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Swallowing Dysfunction After Critical Illness

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Critical care practitioners must frequently make decisions about their patients' ability to swallow food, liquids, and pills. These decisions can be particularly difficult given the incompletely defined epidemiology, diagnostic criteria, and prognostic features of swallowing disorders in critically ill patients. Furthermore, the consequences of improper decisions—namely, aspiration, malnutrition, hunger, and thirst—can be devastating to patients and their families. This review outlines the problem of swallowing dysfunction in critically ill patients and then addresses the most clinically relevant questions that critical care practitioners face today. First, we review the epidemiology of swallowing dysfunction in critically ill patients. Next, we describe the different diagnostic tests for swallowing dysfunction and describe a general approach to the initial assessment for swallowing disorders. Finally, we explore the existing treatments for swallowing dysfunction. Given the burden of swallowing dysfunction in patients recovering from critical illness, enabling critical care practitioners to manage these disorders, while stimulating new investigation into their pathophysiology, diagnosis, and management, will enhance our care of critically ill patients. CHEST 2014; 146(6):1681-1689

ABBREVIATIONS: FEES = fiber-optic endoscopic evaluation of swallowing; NMES = neuromuscular electrical stimulation; VFSS = videofluoroscopic swallow study

> "Let food be thy medicine and medicine be thy food."
>
> Hippocrates

About every 90 s in the United States, a critical care practitioner makes a decision about the diet for a patient who was recently extubated.[1,2] As Hippocrates may have predicted, these decisions surrounding when a patient should resume attempts to swallow food, liquids, and pills can be difficult. Patients with swallowing problems who start to eat and drink could aspirate, and subsequently develop acute respiratory failure and increase their risk of developing a health-care-associated pneumonia.[3-5] However, depriving oral nutrition to patients who can effectively swallow results in thirst, hunger, feeding tube placement, electrolyte disturbances, and increased caregiver burden.

The decision of when to allow a patient who is recently extubated to begin to eat and drink is complicated for at least two reasons. First, swallowing problems occur relatively frequently in survivors of critical illness. Second, the diagnostic criteria, prognostic features, and treatment options for these disorders remain incompletely defined.

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Increasingly, critical care practitioners delegate the decision of when to resume oral feeding to the nationally accredited discipline of speech-language pathology. Over the 9-year period between 2002 and 2011, speech-language pathologists increased their inpatient evaluations for swallowing disorders by nearly 20%.[6] Ninety percent of the time, a speech-language pathologist requires a consult from the treating physician to become involved in the care of critical illness survivors.[7] In part due to the morbidity of dysfunctional swallowing and the increasing resources required to evaluate and treat swallowing disorders, the national yearly cost of swallowing problems in hospitalized patients is estimated to be over $500 million dollars.[8]

This review seeks to shed light on the particular questions faced by critical care practitioners. Throughout the review, we will use the following terms: dysphagia or swallowing dysfunction refers to the general phenomena of abnormal swallowing, and aspiration denotes oral contents spilling into the trachea. We will address six questions that are relevant to patients who are recently extubated.

How Common Are Swallowing Disorders in Critically Ill Patients?

The frequency of dysphagia and aspiration in critically ill patients has not been definitively determined. Some of the variability in the estimated frequency of dysphagia is related to the lack of universally applied diagnostic criteria, cohort differences, and variation in the timing of the swallowing evaluation. An additional factor in determining the prevalence of dysphagia is whether swallowing dysfunction in these patients predates ICU admission or whether it developed as a result of critical illness. Conservative estimates suggest that a minimum of 20% of all extubated survivors of acute respiratory failure suffer from an abnormality in swallowing function.[9] Barker and colleagues[10] in Toronto, Ontario, Canada, demonstrated that 51% (130 of 254) of cardiac surgery patients who received mechanical ventilation for >48 h had abnormal swallowing as detected by bedside swallow evaluation. Additionally, El Solh and colleagues[11] demonstrated endoscopic evidence of aspiration in 44% of recently extubated patients (37 of 84). In a large cohort of survivors of critical illness, 15% of all ICU admissions (374 of 2,484) had dysfunctional swallowing, despite the fact that over two-thirds of patients received no formal evaluation of their swallowing function.[3] While these studies attempted to exclude patients with preexisting swallowing dysfunction, it is possible that existing estimates include patients with previously undiagnosed dysphagia that is subsequently identified after critical illness.

