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Dysphagia: State of the Clinical Examination
Dysphagia: State of the Clinical Examination

Paula A. Sullivan

During the past 3 years, the division and SC have been faced with many threats and challenges as well as opportunities related to our specialty area of practice. When the American Academy of Otolaryngology-Head and Neck Society (AAO-HNS) retracted its support for the 1999 joint position statement on FEES, Division 13 developed a “talking points” resource as well as three documents affirming the role of the speech-language pathologist in performing FEES independently to evaluate swallowing function. Two additional policy documents were developed to assist members faced with the issue of training and supervising members of other professions in the delivery of dysphagia services.

Other documents supported and developed by the division have included knowledge and skills guidelines for speech-language pathologists performing videofluoroscopic swallowing studies and a instrumental diagnostic procedures for swallowing document. A grand total of eight policy documents and two “talking points” resources have been supported and created by Division 13 over the past 3 years.

With the rapid emergence of new dysphagia treatments, a major focus of this SC has been to educate members to think critically about what we are doing and why and to make principled decisions to guide best practice until sufficient evidence is available to support these procedures. During the past 3 years, I have been exposed to the diverse perspectives of affiliates working in the area of swallowing and swallowing disorders. Our views, concerns, and approaches certainly are not homogeneous. However, I have been impressed by the dialogue, respect, and collaboration exhibited by affiliates in confronting and trying to find equitable solutions to the many challenges facing us. This certainly has been an educational and revealing period of growth and provides me great faith in the future of our division and specialty area of practice.

Note: Paula A. Sullivan was the Division 13 Coordinator at the time the content of this self-study was first published in Perspectives on Swallowing and Swallowing Disorders. For current information on ASHA’s special interest divisions, visit the division pages on the ASHA Web site (http://www.asha.org/about/membership-certification/divs/) or call the ASHA Action Center at 1-800-498-2071.
Dysphagia: State of the Clinical Examination

To See or Not to See: A Question of Clinical Importance

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Dysphagia may be considered an abnormality of bolus flow. Specifically, bolus flow may be inhibited, as in the case of oral or pharyngeal residue, or bolus flow may be misdirected, as in the case of laryngeal penetration/aspiration (McCullough, Rosenbek, Robbins, Coyle, & Wood, 1998). Bolus flow is altered due to biomechanical changes in swallow function resulting from neurological changes, structural changes, or other medical/physical impairment, which can occur at any age. Dysphagia is a major cause of morbidity, mortality, and costly disabilities. Aspiration of food, liquid, or secretions can lead to respiratory complications, aspiration pneumonia, and even death (Bartlett, Gorbach, & Finegold, 1974; Langmore et al., 1998; Martin et al., 1994). In addition to respiratory complications associated with aspiration, biomechanical inhibitions to bolus flow through the oral and pharyngeal cavities can cause problems such as dehydration and malnutrition (Siebens et al., 1986). Malnutrition occurs in as many as 85% of nursing home patients and creates problems with the immune system, increasing length of hospitalizations (Mion, McDowell, & Heaney, 1994). And then, of course, there are the quality of life issues, which are important to the lives of the patients we serve, even if they are not important to third-party reimbursement agencies.

Assessment

With frequent and severe consequences resulting from dysphagia, it can be clearly understood why proper assessment of swallowing is so important. Evaluations of swallowing function can be conducted using various methodologies depending on the stage(s) of the swallow one needs to assess and on the clinician’s purpose. Speech-language pathologists attempting to evaluate oral, pharyngeal, and cervical esophageal function in medical settings most frequently choose one (and often two) of three options:

1. Clinical Swallowing Examination (CSE),
2. Videofluoroscopic Swallowing Examination (VFSE),
   or
3. Fiberoptic Endoscopic Examination of Swallowing (FEES).

The latter study, FEES, has a trademark on the term and implies the use of a standard, published protocol (Langmore, Schatz, & Olsen, 1988). Many variants of this protocol, however, are in use. Each of the three examinations mentioned above has strengths and weaknesses, and data to define those strengths and weaknesses are continually emerging. VFSE (often referred to as “modified barium swallow”) has, historically, been considered the gold standard, largely for its utility assessing oral, pharyngeal, and cervical esophageal stages of swallowing. However, it is often difficult to obtain due to transport and other issues with patients and is necessarily brief due to the use of radiation. Furthermore, it is unnatural because it examines swallowing function in idealized circumstances with upright posturing and coaching and uses boluses that only loosely approximate normal food and liquid intake (McCullough et al., submitted). In addition, barium sulfate must be present in a bolus so it can be visualized during the radiologic exam. Barium sulfate is an inert substance that is not a dietary food. It certainly changes several properties of a food or liquid, such as its taste, density and viscosity, thus making exact comparisons to dietary foods difficult, if not impossible. FEES, on the other hand, can be an excellent tool for assessing numerous aspects of the pharyngeal swallow over time in a more natural feeding environment with a variety of foods. However, it does not allow for a thorough assessment of oral or cervical-esophageal function, and the actual moment of the pharyngeal swallow is obscured due to apposition of tissue (Daniels et al., 2003). A CSE, on the other hand, provides no opportunity to directly observe the physiology of the swallow at any stage. Nevertheless, pertinent historical information and information regarding oral motor and feeding abilities can be gathered.

In order to efficiently evaluate swallowing function, it is important to choose the best examination, under existing constraints, for your patient. For some, “constraints” may mean that no instrumental evaluation
tools are available. For others, it may mean that you don’t know where the problem may be occurring (which stage) and, therefore, are not sure which exam to utilize. Regardless, it is important to bear in mind exactly what we do and don’t know about the CSE before you choose to employ it.

CSE

What do we really know about the CSE? Actually, we don’t even what to call it. The name of the clinical swallowing examination (CSE) has varied (Daniels, McAdam, Brailey, & Foundas, 1997; Logemann, Veis, & Colangelo, 1999; Mann & Hankey, 2001; Martino, Pron, & Diamant, 2000; McCullough et al., submitted) almost as much as sentiments regarding its purpose. While some have asserted the CSE serves largely to clarify cranial nerve function, assess anatomic abnormalities, and “screen” for impairments in speech, language, and cognition (Perlman, 1996), others have reported at least some success using the CSE to identify aspiration and/or other signs of severity of dysphagia in post-stroke patients (Daniels et al., 1997; DePippo, Holas, & Reding, 1992; Logemann et al., 1999; Martino et al., 2000; Mann & Hankey, 2001; McCullough, Wertz, & Rosenbek, 2001). Some question the utility of a clinical examination entirely. After all, even if aspiration is detected, diet and treatment recommendations are not likely to be derived from such information (Splainingard, Hutchins, Sutton, & Chauduri, 1988). Rather, treatments and compensation strategies are derived based on the underlying physiologic abnormalities of the swallow. And, despite the controversy surrounding all aspects of the CSE, the one fact that seems inarguable is that the CSE is a tool that does not employ instrumentation for direct, visual examination of swallowing function. It is not a matter of “what you see is what you get”; although, again, many might claim that’s exactly what you get: nothing. And the data are not far from supporting that view.

Martino and colleagues (2000) evaluated 154 sources, 89 of which were original articles, on the CSE. Data, when available, were collapsed and reanalyzed for sensitivity, specificity, and likelihood ratio. Their results suggested few data are currently available to support the concept that clinicians are able to detect abnormal swallow physiology with a clinical examination and suggest that “large, well-designed trials are needed for more conclusive evidence of screening benefit” (p. 19).

The concerns expressed by Martino and colleagues are understandable when examining some of the individual clinical signs reported in the literature. The presence of an abnormal, volitional cough (Daniels et al., 1998; Gordon, Hewer, & Wade, 1987; Horner, Brazer, & Massey, 1993; Horner, Massey, & Brazer, 1990) and the absence of a pharyngeal gag reflex (Gordon et al., 1987; Horner et al., 1990, 1993; Linden & Siebens, 1993; Logemann et al., 1999) have been identified as signs of aspiration in stroke patients by some researchers. Others have found no significant relationship between an abnormal, volitional cough or the lack of a pharyngeal gag reflex and aspiration (Leder, 1997; Linden, Kuhlemeier, & Patterson, 1993). Other signs that have been investigated garner more consistent support from the data. Signs of laryngeal dysfunction, such as an overall rating of the presence or absence of dysphonia, have been identified in several studies (Daniels et al., 1998; Horner et al., 1990, 1993; Linden & Siebens, 1993; McCullough et al., 2001). Additional signs linked to aspiration in adults with neurologic etiologies are: the presence of dysarthria (Daniels et al., 1998; Hartelius & Svensson, 1994), depressed mental status (Chokski, Asper, & Khandeheria, 1986; Feinberg, Ekberg, Segall, & Tully, 1992), cough after the swallow (Daniels et al., 1997, 1998; Logemann et al., 1999; McCullough et al., 2001), voice change after the swallow (Daniels et al., 1997 1998; Logemann et al., 1999; McCullough et al., 2001), reduced laryngeal elevation (Logemann et al., 1999), multiple swallows per bolus (Logemann et al., 1999), difficulty managing secretions (Linden et al., 1993), and choking during the “3 oz Swallow Test” (DePippo et al., 1992; McCullough et al., 2001). A history of pneumonia may also help with the detection of aspiration (Cogen & Weinryb, 1989; Logemann et al., 1999; McCullough et al., 2001).

Collections of signs have also been investigated. Daniels and colleagues (1998) reported that the presence of any 2 of 6 clinical signs (dysphonia, dysarthria, abnormal gag, abnormal volitional cough, cough with swallow, and voice change after swallow) is highly predictive of aspiration when compared with
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VFSE. A subsequent investigation (McCullough et al., 2001) addressed the same six factors as one of several analyses and also reported a correlation, though not as strong, between two of the six factors and aspiration. Leder & Espinosa (2002) later studied the same six clinical signs, as well, this time in comparison with FEES, and reported underestimation in patients with aspiration and overestimation in patients who did not aspirate. Reliability for rating the clinical signs was not reported in all of those studies. Poor agreement in how to make some of the clinical judgments could be one reason for variability in results, as well as differences in the gold standard employed (VFSE v. FEES). Daniels and colleagues (1997) later reported that the same two of six signs were also predictive of dysphagia severity.

Data from two other CSE protocols have been published that report good results in assessing dysphagia if used as a collective whole (Logemann et al., 1999; Mann & Hankey, 2001). The authors of both protocols, however, report that aspiration and other aspects of dysphagia do go unnoticed in a certain percentage of patients. The costs of false positives may be financially high, but the costs of false negatives can be life-threatening.

