Speech and Swallowing in Patients with Tracheostomy

Normal Airflow for Phonation
Trach-Related Changes

- **01** Open system
- **02** Decreased airflow through glottis
- **03** Increased secretions

Anatomy of a Trach Tube

- 1. Faceplate
- 2. Hub
- 3. Outer Cannula
- 4. Pilot line/pilot balloon
- 5. Cuff

Trach Tubes (cont.)

- Shiley
  - Flex trach tubes
  - Extended length trach tubes
Trach Tubes (cont.)

• Portex
  – Plastic tube
  – Clear or white faceplate
  – Blue pilot balloon

Trach Tubes (cont.)

• Bivona fomecuff (red pilot balloon)
  – Used when unable to maintain seal with standard cuff
  – Reduces risk of damage from over-inflation of cuff
  – Passive cuff inflation
  – Cannot be used with speaking valves

Trach Tubes (cont.)

• Extra length
  – Used primarily with bariatric patients to ensure proper ventilation
  – Made by most trach manufacturers
Trach Tubes

- Jackson (metal)
  - Used for non-vent patients
  - Cuffless model only

Communication Options

- Leak speech
- Speaking Valves
- Talking trach tubes
- Fenestrated trach tubes
- Digital trach tube occlusion
- Augmentative communication systems
- Electrolarynx

Leak Speech

- For patients who are ventilator-dependent
- Leak is created by a partially deflated trach tube cuff
  - Must have medical clearance prior to attempting cuff deflation
- Concurrently with cuff deflation, changes in the ventilator that compensate for the loss of volume through the upper airway must be made.
Leak Speech

- Protocol for Cuff Deflation
  - Obtain MD order for cuff deflation and vent modifications
  - Suction patient through the trach tube, cuff inflated
  - RT makes adjustments in vent settings (e.g., tidal volume)
  - SLP assesses patient's voice
  - Monitor oxygen saturation and HR
  - If patient is unable to voice adequately, review other vent settings (e.g., respiratory rate, inspiratory flow rate)
  - Reassess patient's voicing
  - Gradually increase length of time pt can tolerate cuff deflation

Speaking Valves

- Patient can continue to breathe in through the trach tube
- Exhalation is then redirected up through the trachea – creating a closed system
- Promotes a more "normal" respiratory pattern for breathing and expelling secretions

Passy-Muir Valve
Passy-Muir Benefits

- Along with allowing the patient to phonate, Passy-Muir valves are also thought to:
  - Expedite weaning from mechanical ventilation
  - Restore positive airway pressure
  - Reduce decannulation time
  - Facilitate infection control
  - Improve olfaction
  - Improve quality of life

Speaking Valve Candidacy

- Can be used with trach patients on and off the vent
- Pt should be awake, alert, and attempting to communicate
- Airway patency – trach size/# of intubations
- Can be used for decannulation purposes in patients who are not communicative

Contraindications for speaking valve use

- Inability to tolerate full cuff deflation
- End stage pulmonary disease
- Medical instability
- Foam-filled tracheostomy tube cuff
- Thick, copious secretions
- Severe airway obstruction
- Total laryngectomy
- Laryngeal masses, stenosis, inadequate patency of upper airway
- Severe anxiety
**Speaking Valve Assessment**

- Preassessment
  - Cognitive status
  - Secretion management
  - Ability to tolerate cuff deflation
  - Airway patency
  - Level of care/length of time post-tracheotomy

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**Ventilator Considerations**

- The Passy-Muir valve can be used with most conventional modes of ventilation
  - Assist/control
  - Synchronized Intermittent Mandatory Ventilation (SIMV)
  - Pressure Support
  - Continuous Positive Airway Pressure (CPAP)
  - Positive End Expiratory Pressure (PEEP)

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**Ventilator Considerations**

- Valve placement may necessitate manipulation of the tracheostomy tube AND modifications of the ventilator.
- Work in collaboration with Respiratory Therapy.

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Ventilator Considerations

Prior to valve placement, record the following:
- Mode of ventilation
- Tidal volume
- Rate: mechanical and spontaneous
- Fractional Inspired Oxygen Content (FiO2)
- PEEP
- Peak Inspiratory Pressure (PIP)

The ventilator is usually set to provide optimal ventilation to a patient with an inflated trach cuff. Cuff deflation creates a leak in that system. Changes of the ventilator that will compensate for the loss of volume through the upper airway must be made.