In Critically Ill Patients, How Long Do Swallowing Disorders Persist?

Long-term neurologic impairment is an important and common complication of critical illness.[12-16] However, the significance and duration of dysphagia in survivors of critical illness is relatively unknown. Only a few studies examining extubated survivors of acute respiratory failure have included follow-up swallow evaluations. At 5 days, and then 14 days postextubation, 40% and 14% of elderly patients had endoscopically confirmed aspiration. In another study, de Larminat and colleagues[17] used a submental electromyogram to determine swallowing efficiency, defined as the latency between installation of liquid at the level of the pharynx and the initiation of swallowing. This study demonstrated improvement in swallowing delay in all patients 7 days after extubation. Finally, in a retrospective cohort trial, 35% of those patients with swallowing dysfunction at the time of extubation had persistent swallowing abnormalities at the time of hospital discharge.[3] Most likely, the underlying mechanism of swallowing dysfunction is the strongest determinant of the duration of dysfunction. For example, mild laryngeal sensory abnormalities caused by local edema may resolve rather quickly. However, laryngeal neuromuscular dysfunction, or more significant damage to laryngeal tissues, may persist for a longer duration of time.[18]

What Specific Features of Aspiration Lead to Clinically Significant Changes in Patient Outcomes?

In patients recovering from a cerebrovascular accident, aspiration that is suggested by a bedside swallow evaluation has been associated with poorer outcomes, such as the development of pneumonia.[4] The association between aspiration and pneumonia exists regardless of whether aspiration occurs with coughing or occurs "silently" (without signs or symptoms).[19-21] "Silent" aspiration is also associated with the development of pneumonia when quantified by pepsin in the respiratory secretions of tube-fed patients who are mechanically ventilated.[5] Importantly, these studies only suggest an association between aspiration and pneumonia, and these associations could be biased by confounding variables, such as other comorbidities or greater severity of illness. In a large study of recently extubated survivors of acute respiratory failure that attempted to control for illness severity, the presence of swallowing dysfunction

on a bedside swallow evaluation was independently associated with poorer outcomes, including pneumonia, reintubation, and in-hospital mortality.[3] Until more compelling evidence exists, this relationship between aspiration and pneumonia is conventionally accepted. The reduction of nosocomial pneumonia in semirecumbent patients in the ICU, as compared with supine patients, further supports this hypothesis that decreased aspiration of gastric contents reduces pneumonia.[22,23]

However, our understanding of the mechanisms of aspiration pneumonia is not complete, as not all episodes of aspiration result in an adverse event. Aspiration can be detected by radionuclide scans in a significant portion of normal, healthy subjects during sleep, who do not subsequently develop pneumonia.[24] Why exactly are critically ill patients who aspirate more likely to develop pneumonia? This may be due to alterations in oral flora to include more pathogenic gram-negative bacteria.[25-27] If this is the case, what is the role for oropharyngeal and digestive tract decontamination?[28] Furthermore, which is more clinically burdensome: refluxed and aspirated gastric contents ("bottom up") or directly aspirated oral food, liquid, and pills ("top down")? Is respiratory compromise more likely if aspiration occurs in frequent, small quantities ("microaspiration"), or episodic, large quantities ("macroaspiration")? Does the type of liquid have an effect on clinical outcomes? Would it be safe for recently extubated patients to aspirate small quantities of water, in an attempt to return to normal swallowing function sooner? These questions deserve further investigation.

What Tests Are Available to Diagnose Swallowing Dysfunction?

The most commonly used diagnostic test for swallowing dysfunction after critical illness is the bedside swallow evaluation. Composed of a patient interview, a physical examination, and the assessment for potential signs of aspiration, the bedside swallow evaluation is usually performed by a trained speech-language pathologist.[29] Bedside signs of swallowing dysfunction include a cough after swallowing, a "gurgling" vocal sound after swallowing, or the absence of a gag reflex. Components of the bedside evaluation can be performed in isolation, or in series, and frequently involve a patient interview, and an examination of tongue, lip, and oral motor and sensory function before and after the swallowing trials.[7]

