Spring 4-11-2017

Speech-Language Pathologists' Estimates of Bolus Sizes Used During Dysphagia Evaluations

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SPEECH-LANGUAGE PATHOLOGISTS' ESTIMATES OF BOLUS SIZES USED DURING DYSPHAGIA EVALUATIONS

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A Thesis Submitted In Partial Fulfillment Of The Requirement For The Degree Of Master Of Science in Communication Sciences & Disorders

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Date of Oral Defense April 11, 2017

Date of Acceptance April 24, 2017

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STRUZZIERI, JOYANNA E., B.S. Speech-Language Pathologists' Estimates of Bolus Sizes Used During Dysphagia Evaluations. (2017)
Directed by Dr. Kellyn Hall. 85 pp.

Dysphagia evaluations play an important role in the assessment and treatment of people with swallowing problems. Protocols and methods for assessment vary greatly among clinicians, however, all assessments involve trials of food and liquid boluses given across different consistencies and in varying amounts. Thin and thick liquids, thin puree, thick puree or pudding, and solid consistencies are considered standard across all types of dysphagia evaluations (McCullough & Martino, 2013). The amounts of food and liquids that are given, e.g. half-teaspoon, full-spoon, drive therapeutic recommendations for bite and sip sizes. Previous research suggests speech-language pathologists (SLPs) do not have specific training in measuring food amounts and that therapeutic bite sizes vary among speech-language pathologists and caregivers feeding patients with dysphagia (Hall & Gillikin, 2015). It is not known if the bite and sip sizes used during dysphagia assessments also vary among SLPs and/or if these amounts accurately measure the intended volume. For example, is the bolus size given during an evaluation really a half teaspoon? It is also not known if indirect training or experience, such as cooking experience, is related to the accuracy of bolus measurements for swallowing evaluations. The purpose of the study was two-fold: 1) to determine what amounts/consistencies SLPs use in dysphagia evaluations; and 2) are SLPs accurate in estimating food/liquids amounts.

Fourteen certified, licensed, and experienced SLPs who routinely perform dysphagia evaluations were included in this study. Actual weight in grams was calculated for exact volumes of thin and thick liquids, thinned puree (applesauce), and thick puree (pudding) in ½ teaspoon (5 milliliters), 1 teaspoon (10 milliliters), and 1 tablespoon (15 milliliters) amounts. These were compared to the observed amounts of these volumes that were estimated by the participants. The results suggest that the average estimation of each amount made by the SLPs was significantly different from the actual amount. The SLPs were the most accurate when estimating ½ teaspoon amounts of thin and nectar thick liquid and the least accurate when estimating 1 tablespoon of thin and nectar thick liquid. Participants who used measuring spoons weekly were more accurate estimators than those with less experience. Finally, a survey was taken to determine the protocols that the SLPs use for swallowing evaluations. Comparisons of the reported protocols showed the most variability for the non-instrumental assessment, the clinical swallowing examination. Here, the SLPs would often use patient controlled bite and sip sizes or "small" and "large" amounts of liquid/purees. The SLPs who reported their protocols for the instrumental assessments, specifically, fiberoptic endoscopic evaluation of swallowing (FEES) and modified barium swallow studies (MBSS) were more likely to adhere to specific food amounts (i.e. ½ tsp or 2.5 ml). Regardless, the protocols varied between the SLPs and their assessment.

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by

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A thesis submitted in partial fulfillment of the requirements
for the Master of Science degree in Communication
Sciences and Disorders in the
Graduate College of
Longwood University

May 2017

Approved by

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Committee Chair

To God, my family, and the CSDS Class of 2017

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ACKNOWLEDGMENTS

Many speech-language pathologists contributed to the completion of this research effort. My thesis committee has been flexible, informative, and extremely helpful. I am grateful for the efforts of Drs. Kellyn Hall, Shannon Salley, and Ann Cralidis for serving on the committee. In addition, I would like to thank Hannah Brisson and Sherilyn Smith for aiding with data collection.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Eating and drinking are fundamental to a person's health and quality of life. When a person is unable to effectively or safely swallow, they may be diagnosed with dysphagia. This diagnosis often requires therapeutic interventions, such as altering food textures, thickening liquids, and implementing swallowing strategies in order for the person with dysphagia to safely eat and drink. Oropharyngeal and esophageal dysphagias have been recognized as medical impairments. According to the American Speech-Language-Hearing Association (ASHA) (n.d.), dysphagia is defined as "problems involving the oral cavity, pharynx, esophagus, or gastroesophageal junction."

