts of aspiration on 1st bolus
  - 1 patient – became ill
  - 1 patient – mild tracheal bleeding
- Age range 34-85 years, mean age=64.38 years (SD=10.64 years)
- 23 males / 14 females
- All rehabilitation patients representing a variety of diagnoses:
  - CVA, TBI, SCI, cardiac, respiratory failure

Procedure

- Design: Prospective, repeated measure
- First provided with up to 3 boluses of puree with the trach tube in place
- Tracheotomy tube was then removed and the stoma site was covered with gauze and gentle hand pressure
- Patients were again presented with up to 3 boluses of puree without the trach tube in place
- Subglottal viewing also completed
Tracheotomy Tube

<table>
<thead>
<tr>
<th>Type</th>
<th>Bivona 18</th>
<th>Shiley 16</th>
<th>Portex 2</th>
<th>Jackson 1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Cuff Status</th>
<th>Cuff</th>
<th>Cuffless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occlusion Status</td>
<td>Capped 21</td>
<td>One-Way Valve 8</td>
</tr>
</tbody>
</table>

Results - Aspiration

- Aspiration status was in agreement with and without the trach in place in 95% (35/37) of the subjects
- Aspiration occurred with the trach tube in place in 8% (3/37) of the subjects
- Aspiration occurred with the trach tube removed in 13.5% (5/37) of the subjects
- The 2 patients who demonstrated a different swallowing pattern with regard to aspiration, only demonstrated aspiration when the trach was removed

\( \chi^2 = 0.561, \ df = 1, \ p = 0.454, \) non-significant

Results - Penetration

- Laryngeal penetration occurred in 67.6% (25/37) of the subjects with and without the trach
- Laryngeal penetration status was in agreement with and without the trach in place in 78% (29/37) of the subjects
  - 4 patients did better with the trach (no penetration)
  - 4 patients did better without the trach (no penetration)
Discussion

• Potential causes of swallowing dysfunction associated with a trach were controlled for by:
  ➢ Deflating the cuff
  ➢ Gentle hand pressure over the stoma site to re-establish glottal airflow
• Difficult to separate the potential contributing causes for dysphagia from the underlying medical conditions that necessitated the trach in the 1st place
• The neurologic diagnosis (e.g. CVA, TBI) alone could be the etiology of the dysphagia

Conclusion

• Majority of the patients, the removal of the trach tube made no difference in the incidence of aspiration/laryngeal penetration
• Results do not support the clinical notion that swallow function will improve with the removal of the trach tube

Translation to Clinical Practice

• If you have seen swallow function improve after your patient has been decannulation…
  ➢ It might be because their underlying medical condition has improved that allowed for their trach to be removed and also allowed for their swallow to improve
• NOT… their trach came out so now they swallow better
• The underlying medical condition must be taken into account.
Marianjoy Trach Effect (Brady et al., in press)

- Pilot Data on Swallow Function in Nondysphagic Patients Requiring a Tracheotomy Tube
- Objective/Hypothesis:
  - 1. To evaluate the effects, if any, do various types of tracheotomy tube occlusion conditions and removing the tracheotomy tube may have upon:
    - A. Bolus flow: Penetration Aspiration Scale
    - B. Durational measurements: Swallow Initiation & White Out time
  - Prospective, single subject, repeated measure

Results

- Six subjects participated in this pilot study
- Age Range: 34-88 years, Mean Age=64.4
- Duration of Tracheotomy:
  - Range 46 to 252 days; Mean=118 days
- Mean PAS Level By Occlusion Condition
  - Open 1.44 (±.88)
  - Finger 1.30 (±.67)
  - Capped 1.33 (±.82)
  - No Trach 1.63 (±.916)
  - F=0.262, p=0.852 (nonsignificant)