To streamline the diagnostic evaluation for swallowing disorders, some of the more sensitive components of the bedside swallow evaluation can be used as an initial screening test. Nearly all of these screening tests involve attempts to swallow small quantities of water and/or ice chips under the observation of a nurse, speech-language pathologist, or physician. Water and ice chips are chosen because of their low perceived risk of complications if aspirated. One of the most common screening tests used in non-critically ill patients is a 3-ounce water swallow test.[30,31] Patients receive 3 ounces of water and are instructed to drink the entire amount, via a cup or straw, complete and without interruption. Test failure is defined as the inability to drink the entire amount continuously, any cough up to 1 min after the swallowing attempt, or the development of a wet, gurgly, or hoarse vocal quality.[30,31] In hospitalized patients without critical illness, Suiter and Leder[32] demonstrated that a 3-ounce water swallow test was 96.5% sensitive and 48.7% specific for aspiration when using endoscopy as a gold standard. Currently, for recently extubated survivors of critical illness, 41% of hospitals in the United States incorporate some version of a water-swallowing protocol as initial screening for swallowing disorders.[7] However, the accuracy of these screening protocols has not been studied in survivors of critical illness.[33-35]

The bedside swallow evaluation and its individual components have been criticized for poor standardization, accuracy, and interrater and intrarater reliability.[36-38] A nationwide survey of speech-language pathologists who care for patients who are recently extubated demonstrated significant variability regarding the individual components that should be included in the bedside swallow evaluation.[7] In patients recovering from a cerebrovascular accident, none of the individual components of the bedside swallow evaluation maintain a sensitivity or specificity $>80\%$.[39] Suboptimal sensitivity is in part due to the inability of the bedside swallow evaluation to detect silent aspiration. In prior studies of patients without critical illness, aspiration occurred silently in over one-half of patients.[20,39-41] The bedside swallow evaluation may also be particularly nonspecific in patients recovering from critical illnesses due to the high frequency of coughing, choking, or a gurgling voice for reasons other than aspiration.

Finally, the bedside swallow evaluation is limited in both its ability to accurately assess the severity of aspiration and to guide prognosis. While several severity scales have been validated for fluoroscopic and endoscopic tests,[42,43] a similar severity scale has not been validated for the bedside swallowing evaluation.[44] Using a speech-language pathologist's bedside assessment of dysphagia as either mild, moderate, or severe, we

demonstrated that moderate or severe dysphagia is associated with an increased risk of reintubation, pneumonia, and death.[3] However, we acknowledge the limits associated with this subjective diagnostic assessment, and would hesitate to use bedside swallow evaluations to guide prognostic discussions. Regardless of these limitations, however, a bedside swallow evaluation is currently the primary assessment of swallowing function in 60% of patients who are recently extubated.[7]

Two more-definitive diagnostic tests are available when further assessment of the presence, severity, and prognosis of swallowing dysfunction is needed in critically ill patients: a videofluoroscopic swallow study (VFSS) and a fiber-optic endoscopic evaluation of swallowing (FEES). Less-frequently used confirmatory diagnostic tests include manometry, surface electromyography, and scintigraphy (a nuclear medicine test) (Table 1). These tests are primarily reserved for research studies and are less-commonly used in the clinical setting.

A VFSS is commonly referred to as a "modified barium swallow," and requires that a patient be transported from the ICU to the fluoroscopy suite, and then swallow barium-containing foods while in a seated position. Most often, the speech-language pathologist performs therapeutic interventions during these swallowing trials. Both a speech-language pathologist and a radiologist then interpret the VFSS. Despite the transportation

TABLE 1] Diagnostic Tests for Swallowing Dysfunction and Their Relative Advantages and Disadvantages