It is difficult to know what to conclude from the controversies surrounding the reports for clinical signs of aspiration and dysphagia, and this is only a sampling. One problem is that some researchers did not compute sensitivity and specificity. Another is that, despite the preponderance of stroke patients in these samples, enrollment criteria were dissimilar. Sensitivity and specificity may differ, depending on whether patients are enrolled consecutively or selectively and whether they are referred by another health care professional or after failing a screening completed by a dysphagia clinician. Additional complications are created by a series of assumptions that appear to underlie selection and use of procedures and signs for the CSE. Inter- and intrajudge reliability data for rating CSE signs have only been reported in a few studies. The assumption appears to be that judges can reliably evaluate responses to CSE measures, although evidence of reliability problems for these measures has been reported (McCullough et al., 2000). And, finally, limited control over the kinds and viscosities of boluses swallowed at the bedside and during VFSE seems to betray an assumption that such control is not critical.

What’s Next?

A subcommittee of the Dysphagia Research Society reported on current best practices for clinical evaluation of swallowing, instrumental evaluation of swallowing, and treatment of swallowing (Martin-Harris & Robbins, 2003). The charge of the group was to review the literature over the past 20 years and present the best evidence we have for evaluating and treating the following physiologic components of swallowing:

1. Oral bolus containment,
2. Bolus preparation and mastication,
3. Lingual motility,
4. Initiation of the pharyngeal swallow,
5. Soft palate elevation and retraction,
6. Tongue base retraction,
7. Hyolaryngeal excursion,
8. Pharyngeal contraction,
9. Laryngeal closure,
10. Pharygoesophageal segment opening,
11. Esophageal motility,
12. LES relaxation, and
13. Sensation.

The subcommittee on the CSE (McCullough et al., 2003) reported, based on over 150 articles, that while data supported, with some dissent, the use of CSE measures to detect aspiration post-stroke, no data existed to support the use of the CSE to evaluate any of the physiologic measures deemed necessary for complete examination of swallowing function. This does not imply that the CSE does not address swallow physiology, but rather that studies have focused exclusively on aspiration, a result of dysphagia, which is difficult to treat without more specific physiologic information. The panel concluded that research needed to be steered away from the quest for aspiration and toward the detection of physiologic abnormalities, which have been entirely neglected. Research focusing on the physiologic measures listed above is sorely needed to validate our ability to not only detect aspiration, but to state its cause and address why compensatory and treatment strategies should work. Furthermore, research studies need to randomize patients to one of either two or three of the evaluation procedures we typically employ (CSE, FEES, and VFSE) to compare each examination’s utility for
assessing physiologic aspects of dysphagia and defining appropriate management.

**But Why?**

Many nursing homes and rehab centers lack expensive instrumental equipment to evaluate swallowing and rely solely on CSEs, sending the patients to hospitals as able. If CSE measures are, in fact, useful for detecting specific problems with swallow physiology, that information would enhance patient care in those settings. If that is not the case but FEES can provide the necessary information regarding swallow physiology needed to manage patient care, then data toward that end could provide the necessary impetus for clinicians in those settings to request and receive nasoendoscopy tools for swallowing evaluation.

Without hard data to support the need for such equipment, facilities are not likely to bear the cost. In the medical center where I work, and many acute medical centers around the country (blanket assumption without data to support it), the dilemma is different, though equally compelling. A CSE is the first tool utilized for most patients with suspected dysphagia. When problems are observed, an instrumental evaluation, FEES or VFSE, is then ordered. Thus, patients are frequently assessed with two measures and billed twice. The same scenario could occur, however, if we started with FEES. That may be less likely; but, thus far, we don’t have the data to make that claim one way or another. Defining which assessments are most appropriate for which types of physiologic deficits and how management decisions can best be made could reduce costs, improve patient outcomes, and refine current clinical practice. It is unlikely that additional research will demonstrate better ratings for cricopharyngeal segment dysfunction from a CSE or FEES than from VFSE.

Nonetheless, who would really want to evaluate and manage a swallowing problem without information regarding a patient’s history? And, wouldn’t it be a good idea to actually watch somebody try to feed themselves and eat a little bit in addition to the timeless practice of force-feeding them blue dye and barium and shouting “Swallow, Mr. Doe, Swallow!” (a scare tactic which has prompted many otherwise dysphagic individuals to swallow promptly and efficiently)? I’ve yet to see any patient eat an entire meal, while undergoing FEES or videofluoroscopy. The former may happen; the latter I hope not. Either way, natural feeding practices are not likely to be observed. All this to say that it is not necessarily appropriate to suggest you can’t see anything with the CSE. It all depends on what you’re looking for.

Thus, while few would argue that one type of examination can do everything, it is very possible that they all offer something. In the end, it may be most cost-efficient and effective to combine the best measures from two or three of our examinations of swallowing function into one. Minimally, it would be advantageous to more clearly define when natural feeding practices and other more non-instrumental types of information need to be gathered and when we need to just set them up right and demand that they swallow.

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**References**


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Researchers in the field of dysphagia have been searching for the Holy Grail of an indicator of aspiration that is accurate, noninvasive, and easy to administer. Exley (2000), in an editorial evaluating the efficacy of pulse oximetry stated:

It fulfills the criteria of the ease of use and noninvasiveness. Pulse oximeters are widely available in hospitals, and nurses are already familiar with their use. (p. 475)

Considering its potential as a noninvasive and easily usable technique, Exley asked whether pulse oximetry was the answer to the problems in screening for aspiration. Exley was hopeful that the answer was “yes.” However, researchers have not been particularly successful in establishing pulse oximetry as a valid and reliable indicator of aspiration. Hirst, Ford, Gibson, and Wilson (2002) noted that the research literature on pulse oximetry as a marker of aspiration has presented conflicting results. In this article, the research on pulse oximetry will be summarized and evaluated and conclusions will be drawn about the value of pulse oximetry in determining aspiration among patients with dysphagia.

**Pulse Oximetry Studies**

A body of research has supported the use of pulse oximetry as a diagnostic tool to identify episodes of aspiration (Collins & Bakheit, 1997; Ramsey, Smithhard, & Kalra, 2003; Rogers, Msall, & Shucard, 1993; Smith et al., 1995). Researchers have proposed to consider pulse oximetry as an alternative to existing instrumental examinations of swallowing such as the Videofluoroscopic Study of Swallowing (VFSS) or Fiberoptic Endoscopic Evaluation of Swallowing (FEES) for the assessment of dysphagia.

Several studies have found that SpO₂ levels declined during or after aspiration. Collins and Bakheit (1997) reported a 2% drop from baseline at two minutes after swallowing/aspiration in aspirating males and a smaller decline among females in a study of 54 stroke patients, suggesting that pulse oximetry accurately predicted aspiration in 81.5% of stroke patients with dysphagia. Their findings indicated a high predictability of pulse oximetry, with a sensitivity ratio of 73% and specificity of 87% using VFSS as the gold standard.

Zaidi and colleagues (1995), conducted a study of 49 acute stroke patients, 55 young fit subjects (YF), and 65 non-neurological disease in-patients (IP) who were matched on age and sex. After subjects swallowed a single 10 ml bolus of water, the investigators observed that stroke patients evinced a mean SpO₂ decrease over a 2-minute period that was significantly larger than for YF or IP subjects. The mean SpO₂ fall was substantially greater in aspirators than nonaspirators as identified by the speech-language pathologist (SLP) on a clinical bedside examination of swallowing. These findings were similar to those of Collins and Bakheit (1997). More recently, in a sample of 46 adult patients (16 stroke patients and 30 non-stroke patients) with dysphagia, Sherman, Nisenboum, Jesberger, Morrow, and Jesberger (1999), reported that patients who either aspirated or penetrated without clearing evidenced a greater decline in SpO₂ than those who penetrated and cleared or had no penetration.

Hypoxemia during feeding (SpO₂ less than 90%) was reported by Rogers, Msall, and colleagues (1993) in a study of two adults with cerebral palsy and one with multiple sclerosis. Periods of aspiration and severe dysphagia were evident on follow-up VFSS for all three participants. Rogers, Arvedson, Msall, and Demerath (1993) also reported hypoxemia during feeding in a similar investigation, with five children with multiple disabilities. All of the children presented with pharyngeal phase dysfunction on the subsequent VFSS; one child aspirated.

Chong, Lieu, Sitoh, Meng, and Leow (2003) conducted a water swallow test, FEES and pulse oximetry in a sample of 50 stroke patients suspected of having dysphagia. The water swallow test was performed by having patients drink 50 ml of water in 10 ml aliquots. Patients did not pass the water study if
they choked or coughed while drinking the water or presented with a change in vocal quality after the swallow. Pulse oximetry and FEES were carried out simultaneously ten minutes after the water swallow test by a speech-language pathologist using different food consistencies. A criterion of 2% was used to indicate desaturation. Using FEES as the marker for aspiration, pulse oximetry had a sensitivity of 55.9% and a specificity of 100%, with a positive predictive value (PPV) of 100% and a negative predictive value (NPV) of 51.6%. Sensitivity refers to the ability of a test (pulse oximetry) to identify those that actually have a specific condition (aspiration) or disease, whereas, specificity refers to the ability of a test (pulse oximetry) to capture those that do not have a specific condition (aspiration) or disease. PPV measures whether a positive test is predictive of a condition or disease by examining the proportion of true positives among all those who have positive test results. Conversely, NPV measures the proportion of true negatives among all those who have negative results. When combined with the water swallow test, sensitivity increased to 94.1% and specificity dropped to 62.5%, with a PPV of 84.2% and a NPV of 83.3%. The results of the Chong et al. study indicated a predictive problem of too many false negatives using pulse oximetry. Although the problem of false negatives was partially solved by including the water swallow test, the reduction of false negatives resulted in an increase in false positives.

In a recent study that compared bedside examination and pulse oximetry with FEES, Lim and associates (2001) fed 50 acute stroke patients 50 ml of water in 10 ml aliquots, while observing for coughing, choking, or change in voice quality. Ten minutes later, using pulse oximetry, a baseline oxygen saturation level was taken after equilibrating for 5 minutes. The patients were then given 30 more ml of water, also in 10 ml aliquots, while observing for desaturation using the criterion of > 2%. Within 48 hours, all study participants underwent a FEES examination with thin and thickened liquids. On the basis of the FEES assessment, 26 participants were identified as aspirators and 24 were nonaspirators. Baseline, minimum, and maximum scores on pulse oximetry were compared between aspirators and nonaspirators. Aspirators had significantly lower minimum oxygen saturation than nonaspirators; there were no significant differences in baseline or maximum measurements. When comparing pulse oximetry to the FEES, sensitivity was 76.9%, specificity was 83.3%, PPV was 83.3%, and NPV was 76.9%.