Symptoms of dysphagia include coughing when eating, food sticking in the mouth or throat, throat clearing when eating, the sensation of something remaining in the mouth or throat after swallowing, and other discomforts that are related to the eating process. Individuals experiencing dysphagia may avoid food that is problematic for them to chew and swallow. Medical complications arising from dysphagia include choking, malnutrition and dehydration, aspiration pneumonia, chronic lung disease, and compromised general health. Patient morbidity stemming from dysphagia is also of great concern to medical professionals. In addition, dysphagia may increase the burden on caregivers and may necessitate significant lifestyle alterations for the individual and his or her family (Bhattacharyya, 2014).

Dysphagia is a common medical complaint among adults who are experiencing complications arising from several different etiologies. Damage to the central nervous system, cranial nerves, and unilateral cortical and subcortical lesions may result in secondary dysphagia (e.g. stroke, traumatic brain injury, dementia, or Parkinson's disease). Some abnormalities and issues related to the head and neck will also result in feeding and swallowing disorders (e.g. trauma/surgery, decayed/missing teeth, cardiac obstructive pulmonary disease, or gastroesophageal reflux disease). In addition, medications with side effects that inhibit the work of the swallowing mechanism have also been shown to cause dysphagia (Cook, 2009). Recent research has demonstrated that dysphagia occurs in about 1 out of every 25 adults in the United States, annually (Bhattacharyya, 2014).

The management of dysphagia is a vital aspect of care for patients demonstrating unsafe food and liquid consumption. The American Speech-Language-Hearing Association's (ASHA) position on this issue states, "speech-language pathologists play a primary role in the evaluation and treatment of infants, children, and adults with swallowing and feeding disorders" (n.d.). Speech-language pathologists (SLPs) are suited to treat this population due to their extensive knowledge of the anatomy and physiology of the upper aerodigestive tract, which include the oral cavity, pharynx, and cervical esophageal anatomic regions. Each of these structures are vital for swallowing and speech functions. Therefore, the responsibility of evaluating for dysphagia is assigned to the SLP.

To conclusively develop accurate goals for therapeutic treatment, assessment of dysphagia may include instrumental and non-instrumental swallowing measures. Instrumental measures include fiberoptic endoscopic evaluation of swallowing (FEES) and modified barium swallow studies (MBSS). If the SLP does not have access to these instruments, or if the patient is not a candidate for these measures, the SLP may use a clinical swallow evaluation (CSE) to assess feeding and swallowing function. The purpose of these assessments is to define swallowing ability and determine the course of treatment. To date, there is no universally recognized protocol for administering trial feeding during dysphagia assessments. Typically, a variety of bolus sizes and consistencies are evaluated that include small to progressively larger boluses (as tolerated) across thin liquid, thick liquid, puree, and solid consistencies. The accuracy and consistency of SLPs in administering specific and uniform amounts of food and liquids during dysphagia assessment is important because the amounts tested drive therapeutic recommendations. If bolus size estimations are not accurate, therapy recommendations for limiting bite and sip sizes may be misleading and potentially unsafe for the patient.

The purpose of this study is twofold. Because the estimation of bolus sizes greatly impacts SLPs' recommendations, the first objective is to determine whether SLPs who conduct FEES, MBSS, and CSEs demonstrate accuracy when estimating specific bolus sizes. Secondly, because there is no universally accepted standardized protocol for conducting swallowing examinations, this study will also gather information regarding the types and amounts of food and liquid used by SLPs when performing FEES, MBSS and CSEs.

CHAPTER II

REVIEW OF LITERATURE

Approximately one in 25 adults experience swallowing problems, called dysphagia, each year requiring the services of a speech-language pathologist (SLP) (Bhattacharyya, 2014). SLPs work collaboratively with each other, the patient, other professionals, families, and caregivers to develop appropriate treatment plans based on careful assessment of swallowing function. In order to fully appreciate the importance of understanding variability that may exist between assessment measures and therapy guidelines, a review of the stages of swallowing, neurology of swallowing, respiratory and digestive tract functions, pathophysiology, clinical and instrumental assessment, and interventions for dysphagia are presented.

Normal Stages of Swallowing

Swallowing is a complex act that involves the coordination of oral cavity, pharynx, larynx, and esophagus. It involves the preparation and transfer of food and liquids, called a bolus, rapidly and efficiently into the esophagus. There are four main stages of swallowing: oral preparation, oral stage, pharyngeal stage, and esophageal stage. In the oral preparation stage, the bolus is prepared for the swallow through mastication, manipulation, and formation. The timing and type of preparation is dependent on the consistency being consumed. Hard, solid foods take longer to masticate than smooth foods, like noodles. The food is mixed with saliva to form a bolus. When the bolus is neurologically perceived as “swallowable”, the second stage of swallowing begins, which is called the oral stage.

