ERABI EVIDENCE-BASED REVIEW of moderate to severe ACQUIRED BRAIN INJURY

Clinical Guidebook

3. Dysphagia, Aspiration, and Nutrition Post Acquired Brain Injury

Mitchell Longval BSc, Penny Welch-West M.Cl.Sc. SLP, Brooke Benton BSc RDH, Robert Teasell MD FRCPC

Ontario Neurotrauma Foundation
Fondation ontarienne de neurotraumatologie
LAWSON HEALTH RESEARCH INSTITUTE
Western
St JOSEPH's HEALTH CARE LONDON

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Dysphagia, Aspiration, and Nutrition Post Acquired Brain Injury

By the end of this chapter you should be able to:

- Identify the different phases of swallowing
- Recognize signs and symptoms of dysphagia and identify aspiration
- Describe an approach in the assessment of dysphagia/aspiration
- Describe the difference between compensatory and therapeutic interventions for swallowing
- Understand the benefits of oral care interventions in dysphagia
- Know the benefits of enteral versus parenteral nutrition

3.1 Introduction to Dysphagia and Aspiration

After an acquired brain injury (ABI) a wide range of swallowing disorders may occur. ABIs are associated with focal, diffuse, cortical, and brainstem damage, which may impair swallowing ability and lead to the development of dysphagia, as well as aspiration (Morgan & Ward, 2001). The goal of this Clinical Guidebook chapter is to present relevant information regarding dysphagia, aspiration, and nutrition after sustaining an ABI. The sections below elaborate on physiology, incidence, risk factors, treatment strategies, and evidence-based interventions for dysphagia, aspiration, nutrition, and oral care. Clinical input has been used to highlight relevant treatment strategies and increase the usability of this guidebook. Although there is limited literature in the moderate to severe ABI population, key studies have been highlighted to provide an introduction to the research literature. In addition, links have been included to connect you to the relevant literature and clinical practice guidelines. Information from stroke guidelines is also included as dysphagia after stroke is comparable to ABI (Lee et al., 2016).

Q1. Describe the 4 phases of normal swallowing

1. Oral preparatory phase
2. Oral propulsive phase
3. Pharyngeal phase
4. Esophageal phase

Swallowing has four sequential coordinated phases which are summarized in Table 3.1, and illustrated in Figure 3.1.

Table 3.1. The 4 Phases of Normal Swallowing (Platt, 2001).

Phase	Characteristics
Oral Preparatory Phase	Food in the oral cavity is manipulated, masticated and mixed with saliva in preparation for swallowing. The back of the tongue controls the position of the food, preventing it from falling into the pharynx.
Oral Propulsive Phase	The tongue transfers the bolus of food through the oral cavity to the pharynx, triggering the pharyngeal swallow.
Pharyngeal Phase	Complex and coordinated movements of the tongue and pharyngeal structures propel the bolus into the esophagus, while protecting the airway.
Esophageal Phase	Coordinated contractions of the muscles of the esophagus move the bolus through the esophagus towards the stomach.

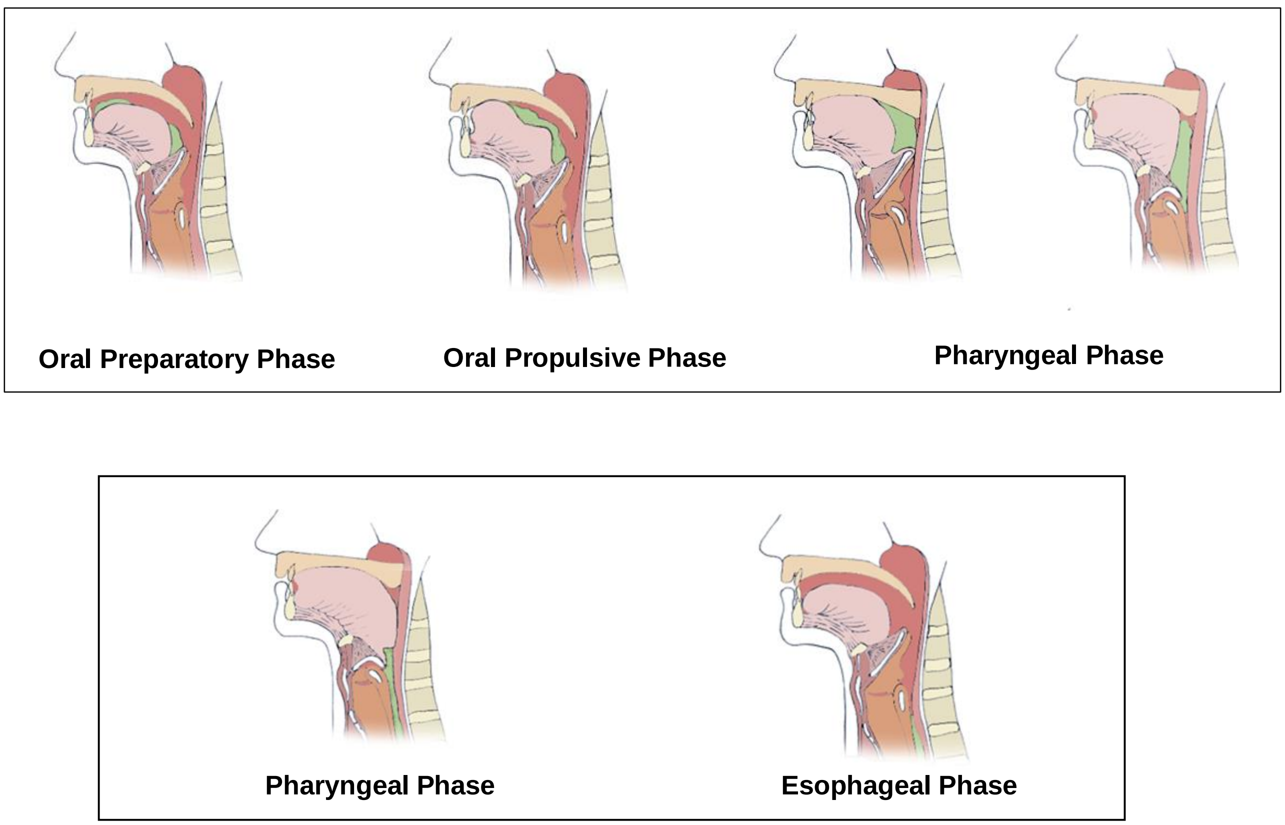


Figure 3.1. The phases of swallowing

3.2 Clinical Presentation

3.2.1 Signs and Symptoms

Dysphagia is defined as difficulty or discomfort with swallowing (Logemann, 1998). Dysphagia and aspiration should be suspected when an individual with an ABI has any of the following: a complaint of difficulty swallowing (such as pain or regurgitation), an abnormal chest x-ray, unexpected weight loss, wet vocal quality, increased drooling, delay in voluntary initiation of the swallow reflex, coughing before or after swallowing, choking, increased body temperature around meal time, and/or avoidance or refusal to eat (Horner et al., 1988).

3.2.2 Pathophysiology

Q2. What is the pathophysiology of dysphagia following ABI?

1. Loss of CNS control leads to pharyngeal muscle dysfunction and incoordination.

Dysphagia post-ABI has been attributed to pharyngeal muscular dysfunction and lack of coordination secondary to central nervous system loss of control. The most common swallowing problems among patients with ABI include, prolonged oral transit time (87.5%), delayed swallow reflex (87.5%), valleculae pooling (62.5%), pyriform sinuses pooling (62.5%); aspiration occurred in 37.5% of patients with brain injury with dysphagia (Field & Weiss, 1989).

Q3. Define aspiration and some of the complications that can arise from it.

1. Entry of material into the airway below the level of the true vocal cords.
2. Complications include choking and aspiration related pneumonia.

Aspiration is defined as entry of material into the airway below the level of the true vocal cords. Many individuals with dysphagia do not have aspiration, as the two are not synonymous. Dysphagia can occur due to problems with bolus transit, where aspiration specifically refers to material entering the airway.

3.2.3 Incidence of Dysphagia and Aspiration Post-ABI

Q4. What is the incidence of dysphagia post-ABI?

1. The incidence of dysphagia among patients entering rehabilitation post-ABI ranges from 26 to 70% (Ward, 2001).

Rates of dysphagia are variable, with the literature ranging between 26% to 70% (Ward, 2001). Many of these rates are found at time of admission, however, Winstein (1983) reported that at time of discharge, 84% of those patients admitted with swallowing problems were eating orally. At follow-up, in the outpatient clinic this number increased to 94% indicating that **dysphagia has a high recovery rate in ABI.**

Q5. What is the incidence of aspiration post-ABI?

1. Aspiration has been reported to range from 25 to 71% in patients with ABI (Mackay et al., 1999a; O'Neil-Pirozzi et al., 2003; Schurr et al., 1999).

Rates of aspiration within the ABI literature are variable, ranging from 25% to 71% depending on the sample surveyed (Mackay et al., 1999a; O'Neil-Pirozzi et al., 2003; Schurr et al., 1999). Mackay et al. (1999b) performed a series of videofluoroscopic swallow studies (VFSS) on 54 young patients with severe brain injuries, 17.6 days post-injury. The authors noted that the incidence of dysphagia was 61%, and of those patients 41% aspirated.

3.2.4 Risk Factors for Dysphagia and Aspiration Post-ABI

Q6. What are the risk factors for dysphagia post-ABI?

1. Severity of brain injury (Logemann, 2013)
2. Duration of coma (Lazarus & Logemann, 1987)
3. Lower Glasgow Coma Score on admission (GCS 3-5) (Mackay et al., 1999b)
4. Severity on CT Scan findings (Mackay et al., 1999b)
5. Duration of mechanical ventilation (Mackay et al., 1999b)
6. Tracheostomy (Mackay et al., 1999b)
7. Translaryngeal (endotracheal) intubation (Mackay et al., 1999b)
8. Severe cognitive and cognition disorders (Mackay et al., 1999b)
9. Physical damage to oral, pharyngeal, laryngeal, and esophageal structures (Mackay et al., 1999b)
10. Oral and pharyngeal sensory difficulties (Mackay et al., 1999b)

Ward and Morgan (2001) identified a body of literature, which has attempted to define factors that may affect the presence and severity of dysphagia post TBI (Cherney & Halper, 1996; Halper et al., 1999; Mackay et al., 1999a, 1999b; Morgan & Mackay, 1999). Injuries that result from translaryngeal intubation or tracheostomy may contribute to swallowing dysfunction in patients with TBI (Morgan & Mackay, 1999). Morgan and Mackay (1999) also note that **patients with severe TBI that have neurogenic dysphagia and a tracheostomy, are at particularly high-risk of aspiration.** However, complications can be minimized by ensuring the use of appropriately sized tracheostomy tubes and by avoiding over inflation of the cuff (Tolep et al., 1996).

Q7. What are the risk factors for aspiration following an ABI?

The risk of dysphagia related aspiration is proportional to the initial severity of the head injury. A list of risk factors is provided below (Morgan & Mackay, 1999):

1. Lower Glasgow Coma Score (3-5)
2. Presence of a tracheostomy
3. Poor cognitive functioning
4. Hypoactive gag reflex
5. Prolonged period of mechanical ventilation
6. Reduced pharyngeal sensation
7. Brainstem involvement
8. Difficulty swallowing oral secretions
9. Coughing/throat clearing or wet, gurgly voice quality after swallowing water
10. Choking more than once while drinking 50 ml of water
11. Weak voice and cough
12. Wet-hoarse voice quality
13. Recurrent lower respiratory infections
14. Low-grade fever or leukocytosis
15. Auscultatory evidence of lower lobe congestion
16. Immunocompromised state
17. Dependence on feeding assistance

While all ABI patients are potential aspirators, certain factors place them at higher risk**. Initial severity of brain injury appears to be the strongest predictor of dysphagia related aspiration.** Additional factors, which may also reflect the injury severity include the presence of a tracheostomy, dependence for feeding, and/or the need for mechanical ventilation support (Morgan & Mackay, 1999).