Problems With Studies
Unlike other studies (Chong et al., 2003; Collins & Bakheit, 1997; Smith et al., 2000) that employed measures of sensitivity and specificity in the comparison of pulse oximetry to FEES or VFSS, Lim et al. (2001) did not have sensitivity or specificity problems, in which attempts to increase sensitivity by eliminating false positives resulted in reduced specificity by increasing false negatives. Although their data suggested that pulse oximetry was a valid indicator of aspiration, design flaws may have resulted in an inflated
PPV due to the inclusion of penetrators with aspirators. Prior research has shown that by including penetrators with aspirators, sensitivity and PPV can be increased. In Lim’s study, penetration was included in the definition of aspiration, therefore, Penetration Aspiration (PA) Scale (Rosenbek, Robbins, Roecker, Coyle, & Wood, 1996) scores 2-8 would be considered in the data analysis. Penetration was defined as “any material entering the laryngeal vestibule but remaining at or above the level of the vocal cords” (p. 3). By using this definition, high penetrators, who would receive relatively low scores (2-3) on the PA Scale and deep penetrators, who would obtain middle scores (4-5) on the PA Scale, were included along with aspirators (PA Scale 6-8). No evidence exists indicating that penetration is predictive of aspiration. In addition, as stated by Leder (2001), “…there is no plausible physiological explanation for a change in oxygen saturation just because food material enters the laryngeal vestibule” (p. 233). In Lim et al.’s study, pulse oximetry was simply used to distinguish between penetrators/aspirators (PA Scale scores 2-8) and those who neither penetrated nor aspirated (PA Scale score 1).

Controversy exists over the use of the 2% desaturation criterion as indicative of aspiration. Although it is a popular criterion that has been used by many researchers (Chong et al., 2003; Collins & Bakheit, 1997; Smith et al., 2000), there is no empirical basis for that determination. Leder (2001) and Colodny (2000) noted that the 2% criterion is arbitrary and at the margin of error for the equipment. Hirst et al. (2002), in a sample of 29 healthy elderly subjects, reported desaturation levels of 2% or more in 59% of the participants; 15% of their subjects desaturated at or above 4%. Sellars et al. (1998) stated that the international standard for significant decline in desaturation is 4%. However, a 4% desaturation rate as the criterion for aspiration would have made the study by Lim and colleagues (2001) unfeasible because, judging from their statistics, no more than five or six study participants desaturated at or above 4%. The mean desaturation rate for the 26 aspirators was 2.3%. Figuring that approximately 13 aspirators scored above the mean and 13 scored below the mean, with a standard deviation of 2.1, approximately 77% of the sample would have desaturation rates of less than 4%, leaving 23%, or six participants having desaturation rates of 4% or more.

Each of the studies reported above that supported pulse oximetry as an indicator of aspiration had at least one major design limitation. For example, the studies by Collins and Bakheit (1997), Rogers, Arvedson, and colleague (1993), and Rogers, Msall, and colleagues (1993) had no comparison groups. Although Zaidi and colleagues (1995) used two comparison groups, they were unable to define the point of aspiration because an instrumental examination of swallowing was not conducted during pulse oximetry. Rogers and associates conducted studies with fewer than 10 subjects, making statistical analyses unfeasible. Collins and Bakheit used the lowest desaturation scores two minutes after feeding rather than means or medians, which artificially increased desaturation rates. Sherman and colleagues (1999) used a squared difference score between baseline SpO2 levels and lowest SpO2 at aspiration. Computing difference scores resulted in a problem of regression to the mean, which increased the probability of a type II error. In addition, the authors did not know whether the decline in pulse oximetry was due to age or aspiration since group membership and age were confounded.

Although most of the researchers used blinded raters in their assessment of aspiration status and provided inter-rater data, none of the studies presented intra-rater reliability information. In Chong’s study (2003), the SLP was blinded to the results of the 50 ml water swallow study but was not blinded to the subsequent FEES and pulse oximetry results. This factor may have biased their findings. Smith (2000) and Lim (2001) did not provide inter-rater data for the assessment of aspiration and penetration leaving the analysis solely to the SLP. Therefore, the results of this study should be viewed with a critical eye.

The review of the literature on the role of pulse oximetry in the identification of aspiration is not persuasive. Each study was flawed by either failure to use instrumentation simultaneously with pulse oximetry, lack of a control group, measurement errors, or an inadequate sample size. Therefore, there is not sufficient support to conclude that there are distinctive alterations in SpO2 during swallowing.
What It Measures

Given the unsettled state of pulse oximetry relative to aspiration, researchers in the field of dysphagia need to discern what pulse oximetry actually indicates. In order to answer this question, additional studies will be considered. Sellars, Dunnet, and Carter (1998), in a study of six dysphagic patients, observed no direct relation between altered arterial oxygenation and oral feeding in dysphagic individuals. SpO$_2$ levels did not change appreciably during feeding in five normal subjects. Although the sample size was small, the study by Sellars and colleagues (1998) raised questions about the reliability and validity of pulse oximetry as a measure of aspiration.

Leder (2000) conducted a prospective study of 60 subjects in intensive care who were not taking nutrition orally and were referred for a dysphagia evaluation prior to the institution of oral feeding. Subjects were monitored using FEES and pulse oximetry while ingesting puree, milk, and a cracker. FEES was conducted simultaneously with pulse oximetry, before during and after the meal. The 60 subjects were divided into four groups based upon whether or not they had been receiving supplemental oxygen and whether or not they had aspirated during the assessment. No significant differences were found in SpO$_2$ levels between aspirators and nonaspirators or between those who required additional oxygen and those who did not. Only one subject desaturated more than 4%; the highest the saturation rates for any of the four groups was 0.07%.

In a controlled study conducted by this researcher (Colodny, 2000), penetrators, liquid aspirators, and solid aspirators were compared to a group of normals on pulse oximetry before, during, and after feeding, using liquid, puree, and chewable solids. Pulse oximetry was conducted simultaneously with FEES. Of the 181 participants in this study, 104 were diagnosed with dysphagia. In this study, patients were defined as having dysphagia if they aspirated (n=72) or penetrated (n=32) during the FEES. Thirty-six percent of the aspiration group aspirated before the swallow secondary to premature spillage into the hypopharynx, 11% aspirated as the swallow was initiated, and 44% aspirated after the swallow due to overflow of residue from the hypopharynx. Due to the “white out period”, it was inferred that 9% aspirated during the height of the swallow secondary to ejection of the bolus out of the trachea after a voluntary cough or residue on the subglottic shelf. Among those that penetrated, 30.8% of the subjects had residue either contacting or remaining above the vocal folds; 59% were able to clear the materials out of the laryngeal vestibule by repeated swallows, throat clearing, or coughing.

In a subsequent analysis that examined correlates of oxygen desaturation, this researcher (Colodny, 2001) concluded that the results implied “that the normal aging changes in swallowing and pulmonary processes combined with an assault to the system, such as CVA or COPD, lead to dysphagia which, in turn, compromise pulmonary functioning” (pp. 56-57). These findings corroborated Sellars et al. (1998) results which indicated that desaturation may be a characteristic of dysphagia rather than aspiration. This observation is further illuminated by the studies listed above in which researchers improved sensitivity of their findings by including penetrators with aspirators.

Additional support for this observation was found in the study conducted by Rowat, Wardlaw, Dennis, and Warlow (2000), who examined oxygen desaturation during feeding in a sample of 106 stroke patients, 50 elderly hospitalized patients without a history of stroke, and 20 young healthy subjects; they found higher desaturation rates at baseline, during eating, and after eating in the stroke patient sample relative to the other two groups. Similarly to other studies (Chong et al., 2003; Collins & Bakheit, 1997; Lim et al., 2001; Smith et al., 2000), only a very small minority desaturated at or above 4%. Given that Hirst and colleagues (2002) were able to identify 15% of a healthy elderly sample who desaturated at or above 4%, the issue of the relationship between desaturation and aspiration becomes even more problematic. Furthermore, Hirst and colleagues also found a decrease in saturation levels of 2% or more in 59% of the normal elders who did not aspirate. This suggests that there are normal variations in saturation levels. It also brings into question whether there is a possibility of an aging factor.

Researchers (Leder, 2000; Singarayar, Ellul, Barer, & Lye, 1993; Tamura, Shishikura, Mukai, & Kaneko, 1999) have reported that positioning of patients during feeding can affect pulse oximetry, although findings have been paradoxical. Singarayar
and associates suggested that feeding stroke patients while sitting upright increased oxygen saturation, while Tamura and colleagues reported that oxygen saturation increased in a semi-recumbent position relative to sitting, in a sample of patients that had cerebral palsy, epilepsy, or postencephalitic symptoms. Although the relationship between positioning and pulse oximetry needs further research, these preliminary findings suggested that pulse oximetry may be subject to extraneous influences that may not be related to aspiration.

If researchers examine the body of literature on pulse oximetry and aspiration, it becomes obvious that desaturation is only tangentially related to aspiration. Although pulse oximetry has been championed by some as the solution to the problem of diagnosing aspiration, research findings have not supported that claim. In some cases, pulse oximetry in combination with bedside examinations has offered possibilities. However, reliability has been maintained only by including penetrators with aspirators, which further confirms that pulse oximetry cannot reliably identify aspirators. There is some research that suggests that dysphagic patients may have consistently lower saturation rates compared to elderly patients who do not have dysphagia. Further, well-controlled studies need to be done to validate this possibility. In addition, more research needs to be conducted on whether there are age-related differences in saturation levels and if saturation levels are influenced by the apnea period in healthy adults.

Therefore, the present state of the art in identifying aspiration requires the use of VFSS or FEES. Pulse oximetry is not the answer to the problems in screening for aspiration as Exley (2000) had hoped. Pulse oximetry, along with the bedside swallowing examination, cannot distinguish reliably between patients with and without aspiration.