Tidal Volume
- Because of the leak created by cuff deflation, the patient does not receive the amount of air that was preset by the ventilator.
- To compensate for the leak, the RT must increase the tidal volume setting on the ventilator.
- If the amount of leakage is so great that ventilation cannot be maintained after an increase in tidal volume, tracheostomy tube size may need to be increased.
Ventilator Considerations

• Airway pressure
  – Airway pressure may rise slightly with valve placement
  – If peak pressures rise above allowable limits, remove valve
  – PEEP requirements may be reduced

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Ventilator Considerations

• Sensitivity Setting
  – Patients who are breathing spontaneously and who are on the assist mode of ventilation must inspire against the resistance provided by the speaking valve membrane
  • Respiratory effort may increase
  • Patient may fatigue
  – Decreasing the sensitivity at which a breath will be triggered from the ventilator will allow the patient to receive a breath after less inspiratory effort

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Ventilator Considerations

• FiO2
  – Due to the effects of physiologic PEEP, FiO2 requirements may be reduced due to increased saturations.
  – If there is significant desaturation, remove valve immediately.
Speaking Valve Assessment

• Assess size and type of tracheostomy tube
  – Patients with Fome cuff trachs are not candidates for speaking valves secondary to passive inflation of cuff
  – Larger diameter trachs may result in inadequate airflow through the upper airway (ideal size of trach is 2/3 size of tracheal lumen)
  – Specialty trachs can be utilized for abnormal airways (e.g. extra length, double cuff, stoma cuff, TTS)

• Verify and record baseline vital signs
• Slowly deflate cuff (~1cc at a time) and monitor pt’s vitals and work of breathing
• Suction patient if necessary
• Verify voice by digital occlusion of trach
• Apply speaking valve and monitor for changes in voice, vitals, or work of breathing
• Advance time of use as tolerated
Speaking Valve Assessment

- Look at
  - Oxygen saturation
  - Vital signs
  - Breath sounds
  - Color
  - Work of breathing
  - Patient responsiveness
  - Secretion status

Swallowing and Trachs

Phases of Swallowing
Swallow Apnea

- During the pharyngeal phase of swallowing, breathing stops briefly.
  - This period usually corresponds to airway closure during the pharyngeal phase and cessation of chest wall movement.
  - Usually occurs mid-expiration and is followed by expiration.
  - Usually lasts 0.3 s to 2.5 s.

Swallow Apnea

- Patients with dysphagia may interrupt inhalation to swallow, which may increase their risk of aspiration.
- Thought to be a result of its own neural mechanism.
  - Laryngectomy patients demonstrate SA (Hiss et al., 2003).

Diagram showing various swallow events.
**Respiration and Swallowing**

- Breathing and swallowing are well coordinated in healthy adults.
  - This coordination is most evident at the level of the larynx.
  - Protection of the airway during and around the time of swallowing is dependent upon the coordination of breathing and swallowing.
  - Disruption of the ability to coordinate airway closure at the appropriate time in the swallow can lead to airway compromise.

**Respiration and Swallowing**

- In healthy adults, there is a close coupling of respiration with swallowing.
- Physiologic conditions, including aging, neurologic disease, and head & neck cancer, disrupt this coupling.

**Respiration and Swallowing**

- Respiratory patterns in young and elderly healthy individuals and in individuals with COPD:
  - Healthy young individuals:
    - Exhalation → Swallow → Exhalation
  - Healthy elderly:
    - Inhalation → Swallow → Exhalation
  - COPD exacerbation:
    - Inhalation → Swallow

  Shaker et al., 1992
**Respiration and Swallowing**

- Factors that affect airway protection in patients with pulmonary disease include:
  - Alterations in timing of airway closure during the swallow
  - Interruption of the normally well timed pattern of swallowing and breathing
  - Diminished respiratory defenses (e.g., diminished cough, reduced airway clearance)

**Do Tracheostomy Tubes Affect Swallowing?**

- Common thoughts
  - Tracheostomy tubes cause aspiration and result in:
    - Decreased hyolaryngeal excursion
    - Decreased adductor vocal fold response
    - Decreased subglottal air pressure

**Question: Do tracheostomy tubes cause aspiration?**

- Reported incidence of aspiration in various patient populations with tracheostomy tubes ranges from 68-87%.
Question: Do tracheostomy tubes cause aspiration?