3.2.5 Silent Aspiration

Q8. Define silent aspiration.

1. Penetration of food below the level of the true vocal cords, without cough or any outward sign of difficulty. Such cases may be missed in the absence of a videofluoroscopic swallow study (VFSS) or fiberoptic endoscopic evaluation of swallowing (FEES) assessment.

Patients may aspirate without outward signs. **Silent aspiration, is defined as "penetration of food below the level of the true vocal cords, without cough or any outward sign of difficulty"** (Linden & Siebens, 1983). Detailed clinical swallowing assessments have been shown to under diagnose or miss cases of aspiration (Horner & Massey, 1988; Horner et al., 1988; Splaingard et al., 1988). **Patients who experience silent aspiration are at an increased risk of developing more serious complications such as pneumonia. Silent aspiration should be suspected in individuals with an ABI who have recurrent lower respiratory infections, chronic congestion, low-grade fever, or leukocytosis** (Muller-Lissner et al., 1982). Clinical markers of silent aspiration may include a weak voice, cough, or a wet-hoarse vocal quality after swallowing. A study by Terre and Mearin (2009), found approximately 33% of their 26 participants silently aspirated. Dietary changes were made to reduce the risk of aspirating. For many, aspiration mostly resolved within the 12 months of study.

3.2.6 Pneumonia and Aspiration

Q9. What are some risk factors for aspiration pneumonia post-ABI?

Langmore et al. (1998) identified the following risk factors as predictors of pneumonia:
1. Dependence in self-feeding and oral care
2. Amount of tooth decay
3. Need for tube-feeding
4. Greater than one medical diagnosis
5. Smoking
6. Total number of medications

Aspiration pneumonia is thought to occur when the lung's natural defenses are overwhelmed by excessive and/or toxic gastric contents that are aspirated, leading to a localized infection or a chemical pneumonitis. Hansen et al. (2008) explored the risk factors associated with pneumonia in patients with severe TBI. The study found that pneumonia was more common among individuals with low levels of consciousness and for those with a feeding or tracheotomy tube, similar to patterns seen in stroke. Lower Glasgow Coma Scale (GCS) scores and lower Rancho Los Amigos scale scores were also associated with an elevated risk of pneumonia. In contrast to that, higher Functional Oral Intake Scale (FOIS) scores and Functional Independence Measure (FIM) scores were found to be predictive of return to an unrestricted diet (Hansen et al., 2008). Recent studies have examined the relationship between oral care and incidence of pneumonia and aspiration and found that rehabilitation facilities with oral care programs report significantly lower rates of mortality, and lower risks of aspiration pneumonia (Sarin et al., 2008; Watando et al., 2004). **The risk of aspiration pneumonia increases through poor oral care by allowing bacteria present in the mouth, on food, and in drinks, to travel into the lungs of individuals with swallowing challenges**. In individuals without swallowing difficulty, these bacteria would normally be neutralized by stomach acids, however if particulates are regularly entering the lungs, the risk of pneumonia is increased. Poor oral care is another factor for consideration when evaluating the risks of pneumonia and aspiration. Figure 3.2 illustrates bacterial pneumonia and its mechanism of action.

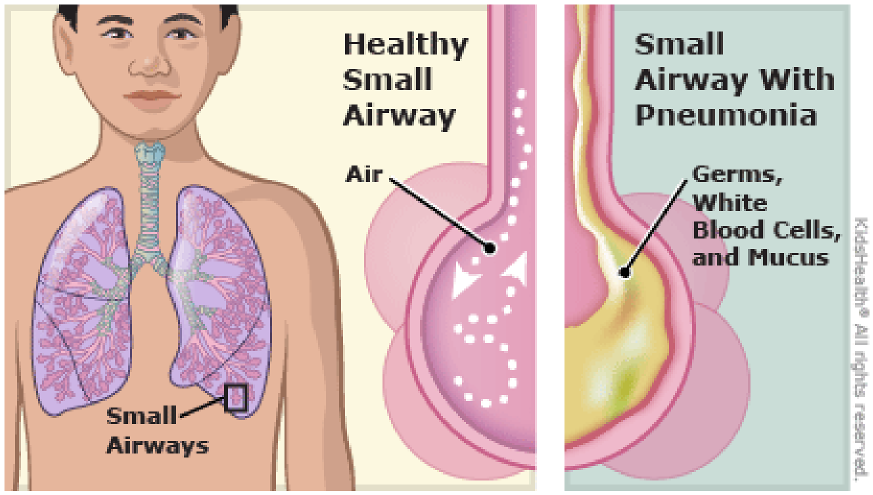


Figure 3.2. Illustration of bacterial pneumonia and its mechanism of action.

3.3 Outcome Measures and Assessments for Dysphagia and Aspiration

Q10. Describe an approach to the assessment of dysphagia and aspiration post-ABI.

1. Patients are initially kept nothing by mouth (NPO)
2. Initially, a bedside clinical evaluation is used to determine whether the patient has dysphagia or not.
3. The assessment describes the dysphagia in detail, determines the severity of the problem, and guides a management approach.
4. Clinical assessment is initially performed and if necessary, a videofluoroscopic swallow study (VFSS) or fiberoptic endoscopic evaluation of swallowing (FEES) is done.

A thorough assessment of swallowing function involves both a bedside clinical evaluation plus an instrumental diagnostic procedure (usually VFSS or FEES) which help to guide appropriate intervention strategies (Table 3.2). A clinical bedside examination usually involves general observations, an oral motor examination, and a swallowing/feeding trial (Ward, 2001). Although many tools are used in practice to assess swallowing disorders in those who have sustained an ABI, none of these tools have been studied extensively or specifically within ABI populations, therefore the appropriate assessment tool should be determined based on clinician experience, combined with the patient's individual needs.

Table 3.2 Summary table of common assessments of dysphagia and aspiration

Assessment	Administration	Outcomes	References
Bedside Clinical Examination	Typically involves: **general observations**, an **oral motor examination**, review of receptive/expressive language, **ability to understand directions**, and review of current medications, **trialling different food/fluid consistencies**, cough strength, and a swallow palpation. Commonly completed by speech-language pathology (SLP).	Areas of investigation: - Deglutition - Oral Preparation (control of saliva, lip seal, etc.) - Oral Phase (gag reflex, palatal movement, etc.) - Pharyngeal Phase (voice quality, reflex/voluntary cough, etc.) - Esophageal Phase (through swallow palpation) - Dysphonia - Dysarthria	(Mann & Hankey, 2001; Perry & Love, 2001; Westergren et al., 2001)
Water Swallowing Test	Patient swallows 3oz (90ml) of water. Done primarily during the bedside clinical exam.	Presence or absence of aspiration.	(Martino et al., 2000)
Videofluoroscopic Swallow Study (VFSS)	Patient is in a seated position and ingests radio-opaque materials of various consistencies with aspects of oral, laryngeal, and pharyngeal movement being noted from the radiographic examination. Optional post exam chest x-ray. Completed by SLP in conjunction with a radiologist.	<u>One or more of the following phases can be examined:</u> <u>Oral Phase</u>: Lip closure, tongue positioning, soft palate, jaw motion, oral pocketing. <u>Pharyngeal Phase:</u> Swallow delay or absence, peristalsis or pharyngeal stripping. <u>Esophageal Phase:</u> Elevation of larynx, penetration into laryngeal vestibule, aspiration, coughing behaviour, vocal cord function. <u>Post Exam Chest X-Ray:</u> Presence of barium in tracheobronchial tree, and lungs.	(Schatz et al., 1991; Splaingard et al., 1988)
Fiberoptic Endoscopic Evaluation of Swallowing (FEES)	Direct viewing of swallowing function using a thin flexible fiberoptic tube through the nose to see directly down the throat. Completed by SLP with special training.	- Presence or absence of aspiration - Motor components of swallowing - Sensory testing (optional)	(Langmore et al., 1988)

3.3.1 The Bedside Clinical Examination

Several forms of clinical or bedside swallowing evaluations have been described for the purposes of screening and/or assessment. Some of these methods target specific functions or tasks, while others evaluate swallowing ability using a more comprehensive approach. This can include the introduction of one or several teaspoons of water and, in some protocols, various other consistencies of food or liquid. **Often an oral motor examination (including diadochokinetic rate) is performed** to determine where and what the deficits are. Table 3.2 outlines several components that may be administered during a bedside clinical examination, however these are at the discretion of the clinician and what areas should be assessed. While bedside assessment is non-invasive and easy to perform, this method has been shown to poorly predict the presence of silent aspiration. **Pairing the clinical examination with an instrumental (VFSS or FEES) is considered best practice.**

Clinical Tip!

For patients with a tracheostomy, Blue Dye tainted food/liquid may be used during your clinical examination. The presence of blue dye at the trach site or upon suctioning may be a sign of aspiration.

3.3.2 Water-Swallowing Test

This screening test has been studied within the stroke population to establish its validity as part of a clinical swallowing evaluation. While the original test required a patient to swallow 3 oz (90ml) of water, smaller amounts have also been used (Martino et al., 2000).

When not provided, the positive predictive value (PPV), negative predictive value (NPV) and positive and negative likelihood ratios (+ LR & -LR) for the water-swallowing test were calculated for each study and summarized in the following table. The gold standard used to confirm aspiration was either VFSS or FEES examination. Data was provided by the authors from DePippo et al. (1992) and found that the sensitivity and specificity reported were actually the PPV and NPV. A likelihood ratio (LR) of either greater than 10 or less than 0.1 is considered to be strong evidence to either rule in or rule out aspiration respectively. While LRs less than 2 are considered to be small. Given the data below, the Water Swallowing Test does not appear to demonstrate high predictive values when diagnosing aspiration and therefore is not the ideal singular method when testing for aspiration. Instrumental assessment should be used to confirm aspiration as well as further delineate swallowing function.

Table 3.3. The Positive and Negative Predictive Value and Positive and Negative Likelihood Ratios for the detection of Aspiration Using the Water Swallowing Test

Study	PPV (%)	NPV (%)	+ LR	- LR
DePippo et al., (1992)	59	76	1.75	0.37
Garon et al., (1995)	79	54	3.24	0.24
Chong et al., (2003)	81.8	58.8	2.12	0.33
Lim et al., (2001)	78.6	81.8	3.39	0.25
Wu et al., (2004)	78.6	73.3	5.74	0.57

3.3.3 Videofluoroscopic Swallow Study

Q11. Describe the importance of videofluoroscopic swallow studies (VFSS) in the management of dysphagia and aspiration.

1. Considered to be the "gold standard" in the diagnosis of aspiration.
2. Patients who aspirate over 10% of the test bolus or who have severe oral and/or pharyngeal motility problems are considered at high risk of pneumonia.
3. May further delineate the mechanism behind the swallowing disorder.