Diagnostic Test	Who Performs	What Is Done	Advantages	Disadvantages
Water swallow test	Nursing staff	Patient asked to swallow a small quantity of water and/or ice chips	Widely available, simple to perform	Uncertain accuracy
Bedside swallow evaluation (BSE)	Speech-language pathologist	Patient interview, physical examination, and assessment for signs suggestive of aspiration	Widely available, noninvasive	High potential for interobserver variability; incomplete standardization; uncertain accuracy
Videofluoroscopic swallow study (VFSS)	Speech-language pathologist (radiologist performs final interpretation)	Patient asked to swallow various foods/liquids under live fluoroscopic imaging	Widely available, noninvasive, real-time visualization of bolus though mouth, pharynx, larynx, and esophagus, can test response to therapies	Requires transportation to a fluoroscopy suite; does not allow endoscopic view of anatomic abnormalities; radiation exposure
Fiber-optic endoscopic evaluation of swallowing (FEES)	Speech-language pathologist or critical care practitioner	Small endoscope is passed through the nose and swallowing is visualized during live endoscopic imaging	Can be performed at the bedside; allows direct visualization of the pharynx and larynx; can assess sensory function	Nasal lidocaine enhances comfort but can affect swallowing function; may need to be reviewed frame by frame
Manometry	Variable (primarily research setting)	A device is inserted into the pharynx/esophagus and pressure is recorded during all swallowing phases	Direct assessment of muscular function	No standardization; not widely available; effort dependent
Surface electromyography	Variable (primarily research setting)	Electromyographic electrodes placed on the skin to record activity	Direct assessment of muscular function	No standardization; not widely available; effort dependent
Scintigraphy	Variable (primarily research setting)	Radiolabeled food is swallowed and location is detected	Direct assessment of aspiration	No standardization; not widely available; time-consuming

concerns, VFSS is sensitive and specific for aspiration occurring at the time of the examination, and has a reasonable interobserver variability when measured in non-critically ill patients.[45-47] While the VFSS does not enable the examiner to see the tissue of the pharynx or glottis, it does allow real-time visualization of food though the mouth, pharynx, larynx, and esophagus. Severity can also be graded on one of several validated scales, including the Penetration Aspiration Scale, Dysphagia Outcome and Severity Score, and the Modified Barium Swallowing Study Tool.[42,48,49] Findings on the these scales may predict patient outcomes, when studied in patients without critical illness. For example, in one study of a mixed group of inpatients and outpatients, a high Penetration Aspiration Scale was associated with a higher risk of developing pneumonia 6 months later.[50]

First described by Langmore and colleagues[51] in 1998, FEES involves passing a 3.4-mm nasopharyngoscope through one nostril into the pharynx to view the glottis. Topical lidocaine and a nasal decongestant can be administered prior to the passing of the endoscope to facilitate patient comfort.[52,53] However, an experienced provider can perform a FEES without lidocaine and not increase patient discomfort.[54] When the endoscope is in place, patients swallow food and liquids while the endoscopic video is recorded. Upon further review of the video, the examiner can observe the presence and severity of aspiration or penetration, as defined by the Penetration-Aspiration Scale.[42] Additionally, while a FEES-based diagnostic approach has not been shown to affect results in critical illness survivors, in patients suffering from an acute stroke, FEES-detected severity of aspiration predicts the development of pneumonia and the degree of independent living at 3 months.[43]

While initially developed for use with outpatients, the FEES has several distinct advantages in critically ill patients. Most importantly, FEES can be performed at the bedside rather than requiring transportation to a radiology suite. The FEES allows direct visualization of local trauma and secretions, and allows assessment of laryngeal sensory function. Laryngeal sensation can be assessed by making contact with different glottic structures or using a puff of air of defined pressures through an open channel in the endoscope.[55] Additionally, the FEES allows visualization of the movement of the pharyngeal and glottic structures, including the vocal cords and the proximal trachea.

The FEES has some important limitations. The sensory blunting of 1 mL of 4% nasal-administered lidocaine can improve patient comfort, but may exacerbate swallowing dysfunction.[56] Additionally, the epiglottis covers the vocal cords at the precise moment of swallowing. Therefore, the endoscopic picture is briefly obscured. The aspiration of food and liquid through the vocal cords is assessed by visualizing residual food or water below the vocal cords, and requires reviewing a frame-by-frame video recording of the swallowing evaluation. Despite these limitations, FEES has comparable sensitivity and interobserver variability to VFSS for the detection of aspiration when tested in a group of non-critically ill patients.[57-61] Limited equipment availability, geographic practice variations, and the lack of appropriate speech-language pathologist training may all be potential barriers for the use of FEES in the evaluation of critically ill patients. FEES is available in only 41% of the hospitals caring for recently extubated patients nationwide, and can be performed by a speech-language pathologist.[7] Even when available, FEES is used infrequently: 15% of the time for university affiliated hospitals and 8% of the time for community hospitals.[7]

When Is an Assessment of Swallowing Function Indicated? Which One Should I Choose? When Should I Consult a Speech-Language Pathologist?