• Research indicates that tracheostomy tubes do not cause aspiration (Brady et al., 2009; Donzelli et al., 2005; Kang et al., 2012; Leder et al., 2005; Leder & Ross, 2000).

Question: Do tracheotomy tubes limit hyolaryngeal excursion?

• Feldman, Deal, & Urquhart (1966)
  – “Fixation of the larynx by the tracheostomy…might prevent normal elevation of the larynx…[leading to] a disorder of swallowing produced by the tracheostomy.”

• Bonzano (1971)
  – Suggested that presence of a tracheotomy tube resulted in reduced laryngeal movement, presumably due to tethering of the larynx by the weight of the tracheotomy tube and/or the presence of an inflated tracheotomy tube cuff
  • However, only 3 of 43 (7%) of participants in this study actually demonstrated this.
Question: Do tracheotomy tubes limit hyolaryngeal excursion?

Yes
- Ding & Logemann, 2005

No
- Suiter, McCullough, & Powell, 2003
- Terk, Leder, & Burell, 2007
- Kang et al., 2012

Question: Do tracheotomy tubes affect vocal fold reflexes?

- Sasaki, Suzuki, Horiuchi, & Kirchner (1977)
  - Examined the effects of tracheotomy on the protective laryngeal closure reflex in 15 adult dogs
  - Sensory threshold of the ipsilateral evoked adductor response was 0.5 volt in 4 dogs immediately post-tracheotomy
  - Sensory threshold of the ipsilateral adductor response was 1.0-1.2 volts in 8 chronically tracheotomized dogs (2-8 months)

- Buckwalter & Sasaki (1984)
  - Demonstrated in humans that threshold of adductor vocal fold reflex nearly doubles after a tracheotomy tube has been in place for 6-8 months
Question: Does loss of subglottal air pressure affect swallow safety?

- Eibling & Gross, 1996
  - Suggest that the loss of subglottic air pressure and glottic airflow are the active factors in predisposing individuals with tracheotomy to aspiration.

- Subglottal Pressure Theory (Diez Gross et al., 2003)
  - Suggests that pressurized air during the swallow plays a role in the neuroregulation of swallowing function by stimulating subglottic mechanoreceptors.
  - Theory originated from observations of altered air pressure below the true vocal folds was modified depending on tube status (open vs. closed)

- Subglottal pressure theory (cont.)
  - Suggests that the preferential timing of the normal swallow with exhalation is a mechanism that allows for stimulation of subglottic mechanoreceptors and the generation of subglottal air pressure.
Question: Does loss of subglottal air pressure affect swallow safety?

- Stretch receptors in the trachea have an inhibitory effect on the respiratory muscles, possibly delaying inspiration until the end of expiration during normal respiration.
  - These mechanoreceptors may also function during swallowing to interrupt inspiration.

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During normal swallowing, positive subglottic air pressure is likely present (Gross, Steinhauer, Zaje, & Venners, 2006).

- The presence of a tracheotomy prevents the subglottic pressure rise associated with normal swallowing, and may reduce or eliminate the inhibitory effect of the stretch receptors.
- This places the individual at increased risk for aspiration or dysphagia.

Eibling & Gross, 1996

- Measured subglottic air pressure and airflow through a tracheotomy during swallowing.
  - Tube open:
    - There was a minimal rise in pressure during a swallow, and there was significant expiratory airflow during the swallow.
    - Patients aspirated.
  - Passy-Muir valve:
    - Airflow ceased during the swallow
    - There was a pressure peak that occurred at the time of the swallow, averaging 10 cm H2O.
    - Patients did not aspirate.
Question: Does loss of subglottal air pressure affect swallow safety?

Gross, Mahlmann, & Grayhack, 2003
- Completed VFSS in 4 individuals with valve on vs. valve off
- Measured subglottal air pressure during the swallow with valve on vs. off
  - Average air pressure with valve on = 8.5 cm H2O
  - Average air pressure with valve off = 0 cm H2O
- Slower pharyngeal activity duration and bolus transit times were observed with valve off.
- Penetration-aspiration scores increased (were worse) with the valve off.

Question: Does tracheotomy tube occlusion affect swallow safety?