When aspiration is suspected, the VFSS (also known as a **modified barium swallow study**) is considered by some to be the "gold standard" in confirming the diagnosis (Splaingard et al., 1988), and is the only assessment recommended by the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI for Dysphagia (example image provided as Figure 3.3). **A VFSS examines the oral and pharyngeal phases of swallowing**; however, the patient must have sufficient cognitive and physical skills to undergo testing (Bach et al., 1989). The participant is assessed in a seated position in a chair designed to simulate the ideal/optimal mealtime posture. Radio-opaque materials of various consistencies are tested: barium impregnated thin and thick liquids, pudding, bread, and cookies are routinely used. Patients who aspirate over 10% of the test bolus, or who have severe oral and/or pharyngeal motility problems on VFSS testing are considered at high risk for pneumonia (Logemann, 1983, 1989; Milazzo et al., 1989). In many cases, it is difficult to practically assess whether 10% of more of the test bolus has been aspirated. Nevertheless, the degree of aspiration seen on VFSS study is a critical determinant of patient management, and precautionary adjustments should be made to ensure safety (Rasley et al., 1993).

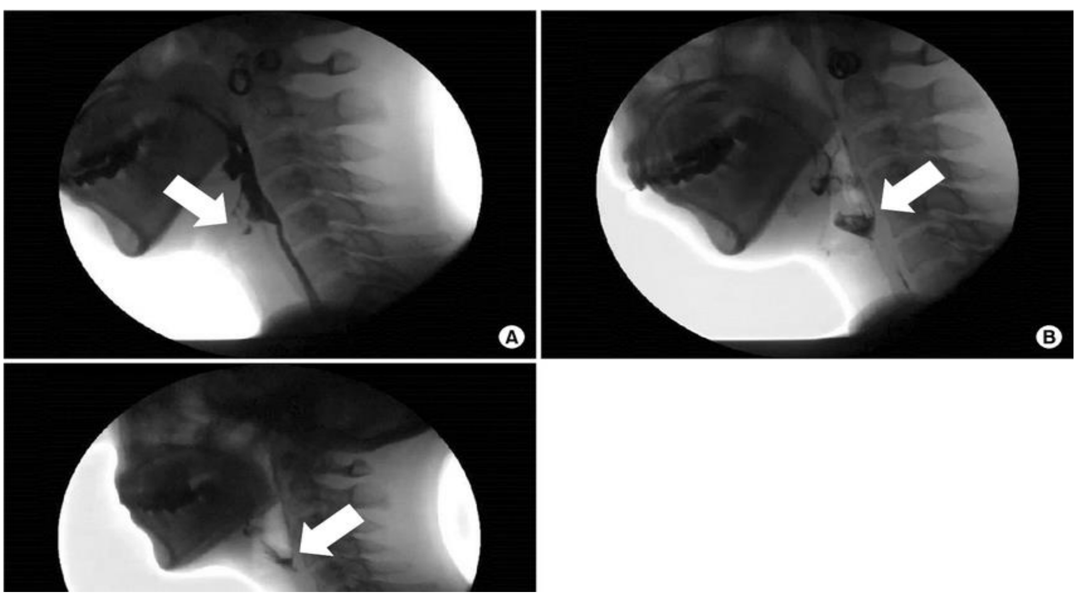


Figure 3.3. Example image of a VFSS assessment showing aspiration. Source: (Hun Lee et al., 2017) Available here under CCA-Noncommercial 4.0 International license.

3.3.4 Fiberoptic Endoscopic Evaluation of Swallowing

Fiberoptic endoscopic evaluation of swallowing (FEES), is recognized as an objective tool for the assessment of swallowing function and aspiration. FEES is a procedure that allows direct viewing of swallowing function by passing a thin flexible fiberoptic tube through the nose to obtain a view directly down the throat during swallowing. FEES allows for the full evaluation of swallowing function as food passes from the mouth into the throat. The evaluation identifies functional abnormalities and helps to determine the safest position and food texture for the patient in order to maximize nutritional status and evaluate the risk of aspiration, and impact of unsafe swallowing. Although there are no studies on ABI populations which meet the ERABI inclusion criteria, a study by Aviv (2000) examining FEES in a stroke population found that individuals assessed by FEES had lower rates of pneumonia overall compared to those assessed via VFSS.

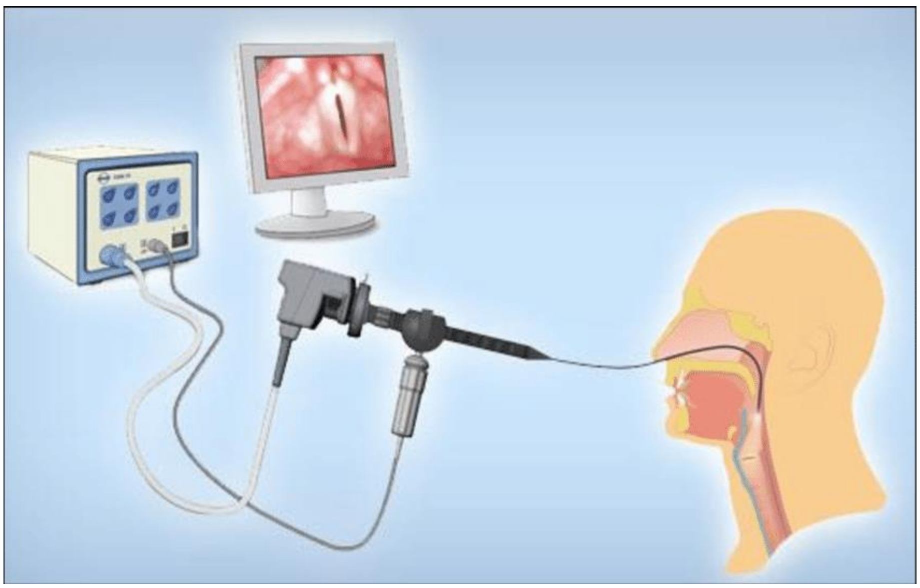


Figure 3.4. An illustration showing how the FEES is administered. Source: (ATMOS 2010). Available here

3.4 Criteria for Diagnosis

The diagnoses of dysphagia and aspiration are made based on clinical examination and/or the use of an instrumental examination (VFSS or FEES). **If dysphagia is suspected patients should be kept 'nothing by mouth' (NPO) until a proper evaluation can be conducted**. Dysphagia may be diagnosed based on symptoms and dysfunctions in one or more of the different phases of swallowing (See Figure 3.1). While not an exhaustive list, examples of dysfunction which can indicate a diagnosis of dysphagia or aspiration are discussed through each of the swallowing phases. The most overt example of swallowing dysfunction is aspiration, with some patients being described as silent aspirators. As mentioned above, **the combination of clinical observations as well as evaluations are used to determine a diagnosis of aspiration**. Moving through the phases of swallowing; during the oral preparatory phase, ineffective mastication can be an indicator of dysphagia. During the oral propulsive phase, common difficulties which can be used for diagnosis may be ineffective tongue control of the bolus, or 'pocketing', while general

difficulties seen during oral phases may be ineffective orolabial seals. Issues that may be observed during the esophageal phase include difficulty in contracting the esophagus muscles.
Upon clinical suspicion of dysphagia, a speech-language pathologist (SLP) should be consulted for a clinical assessment. The SLP should consider VFSS or FEES as a follow-up to the clinical assessment**. The addition of an instrumental assessment will provide a more comprehensive understanding of the swallowing difficulty than clinical observation alone** (e.g. identifying silent aspiration**). Upon diagnosis, a nutritional assessment should be conducted, and individuals should be placed on the appropriate nutrition management program and treated by an SLP**. A clinical algorithm (Figure 3.5) is presented below as one example outline of this process.

3.5 Interventions for Dysphagia and Aspiration

For patients with dysphagia following head injury, based on the status of swallowing function at the time of admission, three distinct types of rehabilitation programs have been described: 1) non-feeding, 2) facilitation and feeding, and 3) progressive feeding (Winstein, 1983). The goal of dysphagia treatment is to have an individual become independent in their feeding skills, as individuals with dysphagia who are fed by someone else have a 20 times greater risk of pneumonia than those patients who are able to feed themselves (Langmore et al., 1998). Compensatory techniques are usually the first line of treatment, however, if they are unsuccessful therapeutic techniques are used. To assist in the development of a potential treatment strategy for an individual with an ABI and suspected dysphagia or aspiration a clinical algorithm has been developed below (Figure 3.5).

Q12. Describe a specific dysphagia management program at the time of acute care admission for an individual with an ABI suspected of suffering from dysphagia.

1. Acute patients should be NPO until swallowing ability has been determined.
2. A **trained assessor** should screen all acute patients for swallowing difficulties as soon as they are able.
3. A speech and language pathologist should assess all patients who fail swallowing screening and identify the appropriate course of treatment.
4. An individual trained in low-risk feeding strategies should provide feeding assistance or supervision to patients where appropriate.
5. A dietitian should assess the nutrition and hydration status of patients who fail the swallowing screening.
6. If the patient is a severe aspirator, a non-oral feeding tube is inserted.
7. If the patient is a mild to moderate aspirator, treatment is determined by VFSS findings . For these patients, compensatory treatment techniques are used.

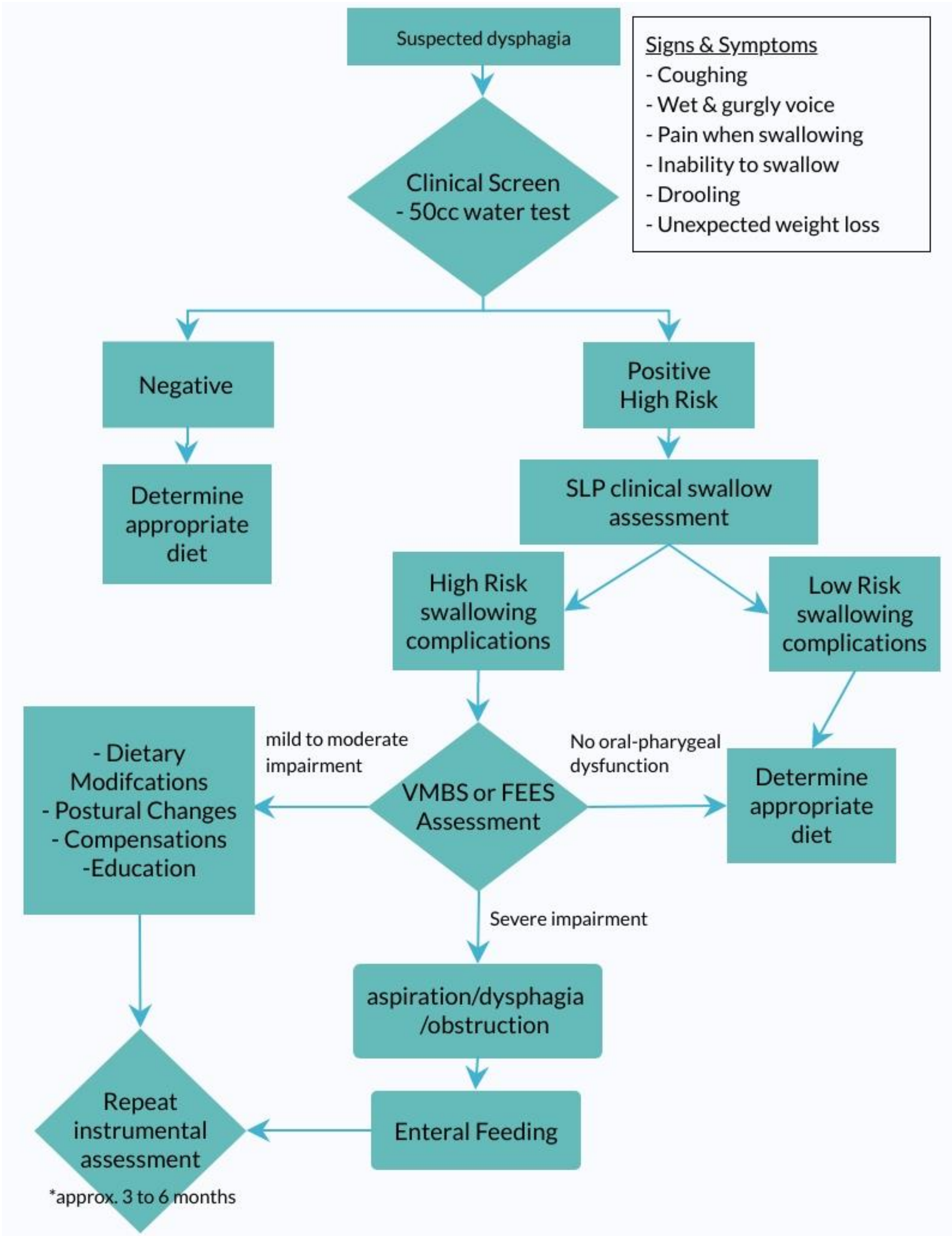


Figure 3.5. A clinical algorithm showing an example of a management strategy for an individual with dysphagia. Nothing by mouth (NPO); Speech-language pathologist (SLP); Videofluoroscopic swallow study (VFSS); Fiberoptic endoscopic evaluation of swallowing (FEES).