<table>
<thead>
<tr>
<th>Occlusion Condition</th>
<th>Mean Swallow Initiation Time (seconds)</th>
<th>Mean “white-out” time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>0.483 (±0.425)</td>
<td>0.661 (±0.343)</td>
</tr>
<tr>
<td>Finger</td>
<td>0.726 (±1.20)</td>
<td>0.711 (±0.698)</td>
</tr>
<tr>
<td>Capped</td>
<td>1.319 (±2.34)</td>
<td>0.726 (±0.096)</td>
</tr>
<tr>
<td>No Trach</td>
<td>0.279 (±0.216)</td>
<td>0.506 (±0.208)</td>
</tr>
</tbody>
</table>
  - F=0.61, p=0.62 (nonsignificant)
Results

• None of the subjects aspirated
• No optimal swallowing patterns were identified
• Durational analysis for swallow initiation time & duration of laryngeal closure were not significantly different by occlusion status or after the removal of the tracheotomy tube

Translation to Clinical Practice

• Understanding the nature of swallowing in persons with a tracheotomy tube without swallowing difficulties is essential to understanding swallowing difficulties in patients with a tracheotomy tube & dysphagia
• Results of this study provide complementary evidence to the growing body of literature demonstrating the lack of a relationship between the presence of a tracheotomy tube and swallowing dysfunction

Occlusion & Secretions with Trachs

• Passy et al.1, 2
• Manzano et al.3
• Lichtman et al.4
• Currently, no studies investigating the relationship between occlusion status and secretion levels using a standardized scale.

1. Passy V, Otolaryngology-Head and Neck Surgery, 1986, vol 95
2. Passy et al., Laryngoscope, 1995, vol 103
3. Manzano et al., Critical Care Medicine, 1993, vol 56
4. Lichtman et al., Jnl of Speech and Hearing Research, 1995, vol 38
Secretions & Occlusion: Marianjoy Study (Donzelli et al., 2006)

• Purpose:
  ➢ To investigate patients with a trach tube & the relationships between:
    1) Secretion level and aspiration status
    2) Secretion level and occlusion status
    3) Occlusion status and aspiration rate
• Design:
  ➢ Prospective, descriptive study

Subjects

• 40 patients with a tracheostomy tube participated in this study over 24 months
• Age Range: 30-85 years
• Mean Age 62.8 years (SD=12.04 years)
• 24 males / 16 females
• 28 patients were NPO prior to FEES
• No ventilator dependent patients
• All rehabilitation patients representing a variety of diagnoses: CVA, TBI, SCI, cardiac, respiratory failure

Results: Secretion Level & Aspiration Status

• Overall 47.5% of the patients aspirated
• 79% of the time it was silent
• Overall mean secretion level: 3.5
  ➢ Aspirators: 4.3
  ➢ Non-Aspirators: 2.8
  (p<0.001)
• Duration of tracheostomy tube:
  ➢ Mean=74 days (SD=46 days)
  ➢ Range: 14–192 days
Secretion Level Distribution

- Level 1 – Normal 15%
- Level 2 – Mild 15%
- Level 3 - Moderate 10%
- Level 4 – Severe 22.5%
- Level 5 – Profound 37.5%

Results: Occlusion Status

<table>
<thead>
<tr>
<th>Occlusion Status</th>
<th>n</th>
<th>Mean Secretion Level*</th>
<th>Aspiration Rate†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capped</td>
<td>19</td>
<td>2.95</td>
<td>36.8%</td>
</tr>
<tr>
<td>One-Way Valve</td>
<td>9</td>
<td>3.67</td>
<td>44.4%</td>
</tr>
<tr>
<td>Finger</td>
<td>12</td>
<td>4.34</td>
<td>66.7%</td>
</tr>
</tbody>
</table>

\[ *F(3.61, p=0.037) \]

\[ †X^2=2.667, p=0.264 \]

Discussion/Conclusion: Secretion Level & Aspiration Status

- Results of current study concur with initial secretion scale study
  - Higher secretion level, more likely NPO and demonstrate laryngeal penetration & aspiration
  - Secretion levels for patients with a trach tube were also similar:
    - Initial study (N=28) 3.96
    - Current study (N=40) 3.50
Discussion/Conclusion: Secretion Level & Occlusion Status

- 1st time a study has described the relationship between secretion level & occlusion status using a standardized scale