Currently, we recommend that extubated patients initially receive a relatively sensitive, simply performed bedside test, such as a water swallow test. While not validated in critically ill patients, the 3-ounce water swallow test can be performed easily by critical care nursing staff, provided patients are alert and able to remain seated in a supported upright position. Patients who fail the 3-ounce water test should promptly receive consultation from a speech-language pathologist for a more comprehensive diagnostic evaluation. Critical care practitioners may also want to risk-stratify the diagnostic strategy to detect swallowing dysfunction and the need for formal consultation from a speech-language pathologist based on previously identified risk factors associated with a higher prevalence of swallowing dysfunction, such as longer durations of mechanical ventilation, multiple intubations, and/or a history of head and neck disorders.[18] For recently extubated patients at a higher risk of swallowing dysfunction, critical care practitioners may consider bypassing the 3-ounce water test and beginning the dysphagia evaluation with a complete bedside swallow evaluation performed by a speech-language pathologist. A proposed diagnostic algorithm is outlined in Figure 1.

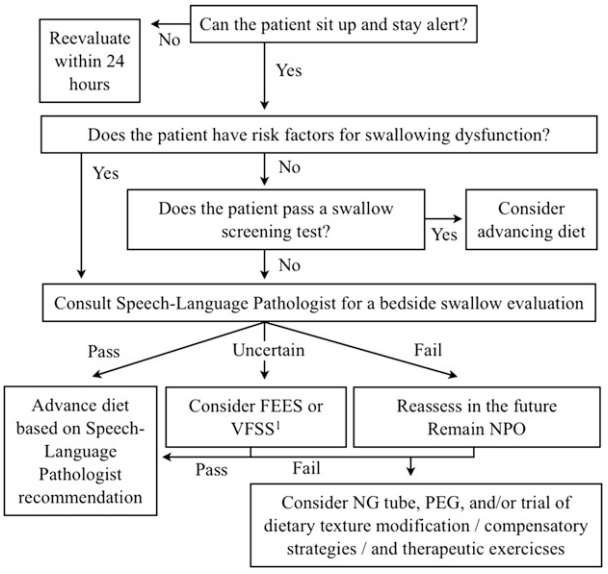

Figure 1 – *Diagnostic algorithm for the assessment of swallowing dysfunction in patients recovering from critical illness. FEES = fiber-optic endoscopic evaluation of swallowing; NG = nasogastric; NPO = nil per os; PEG = percutaneous endoscopic gastrostomy; VFSS = videofluoroscopic swallow study.*

What Are the Current Treatments for Swallowing Dysfunction in Critically Ill Patients?

Current treatments for patients with swallowing dysfunction of any etiology involve dietary texture modification, postural changes, compensatory maneuvers, therapeutic exercises, and nerve stimulation. Working in conjunction with speech-language pathologists, gastroenterologists, otolaryngologists, and neurologists, critical care practitioners can use a multidisciplinary approach to determine the appropriate individualized therapy for each patient.[62] In general, most of these treatments are administered by a speech-language pathologist. Additional therapeutic decisions include when to initiate enteral nutrition through nasogastric and percutaneous feeding tubes that allow appropriate nutrition while bypassing the oropharynx. In patients recovering from critical illness, minimizing sedation and delirium also plays an important role in enabling patients to eat normally.

Dietary Texture Modification

Using fluoroscopic guidance, speech-language pathologists determined that aspiration can be reduced by modifying dietary textures. Thin liquids are more likely to be aspirated due to the relative speed that they travel into the oropharynx. To reduce the risk of aspiration, commercial thickeners can be added to thin liquids. However, the use of commercial thickeners has been associated with reduction in patient satisfaction, reduced intake, and dehydration.[63] Solid foods can also be chopped into different consistencies to facilitate normal chewing and swallowing. There is conflicting evidence concerning the utility of dietary texture modification to reduce aspiration and its deleterious consequences. In 56 nursing home patients with a history of aspiration pneumonia, Groher[64] prospectively compared a mechanically softened diet and thickened liquids with a pureed diet and thin liquids. Over 6 months, patients receiving a mechanically softened diet with thickened liquids had a dramatic reduction in the subsequent development of pneumonia (17.4% vs 86.9%, $P < .05$).[64] In contrast, three subsequent trials of dietary texture modification in nursing home patients have not demonstrated differences in the development of pneumonia.[65-67] These conflicting results likely stem in part from differences in study protocols and patient populations. Currently, we recommend that clinicians making dietary texture decisions communicate directly with speech-language pathologists familiar with individual patients. Based on each patient's unique dietary preferences, perceived aspiration risk, and tolerance for texture modifications, clinicians should consider a risk/benefit discussion with patients and their families to determine the appropriate diet.