During the oral phase, the bolus is propelled rapidly through the action of the tongue directing it down towards the oropharynx. The time it takes for a prepared bolus to move through the oral cavity in the oral stage is less than 1 second (Logemann, 1988). Special sensory receptors perceive when the base of the tongue and bolus reach the area of the anterior faucial pillars stimulating a swallowing response. In healthy adults, this triggering can be instantaneous although there is variability within individuals, and the timing increases with age (Clave, Verdaguer, & Arreola, 2005). The complete period of the swallow response in healthy adults ranges from 0.6–1 second (Jean, 2001).

The pharyngeal phase begins with the triggering of the swallow response. Regardless of food consistency, this phase involves a rapid sequence of overlapping events that takes place in less than 1 second (Logemann, 1995). The soft palate elevates and closes off the nasal passages. The hyolaryngeal complex, i.e. hyoid bone and larynx, elevate and move upward and forward. This elevation and anterior movement closes the larynx and protects the airway from aspiration. The overall transfer of the bolus from the mouth through the pharynx is primarily produced by the squeezing action of the tongue (Rofes, et al., 2011). The tongue pushes the bolus backwards and downward into the pharynx which squeezes the bolus through to the upper esophageal sphincter (UES) completing the pharyngeal phase of swallowing.

The final stage of swallowing takes place within the esophagus. Once the bolus has entered the esophagus, it is carried to the stomach by a mixture of esophageal peristalsis and gravity. This process is an important facet to note as it means that this phase requires no brainstem mediation (American Speech-Language-Hearing Association, n.d.). This process is completed using an anterograde sequence of contractions that propel the bolus from proximal to distal toward the digestive system. More specifically, upon entry of the bolus through the cricopharyngeal muscle, the esophageal phase is initiated (Kuo, Holloway, & Nguyen, 2012). Esophageal propulsion commences via muscle contractions that occur in response to the arrival of a bolus. This event then stretches the esophageal lumen and progresses downward as each segment of the esophagus is stretched by the bolus. Once the bolus reaches the bottom of the esophagus, the lower esophageal sphincter (LES) relaxes in order to permit the bolus entry to the stomach for breakdown of nutrients (Logemann, 1988).

Neurology of Swallowing

Taste, pressure, temperature, and general somatic stimuli from the oropharynx and larynx are transported via cranial nerves V, VII, IX and X to the "swallowing center" in the medulla. This central pattern generator (CPG) is located within the nucleus tractus solitarius (NTS) of the brainstem which integrates and organizes the coordinated muscle activity for swallowing. Once activated, the CPG triggers motor neurons in the brainstem and axons traveling through C1 and C2 of the cervical spinal cord and cranial nerves V, VII, IX, to XII to initiate the swallow motor response (Jean, 2001).

Swallowing requires the integration of various asymmetrical areas of the brain. More specifically, cerebral representation is found within the caudal sensorimotor and lateral premotor cortex, insula, temporopolar cortex, amygdala, and cerebellum (Jean, 2001). The complexity of the brain structures involved in the swallowing process explains why approximately 30%-50% of all unilateral hemispheric stroke patients will develop a form of dysphagia (Hamdy et al., 1999).

Pathophysiology

Dysphagia results when any one or more of the stages of swallowing are disrupted or impaired. The SLP's goal is to identify patients at risk for dysphagia early, by assessing alterations in the events of deglutition and attempt to prevent and treat the potential complications of dysphagia such as aspiration pneumonia (PNA), dehydration, and malnutrition (Rofes, et al., 2011).

Aspiration pneumonia is a serious concern for many individuals, and there are several etiologies and factors that contribute to the disease. Figure 1 highlights the connections between risk factors to PNA. Two culprits that are often responsible for PNA are oropharyngeal colonization and oropharyngeal dysphagia (Rofes, et al., 2011). Oropharyngeal colonization is a condition where an individual develops pathogens in the lungs that cannot be removed (Palmer, et al., 2001). Colonization may be due to different etiologies including age, smoking, immunity, medication, poor nutrition or hygiene, or dry mouth (Rofes, et al., 2011).