3.5.1 Stroke Best Practice Guidelines for Managing Dysphagia

Best practice guidelines for managing dysphagia have been developed by a consensus committee of the Heart and Stroke Foundation of Ontario in 2016. Although these guidelines were developed for the stroke population they are applicable to patients with an ABI as dysphagia following either of these conditions is comparable (Lee et al., 2016). Relevant sections of the recommendations are summarized below.

Canadian Stroke Best Practice Recommendations – Management of Dysphagia and Malnutrition (Heart and Stroke Foundation of Ontario, 2002)

- Maintain NPO until swallowing status is determined.
- Regular oral care, with minimum of water to limit build-up of bacteria.
- Screen for swallowing status once awake and alert by trained team member.
- Screen for risk factors of poor nutrition early by trained team member.
- Swallowing assessment by speech-language pathologist to:
  a. Assess ability to swallow.
  b. Determine risk of swallowing complications.
  c. Identify associated factors which may be compromising swallowing and nutrition.
  d. Recommend appropriate individualized management program including appropriate diet.
  e. Monitor hydration status.
- Where appropriate feeding assistance or mealtime supervision by individuals trained in low risk feeding strategies.
- Assess the nutrition and hydration status of those who fail screening; reassess regularly.
- Education of patient and family with follow-up upon discharge.
- Consider the wishes and values of the patient and family concerning oral and non-oral nutrition; provide information to allow informed choices.

3.5.2 Compensatory Treatment Techniques

Q13. Describe some compensatory treatment techniques for dysphagia post-ABI.

1. Postural adjustment of the head, neck and body to modify the dimensions of the pharynx and optimize the flow of the bolus (including chin tuck, head turn, etc.) (Figure 3.6).
2. Food consistency and viscosity alterations.
3. Sensory stimulation techniques to improve sensory input.

Compensatory treatment techniques do not involve the direct treatment of the swallowing disorder. Their purpose is to reduce or eliminate swallowing problems and the risk for aspiration without changing swallowing physiology (Logemann, 1991, 1999). Compensatory treatment techniques are typically the first rehabilitation strategy initiated. **Examples of compensatory strategies include: (a) low risk feeding strategies, (b) postural adjustments while eating, (c) sensory stimulation techniques used to improve**

sensory input either prior to or during the swallow, and (d) food consistency and viscosity alterations (Logemann, 1999). Individuals who can play a role in safe feeding techniques are speech-language-pathologists, communicative disorders assistants, registered dieticians, occupational therapists, physical therapists, physicians, and registered nurses (RN or RPN).

3.5.2.1 Low Risk Feeding Strategies

Q14. Describe some low-risk feeding strategies.

From Heart and Stroke Foundation, 2016:

1. Calm eating environment, with minimal distractions.
2. Patient is in an upright position with the neck slightly flexed facing midline.
3. Proper oral care.
4. Feed at eye level.
5. Feed slowly.
6. Feed using metal teaspoons (no tablespoons or plastic).
7. Drink from wide mouth cup or a straw to reduce the neck extending back.
8. Ensure bolus has been swallowed before offering more.
9. Properly position the patient and monitor for 30 minutes after each meal.
10. Self-feeding.

Q15. Describe why low-risk feeding strategies are necessary?

1. Introducing low-risk strategies reduces risk of choking, the incidence of pneumonia, and allows patients to gain more autonomy in feeding.

In an effort to reduce the risk of pneumonia after stroke, patients are encouraged to feed themselves whenever possible (Heart and Stroke Foundation, 2013). To our knowledge, there are no such studies specific to the ABI population that evaluate the benefits of self-feeding, however commonalities exist between the stroke and ABI population in terms of the clinical presentation and symptoms for dysphagia and aspiration**. For stroke patients who require assistance to eat there is a consensus that hand-over-hand support should be provided at eye-level. If full feeding assistance is required, it needs to be provided by trained personnel using low risk feeding strategies**.

Click HERE to see the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI on Feeding

3.5.2.2 Postural Techniques

Moving the patient or changing the position of the head, neck or body may assist in changing the direction of the bolus flow, thereby improving oropharyngeal clearance and reducing the risk of aspiration. **There are five postures (Table 3.4) that have been shown to have success in assisting individuals improve swallowing function**. These include: chin-up, chin-down, head turn (left or right), head tilted (left or right) and lying down (Logemann, 1998). These are illustrated in Figure 3.6 below.

Table 3.4 Five Postures to Improve Swallowing Function (Logemann, 2008)

Posture	Benefits
1. Chin Down Posture	• Helpful for those who have tongue base retraction issues. • Mechanism of change widens the valleculae, allowing the valleculae to contain the bolus better in event of pharyngeal delay.
2. Chin Up Posture	• Helpful for those who have oral tongue propulsion problems. • Aids in gaining adequate lingual pressure to drive the food or liquid out of the mouth and into the pharynx.
3. Head Turn (left or right)	• Involves rotating the head to the side that is damaged. • Bolus is then directed through the "normal" safe side.
4. Head Tilt (left or right)	• Head is tilted toward the stronger side, to promote the flow of food and liquid through the same side.
5. Lying Down	• Effective in those with posterior pharyngeal wall contraction or reduced laryngeal elevation with resulting residue and subsequent aspiration after swallowing. • Residual or pooling of food or liquid in the pharynx is less able to enter the airway as gravity pulls the bolus towards the posterior pharyngeal wall and in more easily moved through to the esophagus (Drake et al., 1997; Rasley et al., 1993).

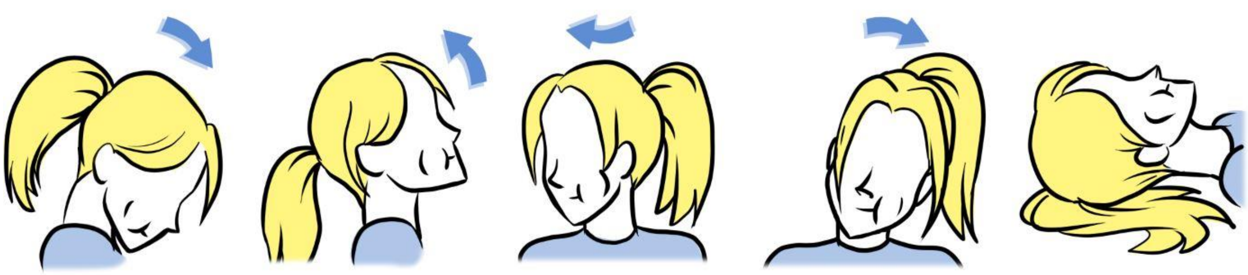


Figure 3.6. Illustration of postural adjustments for swallowing improvement.

3.5.2.3 Diet Modification

Q16. What are some common diet modifications that can aid swallowing?

1. For solid textures, food may be diced, minced, or pureed.
2. For fluids, they may be thickened to nectar, honey, or pudding consistencies.
3. Other modifications, such as no bread products or mixed consistency foods, can be beneficial.

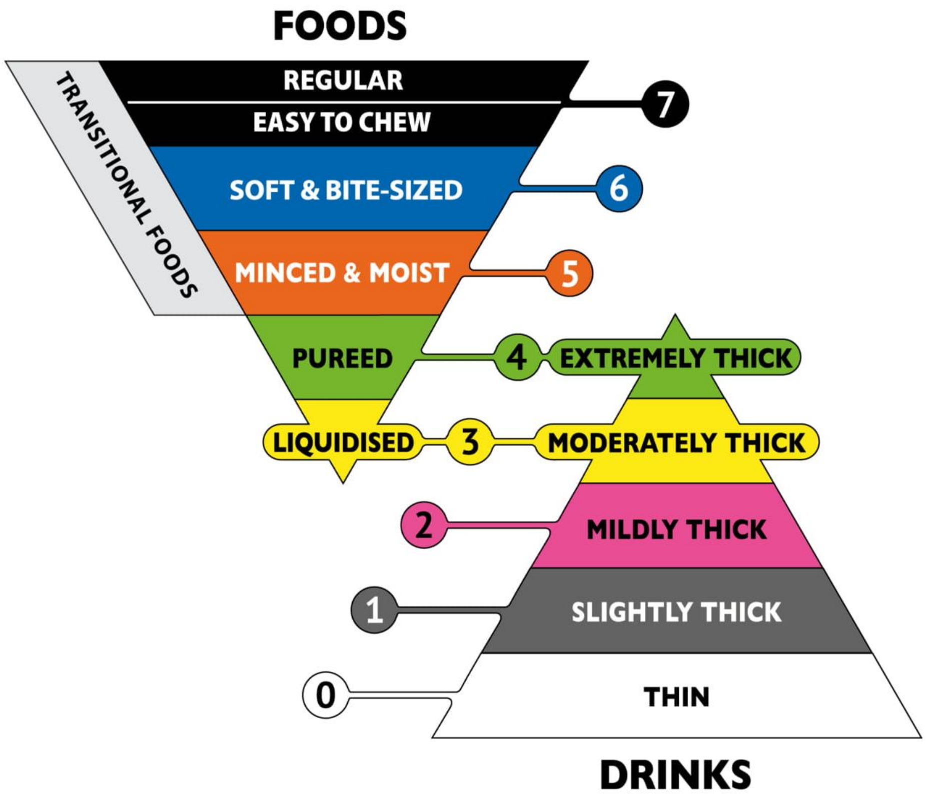
The consistency of food should be chosen based on the specific nature of the deficit the patient is experiencing. It should also be noted that dietary restrictions and consistency modification should be the last strategy examined (Logemann, 1997). Restrictions to diets and consistencies, especially thin fluids, can be very challenging as individuals almost always encounter thin fluids in their daily lives (Logemann, 1997). That said, diets for those who have been identified with dysphagia not remedial to other compensatory strategies are generally determined by speech language pathologists or others trained in dysphagia management. These patients may begin with a very restrictive diet (liquids of various consistencies – purees) and move to less restrictive diets (diced to regular foods) at a pace that has been deemed safe for that individual (Kramer et al., 2007). **Asking the patient to limit the amount of food they attempt to swallow (e.g. taking smaller bites, slower pacing, etc.) will also help reduce complications arising from dysphagia.**

To increase fluid consumption and decrease the risk of dehydration, the **Frazier Free Water Protocol allows patients who are receiving thickened liquids to be given regular, thin water in between meals**. Thickened fluids do not quench thirst in the same way that regular thin water does; therefore, the regular water, in combination with the recommended thickened fluids, works to assist some patients in better meeting their daily hydration needs. Patients who are NPO are often permitted to have water (following screening) and those who have found success using various postural changes are asked to use these postural maneuvers when drinking water. The Frazier Free Water protocol states that, by policy, water is allowed for any patient NPO or on a dysphasic diet (Panther, 2005).