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Yes
- Muz, Mathog, Nelson, & Jones, 1989
- Muz, Hamlet, Mathog, & Farris, 1994

Maybe
- Logemann, Pauloski, & Coleangelo, 1998

No
- Leder, Ross, Burrell, & Sasaki, 1998

Question: Does speaking valve placement affect swallow safety?

Sutter, McCullough, & Powell, 2003
- Dettelbach, Gross, Mahlmann, & Eibling, 1995
- Stachler, Hamlet, Choi, & Fleming, 1996
- Elpern, Gkonek, Bacon, Gerstung, & Skrzynski, 2000
- Gross, Mahlmann, & Grayhack, 2003
- Leder, Joe, Hill, & Traube, 2001
Question: Does speaking valve placement affect swallow safety?

Overall, most reports in the literature indicate that the speaking valve placement improves swallow safety. Research is needed to further elucidate the specific effects of speaking valve placement on swallow function.

Discussion: Cuff Deflation
- Cuff deflation did not reduce the incidence or severity of aspiration.
- Anatomical and functional separation of the respiratory and digestive tracts, such as occurs with tracheotomy, results in the loss of coordination between the protective and respiratory functions of the larynx.
- Cuff deflation may not fully restore pharyngeal and laryngeal sensation.

Discussion: One-Way Speaking Valve
- Speaking valve placement reduces the incidence and severity of aspiration of thin liquids. This may be due to restoration of subglottal air pressure or increased pharyngeal/laryngeal sensation.
- There was an increased incidence of penetration with speaking valve placement.
Conclusions

- Patients who are able to tolerate cuff deflation and speaking valve placement may benefit from eating with a valve in place.
- Specifically, patients with tracheotomy tubes who are unable to tolerate thin liquids may be able to safely take thin liquids when the valve is in place.
- Clinicians who complete swallow evaluations with patients with tracheotomy tubes should include several bolus presentations with the speaking valve in place before making any decisions regarding the use of the valve as a means to reduce aspiration.

Bedside Swallow Evaluation

- Clinical bedside evaluation
  - Modified Evans blue dye test
  - Glucose oxidase strips

Bedside Swallow Examination

- Components of a bedside swallow evaluation include
  - Chart review
    - Medical diagnoses and complications
    - How stable is the patient?
  - Current and past respiratory details
    - Trach size, type, cuff deflation, capping trials
    - Weaning parameters, number and length of intubations, suctioning frequencies, oxygen requirements
  - Physical abilities
    - Ambulation, sitting tolerance, self care
Bedside Swallow Examination

- Components (cont.)
  - Patient observation
    - Level of consciousness
    - Secretion tolerance
      - Suctioning frequency, spontaneous coughs, spontaneous swallows
  - General bed/chair mobility
  - Respiratory measures: Oxygen saturation levels, respiratory rate

Bedside Swallow Examination

- Components (cont.)
  - Oral mechanism examination
    - Assess integrity of oral mucosa
    - Assess oral hygiene, dentition
    - Oral/tongue strength/range of motion

Bedside Swallow Examination: Patients with Trachs

- Bolus presentation (if appropriate)
  - Does the cuff need to be deflated in order for the patient to swallow safely?
    - NO
    - Cuff status did not impact hyolaryngeal excursion or aspiration status (Rahman et al., 2006, Thome, Lander et al., 2007)
    - Assess swallow function under condition in which patient is going to be eating.
  - Deflating the cuff may allow better identification of aspiration if it occurs.
Bedside Swallow Examination: Patients with Trachs

- If cuff is to be deflated
  - Need medical clearance
  - Patient is suctioned prior to and immediately following deflation
  - Note tolerance
    - O2 sats, respiratory rate
    - Digital occlusion during exhalation
    - Can patient phonate?

Bedside Swallow Examination: Patients with Trachs

- Is speaking valve placement necessary?
  - Research on its benefits is equivocal
    - Does eliminate aspiration for some individuals
      - We're not sure why
        - Necessitates cuff deflation
        - Restores airflow through glottis
        - Restores subglottic pressure
  - If patient is a candidate for speaking valve placement, assess swallow function with valve on versus off.