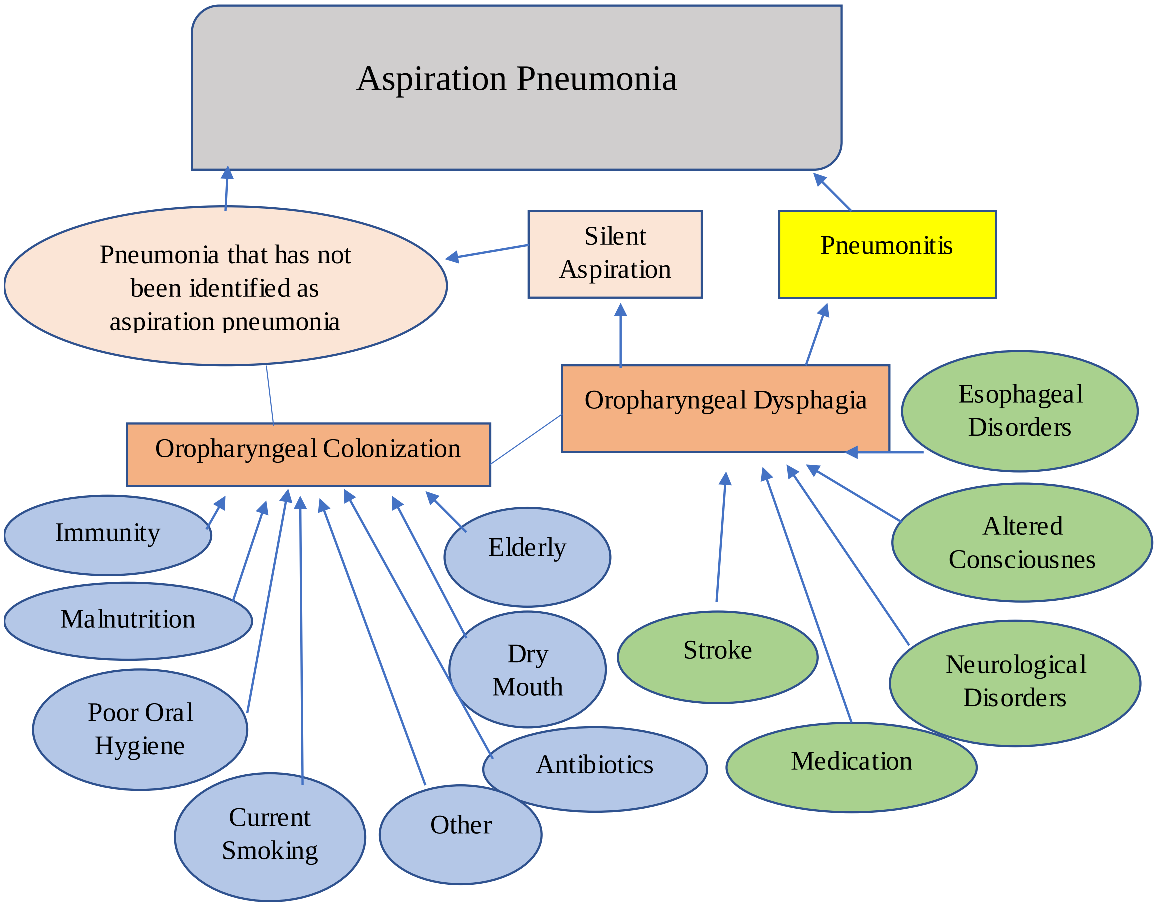


Figure 1. Etiologies for Aspiration Pneumonia (Adapted from Rofes, et al, 2011)

Oropharyngeal dysphagia may result from a wide range of etiologies including alterations to the structures of the swallowing mechanism that may impair bolus progression. Some of the most common structural abnormalities include esophageal and ear, neck, and throat (ENT) tumors; Zenker's diverticulum; neck osteophytes; and postsurgical esophageal stenosis (Clave, Terre, de Kraa, & Serra, 2005). In addition, patients with head and neck cancer undergoing radiotherapy may experience dysphagia as a side effect (Rofes, et al., 2011). Dysphagia within the elderly population is often a functional disorder of deglutition affecting the oropharyngeal swallow response resulting from aging, stroke, or another associated systemic or neurological disease (Clave, Verdaguer, & Arreola, 2005). A list of etiologies for oropharyngeal dysphagia may be found on Table 1.

Table 1. Oropharyngeal Dysphagia Etiologies

Central Nervous System	**Drugs**
Stoke	Centrally acting
Extrapyramidal syndromes (Parkinson, Huntington, Wilson's)	Phenothiazines
Brainstem tumors	Metoclopramide
Alzheimer's	Benzodiazepines
Motor neuron disease	Antihistamines
Peripheral nervous system	**Drugs acting at neuromuscular junction**
Spinal muscular atrophy	Botulinum toxin
Guillain-Barre	Procainamide
Post-polio syndrome	Penicillamine
	Aminoglycosides
	Erythromycin
Myogenic	**Drugs toxic to muscles**
Myasthenia gravis	Amiodarone
Polymyositis/dermatomyositis, inclusion body myositis	Alcohol
	HMG-CoA reductase inhibitors
Thyrotoxicosis	Cyclosporin
Paraneoplastic syndrome	Penicillamine
Structural disorders	**Miscellaneous, presumed neuromyopathic**
Zenker's diverticulum	Digoxin
Cricopharyngeal bar or stenosis	Trichloroethylene
Cervical (mucosal) web	Vincristine
Oropharyngeal tumor	
Head and neck surgery	
Radiotherapy	
Drugs inhibiting salivation	
Anticholinergics	
Antidepressants	