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References


Dysphagia: State of the Clinical Examination


The Utility of Cervical Auscultation in the Evaluation of Dysphagia

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Introduction

In approximately 6000 B.C., an ancient civilization arose on the plains of Mesopotamia (Piggott, 1961). This civilization, bordered by the Tigris and Euphrates rivers, in the area now comprising portions of Iraq, Iran, and Syria, proved to be surprisingly advanced. By 4000 B.C., several large walled cities marked the area. Though constantly invaded by their poorer neighbors, within these cities architecture, art, written language, mathematics, medicine and science flourished. Archeological investigations have shown that there were individuals identified as “physicians” within the Mesopotamian society. Their understanding of disease and its treatment was an interesting mix of religion, demonology, magic, and herbal treatments. They were severely limited by the absence of medical instrumentation that would allow them to understand the workings of the human organism. Consequently, they functioned with the only information available, the overt symptoms presented by their patients.

Emerging Technology

It is known that during the Mesopotamian era there was widespread exchange of medical information among scholars of the region. Much of the historical information of the time, including that describing medical knowledge from Assyria, Greece, Persia, Egypt, and India found its way as more than half-a-million documents into the Royal Library at Alexandria beginning in 283 B.C. In the greatest loss of accumulated knowledge of humankind, the Royal library burned in 642 AD and its contents were lost (Mellersh, 1994). As a consequence, across the middle ages, Western medicine consisted of increasingly degraded remnants of classical learning from earlier centuries mixed with a healthy dose of folklore and superstition. The understanding of physicians continued to be severely hindered by the lack of instrumentation.

As the curtains of the dark ages parted there was newly inspired interest in science and medicine. The 1600–1800s proved to be a remarkable era of technological development. In a span of only 100 years, the thermometer, microscope, and instrumentation for the measurement of blood pressure and respiration came into being (Trefil, 2001). Equally important was the discovery in 1791 by Austrian physician Leopold Auenbrugger that “percussing” (tapping) on various locations on the chest and abdomen would yield acoustic information that was of diagnostic value (Steudel, 1970). While this was a seminal finding, it remained for French physician Dr. R.T.H. Laennec to develop the necessary instrumentation for widespread use of the technique. It was in 1816 that Laennec first rolled up a tube of paper and held one end to a patient’s chest and the other to his ear (Sakula, 1981). Appreciating the sounds he heard, Laennec then developed a series of devices now known as stethoscopes. The technique Laennec developed is “auscultation” and is defined as: “The act of listening for sounds arising within organs (as the lungs or heart) as an aid to diagnosis and treatment, the examination being made either by use of the stethoscope or by direct application of the ear to the body” (Gove, 1981, p. 145). While this classical definition of auscultation has been adequate in the past, it does not reflect the applications made possible by current developments in signal processing technology. Consequently, for the purposes of this article, I will broaden the definition to include the gathering and interpretation of acoustic information that may be made possible, not just through a stethoscope or the naked ear, but also through microphones, accelerometers, and electronic signal processing devices.

Long-Term Care Settings

In the United States, there are over 14,800 free-standing nursing homes (Moody, n.d.). A common characteristic of many of these facilities is a lack of access to common technologies used in the evaluation of dysphagia, especially the videofluoroscopic swallowing study (VFSS). In a study of dysphagia assessment practices in western Washington State, Mathers-
Schmidt and Kurlinski (2003) found that 42.2% of their respondents had no access to an instrumental evaluation for those in need of a dysphagia assessment. While the work settings were not identified, it is likely that many are employed in long-term care settings. Clinicians working in these facilities find themselves in a position not unlike that of the Mesopotamian physicians. That is, they are lacking the instrumentation that will allow them to detect covert elements of the condition they study. They are left to rely on the overt symptoms revealed in the clinical swallowing evaluation, an examination that is well recognized to have serious limitations.

While numerous limitations of the clinical examination have been noted (McCullough et al., 2000), the most frequently mentioned is its inability to detect aspiration when it is “silent.” Though populations and study methods have varied, it is clear that silent aspiration is a common event. Splaingard, Hutchins, Sultan, and Chaudhuri (1988) found that 42% of their aspirators were of the silent type while Daniels, McAdam, Brailey, and Foundas (1997) and Holas, DePippo, and Reding (1994) found greater percentages, 68% and 72%, respectively. Of great concern is the finding reported by Splaingard and colleagues (1988) that only 30% of profound aspirators (aspirated greater than 10% of bolus) identified on VFSS were also detected by the clinical examination. Finally, Leder and Espinosa (2002) identified still another serious limitation when the clinical examination produced a 70% false positive and 14% false negative rate in identification of aspiration risk. While the false positive errors may result in over referral for instrumental examination, it is this false negative rate that may be of greatest concern because these patients may be judged not to be at risk when they actually are. Any technology that can be applied in the long-term care setting that will improve the identification of true aspirators and true non-aspirators will strengthen the clinical examination.

**Forms of Auscultation**

To understand auscultation as it might be applied to the swallow, it is important to recognize that it exists in two distinct forms. In the first, the targets of auscultation are the sounds of the swallow. Here the investigators capture the acoustic waveform created during the swallow and attempt to tease from it the “acoustic signature” of the swallow. They have then attempted to identify the physiological events that have produced embedded elements of the signature. This form is dependent on signal processing technology. In the second form, the clinician listens primarily to airway sounds that surround the swallow. The clinician listens for airway turbulence or a “wet” sound that may be indicative of penetration/aspiration. Only a stethoscope is needed to perform this type of cervical auscultation. Following is a summary of what we know about auscultation according to these two forms.

**Swallowing Sounds**

Early reports of the evaluation of swallowing sounds began to appear in the mid 1900s (Lear, Flanagan, & Moorress, 1965; Logan, Kavanagh, & Wornall, 1967; Mackowiak, Brenman, & Friedman, 1967). While these authors appreciated the “double click” of the swallow and collected its waveform, they were limited by the technology available at the time. Because the swallow is so fleeting and because there are likely so many acoustic components buried in its acoustic signal, the human ear is not sufficient for processing it in real time. Therefore, this technique requires significant instrumentation, including a device to detect and collect the sound (accelerometer or microphone) and a sound storage/signal processing unit. With this equipment, the investigator can manipulate the signal to focus on individual components embedded in the waveform.

To begin to understand swallowing sounds it has been necessary for investigators to make some important methodological determinations. In two publications (Takahashi, Groher, & Michi, 1994a, b) the authors evaluated the utility of different methods of transducing the sounds of the swallow and concluded that an accelerometer attached to the neck by two-sided paper tape was superior. They reported that the best placement for the transducer was at a midpoint between the center of the cricoid cartilage and the jugular notch where it provided the best signal-to-noise ratio and that placement on either the left or right side produced equivalent results. Cichero and Murdoch (2002), however, are not in agreement, concluding that an electret microphone was superior to other methods in transducing swallowing sounds and that any of four placement sites produced equivalent results.
Investigators have attempted to describe the acoustic characteristics of the “normal” swallow in terms of the shape of the waveform including its duration, peak frequencies, and intensities. Some agreement has been reached regarding the duration of acoustic signature of the liquid swallow. Lear and colleagues (1965); Selley, Ellis, Flack, and Brooks (1990); Takahashi and colleagues (1994b); and Youmans and Stierwalt (2003) all seem to agree that it approximates 500 milliseconds. Such agreement does not exist, however, in regards to the swallow of greater viscosities. While Hamlet, Patterson, Flemming, and Jones (1992) found that a paste swallow was much shorter, approximating 250 milliseconds, Youmans and Stierwalt (2003) found the duration of puree and soft solids are not significantly different from liquids.

When attempting to locate the frequencies of acoustic peaks Mackowiak and colleagues (1967) found an initial 400 Hz “alpha” component followed by a 1,000 Hz “beta” segment. These authors also identified a third sound that was present in wet swallows. Hamlet, Nelson, and Patterson (1990) obtained results that approximated these with an initial peak at 556 Hz and a second peak at 1,384 Hz.

There is also general agreement regarding the amplitude and duration of the first two peaks (Hamlet et al., 1990; Lear et al., 1965; Mackowiak et al., 1967). Generally, the first peak is weak and lasts 30-50 milliseconds. The second lasts from 150-200 milliseconds and is far stronger. If a third peak is seen, it will be weak. While identifying the components of the acoustic signature is important, it only becomes useful when the physiological causes of the events are determined.

**Physiological Causes**

Cichero and Murdoch (1998) have applied the information they have gleaned to an elegant model they call the “cardiac analogy hypothesis.” These authors contend that the swallowing mechanism is, in an acoustic sense, much like the heart for which auscultation has long been relied upon as a diagnostic tool. That is, auscultation of the heart will reveal acoustic events that correspond to:

1. The contraction of muscle (i.e., pumps) with potential for vibration (e.g., ventricular contraction);
2. The movement of valves (e.g., tricuspid valve and mitral valve); and
3. The flowable contents (i.e., blood).

Equivalents exist in the human swallow in the form of muscular contractions (e.g., pharyngeal constrictors, and hyolaryngeal musculature), valves (e.g., the velopharyngeal closure mechanism and upper esophageal sphincter), and flowable contents (i.e., bolus).

Heinz, Vice, and Bosma (1994) concluded that the acoustic signature of the swallow is composed of components that are tied to specific physiological events. Cichero and Murdoch (1998) have not only hypothesized the sources of these sounds based on their model, but have found support from studies that have used other technologies, namely manometry and VFSS. They conclude that the simultaneous closing of the laryngeal valve and the pressure of the tongue as it makes its first movement against the posterior pharyngeal wall produce the first swallowing sound. As was shown by Takahashi and colleagues (1994a), elevation of the hyolaryngeal mechanism may also contribute to this peak. They believe that the second movement of the tongue against the posterior wall and the pharyngeal clearing wave combine to produce the second peak, one that is stronger and one that lasts longer than the first. Perlman, Ettema, and Barkmeier (2000) found that this second sound does not occur until the bolus was often well into the esophagus and should not be construed as being due to bolus passage through the pharynx. Rather, Hamlet and colleagues (1990) proposed that this point in the waveform reflects the onset of a pressurized flow of the bolus into the esophagus. Finally, if a third peak is noted, it may be due to an “un-valving” of the system at the conclusion of the swallow.

While these findings tell us something of the form and causes of the acoustic signature of the normal swallow, one test of the technique is in its ability to separate normal from abnormal and/or aspiration events from non-aspiration events. Cichero and Murdoch (1998) discussed the concept of heart murmurs of the stenotic and regurgitive types, suggesting that in a stenotic condition high pressures will be reached as fluid is propelled through a narrow opening. Thus, one might speculate that an achalasia of the UES could produce increased amplitude in the second peak.
of the waveform. Likewise, a weakness in pharyngeal contractions might reduce the resultant fluid pressure and also affect the second peak, but in an opposite direction.