Bedside Swallow Examination: Patients with Trachs

- Speaking valve placement
  - Cuff deflation
  - Digital occlusion
  - Speaking valve placement
    - Secretion management
    - Monitor O2 sats, respiratory rate, patient anxiety level
    - Gradually increase length of time patient is to wear speaking valve
Bedside Swallow Examination

- Patients on mechanical ventilation
  - Higher incidence of silent aspiration
  - May not be able to tolerate cuff deflation and/or speaking valve placement
    - If they are, BSE may still not be the best choice
    - No evidence to suggest BSEs are accurate with this population

Bedside Swallow Examination

- Patients on mechanical ventilation
  - Can eat and drink safely, but we must consider
    - Ventilator settings
      - FiO2, Pressure Support, SIMV vs. spontaneous ventilation
    - Cuff deflation
    - Ability to tolerate speaking valve placement
    - Instrumental assessment is preferential to clinical swallow evaluation

Bedside Swallow Examinations (BSE)

- Evidence in the research indicates that bedside swallow evaluations are not accurate:
  - Logemann, Lazarus, & Jenkins (1982)
  - Splaingard et al. (1988)
  - Aviv et al. (1996)
  - Silent aspiration can occur in 40% to 70% of dysphagic patients who aspirate (Daniels et al., 2000)
BUT, There are some clinical predictors of aspiration that can be detected during BSE:

- Dysphonia
- Wet vocal quality
- Presence of a spontaneous cough during the swallow
- Overall estimate of the presence of aspiration
- Weak volitional cough
- Dysarthria

Issues Specific to Individuals with Tracheotomy

- Cough response may be diminished
- Most who aspirate do so silently

Dysphonia

May be present due to history of intubation

If unable to tolerate valve placement, may not be able to use.

Difficult to assess hyolaryngeal excursion

This isn’t assessed accurately at bedside regardless of presence or absence of trach (Bates et al., 2017)

Supplements to the Bedside Swallow Evaluation

- Modified Evans Blue Dye Test
- Glucose Oxidase Test Strips
- Pulse Oximetry
- Cervical Auscultation
Evans Blue Dye Test

- Original test (Cameron et al., 1973)
  - Place 4 drops of a 1% solution of Evans blue dye on the tongue every 4 hours
  - Tracheal suctioning at set intervals
  - Aspiration assumed if blue dye is suctioned from the trach tube.

Advantages of Blue Dye Test

- Less expensive than instrumental assessment
- Quick
- Easy to administer

Accuracy of the Blue Dye Test

- When done simultaneously with instrumental assessment, blue dye often fails to detect aspiration when it less than gross aspiration
  - Brady et al.
- Blue dye test detected aspiration in 100% of cases in which aspiration was greater than trace.
- Blue dye test failed to identify 100% of those with trace aspiration.
- Most studies have similar results
  - Acceptable specificity but low sensitivity
The FDA has approved the use of Blue No. 1 for use in foods, drugs, and cosmetics.

Blue dye is commonly found in candies, confections, and beverages.

Maloney et al., 2000

- Reported 2 cases in which blue dye was added to enteral feedings.
  - Both developed pneumonia with sepsis.
  - Both died of refractory hypotension and acidosis.
  - Their skin, serum, and urine turned green or blue.
  - Autopsies revealed green or blue discoloration of the skin and internal organs.

Maloney et al. (cont)

- Blue dye no. 1 is an inhibitor of mitochondrial respiration in vitro and reduces oxygen consumption by a factor of 8 in mitochondrial preparations in vitro.
- Maloney and colleagues hypothesized that the refractory hypotension and metabolic acidosis seen in the 2 patients was due to the known biochemical effects of the blue dye.
Is Blue Dye Safe?

Other issues

- Fife, Tan, & Thomson (1995) described an outbreak of pseudomonas aeruginosa, a ventilator-associated infection.
  - 18/20 patients with this infection had received tube feedings that had been tinted from the same common-use bottle of blue dye.
  - When the hospital replaced the bottle with single-use vials, the outbreak stopped.

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Knoll (1993) reported a study in which gram-negative and gram-positive rods (types of bacteria) were found, not only in an open bottle of dye, but also in two unopened bottles.

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Amount of dye SLPs use in MIBDT is typically quite small—5-10 cc

Sterile vials of blue food dye are available, which might alleviate the concern over contamination (Novartis Nutrition, Fremont, Mi).
Glucose Oxidase Testing

- Potts, Zaroukian, Guerrero, & Baker (1993)
  - Evaluated the use of glucose oxidase strips to detect aspiration of enteral feedings.
  - Based on the premise that enteral feedings contain glucose whereas tracheal secretions do not.
  - Compared blue dye in tracheal secretions to glucose oxidase strips for detecting aspiration.
  - Glucose oxidase strips proved to be better at detecting aspiration than blue dye.