As a potential resource, the International Dysphagia Diet Standardization Initiative (IDDSI.org) is a collaboration effort of professionals from areas of nutrition, medicine, speech pathology, nursing, patient safety, and more. Their aim is to develop a standardization of texture modified food and liquids for individuals with dysphagia. The IDDSI framework (Figure 3.7) below provides a consensus on terminology and measurement of food and drink modifications for individuals with dysphagia**. Appendix A at the end of this guidebook provides a more comprehensive illustration of the framework below**. An example food modification chart (Table 3.5) from Parkwood Institute, London, ON CA, has also been added as a reference as to what food may be included in each texture category.

Table 3.5. Example summary of the Diet Modification Handout from Parkwood Institute, SJHC, London, Ontario, Canada.

Texture	Food Modifiers	Fluids
Regular: food unmodified.	**No dry particulates**: remove all dry, crumbly food.	**Thin**: fluids that are thin at room temperature (e.g. water).
Ready: foods unmodified, but roast meats are diced.	**No regular bread products**: remove all gummy or doughy bread type foods.	**Nectar thick**: consistency of nectar and sipped from a cup.
Diced: meats are diced, soft protein items are allowed whole, no raw vegetables, and items served on a bun are not allowed.	**No mixed consistency**: remove foods that combine a solid and liquid together.	**Honey thick**: consistency of liquid honey and sipped from a cup.
Minced: meats and vegetables are minced, soft protein items are allowed, and items served on a bun are not allowed.	**No crust**: remove all bread-type items with crust, or removal of the crust.	**Pudding thick**: consistency of pudding and eaten with a spoon.
Pureed: all foods have a smooth, pudding-type consistency. No particulate foods are allowed. All entrée's (meat/fish/poultry, potatoes, vegetables, fruits, desserts) are pureed. All soups are strained		



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@ https://iddsi.org/framework/

Figure 3.7. International Dysphagia Diet Standardisation Framework (IDDSI).

3.5.3 Therapeutic Treatment Techniques

Q17. What are some therapeutic treatment techniques in dysphagia to reduce the risk of aspiration?

1. Oral and motor exercises, such as: range of motion, vocal fold adduction, and the Shaker exercises.
2. Swallowing maneuvers.
3. Passy-Muir Speaking Valve (PMV).
4. Thermal-tactile stimulation.

Therapy techniques are designed to alter the swallow physiology (Logemann, 1999). They include range-of-motion and bolus handling tasks to improve neuromuscular control without actually swallowing, and swallowing maneuvers that target specific aspects of the pharyngeal stage of the swallow. Both medical and surgical management techniques are included in this category (Logemann, 1991); these interventions are typically only initiated once trials of compensatory techniques have been unsuccessful.

3.5.3.1 Oral and Motor Exercises

Range of motion exercises for the tongue and the pharyngeal structures are some of the common motor exercises for those who have developed a swallowing disorder (Logemann, 1998). These exercises are designed to improve strength, movement, awareness, and muscle coordination when swallowing (Kramer et al., 2007). This is not an exhaustive list of the available exercises.

Clinical Tip!
Consider incorporating Oral motor exercise devices (Such as the Abilex* Oral Motor Exerciser, developed by an SLP) into practice. They can be easier to use for the patient than a tongue depressor and come with practice videos and instructions!

Range of Motion Exercises of the Pharyngeal Structure:

When participating in range of motion exercises, the individual is asked to clench or to tense their jaw muscles while holding their breath from a seated position. This exercise is not recommended for those with uncontrolled blood pressure (Logemann, 1998). It is recommended that this exercise be done five to ten times each day for five minutes. To aid in the improvement of oral transit, exercises to assist in tongue elevation and lateralization may be implemented. Here the patient may be asked to perform very specific tongue exercises in an effort to improve speech and swallowing (Logemann, 1998). Individuals may also be asked to participate in tongue resistance exercises (pushing the tongue against a tongue blade or popsicle stick for 1 second) and bolus control exercises (to allow the patient to learn to control or manipulate items placed in the mouth) (Logemann, 1998).

Vocal Fold Adduction Exercises

To improve vocal quality and reduce the risk of aspiration, individuals are asked to bear down, with one hand against a chair while producing a clear voice. Following this the individual is asked to repeat an “ah” sound five times. It is recommended that these exercises be repeated three times in sequence, five to ten times each day for five minutes. If there is no significant improvement in swallowing at the end of one week, individuals may be asked to pull up on the seat of a chair, while sitting in it, and prolong phonation (Logemann, 1998). This exercise is recommended for those individuals with vocal fold adduction issues (Kramer et al., 2007).

The Shaker Exercise

Patients are asked to lay flat on the floor or in bed and raise their head high enough to see their toes. This position is held for one minute then the patient rests for one minute. The exercise is repeated three times. Following this sequence, the patient lifts their head, looks at their toes, and then lowers their head. This, head up - then down, sequence is repeated 30 times. It is recommended that the Shaker Exercise be completed three times per day for a period of six weeks. This exercise has been shown to have some success in improving hyolaryngeal movement;

Clinical Tip!
YouTube typically has tutorial videos for most exercises! Here is a quick video demonstrating [the Shaker Exercise]

however it has not been studied specifically in the ABI population (Logemann, 2008; Shaker et al., 2002; Shaker et al., 1997).

3.5.3.2 Swallowing Maneuvers

Q18. List at least two swallowing maneuvers that may be used in dysphagia management.

Four potential swallowing maneuvers are:
1. Supraglottic swallow.
2. Super-supraglottic swallow.
3. Effortful swallow.
4. Mendelsohn maneuver.

During the acute stage of recovery, patients may experience more swallowing difficulties then they do later during rehabilitation. Failing to address and treat swallowing difficulties in the acute stage may lead to poor compliance with recommended diet modifications and possible setbacks due to aspiration pneumonia. Such infections may quickly become a barrier to the patient's ability to participate fully in any formal rehabilitation. Post-ABI swallowing difficulties are often the result of eating too quickly, taking large bites, cognitive impairments, and decreased swallowing sensitivity (Logemann, 1998; Youmans & Stierwalt, 2005). To address swallowing difficulties, several maneuvers have been developed, each addressing a specific dysphagia presentation. For patients to be successful with each of these maneuvers they must have the ability to follow direction; they must also be alert and able to exert the physical effort it takes to do the maneuvers correctly (Kramer et al., 2007). These maneuvers are described in Table 3.6.

Table 3.6. Swallowing Maneuvers.

Swallow Maneuver	Description
Supraglottic Swallow	This maneuver was *"designed to close the airway at the level of the true vocal folds before and during the swallow" (Logemann, 1998; Logemann et al., 1997)*. In this maneuver individuals are asked to hold their breath while swallowing and then to cough immediately after the swallow. This maneuver encourages closure of the true vocal cords in an effort to address reduced or delayed vocal fold closure or delayed pharyngeal swallow. The cough portion of this maneuver is meant to eject any objects or residue from the laryngeal vestibule.
Super-supraglottic Swallow	During this maneuver, individuals are asked to take a breath in and hold it while bearing down hard, swallow while holding this breath and bearing down, then cough immediately after the swallow (Logemann et al., 1997). This procedure is designed "*to close the airway entrance before and during the swallow*" (Logemann, 1998). The Super-supraglottic Swallow maneuver is used to address reduced closure of the airway entrance (Logemann, 1997).
Repeat Swallow	The patient repeats the swallow a second time after the initial swallow. This can help reduce residue from the bolus and the likelihood of aspiration.
Effortful Swallow	This technique was designed to "*increase posterior movement of tongue base*" (Kramer et al., 2007). As the individual swallows they are asked to squeeze hard with all the muscles (throat and neck muscles) they use for swallowing. This maneuver is intended to address reduced posterior movement of the tongue base.
Mendelsohn Maneuver	The objective of this maneuver is to remediate poor laryngeal movement and discoordination of swallowing (Logemann, 1997). Improvements in swallowing

	function are achieved through *"increasing the extent and duration of laryngeal elevation, thus increasing the duration and width of the cricopharyngeal opening"* (Logemann, 1998). Typically, patients are asked to swallow, but as they do so, to hold their Adam's apple up, for 2-3 seconds then complete the swallow. It is recommended that this exercise be performed several times a day.

3.5.3.3 Passy-Muir Speaking Valve

Aspiration is often problematic in patients who have a tracheostomy. These patients are essentially unable to achieve the apneic interval necessary for an efficient swallow (Bell, 1996). It is thought that normalization of subglottic air pressure, achieved through placement of a Passy Muir Speaking Valve (PMV), reduces the potential for aspiration. The valve may be attached to the 15mm connector found on most adult tracheostomy tubes (Dettelbach et al., 1995; Passy et al., 1993). While wearing the valve, patients also have the opportunity to more easily express themselves verbally (Bell, 1996). Passy et al. (1993) found that patients began speaking almost immediately and their speech improved making it easier for them to communicate with hospital staff, doctors, and family. This ease of communication is very beneficial in the patient's ability to direct their own care. Benefits of the PMV include: improved oxygenation, decreased oral and nasal secretions, improved sense of smell, enhanced airway clearance, and improved swallowing (Bell, 1996). However, to determine its effectiveness specifically within the ABI population more research is recommended. Other speaking valves also exist which have demonstrated similar efficacy to the PMV.

3.5.3.4 Thermal-Tactile Stimulation

Thermal stimulation or thermal-tactile stimulation was developed to stimulate the swallowing reflex in patients with neurologic impairment (Lazzara et al., 1986). The procedure for thermal-tactile stimulation involves having the patient open their mouth and applying a cold laryngeal mirror at the base of the faucial arches. The mirror, while being in contact with the arch, is then rubbed up and down five times. For those patients who have sustained an injury contact will be made on the non-injured side of the mouth (Logemann, 1998). Pharyngeal swallow may not be triggered at the time of stimulation, but the purpose is to heighten the sensitivity for swallowing in the central nervous system. The goal of this stimulation is to trigger pharyngeal swallow quickly and consciously when desired (Logemann, 1998).

3.6 Oral Care Interventions

Q19. Why is oral care important in the management of patients with dysphagia?

1. Research suggests that the introduction of oral bacteria to the lungs via aspiration is more problematic than the food or liquid that is aspirated (Clayton, 2012).

Q20. When is the best time to initiate oral care with a patient who has dysphagia?

1. Mouth care should be thorough and performed before eating or drinking (Clayton, 2012).

Click HERE to see the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI on Oral Care

Oral hygiene and dental care have become an important component of management in individuals post-stroke and TBI (Clayton, 2012; Zasler et al., 1993). **The actual provision of mouth care is more challenging in patients with TBI given the frequent presentation of significant cognitive-communication issues including: fatigue, reduced level of alertness, cooperation and comprehension, as well as a lack of physical recovery necessary to complete the task of brushing independently** (Zasler et al., 1993). For the reasons listed, as well as improper or insufficient staff training, there may be less priority placed on providing oral care as part of the overall care routine.