Antipsychotics Antiparkisonian drugs Antihypertensives Diuretics

Individuals with neurogenic dysphagia or elderly patients will likely demonstrate an impaired swallowing response (Kahrilas, Rademaker, & Logemann, 1997). Researchers have found that elderly humans present with a prolonged reaction time for the submental muscles (Nagaya & Sumi, 2002). In addition, overall duration of OSR in this population is a significantly longer period than in healthy individuals. This difference is believed to be due to the delay in the early phase of oropharyngeal reconfiguration from a respiratory to a digestive pathway (Rofes, et al., 2011). Prolonged intervals to LVC and UESO were determined to be significant abnormalities of the swallow response. These periods doubled those of healthy individuals and have the tendency to lead to unsafe deglutition and aspiration in neurologically impaired patients (Kahrilas, Rademaker, & Logemann, 1997).

Dysphagia may also arise due to a disordered esophagus. The etiologies of esophageal dysphagia have been broadly separated into either mechanical (Schatzki's ring) or dysmotility (diffuse esophageal spasm) (Kuo, Holloway, & Nguyen, 2012). A comprehensive list may be found in Table 2. However, a clinician must also account for instances of dysphagia due to problems with both the mechanical and dysmotility mechanisms. For example, achalasia is a classic example of such a condition where there is a failure of peristalsis within the esophagus in conjunction with the impaired relaxation of the LES which leads to anatomical obstruction (Boeckxstaens, Zaninotto, & Richter, 2014).

Table 2. Etiologies for Esophageal Dysphagia: Mechanical Versus Dysmotility (adapted from Kuo, Holloway, & Nguyen, 2012)

Mechanical	**Dysmotility**
Malignant strictures Squamous cell carcinoma Adenocarcinoma Extrinsic compression (e.g. malignant mediastinal lymph node, lung cancer, lymphoma) Benign strictures Peptic stricture Schatzki's ring Webs Eosinophilic esophagitis Post-surgical or anastomosis Caustic injury Radiation injury Extrinsic compression (e.g. benign inflammatory mediastinal lymph node, spine osteophyte, vascular compression) External compression e.g. large Zenker's diverticulum, cardiac or pulmonary mass Post fundoplication	Achalasia Reflux esophagitis and Barrett's Esophagus Diffuse esophageal spasm Eosinophilic esophagitis

Dysphagia Symptoms and Impact on Quality of Life

A clinician must take into account that there are various etiologies that lead to dysphagia. However, there are general signs that should be looked for when screening and evaluating patients. According to ASHA (n.d.), these symptoms include: coughing while eating and drinking or directly following, wet or a seemingly gurgly voice during or after eating or drinking, additional exertion or time needed to chew or swallow, food or liquid either becoming stuck in the mouth or escaping past the lips, habitual pneumonia or chest congestion after eating, and weight loss or dehydration stemming from an inability to take in adequate nutrition. Research has shown these signs and symptoms of dysphagia to be reliable indicators when holistically evaluating a patient (American Speech-Language-Hearing Association, n.d).

Oropharyngeal dysphagia has the potential to leave temporary or lasting effects on the impacted individuals. Dysphagia may lead to poor nutrition or dehydration because the individual is unable to consume a healthy diet either due to neurological or anatomical reasons. The risk of aspiration has the potential to cause aspiration pneumonia and chronic lung disease (American Speech-Language-Hearing Association, n.d). In addition, the patient will likely experience a reduced enjoyment of eating or drinking and increased embarrassment or isolation in social circumstances involving eating or drinking (Rofes et al., 2011).

Dysphagia Therapy

Research has shown that SLPs recommend a wide variety of therapeutic activities once dysphagia has been diagnosed. Recommendations for dysphagia management may include a combination of strategies including dietary modifications, postural changes, compensatory maneuvers, behavioral strategies, exercise regimens, or alternative means of feeding (i.e. non-oral) (Foley, Teasell, Salter, Kruger, & Martino, 2008). Swallowing therapy falls within the general dichotomy of compensatory versus facilitative interventions. Compensatory strategies are interventions designed to help the individual with dysphagia compensate for their disorder by reducing the risk of aspiration. The most common compensatory strategies are postural adjustment (e.g. eating in an upright position), reducing the amount per swallow to ½ teaspoon, or changing the consistencies of the food/liquids to thickened liquids, soft solids, and purees. Diet change recommendations and compensatory strategies are trialed during objective swallowing evaluations and clinical swallowing evaluations. During these assessments, a variety of foods in varying volumes and viscosities are given to determine the consistency and volume that promotes the safest swallowing environment (Archer, Wellwood, Smith, & Newham, 2013). For some patients, a specific volume of food per swallow elicits a faster pharyngeal swallow while in others the thinner viscosity may increase pharyngeal transit (Logemann, 1995). Therefore, it is important that SLPs who conduct thorough assessments of swallowing function note the exact amount and the viscosity that resulted in the most appropriate recommendations.