Uyama and colleagues (1996) analyzed the acoustic swallow signatures of normal and dysphagic swallows. They found significant detectable differences. Swallows without aspiration were shorter than both swallows with aspiration and those with penetration. The maximal amplitude of swallows without aspiration was greater than for swallows with aspiration. Sensitivity (detection of true aspirators) was 87.1% and specificity (detection of true non-aspirators) was 88.9%. Their conclusion was that the acoustic characteristics of the swallow could be used to identify swallows as dysphagic. These same authors (Takahashi et al. 1996) studied a related technique, the use of Soft Expiratory Sounds (SES) that was acoustically analyzed. They found that the technique showed sensitivity of 83.2% and specificity of 82.6%, concluding that it is a viable means of detecting aspiration.

**Airway Sounds**

The use of auscultation to assess the respiratory system flowed directly from Laennec’s original work from which came the technique, the first instruments and the terminology to describe both normal and abnormal breath sounds (Sakula, 1981). For a readable discussion of breath sounds and the techniques of pulmonary auscultation, the reader is referred to Karnath and Boyars (2002).

Auscultation by stethoscope, whether for the purposes of assessing cardiac or respiratory sounds, has not been without problems. It has long been plagued by the inexact nature of the vocabulary used to describe the sounds (e.g., rales, crackles, friction rubs, wheezes, rhonchi, and stridors) and the postulated relationships between the acoustic and physiological events. Patients assume that auscultation is a skill well learned and precisely applied by their physicians. This is challenged by findings of Mangione and Nieman (1999) who, in a study of 627 postgraduate family practice and internal medicine trainees, found all of the subjects recognized less than half of all clinically significant respiratory events via pulmonary auscultation. Further, there was little improvement after one year of experience with the technique. This may reflect their additional finding that only 10% of U.S. graduate medical programs offered formal training in pulmonary auscultation. Perhaps it is the subjective nature of the technique that has caused some physicians to no longer rely on it as a diagnostic tool (Gavriely, Nissan, Rubin, & Cugell, 1995). Some speech-language pathologists are leaping into this pot of imprecision as auscultation is proposed as an alternate diagnostic technique for dysphagia. Will we find that auscultation of airway sounds associated with the swallow to be valid and reliable? While experimental data are limited, here is some of what we currently know, but first a brief discussion of the methodology.

**Auscultation via Stethoscope**

**Instrumentation**

While auscultation of airway sounds in swallowing can be performed using only a stethoscope, it is important to recognize that not all stethoscopes are created equal. Logan and Kavanagh (1967) reported that energy in the acoustic waveform of the swallow extended to 8,000 Hz, but it seems that most of the critical information (reported earlier in this paper) is located well below 3,000 Hz. It has been concluded that respiratory sounds should typically be assessed using the stethoscope diaphragm, since it responds to higher frequencies. Airway sounds that are associated with aspiration are thought to be low in frequency. It is the bell of the stethoscope that normally responds best to these lower frequencies. Following their assessment of six popular stethoscopes, Hamlet, Penney, and Formolo (1994) identified two that they believe are most appropriate for cervical auscultation of the swallow: the Littmann Cardiology II and the Hewlett-Packard Rappaport-Sprague with medium bell and small diaphragm. Only the Littmann Cardiology II met all six established criteria for sound transmission when only the diaphragm was used. This simplifies the selection of the stethoscope and requires that only the diaphragm be used in cervical auscultation. When using a stethoscope with a standard sized diaphragm, the clinician will find a lateral placement will yield improved acoustics. The clinician should experiment with placement and determine which provides the best acoustic results.

**Patient Selection**
The health status of the patient is an important issue when cervical auscultation of test swallows is considered. If test swallows are to be administered, then the clinician must consider that aspiration is possible. He/she must determine whether the risks associated with potential aspiration are outweighed by the potential benefits of the information that might be derived from the test. General factors might include patient age, presence of infectious pulmonary disease, coughing with per oral intake, malnutrition, and cognitive impairment. Zachary and Mills (2000) and Mills, Ashford, and Yarber (2004) have determined that there are specific laboratory values that can indicate which patients are, at the time of evaluation, most medically fragile and who may not be able to tolerate the administration of test swallows.

Technique

I use the following procedures when auscultating airway sounds in swallowing. The first step is to select and prepare the test materials that will answer the diagnostic questions posed. In my clinical setting, these most often include ice chips and three liquids. The liquids are keyed to viscosities of regular dietary, nectar-like and honey-like liquids and, perhaps, a thin puree according to recommendations from the National Dysphagia Diet (Clayton, 2002). Though ice chips assume the viscosity of water when melted, they are often presented first due to their less harmful nature if aspirated (Groher, 1984). The clinician should locate him/herself to the front of the patient, such that the diaphragm of the stethoscope can be held with one hand on the skin that overlies the lateral aspect of the thyro-cricoid junction. Placement should be sufficiently anterior to minimize interference from the carotid pulse. Tissue coverage of the diaphragm must be complete to allow adequate sound transmission and to eliminate the transmission of airborne sounds.

The clinician should listen across several inspiration/expiration cycles for the presence of turbulence in the airway stream. The normal flow of air should yield a sound that Zenner, Losinski, and Mills (1995) has described as “continuous,” “breezy,” or “tubular.” Turbulent sounds are often discontinuous or interrupted or possess a wet quality. Turbulence present prior to the swallow may indicate the presence of unmanaged oropharyngeal secretions. Once the clinician has determined the nature of the pre-swallow sound, he/she should explain to the patient that the patient will be asked to sip the test material from the cup and should hold it in the mouth until the command to swallow is given. The clinician then hands a cup of the first test material to the patient. It is recommended that the clinician’s index finger of the free hand be placed at the midline on the thyroid notch, between the thyroid cartilage and the hyoid bone (Groher, 1984). Finger placement on the structures of swallowing will give the clinician a measure of the promptness of the onset of the swallow and completeness of hyolaryngeal elevation. The command is then given to swallow. These procedures may need to be modified according to the patient’s ability to participate. For example, in some cases it may be necessary to enlist a staff member to administer the test material while the clinician auscultates.

Auscultation of the swallow begins before the swallow occurs, as the clinician listens for premature spillage into the pharynx. As the swallow occurs the clinician should listen for a crisp double-click sound of the swallow, a sound that is reportedly less distinct in the abnormal swallow. Following the swallow, the clinician should again listen through several inspiratory/expiratory cycles for changes in the airway sounds. An increase in airway turbulence may indicate the presence of penetration/aspiration for that bolus.

Because portions of the bolus may be trapped in pharyngeal spaces, Logemann (1998) recommends as part of the standard clinical examination that the patient be asked to phonate “ah,” pant for several seconds, and turn his/her head from side to side. These are also appropriate for inclusion when auscultation is added to the clinical swallowing examination. Auscultation following these movements may reveal increased turbulence from dislodged stasis that has now penetrated or been aspirated.

The indicators of penetration/aspiration derived from auscultation may be any of the following:

1. A pattern of normal airway sounds prior to the swallow followed by turbulence following the swallow,
2. Turbulence prior to the swallow that is increased after the swallow, or
3. Turbulence that is first heard or increased following testing of the movements recommended by Logemann (1998).

**Stethoscopic Studies**

Zenner and colleagues (1995) evaluated the effects of cervical auscultation to their standard clinical examination of 50 patients in a long-term care setting. They calculated the technique’s degree of sensitivity (ability to detect true aspirators) and its specificity (ability to detect non-aspirators). Using the Splaingard and colleagues’ (1988) data, they calculated that the clinical examination alone had sensitivity of .419. When cervical auscultation was added to the clinical examination Zenner and colleagues (1995) showed a sensitivity for severe aspirators of .842 and a mean specificity value of .710. There were no mild aspirators in the study, so conclusions could not be reached regarding this group. The resultant kappa values were significant at p< .05 and below. Thus, these data indicate that the addition of cervical auscultation improved the ability of the clinicians to detect true aspirators. The detection of true non-aspirators was also improved over that expected in the clinical examination.

More recently, Leslie, Drinnan, Finn, Ford, and Wilson (2003) assessed the effect of cervical auscultation of airway sounds by collecting acoustic recordings of 10 normal and 10 penetration/aspiration swallows through a Littmann Cardio III stethoscope during VFSS. These recorded sounds were played for rating and re-rating by 11 speech-language pathologists who were experienced in the use of cervical auscultation. The authors found that 7 of the 11 clinicians were at least “fair” in their judgments. Sensitivity (.620) and specificity (.660) were lower than that found in the study by Zenner and colleagues (1995), but sensitivity was higher than that predicted for the clinical examination alone. Performance across the group varied widely, and, thus, inter-judge agreement was poor. Reliability appeared to be independent of factors that have been assumed to be important such as years of experience, practice pattern, or frequency of use of cervical auscultation. Stroud, Lawrie, and Wiles (2002) found a high degree of agreement when aspirated swallows were rated, but a high level of false-positive errors was found when non-aspirated swallows were presented. The authors question the value of auscultation as a “stand-alone evaluative technique” and suggest that its value may be seen in support of other examination techniques.

**Conclusions**

At the conclusion of their report on the auscultation of swallowing sounds, Cichero and Murdoch (2002, p. 49) stated “Clinicians should now proceed with the introduction of cervical auscultation into dysphagia clinics.” The results from two additional studies reviewed have shown that by this technique it is possible to differentiate between normal and dysphagic swallows and between aspirated and non-aspirated swallows. Further, the studies reviewed in this article show that cervical auscultation of airway sounds add significant information to the clinical examination. The data also show that some individuals are able to reliably detect aspiration in real time via an acoustic signal, but that others cannot. There is a question as to whether these are clinicians who come to the technique possessing a “good ear” and whether that ability can be trained to others who do not seem to have this innate ability.