Unlike the general population, oral care in patients with dysphagia is best performed before eating/drinking. The rationale is that the introduction of oral bacteria to the lungs via aspiration is more problematic than the food or liquid that is aspirated alone. Brushing before eating/drinking for patients with dysphagia means that bacteria have no opportunity to be introduced to the lungs even in "known aspirators", thereby reducing the incidence of pneumonia (Seguin et al., 2014). A variety of higher controlled studies have demonstrated that oral care interventions, such as oral care routines and decontamination procedures, significantly reduce the rates of ventilator associated pneumonia, as well as being associated with decreased rates of mortality (Yoneyama et al., 2002). Other RCTs have demonstrated benefits of using chlorohexidine gel in reducing nosocomial infections and length of stay in non-ABI populations, and that oral care can reduce rates of pneumonia, febrile days, and pneumonia related deaths in mixed populations (Cabov et al., 2010; Sarin et al., 2008).

Key Study

Author/Year/ Country/Study Design/PEDro Score/N	Methods	Outcome
Cabov et al. (2010) Croatia RCT PEDro=8 N=60	**Population**: Neoplasms (61.7%), Head trauma (28.3%), Polytrauma (10%). **Intervention**: Patients were randomized to either the chlorhexidine group or the placebo group. Those in the chlorhexidine group had antiseptic decontamination of dental plaque and the oral mucosa by applying the gel to their oral cavity. The gel was not rinsed off after application. **Outcome Measure**: Rate of infections, Plaque score.	1. The plaque score significantly increased in the placebo group and decreased in the chlorhexidine group ($p<0.05$). 2. Post treatment results indicate that the placebo group acquired nosocomial infections, including nosocomial pneumonia, more often than in the chlorhexidine group. 3. Mortality in the treatment group was lower (3.3% vs 10%), as was the length of stay (5.1 ± 1.6 versus 6.8 ± 3.5, $p=0.0187$), compared to the placebo group.

The key study above showed that antiseptic treatment, compared to placebo treatment, decreased plaque scores, rates of nosocomial infections, and significantly reduced mortality (Cabov et al., 2010). **The existing body of literature on ABI populations specifically provides strong incentive to see that all ABI patients who are unable to manage their own oral care receive support in doing so**.

Click HERE to see the complete ERABI module for oral care interventions

3.7 Nutritional Management

The nutritional management of individuals recovering from an ABI presents many challenges. Despite the efforts of clinicians, several factors make is difficult to avoid malnutrition in ABI patients including the metabolic changes that occur post-injury (Elovic, 2000). In the event of an ABI, damage to the metabolic control center may cause more severe and protracted systemic responses than seen in many other forms of injury. This may be a consequence of the change in feedback mechanisms post-injury and the brain's critical role in triggering the metabolic response (Young et al., 1992). Loan (1999) noted that directly following ABI, a catabolic and counter regulatory hormone (glucagons and cortisol) increase takes place. "Deficiencies of follicle-stimulating hormone (FSH), luteinizing hormone (LH), and growth hormone (GH) indicate an alteration in the hypothalamic-pituitary feedback mechanism that normally regulates metabolism" (Loan, 1999). Depending on the severity of the injury, nutritional requirements will be markedly increased, while gastroparesis and ileus may delay the initiation of enteral nutritional support in mechanically ventilated patients. For more information on metabolic changes following an ABI please see the Neuroendocrine Module in ERABI.

Click HERE to see the INESSS-ONF Clinical Practice Guideline for the Rehabilitation of Adults with Moderate to Severe TBI on Nutritional Management

ABIKUS Recommendations (Bayley, 2007): Nutritional Management

- All brain injured patients with significant ongoing impairment or disability should have their nutritional status assessed using a validated method, within 48 hours of admission/onset of injury. (ABIKUS B, adapted from RCP, G52, p.30) (G64-p.26).
- Where patients are unable to maintain adequate nutrition orally, nutrition should be provided via nasogastric tube within 48 hours of injury, in collaboration with a physician, dietician, as well as nursing staff (ABIKUS A, adapted form RCP G53, p. 30) (G65-p.26).
- A dietician trained in the management of brain injury should review nutrition and hydration needs regularly. This should include regularly weighing the patient (ABIKUS C, adapted from RCP, G55, p.30) (G66-p.26).
- Nutritional needs may need to be changed according to changing metabolic demands (ABIKUS B, adapted from RCP, G54, p.30) (G67-p.26).
- If the patient is unable to take adequate nutrition orally for longer than 2-3 weeks after injury, Percutaneous Endoscopic Gastrostomy (PEG) or similar intervention should be instituted, unless contraindicated. (ABIKUS B, adapted from RCP, G56, p.30) (G68-p.26).

3.7.1 Malnutrition Post-ABI

The incidence of malnutrition following ABI is difficult to estimate. No consistent criteria have been used to define it and relatively few studies have examined the issue. Among studies evaluating the nutritional status of patients in the acute phase of injury, only changes, which were typically declines, in nutritional parameters were reported. Additionally, substantial weight loss within the first several weeks has been reported and is certainly indicative of a compromised nutritional state. Brooke et al. (1989) reported an average weight loss of 13.2 kg from the time of injury to admission to a rehabilitation facility. Similarly, Weekes and Elia (1996) also reported weight loss from the time of injury to day 19 (9.8 kg) among four previously healthy young males. **In the early rehabilitation phase, Brooke et al. (1989) reported that 60% of patients were considered underweight, while Haynes (1992) reported 58%.** However, obesity has also been reported among patients, typically in the chronic phase of recovery (Henson et al., 1993).

Q21. What are some of the risk factors for malnutrition in individuals with an ABI?

1. Hypermetabolic state.
2. Hypercatabolic state associated with additional injuries.
3. Decreased level of consciousness.

As a result of hypermetabolism and hypercatabolism, both energy and protein requirements will be elevated in the first several weeks following injury (Souba & Wilmore, 1999). Negative energy and nitrogen balances, which may exceed 30 grams/day, have been reported within the first week following injury (Bruder et al., 1994; Weekes & Elia, 1996; Wilson et al., 2001; Young et al., 1985). Although muscle wasting occurs as a consequence of bed rest and immobilization, only a portion of these losses are responsive to nutritional interventions (Behrman et al., 1995). **Dénes (2004) stated that rehabilitation problems associated with severely malnourished ABI patients include an increased occurrence of complications, more difficulties with patient mobilization, an increased frequency for the need to operate on contractures, and a longer length of stay in the rehabilitation unit**. Currently there is little research on the nutritional status of those with an ABI during rehabilitation.

Q22. Define Hypermetabolism

1. An increase in metabolic rate above that predicted using equations, which take into account age, sex, height, and weight.
2. Characterized by increased oxygen consumption and nitrogen excretion following injury.

Hypermetabolism has been defined as an increase in metabolic rate above that which is predicted using equations which take into account age, sex, height, and weight (Souba & Wilmore, 1999). The hypermetabolic state, which is characterized by increased oxygen consumption and nitrogen excretion following injury, is thought to be mediated by an increase in i) counterregulatory hormones such as epinephrine, norepinephrine and cortisol, ii) corticosteroids and iii) proinflammatory mediators and cytokines (Pepe & Barba, 1999). Tremendous variability has been reported regarding the magnitude of the hypermetabolic state post-ABI. The variations are likely due to the timing of the measurements, patient characteristics (initial level of injury, concomitant infections) and management (i.e. craniotomy, intubation and sedation and/or barbiturate use, ambient temperature).

3.7.2 Routes and Timing of Non-Oral Nutritional Interventions

3.7.2.1 Enteral Nutrition

Enteral Nutrition (EN) consists of delivering complete nutritional requirements directly into the stomach, duodenum, or jejunum using a gastroenteric tube. EN is beneficial when patients are unable to ingest nutrients independently, but their bodily functions still allow for the digestion of food.

Q23. What would the indications for enteral feeding be?

1. Enteral feeding is required when an individual has significant dysphagia, high rates of aspiration, is in a coma, or is medically ventilated.

In the early stages of recovery, a significant percentage of patients will be comatose and mechanically ventilated, precluding oral feeding. **While enteral feeding is the preferred route of nutrient administration, feeding intolerance due to gastroparesis and ileus may be common** (Ott et al., 1990).

Key Study

Author/Year/ Country/Study design/PEDro Score/N	Methods	Outcome
Horn et al. (2015) USA Prospective Controlled Trial N=1701	**Population:** TBI=1701; *Enteral Nutrition (EN; n=451)*: Mean Age=38.5 yr; Gender: Male=326, Female=125; Mean Time Post Injury=31.9 days; *No EN (n=1250)*: Mean Age=47.1 yr; Gender: Male=895, Female=355; Mean Time Post Injury=19.8 days. **Treatment:** Patients admitted to an inpatient rehabilitation center post TBI were grouped into either EN (>1 days on EN) or no EN (<1 day or no days). Analysis of demographic and treatment data to determine the relationship between EN and patient outcomes. **Outcome Measure:** Functional Independence Measure (FIM), Comprehensive Severity Index (CSI), chart reviews, weight loss, length of stay (LOS).	1. Upon admission, high brain injury score on CSI, low FIM motor score, and having moderate-severe dysphagia were the strongest predictors of needing EN ($p<0.001$; c statistic=0.903). 2. EN patients had borderline better scores compared to no EN upon discharge on FIM-motor ($p=0.055$) and cognition ($p=0.050$), longer LOS ($p=0.062$), and smaller weight changes ($p=0.075$). 3. Patients that received EN at standard or high protein concentrations for >25% of their stay (mean=19 days) had better FIM discharge scores ($p<0.030$).

To date only two studies have examined the efficacy of EN for individuals with an ABI meeting the ERABI inclusion criteria. In the above prospective controlled trial conducted by Horn et al. (2015), patients who were admitted to a rehabilitation facility received EN for more than one day, EN for less than one day, or not at all. The strongest predictors of needing enteral nutrition were injury severity, low FIM motor score, and moderate-to-severe dysphagia. While non-significant, patients in the EN group had a strong trend towards better scores on FIM motor and cognition at discharge. While, patients that had enteral feeding at standard or high protein concentrations for greater than 25% of their stay had better discharge FIM scores. This study suggests that enteral nutrition may be beneficial to patients with moderate-to-severe brain injuries when compared to patients with no enteral feeding.

Enhanced Enteral Nutrition

Q24. What is enhanced enteral nutrition? What evidence is there to support enhanced enteral nutrition post-ABI?

1. Enhanced enteral nutrition consists of enteral solutions that are enriched with immune-enhancing nutrients.
2. There is strong evidence that enhanced enteral nutrition such as glutamine and bacterial probiotics, may reduce the incidence of infection, duration of ventilator dependency, and ICU length of stay.

Enteral feeding solutions enriched with immune-enhancing nutrients may decrease the occurrence of sepsis and reduce the inflammatory response. Theoretically, glutamine may improve the nutrition of both the gut mucosa and immune cells, while probiotic bacteria could favorably alter the intraluminal environment by competing for nutrients and adhesion sites with pathogenic bacteria. These co-operative actions may reduce the rate of bacterial translocation thus decreasing both the incidence of infection and the length of hospitalization (Falcao de Arruda & de Aguilar-Nascimento, 2004).

Click HERE to see the complete ERABI module for nutrition including enhanced enteral nutrition

Timing of Enteral Nutrition

Q25. What are the benefits of early administration of enteral nutrition post-ABI?

1. Early enteral feeding is associated with a trend towards better survival and disability outcomes (Yanagawa et al., 2002).