Objective Dysphagia Evaluations

Early detection of dysphagia is of vital importance to reduce the risk of aspiration related pneumonia (Coyle, 2015). A variety of objective dysphagia evaluation techniques are necessary for assessing feeding and swallowing disorders in the different settings. Ideally, the dysphagia diagnostic process contains three significant components: a screening, clinical swallowing examination (CSE), and objective instrumental assessment (Coyle, 2015). Clinicians may find that it is unnecessary for some patients to be given all three components. However, there are situations where one or more of the elements is omitted due to extenuating circumstances. These conditions may include instrumental assessment is not available, an element is not needed or is ignored by the clinician, or the component's value is not recognized (Coyle, 2015).

Clinical swallowing exams (CSEs) are given by many SLPs as a clinical dysphagia assessment of swallowing function. The results of the CSE determine if further objective instrumental evaluations are necessary. It is important to discriminate between a CSE and a feeding and swallowing screening. A simple dysphagia screen is completed by a medical professional who is watching an individual eat or drink to observe whether there are abnormal behaviors. A CSE is conducted by an SLP who completes complex dysphagia testing which includes observation for abnormal sensorimotor function, general cognitive status, comprehension of spoken language, awareness of impairments, motor speech production, and other signs that may predict impaired swallowing function (Coyle, 2015). The common components for a CSE may be located on Table 3.

Table 3. Components of a CSE (adapted from Coyle, 2015)

Evaluation Section	Section Components	What does it provide?
General Observations	■ Posture ■ Respiratory rate, rhythm swallowing trials ■ Supplemental oxygen dosage, delivery method	■ Baseline for comparison during ■ Prediction of respiratory-swallow coordination
Medical/case history	■ Review past medical history ■ Review current situation, medications, swallow history ■ Interview patient, informants	■ Baseline information ■ Recent/current factors altering baseline ■ Predisposing conditions ■ Swallowing situation before, since illness ■ Attitudes, expectations of informants ■ Awareness of impairments
Oral-facial sensorimotor examination	■ Sensory function of oral cavity, oropharynx, face, head, neck	■ Ability to follow commands ■ Oral health

	■ Motor function of oral cavity, oropharynx, face, head, neck ■ Dentition, denture, saliva management, oral hydration ■ Predisposing oral disease	■ Prediction of pharyngeal abnormalities ■ Ability to perform compensatory postures ■ Infection risk factors ■ Explanations for sensorimotor impairments
Speech/Language	■ Precision of articulation, resonance ■ Phonation ■ Auditory comprehension ■ Verbal, other expression	■ Function of oral, palatal structures ■ Predict laryngeal, pharyngeal function ■ Predict pharyngo-laryngeal secretions ■ Training capacity ■ Ability to express symptoms
Cognition	■ Attention, orientation, memory ■ Awareness of impairments ■ Self-regulation	■ Ability to participate in testing ■ Learning/training capacity ■ Cognitive factors interfering with efficacy of interventions
Swallow Trials	■ Variety of conditions of swallowing ■ Compare eating and feeding behaviors in controlled, naturalistic environment	■ Overt signs of impaired airway protection ■ Evidence of oral impairments ■ Predict effects of post-swallow oral residue ■ Form hypotheses about clearance of swallowed material, their nature ■ Identify potential efficacy of interventions that are logical to assess with instrumentation ■ Assess ability to participate in instrumental testing

A CSE is an important evaluation option for clinicians for several reasons across settings. This evaluation type enables the clinician to build rapport with the patient as she learns the case history. Establishing a firm patient-clinician relationship and patient-clinician trust is a vital component of intervention that a clinical evaluation accomplishes (Coyle, 2015). In addition, communication among all stake holders, including caregivers, provides the clinician with a broader picture of the patient (Verghese, Brady, Kapur, & Horwitz, 2011). For some patients, a CSE leads the SLP to avoid unnecessary, invasive diagnostic testing. In addition, a clinical evaluation is easily accessed by many clinicians working in skilled nursing facilities (SNFs) or home health settings which often do not have access to the expensive equipment required for fiberoptic endoscopic evaluation of swallowing (FEES) or a modified barium swallow study (MBSS). Therefore, a CSE is the least expensive and readily available option to many clinicians (Coyle, 2015). Another instance when the CSE is the most appropriate choice without using instrumental dysphagia assessments is when the patient is terminally ill. The patient, or his legal guardian(s), may decide that further testing is not desired at that point.