Capping ➔ PMV ➔ Finger

- Duration of tracheostomy tube was not related to secretion level

Discussion / Conclusion: Occlusion Status & Aspiration

- Even though finger occlusion had the highest aspiration rate, a significant relationship was not observed

- Aspiration rate for the profound secretion level was fairly evenly distributed between the 3 types of occlusions

Limitations

Descriptive Study - cannot establish a cause/effect relationship

An association was observed between occlusion status and secretion level


Discussion / Conclusion:

- Additional factors that may affect accumulated oral pharyngeal secretions:
  - Pulmonary secretions
  - Infection
  - Patient mobility
  - Medical instability
  - Vocal fold immobility / glottal closure
  - Swallowing frequency
  - Laryngeal sensation
  - Cognitive / alertness level

Translation to Clinical Practice

- SLPs should work with the interdisciplinary team to determine the type of occlusion the patient can safely tolerate; potentially resulting in reduction of accumulated oropharyngeal secretions
- Reduced oropharyngeal secretions have been associated with reduced risk of aspiration

Occlusion & Swallowing Ability

- Occlusion improves swallow (reduces or eliminates aspiration)
  - Gross et al., 2003
  - Elpern et al., 2000
  - Stachler et al., 1996
  - Dettelbach et al., 1995
- Occlusion has no effect on aspiration
  - Leder 1999
  - Leder et al., 1998
- Occlusion may benefit some patients but not others
  - Suller et al., 2003
  - Logemann et al., 1998
Marianjoy Trach Occlusion Study
2009 (Ongoing)

- Objective: Compare the effects, if any, of various types of tracheotomy tube occlusion conditions may have upon swallowing during either the VFSS or FEES
- Method: Prospective, repeated measure design.
- Randomized order of occlusion conditions (open, finger, one-way valve, and capped)
- Protocol Swallows: 3-5 mL pureed, nectar, and thin
- 56 participants have completed the protocol

Results

<table>
<thead>
<tr>
<th>Occlusion Condition</th>
<th>Aspiration with open</th>
<th>Aspiration with finger</th>
<th>Aspiration with cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>16% (9/56)</td>
<td>10.7% (6/56)</td>
<td>5.35% (3/56)</td>
</tr>
<tr>
<td>Finger</td>
<td>10.7% (6/56)</td>
<td>10.7% (6/56)</td>
<td>5.35% (3/56)</td>
</tr>
<tr>
<td>Capped</td>
<td>5.35% (3/56)</td>
<td>10.7% (6/56)</td>
<td>16% (9/56)</td>
</tr>
</tbody>
</table>
Conclusion / Translation to Clinical Practice

- No clear pattern for optimal occlusion conditions for swallowing were identified.
- Trending that open condition for liquids most difficult, however, majority of subjects were able to safely swallow under all of the occlusion conditions without airway invasion.
- Preliminary results suggest that swallowing dysfunction in patients with a trach tube is a multifactorial problem and several factors may be associated with the swallowing dysfunction.
- Patients should be evaluated under various occlusion conditions to determine their specific optimal swallowing condition.

Late Complications - Tracheostomy

- Bleeding
  - Granulation tissue (most common)
  - Tracheoinnominate artery fistula
    - Very Rare - occurs in 0.6-0.7% of patients
    - Mortality rate: 80% if treated aggressively
    - Artery supplies the right arm, right side of head & neck
    - Erosive process that lead to the fistula
    - Sentinel bleed
      - Brief episode of brisk bright red blood from the tracheostomy site hours or days before catastrophic bleeding

- Stenosis (Zias et al., 2008)
  - Female
  - Obese
  - History of diabetes mellitus
  - Hypertension
  - Cardiovascular disease
  - Current smoker

- Tracheoesophageal fistula
  - Typically caused by friction between a posteriorly displaced tracheostomy tube or overinflated cuff and a rigid nasogastric tube

- Tracheocutaneous fistula
Emergencies-Loss of Airway

- Obstruction
  - Remove any speaking valve or cap
  - Be suspicious of a mucus plug and always suction the trach and oral cavity
  - Remove trach if needed

- Establish ventilation through the easiest and most efficient opening possible (Bag mask)

References