Early enteral feeding is desirable as a means to prevent intestinal mucosal atrophy and to preserve gut integrity, although, as previously noted, feeding intolerance occurs frequently. A Cochrane review authored by Yanagawa et al. (2002) identified six RCTs, which addressed the timing to initiation of feeding and assessed mortality as an outcome. The relative risk for death associated with early nutritional support was 0.71 (95% CI 0.43-1.16). The pooled RR from three trials, which also assessed death and disability for early feeding was 0.75 (0.50-1.11). Although the results were not statistically significant, the authors concluded that early feeding may be associated with a trend towards better outcomes in terms of survival and disability.

Types of Enteral Feeding Tubes

Q26. What evidence is there for one type of enteral feeding tube over another?

1. There is moderate evidence that the risk of developing pneumonia is higher among ventilated patients fed by a naso-gastric tube compared with a gastrostomy tube.
2. There is limited evidence that early naso-jejunal hyperalimentation improves caloric intake, nitrogen intake, nitrogen balance, bacterial infection and days of stay in the intensive care unit in patients post-ABI.

The effectiveness of the interventions may vary depending on the mode of feeding an individual receives. Nasogastric feeding tubes have been associated with an increased incidence of pneumonia, while feeding tubes placed more remotely theoretically decrease this risk. Gastrostomies have proven to be a safe and dependable process used to provide enteral access for meeting nutritional needs as well as delivering medications in ABI patients (Harbrecht et al., 1998).

3.7.2.2 Parenteral Nutrition

Parenteral Nutrition (PN) consists of receiving nutrition directly through the vein. PN is usually initiated when a patient's stomach or bowel is not functioning properly negatively impacting digestion (American Society for Parenteral and Enteral Nutrition, 2018). PN includes protein, carbohydrates, fats, minerals, vitamins, and electrolytes (Mousavi et al., 2014).

Key Study

Author/Year/ Country/Study design/PEDro Score/N	Methods	Outcome
Mousavi et al. (2014) Iran RCT PEDro=6 N=26	**Population:** TBI; Gender: Male=26, Female=0. *Intervention Group (n=13):* Mean Age=31 yr; Mean GCS Score=7.3. *Conventional Group (n=13):* Mean age=36.6 yr; Mean GCS Score=8.4. **Intervention:** Patients on parenteral nutrition were randomly allocated to receive continuous infusion of 50 IU insulin (IIT; intervention) or conventional glucose treatment (CGC; control). ITT group had blood glucose (BG) levels maintained at 80 mg/dl–120 mg/dl. Patients were followed up on day 7 and 14. **Outcome Measures:** Frequency of hypoglycemic episodes, BG concentration, mid-upper arm circumference (MAC), C-reactive protein (CRP), lipid profile, blood electrolytes, and liver function tests.	1. Mean BG concentration was significantly lower in the IIT group compared to the CGC group (118±28 mg/dl versus 210±31 mg/dl; p<0.01). The CGC group had more hyperglycemic episodes. 2. There were no significant between group differences in any of the secondary outcome measures on day 7 follow-up (p>0.05). 3. On day 14, patients receiving IIT had significantly lower levels of CRP (p=0.0001), triglycerides (p=0.02), magnesium (p=0.03), and phosphorus (p=0.01). Chloride levels were significantly elevated in IIT patients compared to CGC patients (p=0.02). These changes were largely in accordance with the hormonal effects of insulin.

In the above RCT by Mousavi et al. (2014), patients on parenteral nutrition were randomized into two groups: an intervention group where individuals received continuous infusion of insulin with their nutrition, and a conventional glucose treatment group with no insulin infusion. The conventional treatment group had a higher incidence of hyperglycemic episodes. While there were no significant differences seen on day 7 for secondary outcomes, at day 14 there were changes in various protein levels within the blood. This is largely attributed to the effects of the insulin. **This study suggests that patients who are receiving parenteral nutrition may benefit from an insulin infusion to lower hyperglycemic episodes.**

Timing of Parenteral Nutrition

Q27. What are the benefits of early administration of parenteral nutrition post-ABI?

1. There is limited evidence that early parenteral nutrition support of closed head-injury patients appears to modify immunologic function by increasing CD4 cells, CD4-CD8 ratios, and T-lymphocyte responsiveness to Con A.

Early parenteral nutrition support provided directly following injury could assist in the maintenance of immune-competence and help reduce the incidence of infection following ABI (Sacks et al., 1995), but there is limited evidence to support this conclusion. In an RCT conducted by Sacks et al. (1995) a significant increase in total CD4 cell counts and CD4% for early versus delayed parenteral nutrition at day 14 was found. From baseline to day 14, following Con A stimulation, an improved lymphocyte response was demonstrated in the early parenteral nutrition group. The CD4-CD8 ratio significantly increased from baseline to day 12 in the early parenteral nutrition group. Regardless of the evidence in support of the timing of parenteral nutrition, if an individual has concerns which prevent them from properly digesting nutrients, parenteral nutrition should be initiated as soon as it is deemed safe by the clinical team.

3.7.2.3 Combination or Comparative Nutrition Administration Strategies

A Cochrane review authored by Yanagawa et al. (2002) identified six trials, which compared parenteral versus enteral nutrition. Parenteral feeding was associated with a decrease in morbidity and mortality, although the results were not statistically significant. The relative risk for mortality at the end of the follow-up period was 0.66 (0.41-1.07) while two trials noted the relative risk of death and disability as 0.69 (0.40-1.15). Young et al. (1992) noted that both parenteral and enteral feeding methods of nutrition administration safely and effectively reduced mortality and improved outcomes following TBI.

Click HERE to see the complete ERABI module on Nutrition including combination administration strategies

Key Study

Author/Year/ Country/Study design/PEDro Score/N	Methods	Outcome
Meirelles and de-Aguilar-Nascimento (2011) Brazil RCT PEDro=5 N=22	**Population:** TBI; *Enteral Nutrition (EN) Group*: Mean Age=31 yr; Gender: Male=11, Female=1; Mean GCS Score=9. *Parenteral Nutrition (TPN) Group*: Mean Age=31 yr; Gender: Male=9, Female=1; Mean GCS Score=9. **Intervention:** Patients were randomized to receive either EN or TPN. Both groups received a 25-30 kcal/kg/day and 1.5 g/kg/day of protein. EN was administered via 8 or 10F oro- or naso-enteral feeding tube in gastric position with pump infusion. TPN was administered via central venous access. Patients assessed daily for 5 days. **Outcome Measure:** Mortality, morbidity, Length of stay (LOS) in ICU, days of mechanical ventilation, amount of calories and protein received/d, blood samples of glucose, albumin, urea, creatinine, C-reactive protein (CRP), urinary urea (N).	1. No significant differences were found in morbidity and mean ICU LOS between the EN and TPN group. 2. Although the amount of calories increased significantly ($p<0.01$) each day of the study, there was a progressive caloric deficit ($p=0.001$) in the two groups without any significant difference between them. 3. Those in the TPN group received significantly more ($p<0.006$) nitrogen than the EN group. 4. Despite the increased loss of nitrogen, all patients showed significant improvement ($p=0.001$) in the nitrogen balance as a result of nutritional therapy. 5. Even though each nutritional therapy offered increasing quantities of nitrogen and calories, the TPN therapy delivered nitrogen more efficiently compared to the EN therapy.

In ERABI, there are multiple studies which discuss the comparison of EN and PN nutrition. Overall, there is evidence that both PN and EN can effectively improve nitrogen balance, and serum albumin levels in ABI populations independently. However, as to which is more effective for these outcomes has yet to be determined by the literature. There is limited evidence that has shown that enteral nutrition, compared to parental, results in higher mortality, but similar rates of morbidity (Hausmann et al., 1985). One study has provided moderate evidence to suggest that combined EN and PN does not decrease the rate of mortality, but may improve the concentration of protein compared to PN alone (Hausmann et al., 1985).

3.7.3 Miscellaneous Therapies

Beyond the therapies and interventions discussed above, a small amount of literature exists supporting other miscellaneous therapies**. These therapies involve supplementing nutritional protocols with additional minerals, vitamins or compounds to improve nutrition and recovery overall**. Table 3.7 contains a brief description of these miscellaneous therapies.

Table 3.7. Miscellaneous Nutrition Therapies post-ABI

Therapy	Description	References
Zinc supplementation	Supplementing the diet with zinc in the immediate post-injury period has shown moderate evidence to be beneficial to neurologic recovery and visceral protein concentrations in ABI patients.	(Young et al., 1996)
Growth hormone	Supplementation with anabolic agents has been proposed as a means to improve lean body mass. There is limited evidence of its effectiveness post-ABI.	(Hatton et al., 2006) (Behrman et al., 1995)
Increased nitrogen feeds	There is limited evidence to support that supplementing diet with high-protein nitrogen feedings may restore nitrogen losses post-ABI.	(Twyman, 1997)
Branched-chain amino acids	There is limited evidence that supplementing diet with branched-chain amino acids will improve disability scores post-ABI.	(Aquilani et al., 2005)

Zinc Supplementation

Q28. What evidence is there for zinc supplementation to improve nutritional status following an ABI?

1. Based on a single RCT there is moderate evidence that zinc supplementation in ABI patients has a positive effect on neurological recovery as measured by the Glasgow Coma Scale. However, no significant improvement in mortality rates could be attributed to zinc supplementation.

"Zinc is an essential element for humans that constitutes less than 0.1% of body weight, yet is vitally important for normal nucleic acid and protein metabolism" (McClain et al., 1986). Serum hypozincemia and increased urinary zinc excretion are common following brain injury and are thought to be an adaptive response to inhibit the proliferation of infective organisms. Levels of serum albumin, the major transport carrier for zinc, are also markedly depressed following brain injury and likely help to explain a portion of the reduction in serum zinc levels. Urinary excretion of zinc appears to be proportional to the severity of the brain injury (Levenson, 2005), leading to the conclusion that zinc supplementation following an ABI could overall support nutritional recovery/maintenance following ABI.

Increased Nitrogen Feeds

Q29. What evidence is there that nitrogen feeds are beneficial following an ABI?

1. Based on a single RCT, there is limited evidence that high nitrogen feedings of approximately 2 g protein/kg are necessary to restore the substantial nitrogen loses that occur post-ABI.

Following brain injury, the incidence of metabolic changes will influence cell turnover, use of substrates, and overall body composition (Twyman, 1997). Twyman (1997) noted that urinary urea nitrogen levels increase by a factor of three compared with normal levels within 10 days of a severe brain injury. On average, about 5 to 10 g of urea nitrogen are excreted daily from a normal individual; however, individuals with an ABI lose a mean of 21g urinary urea in a single day (Twyman, 1997). The same study also found that by treating patients with 1g of nitrogen per 90 calories, patients had significantly greater daily and cumulative nitrogen balance compared to controls at 1 gram of nitrogen per 150 calories. **Overall, there is limited evidence that supplemental nitrogen feeds may improve nitrogen balance following an ABI.**

Growth Hormone Supplementation

Anabolic agents have been proposed as a means to improve lean body mass (Behrman et al., 1995). In a study conducted by Behrman et al. (1995), growth hormone (GH) treatments administered to patients who were completely immobilized did not improve nitrogen balance. However, a later RCT found that individuals who were administered insulin-like growth factor-1 (IGF-I)/GH had a higher nitrogen balance per day than those in the control group (Hatton et al., 2006). The treatment group also had higher mean daily glucose concentration, compared to controls. **Overall, there is mixed evidence in support of the use of GH for individuals with an ABI and should be used with caution.**

Branched-chain Amino Acids

Branched-Chain Amino Acids (BCAAs), which include leucine, valine, and isoleucine, make up roughly 35% of the human body's essential amino acids and approximately 14% of skeletal muscle amino acids (Aquilani et al., 2005). Amino acids are not just nutritionally beneficial, but they may also impact cognitive function (Aquilani et al., 2005). **There is limited evidence from one RCT that BCAA supplementation may significantly improve disability scores and plasma BCAA concentrations**.