Given these limitations, should dysphagia clinicians incorporate these technologies into their dysphagia practices? The data suggest that it may well depend upon the skills of the clinician and the purpose for which the technology is used. The results suggest that both techniques can add utility to the clinical examination, but that the limits of the technologies must be appreciated. Detection of abnormality or the presence of aspiration still leaves the clinician with important questions such as, What is the cause of the abnormality? and What is an appropriate management plan? This limitation points specifically to the difference between screening and evaluation tools. The screening tool’s function is to detect the presence of a condition and allow triage for further evaluation. The evaluation tool’s function is to detect a condition and to describe it sufficiently that its causes are understood and effective treatment planning can take place. It is my opinion, and one that is shared by several other authors (Leder & Espinosa, 2002; Logemann, 1998; Saaski & Leder, 2003; Stroud et al., 2003), that, in their current state of development, both forms of auscultation are best viewed as screening tools. With further development, the procedure may at some point transcend this
limitation, but in their current states they have not.

**Learning to Auscultate**

If a clinician wishes to learn to use auscultation as a screening tool, there are few well-developed options. Karnath and Boyars (2002) have suggested that we take advantage of today’s digital technology to create structured training materials designed to teach those who innately do not come to the task with the necessary skills. These courses may be presented on-site or through distance learning. To date, only one such program has been located that has been awarded ASHA CEUs (Logsdon, n.d.). This program presents a discussion of important aspects of auscultation including a review of the respiratory system, presentation of auscultation terminology, and a review of relevant publications. It does not, however, provide experience in judging auscultated sounds of the swallow or of airway sounds surrounding the swallow. Surely, if courses are to be developed to provide skill-based training, then such practice modules will be required.

While formal courses may prove helpful, there is another technique that clinicians with access to VFSS can employ to help train themselves in the auscultation of airway sounds surrounding the swallow. The clinician can connect a contact microphone to throats of patients who are completing the VFSS. The microphone should be connected to an audio input on the VCR, so that the acoustic signal is recorded simultaneously with the video image. Following each swallow of interest, the patient is allowed to inhale and exhale as the transducer collects its information. In this way, on review of the videotape, the clinician’s ear can begin to hear what the eye is accustomed to seeing in the fluoroscopy suite when aspiration occurs. While it is true that a microphone is used rather than stethoscope, such practice may still prove beneficial in learning to recognize sounds associated with aspiration versus those where aspiration does not exist. These same videotape recordings could also be provided to clinicians who do not have access to VFSS for use in their own training.

The contributions of auscultation in dysphagia management in the future will be significant. The continued study of the sounds of the swallow will yield a better understanding of the normal and disordered swallow. It is likely that through further study specific physiological swallowing events, both normal and abnormal, will be tied to elements of the waveform. At some point, this form of auscultation may begin to serve us as an evaluation tool that can be applied at the bedside with relatively minimal cost and no radiation exposure to the patient. The cervical auscultation of airway sounds is making a more immediate impact on clinical practice due to the limited equipment that is required, but is likely to remain as a screening tool unless intelligent stethoscopic technology can be brought to bear. With either form, clinicians who undertake their use at the present time must recognize their limitations and understand that they are best used as screening tools.

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**References**


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Introduction

Why is it essential for an infant, child or adolescent with feeding/swallowing problems to receive a clinical examination and evaluation prior to considering an instrumental assessment? The value of the pediatric clinical feeding/swallowing assessment lies in the comprehensive nature of the process.

The clinical assessment will provide the speech-language pathologist with the greatest amount of information regarding the child’s typical feeding/swallowing function. No other tool available is capable of providing the vast amount of information that can be obtained through the clinical assessment process. Through the clinical assessment, information about all aspects of the child’s internal and external environment that may affect his or her feeding/swallowing function will be obtained. A thorough clinical assessment provides information necessary to make appropriate intervention recommendations.

The infant, child, and adolescent are different from each other, and all are very different entities from the adult. The child has immature anatomy and physiology as compared to the adult. Growth and development is an underlying process, which affects all aspects of feeding and swallowing. Growth enlarges and remodels the anatomy, especially of the oral and pharyngeal mechanisms, expands internal spaces, modifies locations of the origins and insertions of musculature, increases nutrition and hydration needs, and requires greater muscular strength and complexity of control (Alexander, Boehme, & Cupps, 1993; Kent & Vorperian, 1995; O’Connor, 1995a; Rommel et al., 2003).

A primary concept that must be foremost in the examiner’s thought processes during the clinical assessment is that growth and development occur in a sequence, on a continuum, in the typical child. Each child progresses through the continuum at his or her own rate, and at times, varies in the sequence. Therefore, an individual child is not likely to be functioning at precisely the same level(s) as his or her same-age peers.

There are four primary areas of influence on pediatric feeding and swallowing function—respiratory system function, gastrointestinal system function, pharyngeal function, and oral function—that must be thoroughly evaluated when conducting a pediatric clinical assessment. These areas must be analyzed in terms of their individual functional characteristics, their interactions with each other, and their interactions with other body systems.

Respiration is the predominant area affecting pediatric feeding/swallowing function. Respiration is essential for life. Swallowing interrupts respiration (swallowing apnea). Therefore, to some children, swallowing may be a life-threatening event (Thach, 1992). Respiration may be affected by structural airway restrictions (e.g., large palatine tonsils and/or adenoids, choanal stenosis) or functional airway restrictions (e.g., tongue and/or jaw retraction, laryngomalacia; Strife & Emery, 1995). Another factor may be unexpected or prolonged airway closure (e.g., laryngeal closure in response to gastroesophageal reflux; O’Connor, 1995b; Putnam, Ricker, & Orenstein, 1992). Any respiratory problem will negatively impact a child’s feeding/swallowing function.

The gastrointestinal (GI) system is responsible for processing, immunizing, digesting, and absorbing nutrition and hydration. The gastrointestinal system is highly complex and regulated by sensory feedback (Hyman & DiLorenzo, 1993). This sensory feedback determines what foods and liquids are accepted, how frequently children eat or drink, and what quantities they are willing to ingest. Gastroesophageal reflux (GER) has a significant influence on pediatric feeding and swallowing function. It is defined as retrograde
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flow of gastric contents into the esophagus. The major effect of GER on infants and children is the laryngeal closure response. Children learn that by eating too much or too often, they may not be able to breathe. In addition, GER that reaches the upper airway can contribute to multiple structural and functional airway issues. Therefore, children may adjust the foods and liquids they accept, change their feeding schedules, and modify the amounts they eat in response to problems with their gastrointestinal function (Gremse, 2004; Putnam, 1997; Putnam, Ricker, & Orenstein, 1992; Rudolph, 1995).

Pharyngeal issues influence feeding and swallowing activities due to the dual functions of the space. The primary function of the pharynx is airway. Swallowing is the secondary function. Therefore, since respiration is essential for survival, pharyngeal issues will interfere with how and what is swallowed and airway protection (O’Connor, 1995b). Pharyngeal issues are most commonly associated with pharyngeal sensory impairment and impaired motility of food and liquid through the pharynx. Structural issues may also affect pharyngeal motility, airway protection, and respiration. Typical function allows these activities to proceed in an effective and efficient manner requiring minimal airway closure time (approximately one second). Any structural or functional impact on the organization, coordination, sequence, or strength of the pharyngeal activities or events will impair the motility of the bolus through the pharynx and jeopardize airway protection. Any time pharyngeal motility is impaired or airway protection is jeopardized, respiration may be negatively affected (Haddad & Prestigiacomo, 1994).

Pharyngeal sensation provides the monitoring system for the timing of pharyngeal events, including airway closure and airway protection. Reduced responsiveness to pharyngeal sensation is likely to result in silent aspiration due to inappropriate timing of pharyngeal events and poor clearance of the mechanism. Heightened responsiveness to pharyngeal sensation is likely to result in the refusal to swallow heavily textured foods, gagging, and choking and may also contribute to oral defensiveness and behavior issues. Direct observation of pharyngeal issues is not possible, but a great deal of information can be obtained by careful observation of the activity of the head and neck and breathing during feeding/swallowing activities (Arvedson & Brodsky, 2002; Sheppard, 1994).

Oral issues are the most easily observed and best known. Oral sensory issues affect the selection of food and liquid textures, tastes, smells, and the types of utensils accepted by the child, the amount of food accepted at a meal, bolus preparation time, the time needed to complete a meal, and saliva management. Oral motor problems affect the effectiveness and efficiency of bolus preparation, control, and propulsion; the selection of food textures; the utensils used for eating and drinking; and saliva management. Oral structural/alignment issues affect airway size, shape, and nasal or oral airway resistance; chewing ability; bolus preparation, control and propulsion; and saliva management (Alexander, 2001; Arvedson & Brodsky, 2002; Morris & Klein, 2000).

Behavioral management issues are not typically a primary influence on swallowing, but develop secondary to respiratory/airway, gastrointestinal, pharyngeal, and oral issues. Behavior management issues are related to the child’s response to the environment and the environment’s response to the child. If atypical feeding/swallowing function occurs, the response from the environment becomes critical. It is from the environmental response that infants and children learn whether they are safe or not and how to manipulate their environment. This manipulation can develop over time into either positive or negative interactions. Problems arise as a result of negative interaction (Satter, 1995, 2000). Parents, caregivers, and service providers must always remember that behavior is communication. If an infant or child responds negatively during a feeding experience, it is highly likely that something is wrong and must be remediated before he or she will learn that feeding can be a positive experience.

Assessment Process

The pediatric clinical assessment process focuses on the examination and evaluation of the variety of factors that influence an infant, child, or adolescent’s feeding and swallowing function (see the clinical assessment guidelines attached at the back of this issue). Several different information collection strategies are used, including gathering of case history information, observations of the child and his family,
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and the introduction of modifications to function.

Case history and pertinent current information (see the case history outline attached at the back of this issue) will need to be gathered through discussions with the child’s caregiver and, if available, through the review of pertinent medical and educational reports. Obtaining birth and neonatal history from the parents will be extremely important. If the infant was born prematurely, it is valuable to obtain a copy of the hospital discharge report, which will give more specifics pertaining to problem areas and possible etiologies (Rommel, DeMeyer, Feenstra, & Veereman-Wauters, 2002).

It is essential to obtain a list of medications that a child has received in the past and is receiving at the present time. The side effects of medications and the interactions among medications can have a significant impact on a child’s appetite and overall feeding/swallowing function (Blank & Harper, 2002).

Other pertinent medical history should include information about past surgeries (e.g., orthopedic, cardiac, neurological, gastrointestinal, pulmonary, oral, pharyngeal) and neurological and genetic testing. When evaluating older children or adolescents with problems in feeding/swallowing function, it is important to ask about past and present therapeutic and educational programming services as well as surgeries. Orthopedic surgery information is especially important, since it may directly affect the movements and position of a child’s body for mealtime and the equipment that can be recommended to provide a more appropriate body alignment for eating (Scherzer, 2001; Wilson, 1993; Woods, 1995).