Pulse Oximetry

- Provides a non-invasive method of testing
  - Some have suggested that swallow-associated declines in oxygen saturation (2% or more) correlate with aspiration events.

Some suggest that aspiration causes reflex bronchoconstriction and therefore ventilation-perfusion imbalance, leading to hypoxia and desaturation (Zandi et al., 1995).

Others suggest that abnormal swallowing leads to poor breathing and ventilation-perfusion mismatching because of reduced inspiratory volumes (Teramoto et al., 1996).
Pulse Oximetry

- Reports on sensitivity and specificity for pulse oximetry to detect aspiration have been variable:
  - Sensitivity = 73-87%
  - Specificity = 39%-87% (Ramsey & Smithard, 2003)

More recent reports have indicated that pulse oximetry, either alone or in combination with bedside swallow evaluation, does not have sufficient sensitivity or specificity to warrant its use for detection of aspiration (Ramsey, Smithard, & Kahn, 2006).

Cervical Auscultation

- Involves the use of a stethoscope to listen to sounds associated with swallowing (clunks & burts)
- Some say these sounds can be indicative of aspiration or penetration of material.
Cervical Auscultation

- Most reports indicate that cervical auscultation does not accurately detect aspiration (Leslie et al., 2007).
- May be useful in listening to breath sounds.

Instrumental Assessment

- Videofluoroscopic Swallow Study (VFSS)
- Flexible Endoscopic Evaluation of Swallowing (FEES)

Videofluoroscopy

- Allows for observation of interaction between three phases of swallowing
  - Only exam that allows observation of esophageal phase
- Allows assessment of hyolaryngeal excursion, tongue base retraction
**Videofluoroscopy**

- Issues specific to patients with trachs or on mechanical ventilation
  - Facility-dependent
  - Some will not allow patients in ICU to travel to fluoro suite
  - Difficulty with positioning
  - Patient fatigue

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**Issues Specific to Individuals with Tracheotomy**

- Cuff deflation
- Speaking valve placement

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**Flexible Endoscopic Evaluation of Swallowing**

- Involves the passage of a flexible endoscope transnasally to obtain a superior view of the pharynx, larynx, and trachea
- Allows the clinician to objectively evaluate the pharyngeal phase of the swallow
Why FEES?

- VFSS has disadvantages
- FEES has advantages, including:
  - Portability
  - Unlimited time for introduction of therapeutic strategies
  - No radiation exposure
  - Direct view of the anatomy

What can we see with FEES?

- Actual structures moving
- Movement of the bolus
- Speed/duration of some movements
- Adequacy/completeness of velopharyngeal closure
- Epiglottal descent and return
- Airway status/closure before and at the onset of swallow

What can we see with FEES?

- Secretion management
  - Murray et al., 1996
    - Endoscopically visible secretions located within the laryngeal vestibule were highly predictive of subsequent aspiration of food and liquid.
    - Hospitalized patients swallowed less frequently than nonhospitalized patients.
  - Donnell et al., 2003
    - Patients with tracheostomy have more secretions
    - Presence and amount of accumulated oropharyngeal secretions were predictive of aspiration of food and/or liquid.
Findings revealed better endoscopically

- Alterations in anatomy
- Effect of feeding tube on anatomy and swallowing
- Velopharyngeal closure, nasal reflux
- Frequency of spontaneous or dry swallows
- Status of secretions, ability to sense, swallow, or clear secretions

Findings revealed better endoscopically

- Amount, location of residue
- Patient response to residue
- Aspiration of residue after the swallow
- Fatigue over a meal
- Ability to hold breath voluntarily or sustain breath holding
Treatment

- Traditional treatments
  - Nothing specific to patients with trachs
    - Supra-esophageal swallow
    - Shaker exercise

Conclusions

- Evidence in the literature suggests there is no causal relationship between tracheotomy and aspiration status.
  - Patients with tracheotomy often have accompanying medical diagnoses, e.g. pulmonary disease, that could predispose them to swallowing difficulty and aspiration.

Conclusions

- Tracheotomy tube occlusion and/or speaking valve placement appear to improve aspiration status for some patients with some bolus types.
  - Clinicians should evaluate swallowing with and without the tracheotomy tube occluded to determine if individual patients benefit.