3.8 Case Study

Patient Snapshot:

Mr. ZZ…
Is a 50-year-old male who sustained a moderate TBI after falling 25 feet from his roof. He is chatty and restless, frequently talking to others during therapy and meal time.
Mr. ZZ was admitted to your inpatient ABI rehabilitation program 1-month post-injury.
Lifestyle Factors: Mr. ZZ has a history of smoking, a post-secondary college education, is currently employed, and married.
Medical History: Mr. ZZ had an initial Glasgow Coma Scale (GCS) score = 9, Rancho Los Amigos (RLA) score = 6, and has early stage chronic obstructive pulmonary disease (COPD). The patient did not require a tracheostomy tube.
Signs & Symptoms: Upon admission Mr. ZZ presented with coughing during meal times and when taking pills with water. He also presents with a wet-gurgly voice and avoids eating on occasion.

Mr. ZZ's nurses have confirmed he is coughing during and after meal time.
What do you do next?

Consultation with an SLP and a minimum of a bedside clinical examination of swallowing should take place to further delineate swallowing function. (*Reminder: if the patient has substantial problems eating or drinking, they should remain NPO until a formal assessment is possible*)

Q1. What are some components of a bedside clinical exam?

1. An oral motor examination.
2. Swallow palpation.
3. Cough strength testing.
4. Trials with various food and fluid consistencies.
5. Receptive and expressive language screening.

Q2. What tests might be used during the bedside clinical examination to predict aspiration?

1. Water swallowing test.
2. Sustained vocalization following swallows.

During the bedside clinical examination, you conduct an **oral motor examination** and assess his cough strength. You notice Mr. ZZ has some cracked and missing teeth (likely due to his fall) and overall poor oral hygiene. You find he has difficulty making /k/ sounds during the oral motor examination, suggesting potential for a poor retro-oral seal. Mr. ZZ has **weak volitional cough strength**.

Clinical Tip!
Another tool for predicting aspiration as well as appreciating other aspects of the swallow during the bedside clinical examination could include use of <u>cervical auscultation</u> <u>(ERABI Module 5, section 5.4.7)</u>

To test for the presence of aspiration you conduct a **water swallowing test**. The patient coughs immediately. Next, you trial **mildly thickened fluid - Level 2** on the IDDSI Framework (Figure 3.7). The patient does not cough and there is no change in vocal quality on sustained phonation of /ah/. After trials of thicker consistencies (such as honey and pudding), you notice multiple swallows in what appear to be attempts to clear the bolus. Next, you trial **various food items**. The patient coughs after trialling cookies, crackers, and mixed consistencies including his pills. Mr. ZZ did not have difficulty with other food consistencies.

Based on your bedside clinical examination, dysphagia is suspected. You then share this information with the interdisciplinary team. You are unable to access any instrumental assessments for the next 7 days.

Q3. Based on these results, what potential <u>compensatory</u> techniques might you recommend?

1. Fluid and food modifications.
2. Oral care and hygiene.
3. Low risk feeding strategies.

Before specific therapy techniques are introduced, compensatory techniques are recommended.

Therapy Breakdown:

Diet Modification → **Modifications to his fluid and food consistencies** could be made **immediately**. His fluids could be modified to **mildly thickened fluid (aka nectar thick).** His diet could be modified to **restrict dry particulates** (such as cookies or crackers), **mixed consistencies** (such as cold cereals or soups with vegetables), and his pills should be taken with **thickened fluid or food** (such as apple sauce, **not water**). You document his diet modifications on the medical chart.

Clinical Tip!
The **Frazier free water protocol** should be considered for any patient who is NPO or has dysphagia requiring thickened fluids. Keeping patients hydrated is of critical importance!

Oral care and hygiene →You noted some cracked teeth from the fall and request a **dental consultation**. You also work with nursing staff and the patient to educate on the importance of proper oral care and hygiene, particularly before any eating or drinking.

Low-risk feeding strategies → Based on the results of the oral motor examination component, you make **two low-risk feeding strategy recommendations** for Mr. ZZ:

1. Eat in a **calm environment** as he is chatty and restless.
2. Encourage the patient to **feed himself** whenever possible.

Before making **postural adjustments**, you elect to wait until an instrumental assessment can be conducted to ensure the adjustment is safe and effective.

Mr. ZZ's apparent difficulties with swallowing as well as his diagnosis of COPD indicate a follow-up. What do you do next?

Conduct an instrumental swallowing assessment to determine where and what the deficits are. (*Reminder: depending on the facility, availability of and different instrumental assessments may be used)*

Q4. What instrumental assessments could be conducted?

1. Videofluoroscopic swallow study (VFSS).
2. Fiberoptic endoscopic evaluation of swallowing (FEES).

The facility you are working at provides access to a VFSS. One week has passed when the VFSS is conducted. Observations and findings from the study are outlined in Table 1 below.

Table 1. Mr. ZZ VFSS findings.

Observations:	Mr. ZZ was filmed in the lateral and anterior-posterior (AP) planes. He fed himself from a wide mouth cup.
Trial 1 – Thin liquid (1 tsp):	Poor retro-oral seal with spillage to the level of the pyriform sinuses (PS); aspiration during the swallow; moderate residue in valleculae and severe residue in the PS; reflexive cough was noted but weak and not judged to be protective.
Trial 2 – Nectar thick fluid (½ tsp):	Mild oral transit delay noted; well-timed pharyngeal swallow; no residue.
Trial 3 – Nectar thick fluid (1 tsp):	Mild oral transit delay noted; well-timed pharyngeal swallow; no residue.
Trial 4 – Honey thick fluid (½ tsp):	moderate oral transit delay; x2 swallows are noted; mild to moderate residual in the valleculae post swallows.
Trial 5 – Honey thick fluid (1 tsp):	moderate oral transit delay; x3 swallows are noted; moderate residue in the valleculae post swallows.
Trial 6 – Pudding (1 tsp):	moderate oral transit delay; x2 swallows are noted; moderate residue on the base of tongue.
Trial 7 – Cookie (pieces)	reduced oral preparation – possibly due to his cracked/missing teeth; x3 swallows noted; moderate residue in the valleculae.
Trial 8 – Mixed consistency (fruit cocktail)	Adequate oral preparatory phase; premature loss of liquid portion of the bolus due to poor retro-oral seal; aspiration with the fluid during swallow; weak cough does not eject aspirate.
Trial 9 – Honey thick fluid (½ tsp) *AP view	x2 swallows are noted; mild to moderate residual in the valleculae post swallows; bolus flow is symmetrical.

In addition to trialling the different fluid and food consistencies, you examine the impact of the **chin tuck** postural adjustment to address the premature spillage seen with thin fluid. The AP view shows symmetrical bolus flow across consistencies using the chin tuck.

Image of Mr. ZZ's swallow (Figure 3.8) from Trial 1 – Thin fluid during the VFSS. He has residue in the valleculae and the PS (indicated by the white arrow) and tracheal aspiration (black arrow)

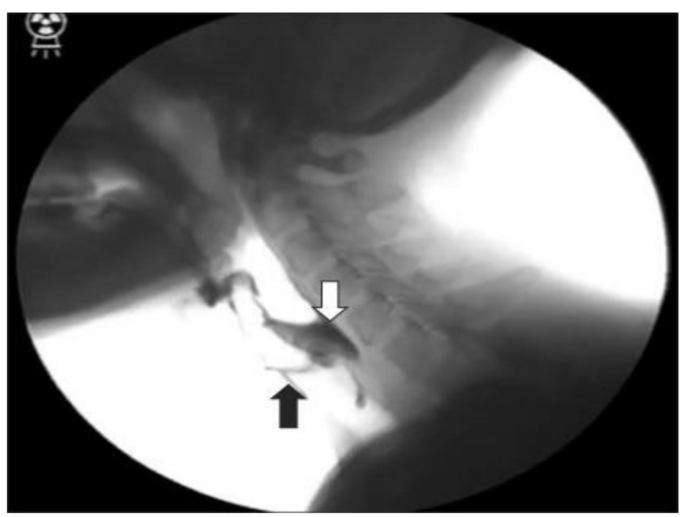

Figure 3.8. Mr. ZZ VFSS Trial 1 Image. Source: (Ji Noh et al., 2010). Available here under CCA-NonCommercial 3.0 Unported license.

Mr. ZZ presents with **moderate-severe oropharyngeal dysphagia** characterized by oral transit delays, poor retro-oral seal, premature spillage of thin fluids and mixed consistency items to the PS; aspiration with thin consistency and a cough response that was not.

Q5. Based on results from the bedside clinical examination and the VFSS, what therapeutic treatment techniques should be considered?

1. Oral motor exercises.
2. Swallowing maneuvers.

In order to strengthen Mr. ZZ's swallowing ability, you recommend oral motor exercises and educate him on using swallowing maneuvers.

Therapy Breakdown:

Now that an instrumental assessment has been done, you can safely recommend the **chin tuck postural adjustment** and continue with the diet modifications.

Range of motion exercise → 20 minute session, 3 to 5x daily. Mr. ZZ is given his own oral motor exerciser (such as the Abilex^{TM}) and is instructed in its use. This exercise should help improve Mr. ZZ's oral transit and tongue strength.

Shaker exercise → 2x daily. The head up and head down sequences should be repeated 30 times in a single session. This exercise should help Mr. ZZ strengthen his swallowing ability and promote pharyngeal clearance.

Clinical Tip!

Does the patient have cognitive-communication challenges? Challenges with memory, attention, or communication may cause difficulties in utilization of therapy techniques! See ERABI Module 6.

Mr. ZZ had a **RLA score of 6**, meaning he is confused-appropriate requiring moderate assistance. The exercises outlined above should be done with support of a **SLP, communications disorders assistant (CDA), or a nurse instructed by the SLP.**

Repeat swallow → The patient should be prompted to swallow subsequent times to clear remaining residue.

Effortful swallow → Mr. ZZ should fully engage muscles of the throat and neck to promote bolus transit and clearance through the pharynx.

Mr. ZZ's swallowing has been assessed, and compensatory and therapeutic techniques have been explored. What do you do next?

During the remainder of his inpatient rehabilitation stay Mr. ZZ's swallowing function is reassessed as appropriate and his swallowing exercises are monitored and adjusted as needed. The goal is to return to regular diet and fluids (*Reminder: diet modifications will change as patient's progress).*

Discharge Assessment:
At time of discharge, Mr. ZZ continues to diligently perform his swallowing exercises, including range of motion and the Shaker, and is now able to do them without the assistance of a CDA or nurse. This has lead to improvements in aspects of his swallowing, which is appreciated during a follow-up bedside clinical examination and VFSS. He has improved his /k/ sounds and has a stronger volitional cough. Mr. ZZ's cracked teeth have been addressed by dentistry and he has been educated about the importance of oral care before eating to reduce the risk of infection due to oral bacteria, which he can now do independently. While eating in a calm environment and adjusting his posture using a chin tuck, he no longer coughs during meal time. At the time of discharge, Mr. ZZ is able to take his medications with water and is able to eat food including dry particulates and foods with mixed consistencies. When challenged, Mr. ZZ has used the repeat and effortful swallow maneuvers; he has been encouraged to continue using these techniques in the community.

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Appendix A. Detailed Image of the IDDSI framework. Source: The International Dysphagia Diet Standardisation Initiative 2016 @https://iddsi.org/framework/