However, there are drawbacks to the CSE to assess all components of swallowing function. For example, a CSE is unable to assess pharyngeal transit of the bolus, timing of the swallowing response, extent of hyolaryngeal elevation, or objectively rule out aspiration. In addition, the competence and quality of airway protection is unknown. Lastly, the swallowed food and liquid’s trajectory is unable to be traced beyond the mouth (Langmore & Logemann, 1991).

Most importantly, a CSE does not allow the clinician to detect the presence of silent aspiration. Silent aspiration is defined as a condition where food, liquid, or some other material has passed the level of the true vocal folds; however, overt clinical signs associated with aspiration, such as coughing and throat clearing, are not present. There are no noticeable outward signs that aspiration has occurred, such as coughing. Because overt behavioral signs are absent, the clinician will likely not be able to confidently diagnosis the patient with aspiration (Leder, Suiter, & Green, 2011).

In recent years as technology and cameras have improved, fiberoptic endoscopic evaluation of swallowing (FEES) has become a popular choice as an objective instrumental dysphagia assessment tool. To administer a FEES, evaluators pass a flexible endoscope trans-nasally through one of the nares. A flexible endoscope is positioned so that a camera is resting in the upper pharynx, just behind the soft palate. While the camera remains in this position, a 2-D superior circumferential view of the pharynx and larynx is visible (Steele, 2015). The patient is then given food or liquids mixed with food color in order to determine safe swallowing function and integrity. Again, the different types of foods (regular or soft solids, pureeds, thin and thick liquids) are given in different volumes to determine the amount and type of food that is safest for the patient to consume.

There are several advantages to using FEES as a method of evaluation. First, it does not involve exposing the patient to ionizing radiation or the use of radio-opaque contrast agents, as is the case with modified barium swallow studies (MBSS), described below (Steele, 2015). When the bolus travels over the tongue base and flows into the pharynx, the FEES provides a full view of the oropharynx. It also allows for direct laryngeal inspection for aspiration and amount of residue. Secretions pooling in the pharynx may also be seen and rated for their appearance and volume (Donzelli, Brady, Wesling, & Craney, 2003).

However, the use of nasoendoscopy as an evaluative method does carry some limitations. First, the procedure does not allow any visualization of events in the oral phase of swallowing or of oral tongue movement (Coyle, 2015). Another limitation is the short period of white-out that occurs when the constriction of the pharynx causes a light reflection that completely obstructs the view. Because this occurs at the height of the swallow, as the bolus is passing the entrance to the airway, airway closure, aspiration and upper esophageal sphincter opening cannot be directly viewed (Steele, 2015). After the swallow occurs, the scope may be lowered for a close-up view of the larynx and the tracheal rings. Evaluators search for any material which may be seen coating structures in this view. Any leftover material is taken as evidence upon which the previous occurrence of aspiration may be inferred. Parameterization of the severity of aspiration is more challenging using endoscopy (Baijens, Speyer, & Pilz, 2014). In addition, other biomechanical features, such as movement of the tongue, hyoid, larynx or opening of the upper esophageal sphincter cannot be measured using this view.

Weighing the benefits and limitations, FEES is considered by many to be the “gold standard” for evaluating patients who are suspected to have aspiration or penetration of solids and liquids. However, whether a particular FEES protocol is sensitive enough to be considered as the “gold standard” is decidedly dependent on the number of swallow trials offered to the patient (Baijens, Speyer, & Pilz, 2014). These researchers found that when a limited number of swallow trials are administered, the risk of aspiration may be underestimated. Greater sensitivity was established when a standardized FEES protocol of ten consecutive swallow trials of 10 cc each for thin and thick liquid was administered to a group of patients with dysphagia (Steele, 2015).

Another tool of a dysphagia evaluation is the MBSS. This assessment may also be known by another name, videofluorographic swallowing study (VFSS). The MBSS is a dynamic x-ray technique, in which a radiographic movie of swallowing is recorded. Barium is commonly used as the radio-opaque contrast material for this assessment. However, this leads to one of the largest limitations of the MBSS. The procedure must be brief in order to lessen the amount of radiation exposure to the patient (Zammit-Maempel, Chapple, & Leslie, 2007). The majority of ethics policies stipulate that over an individual's lifetime, the maximum amount of radiation exposure must be limited to 5 minutes for research volunteers (Steele, 2015). However, recent studies in healthy adults suggested that a dysphagia evaluation protocol for MBSS that involved 16 boluses of barium required an average radiation exposure duration of 1.75 minutes. (Molfenter & Steele, 2013). Therefore, it is imperative that evaluators maximize efficiency when conducting their dysphagia evaluation protocols to ensure that the necessary data to answer their questions will be obtained while minimizing radiation exposure. Until FEES became more prevalent, the MBSS was considered the gold standard for dysphagia evaluations. This tool was highly valued because it provides the clinician an opportunity to watch the physiology of swallowing as it takes place with different boluses. (Steele, 2015).