More specific information pertaining to a child’s feeding/swallowing and respiratory history will be required (see the case history outline). Information about the methods by which a child has received nutrition in the past is significant, since it directly influences strategies that may be recommended subsequent to the evaluation. A history of frequent coughing, choking, or gagging may be indicative of pharyngeal sensory issues or respiratory/airway issues. A history of vomiting, spitting up, and chronic constipation may suggest that gastrointestinal issues exist. Chronic upper respiratory infections, chronic ear infections, and a wet/gurgly voice/respiratory quality suggest that problems with pharyngeal and/or posterior oral sensory awareness or musculature activity may exist requiring more direct examination through instrumental testing procedures.

Gathering information from the parent/caregiver about a child’s sleep history can be extremely enlightening. Infants and young children who wake often and need to be fed frequently during the night may have gastrointestinal or respiratory/airway issues that will need further evaluation by other specialized medical professionals. Some older children with feeding/swallowing problems have difficulties getting to sleep and wake often during the night, suggesting possible gastrointestinal problems or underlying sensory processing issues, which will require further evaluation by a pediatric occupational therapist (Glass & Wolf, 1993; Morris & Klein, 2000).

Talking with parents about allergies that the child’s family members might have or increases in congestion that the child may exhibit at different times of the day is essential. Even young children who cannot be reliably tested for certain allergies or sensitivities, may exhibit signs similar to those of their parents. Allergies that affect the gastrointestinal or respiratory systems can have a direct influence on a child’s nutritional intake and overall feeding/swallowing function (Burks & Sampson, 1993; Canny & Levison, 1994; James & Burks, 1999).

The most efficient way to collect information about an infant, child, or adolescent’s present function is through the use of the daily diet diary. Two or three diet diary sheets (see the attached Daily Diet Diary form at the back of this issue) should be sent to a child’s parent/caregiver for completion prior to the evaluation session. Such a daily log will provide specific information on feeding schedule, food and liquid intake amounts, types of foods eaten, and medications. Additional information about food likes and dislikes, preferred food temperatures, equipment used, and environment modifications provide important sensory-based information about the child, which can be used in future intervention strategy development.

It is important to ask the caregiver for an estimate of the length of time it takes for the child to complete each meal. The longer a child takes to eat a meal (over 30 minutes), the more calories they burn during the actual eating process. Some infants are so exhausted by the drinking process, that they fall asleep after only
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10 minutes of bottle drinking. Therefore, weight gain and nutritional intake may be directly influenced by the length of time during which a child is actually feeding.

Asking the right questions can provide the evaluator with significantly greater insight into the multiple factors that may influence an infant or child’s feeding and swallowing function (Sullivan et al., 2000). When this information is combined with clinical examination findings, a preliminary intervention plan and recommendations can be made, including referring the infant or child to other members of the swallowing team (e.g., otolaryngologist, speech-language pathologist for a videofluoroscopic swallow study).

The clinical examination (see attachment) includes clinical observations of the infant, child, or adolescent during a mealtime eating and drinking situation that is as typical as possible. It is also essential to observe the infant during other activities, such as during play, communication, and movement-based activities. Often, problems that occur during oral and pharyngeal function are also observed during other functional activities. This is significant for treatment program planning. Eating and drinking tasks require the child to tolerate, integrate, and respond to a variety of sensory experiences. It is important to recognize the sensory information being provided during each aspect of the feeding and swallowing process as you observe the child being fed by the caregiver. The texture, size, or shape of the nipple on the bottle, the spout on the cup, or the spoon may have more influence on the child’s oral activity than the food or liquid being presented. The speed and direction with which a spoon or cup is brought to a child’s mouth can dramatically affect the child’s head/body position as well as oral activity during feeding. The texture, size/volume, temperature, taste, and smell of food placed in the mouth may determine whether the child can prepare and move the food efficiently through the oral and pharyngeal areas or whether problems with the clearing of residual material or aspiration will occur. Recognizing the impact of sensory influences on a child’s eating and drinking will result in the development of appropriate treatment goals and strategies that will advance the child’s functional abilities (Alexander, 2001; Morris & Klein, 2000; Murphy & Caretto, 1999).

Observing respiratory function during play, communication, and eating/drinking activities is an underlying theme throughout the examination process. Since the quintessential issue determining whether a child should orally feed relates to his or her ability to protect the airway during the feeding process, respiratory function overall, and how the child coordinates respiratory function with oral and pharyngeal activity during different functional tasks are fundamental to any pediatric clinical assessment (Connaghan, Moore, & Higashakawa, 2004; Morton, Minford, Ellis, & Pinnington, 2002).

While observing the child in play and during feeding, it is imperative that the relationship between the child’s postural control and body movements and his or her oral and pharyngeal activity be examined. Although the equipment the child uses for eating (e.g., highchair, booster seat, wheelchair, stander) is important, the child’s head/neck/body alignment in the equipment is the most important issue because it provides the underlying foundation for the oral, pharyngeal, and respiratory function during oral eating and drinking activities (Alexander, 2001; Larnert & Ekberg, 1995; Snyder, Breath, & DeMauro, 1999). The position of the parent/caregiver while feeding must also be analyzed with regards to its influence on the infant or child’s body alignment as the food is presented.

During the clinical examination, the evaluator may identify modifications to the sensory characteristics of the food/liquid being presented, the equipment being used for positioning or food presentation, the oral preparation of the child prior to feeding activities, or the body alignment of the infant or child prior to being held or positioned for feeding that would be valuable to investigate further. Sometimes it is possible to attempt a change during the evaluation session. However, sometimes modifications cannot be made because the infant falls asleep after feeding or due to the anxiety/concerns of the child or caregiver in regard to the specific change that is being suggested. With some children, it is more effective if the clinical assessment is done over several sessions so that more specific findings can be collected. For additional information on specific aspects of the pediatric clinical assessment process, the following publications are suggested: Alexander (2001, 2002); Alper and Manno (1996); Arvedson and Brodsky (2002); Comrie and Helm (1997), Girolami, Ryan, and Gardner (2001); Glass
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and Wolf (1993); Mathers-Schmidt and Kurlinski (2003); Morris and Klein (2000); Pinder and Faherty (1999); Schwarz (2003); and Sheppard (1995).

Recommendations/Intervention Plan

Once the findings of the examination have been analyzed and summarized, recommendations for an intervention plan must be developed and discussed with the parent/caregiver as well as the child’s referring physician. There are four key areas, which compose this intervention plan (see attachment).

Information provided by the parent/caregiver and the findings of the clinical examination need to be analyzed to determine if there are questions that exist pertaining to the influences of other body systems on the child’s feeding and swallowing function. If so, then it will be important to discuss the findings that suggest the need for the child to be evaluated by other specialized medical professionals.

If there are suspected sensory issues, a pediatric occupational therapist with special knowledge and experience in this area would be an appropriate referral source. If there are positioning and body alignment issues affecting the postural foundation needed to support oral and pharyngeal activity for feeding, referral to a pediatric physical therapist would be valuable (Howle, 2002; Stamer, 2000). If there is a history of chronic ear infections, sleep problems, and wet/gurgly respirations, a pediatric otolaryngologist should be consulted. The pediatric gastroenterologist should be referred to for evaluation if there appear to be problems with chronic constipation, refusal of specific types of foods, or clinical indicators of GER. If there is a history of chronic respiratory problems or chronic aspiration, the pediatric pulmonologist would be a very important medical professional to have examine the child. When there is a history of poor weight gain and slow growth, limited or excessive food or liquid intake, or a restricted variety of foods in the child’s diet, evaluation by a pediatric dietitian would be valuable (Kovar, 1997; Nardella, Campo, & Ogata, 2002; Sullivan et al., 2002).

Instrumental assessment of feeding/swallowing function may be necessary to investigate pharyngeal issues, airway issues, or potential aspiration. These issues, including aspiration, cannot be directly observed during the clinical examination; only inferences can be made. In fact, many infants and children with oropharyngeal disorders silently aspirate, and only an instrumental evaluation can determine this problem. The two instrumental assessments available are the Fiberoptic Endoscopic Evaluation of Swallowing (FEES) with or without sensory testing and the Oral-Pharyngeal Motility Study (OPMS, i.e., Modified Barium Swallow, Videofluoroscopic Swallow Study).

The FEES should be considered if it is essential to provide direct visual inspection of the upper airway, to directly observe the pharyngeal phase of the swallow, assess airway safety, or to locate and quantify residual or aspirated material (Willging, Miller, Link, & Rudolph, 2001). This study also provides visual inspection of the condition of the pharyngeal and laryngeal tissues, which may provide valuable information regarding potential pathologies.

The OPMS should be considered if it is essential to observe the interaction of oral and pharyngeal phases, assess timing of events through the entire swallow process, evaluate the swallow patterns, assess upper esophageal sphincter and proximal esophageal function, and airway protection (Arvedson & Lefton-Greif, 1998). Modifications of the feeding/swallowing process can be made, and the effectiveness of these modifications can be immediately evaluated.

One of the primary outcomes of a pediatric clinical assessment is determining the appropriateness of oral feeding. The decision must be made by considering a number of variables, including the efficiency and effectiveness of oral feeding, airway safety, work of breathing, availability of an alternative feeding route, and family issues. If there are concerns regarding the possible need for an alternative feeding route, the child should be evaluated by a team including a pediatric gastroenterologist, dietitian, pediatric psychologist as well as the speech-language pathologist.

It is essential that recommendations for treatment program planning be included in the intervention plan. This will allow for immediate scheduling of treatment services, even if modifications or additions are made to the plan by the treating speech-language pathologist.

There are two parts to the treatment program plan. Recommendations regarding both direct treatment and mealtime feeding goals and strategies should be provided, focusing on areas that do not need additional medical investigation prior to implementa-
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Infants, children, and adolescents with feeding and swallowing problems require that a comprehensive clinical examination and evaluation be conducted. If additional evaluations and testing are required to determine the primary areas influencing that child’s function, they must be conducted and their findings must be incorporated into the intervention plan. Treatment programming must reflect the infant, child, or adolescent’s needs, not just in terms of intake at mealtime, but also, in terms of his or her potential for developing more efficient, coordinated feeding and swallowing function.