Postural Changes, Compensatory Maneuvers, and Therapeutic Exercises

Both postural changes and compensatory maneuvers attempt to reduce the amount of food and liquid that is aspirated. Postural changes involve a speech-language pathologist's coaching of a patient to either place his or her chin down, or turn his or her head to one side at the time of swallowing. Compensatory maneuvers include a patient's attempts to swallow small amounts, swallow multiple times, purposely coughing each time after swallowing, or maintaining the larynx in a superior position with a hand at the time of swallowing (referred to as the Mendelsohn maneuver). Therapeutic exercises attempt to improve underlying swallowing function. Therapeutic exercises involve progressive strengthening and coordination of swallowing muscles. In outpatients with chronic swallowing disorders, regular therapeutic exercise sessions have demonstrated feasibility and benefit in several small clinical trials.[68-70] However, a review of therapeutic exercises concluded that these studies included patients with heterogenous disorders, varied protocols, and different outcome measures.[71] Therefore, the efficacy of therapeutic exercises is

currently uncertain. The trial most applicable to patients recently extubated involved 306 inpatients with acute cerebrovascular accidents and swallowing dysfunction. Patients were assigned to one of three groups: (1) usual care without speech-language pathologists, or either a (2) high intensity or (3) low intensity of organized speech-language pathology interventions, consisting of dietary texture modification, compensatory strategies, and therapeutic exercises. Patients in the high-intensity group received more frequent instruction from speech-language pathologists and also received more directed swallowing exercises. After 6 months, patients receiving both low-intensity and high-intensity speech-language pathology treatment had a significant reduction in swallowing-related medical complications, chest infection, and death or nursing home admission when compared with those only receiving usual care. Furthermore, higher-intensity speech-language pathology care was associated with an increased return to normal diet after 6 months as compared with the lower-intensity group.[72] These bundled interventions hold promise and should be studied further in other patient populations, including those recovering from critical illness.

Nerve Stimulation

Transcutaneous neuromuscular electrical stimulation (NMES) involves placing electrodes on the skin and delivering an electrical current to the oropharyngeal musculature. In theory, NMES can strengthen muscles suffering from disuse atrophy, while simultaneously providing sensory feedback to both cortical and subcortical swallowing centers. However, it is not thought to be useful in stimulating muscle contractions in denervated muscles.[73] For peripheral muscle weakness, previous studies of NMES have yielded mixed results in patients recovering from critical illness.[74] Despite being approved by the US Food and Drug Administration since 2001, there are relatively few randomized controlled trials that validate the use of NMES to treat swallowing dysfunction. Many of these studies have been criticized for study design weaknesses and low external validity. As a result, many speech language pathologists remain unconvinced about the effectiveness of NMES to treat swallowing dysfunction.[7,73,75] For example, only 6% of speech-language pathologists nationwide commonly use NMES for recently extubated patients with swallowing dysfunction.[7]

Conclusions

Based on conservative estimates, swallowing dysfunction occurs in at least 20% of recently extubated survivors of acute respiratory failure. Unfortunately, the lack of a uniformly applied diagnostic algorithm and nomenclature for swallowing dysfunction limits the applicability of these epidemiology studies. To improve the care of swallowing dysfunction in patients recovering from critical illness, future research is necessary in several specific areas. The multidisciplinary critical care community needs to develop a standardized algorithm for the diagnosis of swallowing dysfunction. Additionally, further investigation is needed to unravel the mechanisms responsible for swallowing dysfunction, and to develop effective therapeutic strategies that prevent and treat swallowing dysfunction and ultimately ameliorate aspiration-related complications. Specifically, oropharyngeal decontamination should be further investigated as a method to reduce the burden of swallowing dysfunction in critically ill patients. Further research is also needed to determine the role and benefit of FEES for patients recovering from critical illnesses. Finally, many questions still remain regarding the optimal duration, timing, and protocol for all therapies, including dietary texture modification, therapeutic exercises, and nerve stimulation. Bundled therapeutic exercises, dietary modification, and speech-language pathology sessions have shown promising results and should be further studied in patients recovering from critical illness.

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