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References


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Oral-Motor, Feeding/Swallowing, and Respiratory Coordination Function

Clinical Assessment: General Guidelines

I. CASE HISTORY/GENERAL INFORMATION
(Refer to written material entitled, “Clinical Assessment: Case History/Pertinent Current Information)

A. Pertinent Medical History
B. Feeding/Respiration History
C. Current Feeding/Nutrition Information

II. CLINICAL OBSERVATIONS

A. Postural Control and Movement
   1. Jaw, tongue, cheek/lip, rib cage, and respiratory musculature activity/control during general movement activities and play.
   2. Jaw, tongue, cheek/lip, rib cage, and respiratory musculature activity/control during upper extremity/hand activities.
   3. Influence of head/body movements on oral-motor function.

B. Responses to Sensory Stimulation
   1. Influences of vestibular (movement), tactile/propiroceptive, visual, and auditory stimulation on postural alignment, head/body movements, oral mechanism posture/activity, and respiratory function.
   2. Influences of tastes, smells, and temperatures on oral/facial activity, postural control and movement, and respiratory function.
   3. Response to and attempts to engage in activities which involve vestibular, tactile/propiroceptive, visual, auditory, taste, olfactory and/or temperature sensory experiences.
   4. Resistance to oral sensory input? Related to history of GER? Related to pulmonary history?

C. Respiratory Function
   1. Alignment and contour (shape) of rib cage and thoracic (chest)/abdominal areas when maintaining/functioning in positions and during general movement, upper extremity/hand, phonation, communication (speech, pointing, etc.), and feeding/swallowing activities.
   2. Pattern, rhythm, speed, and depth of respiratory functioning when maintaining/functioning in positions and during general movement, upper extremity/hand, phonation, communication (speech, pointing, etc.), and feeding/swallowing activities.
   3. Changes in respiratory function characterized by variations in loudness and quality of breathing and phonation.

D. Oral-Motor/Feeding/Swallowing Function
   1. Oral facial structure
      (a) Alignment/relationship of oral-facial structures at rest and during movement activities.
      (b) Contour/shape of face. Asymmetries?
      (c) Cheeks and Lips: Any asymmetries? Position of lips at rest. Do cheeks appear inactive/hypotonic or tight at rest and/or during movement? Do lips appear inactive/hypotonic or tight at rest and/or during movement?
      (d) Jaw: Size and shape. Relationship to maxilla when mouth is either closed or opened. Retracted? Protruded? Asymmetrical?
      (e) Tongue: Size, shape, contour, and position of tongue at rest. Shape, contour, and position of tongue with mouth opening. Asymmetrical? Does the tongue appear inactive/hypotonic or tight at rest and/or during movement?
      (f) Hard Palate: Symmetrical? Shape (high arch or narrow). Cleft?
      (g) Soft Palate: Shape. Symmetrical? Cleft?
      (h) Gums and Dentition: Color/general appearance of gum tissue. General condition of teeth. Alignment of teeth. Relationship of upper and lower teeth when mouth closed.
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2. Feeding position(s)
   (a) Equipment used during eating and drinking activities related to the position of the infant/child.
   (b) Postural alignment of infant/child at the start of feeding.
   (c) Changes in the postural alignment of the infant/child during eating and drinking activities.
   (d) Influence of head/neck/body alignment on oral and pharyngeal alignment/function.
   (e) Position of parent/caregiver in relationship to position of infant/child during feeding activities.
   (f) Influence of parent/caregiver’s position/movements on infant/child’s postural and oral-pharyngeal alignment/function.

3. Bottle drinking/breastfeeding/cup drinking/other methods of liquid intake
   (a) Utensils/equipment/types of liquids being used/presented.
   (b) Position(s) of infant/child and caregiver throughout drinking activity.
   (c) Movements (independent and in coordination) of the jaw, tongue, and cheeks/lips at the start of, during, and at the conclusion of drinking. (Describe range, direction, typical or atypical, etc.)
   (d) Loss of liquid? When? From where?
   (e) Sequencing of suck/swallow/breathe? How long?
   (f) Coughing? Choking? Changes in respiratory coordination/function and/or respiratory-phonatory quality during and/or after drinking.
   (g) Differences in 3(b)-3(f) if infant/child holds bottle or cup or if caregiver holds bottle or cup.

4. Spoon feeding of pureed/semisolid foods
   (a) Utensils/equipment/types of food being used/presented.
   (b) Position(s) of infant/child and caregiver throughout spoon feeding activity.
   (c) Movements (independent and in coordination) of the jaw, tongue, and cheeks/lips at the start of, during, and at the conclusion of spoon feeding. (Describe range, direction, typical or atypical, etc.)
   (d) Loss of food? When? From where?
   (e) Coughing? Choking? Changes in respiratory coordination/function and/or respiratory-phonatory quality during and/or after spoon feeding.
   (f) Differences in 4(b)-4(e) if infant/child holds/uses spoon or if caregiver holds/uses spoon.

5. Biting and chewing of soft/hard solids
   (a) Utensils/equipment/types of solids being used/presented.
   (b) Position(s) of infant/child and caregiver throughout solid food intake activity.
   (c) Movements (independent and in coordination) of the jaw, tongue, and cheeks/lips at the start of, during, and at the conclusion of solid food intake. (Describe range, direction, typical or atypical, inactivity, etc.)
   (d) Loss of food? When? From where?
   (e) Coughing? Choking? Changes in respiratory coordination/function and/or respiratory-phonatory quality during and/or after solid food activities.
   (f) Differences in 5(b)-5(e) if infant/child is finger feeding or if caregiver is presenting the solid.

6. Drooling
   (a) Age appropriate?
   (b) Related to teething, oral sensory awareness, oral-motor activity, alignment of oral structures, and/or head position?
   (c) Activities when drooling stops or reduces.
   (d) Activities when drooling is increased.
   (e) Wet/gurgly quality due to problems with clearing saliva from the oropharyngeal area as well as problems with drooling?

7. Oral motor function during sound/speech production (May require additional testing)
   (a) Sound/speech production occurs in direct relationship to head/body movements.
   (b) Sound/speech production occurs separate from significant head/body movements.
   (c) Problems with coordination of oral activity, laryngeal function and air stream, especially at initiation of phonation/sound production (closed or open laryngeal blocks).
   (d) Types and duration of sounds/sound sequences being produced.
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(e) Changes in sound production during oral sensory and/or feeding activities?

8. Imitation of oral facial movements/sound production (May require additional testing)
   (a) Age appropriate response to changes in facial expression or oral activity presented by adult, but not yet able to imitate.
   (b) Tries to imitate, but cannot reproduce movements/activity/sounds due to atypical oral and pharyngeal function.
   (c) Tries to imitate, but cannot organize motor plan of movement sequence, even when has produced the movement spontaneously during the session.

E. Communication (May require additional testing)
   1. Interactions between infant/child and caregiver during play, dressing, and feeding/swallowing activities.
   2. Infant/child initiates communication interaction using body movements, pointing, gestures, sounds, etc. and parent/caregiver responds – how?
   3. Parent/caregiver initiates communication and infant/child responds – how?
   4. Infant/child’s attempts at or modes of communication appear appropriate for infant/child’s age and/or restrictions due to physical limitations.

III. Modifications to Function Introduced During the Assessment
   A. Infants often fall asleep before any modifications can be made.
   B. Children may resist modifications in feeding activities when presented by the evaluator and not the parent/caregiver.
   C. Modifications to feeding position/postural alignment, textures, or equipment/utensils introduced during the assessment should be done very cautiously, especially if there are questions regarding the safety of the infant/child’s swallow.

IV. Summary

V. Recommendations/Intervention Plan
   A. Areas in which further investigation through other medical referrals are strongly suggested.
   B. Instrumental testing recommended for further investigation of the swallowing process, if needed (e.g., videoswallow study, FEES).
   C. Recommendations regarding appropriateness of present feeding method(s) and/or need to consider other supplemental or alternative methods for nutritional intake.
   D. Treatment program planning (if applicable; the child’s swallow may need further assessment before certain treatment protocols are implemented, for example, changes in food consistencies allowed).
      2. Recommendations regarding mealtime feeding and other appropriate
      3. Carryover activities.

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When conducting a clinical assessment of oral motor, feeding/swallowing, and respiratory-phonatory function, it is essential that questions be asked of the parent/caregiver, which obtain information in the following areas:

A. **Pertinent Medical History**
   1. Birth/neonatal history and etiology
   2. Medications (past/present)
   3. Surgeries (e.g., cardiac, orthopedic, neurologic)
   4. Neurological or genetic testing/outcomes
   5. Diagnoses
   6. Physician(s)/significant health professionals presently providing services.
   7. Programming presently involved in (e.g., PT, OT, Speech, Education)

B. **Pertinent Feeding/Respiratory History**
   1. Tube feeding (past/present)
   2. If tube fed in the past, but orally fed now, procedures used to transition (when? who assisted?)
   3. If only orally fed, description of feeding in the past (food/liquid presented, utensils, positions, intake, feeding schedule, special modifications)
   4. Ventilatory/respiratory support (past/present)
   5. History of failure to gain weight or poor weight gain
   6. Frequent coughing, choking, and/or gagging during/after feeding (past/present)
   7. Reflux, vomiting, and/or spitting up during/after feeding (past/present)
   8. History of chronic constipation
   9. History of pneumonia, bronchitis, or frequent upper respiratory infection (when? how often?)
   10. History of persistent ear infections (when? how often?)
   11. Sleep problems (past/present)
   12. History of frequent irritability (when?)
   13. Wet/gurgly voice quality (when?)
   14. Problems with oral secretions/increased congestion/drooling
   15. History of allergies (to what? other family members have allergies? pediatric allergist seen?)
   16. Previous testing for GER, respiratory problems, or swallowing problems (what tests? when? who/where conducted? results.)
   17. Structural/functional problems of oral and pharyngeal mechanisms (pediatric otolaryngologist seen?)
   18. Structural/functional problems of gastrointestinal and/or respiratory systems (pediatric gastroenterologist and/or pulmonologist seen?)
   19. Surgeries (oral, pharyngeal, gastrointestinal, pulmonary)

C. **Current Feeding/Nutrition Information**
   1. Daily feeding schedule (2-3 day daily log preferable)
   2. Intake amounts (2-3 day daily log preferable)
   3. Medication schedule (2-3 day daily log preferable)
   4. Types of foods/liquids presently receiving (since when? changes?)
   5. Food likes/dislikes
   6. Temperature of food/liquids prefers
   7. Length of time for feeding
   8. Special environment changes for feeding
   9. Feeding utensils/equipment (past/present)
   10. Feeding position(s) generally used

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