MBSS provides the evaluator with a two-dimensional view of the structures relating to the swallowing mechanism. The video is typically recorded either from the sagittal or anterior-posterior perspective. However, evaluators may be challenged by the spatial resolution because the two-dimensional views are looking through the three-dimensional pharynx. This is important, because if the patient is not seated at the requisite 90-degree angle to the camera, or is even tilting his head or shoulders, the image may become distorted so that it is difficult to clearly define structural boundaries (Steele, 2015). For example, a situation that arises due to the spatial resolution is the measurement of residue severity. Residue in the pharynx may collect in the vallecular spaces, which sit bilaterally at the base of tongue and anterior to the pyriform sinuses. When viewing the lateral view provided on the MBSS, the right and left pyriform sinuses will overlay each other, and the impression of residue severity will be based on the pyriform containing the higher fluid level (Molfenter & Steele, 2013).

Another limitation is in regards to temporal resolution on the MBSS. Frames are typically shown at the relatively slow frequency of 30 frames per second. Clinicians must consider that the MBSS may only be expected to capture events with durations of at least 0.03 seconds or longer. This is recognized to be a limitation for capturing very brief aspiration events because there are small amounts of material that may only be visible entering the airway on only a single video frame (Bonilha, Blair, Carnes, & Huda, 2013). In addition, temporal resolution may create challenges to investigators when capturing dynamic events, such as bolus movement. For instance, estimated bolus velocities reach speeds of up to 1 meter per second in the pharynx, and a liquid bolus may travel the entire length of the pharynx as quickly as one or two frames. Therefore, it is difficult for researchers to identify the velocity of fluid movement as it flows through the pharynx based solely on MBSS (Brito De La Fuente, et al., 2012).

Consistencies and Amounts Given During Dysphagia Evaluations

Regardless of the type of assessment, CSE, FEES, or MBSS, the patient with dysphagia is given varying amounts of different consistencies of food and liquids. There are no widely-used, published protocols. The consistencies and amounts given by therapists during dysphagia evaluations vary based on the facility and the clinician. In a systematic review completed on the topic of dysphagia therapy following stroke, researchers noted a lack of standardized assessments (Foley, Teasell, Salter, Kruger, & Martino, 2008). Even within a single instrumental measure, such as an MBSS, there is little similarity in the protocols used across the field. However, tools such as the Modified Barium Swallow Impairment Profile (MBSImP) attempt to provide some standardization to MBSS studies (Sandidge, 2009). The protocol provides standardized language, administration procedures, measurement of contrast viscosities, and reporting method for clinicians administering MBSS. The protocol that is available online provides a comprehensive list of viscosities and amounts that clinicians may choose to utilize the standardized protocol of the MBSImP (Northern Speech Services, 2015). According to Groher (2016), bite sizes that are typically tested during a FEES evaluation include pureed consistencies measured to ½ teaspoon, 1 teaspoon, and 1 tablespoon. In addition, liquids are given to patients in the sip sizes of 5 millimeters, 50 millimeters, and 100 millimeters, or large “challenge” swallows (Groher, 2016). Restricting bite and sip quantities to ½ teaspoon, 1 teaspoon or less, or “small bites/sips” may result as the therapeutic recommendations following an objective dysphagia evaluation (Clave, et al., 2006).

Compliance with Swallowing Precautions

Following an assessment of swallowing function, a patient is typically given safe swallowing precautions and guidelines to alert caregivers regarding the safest volumes and types of food they should receive. One concern, particularly for patients who are institutionalized and unable to self-feed, is medical staff adherence to appropriate dietary modifications in order to reduce the risk of aspiration during feeding.

It is the SLP's responsibility to educate and train the certified nursing assistant (CNA) to assist patients during meals with dysphagia. Training for CNAs should include safe swallowing precautions, which are based on bolus volumes tested during an objective dysphagia evaluation. The safe swallowing precautions should include instructions to limit the bolus sizes given to the patient during a mealtime to the amounts that were found therapeutic during the evaluation (Pelletier, 2004). A study conducted by Hall and Gillikin (2015) surveyed whether CNAs feeding solid food to persons with dysphagia kept to the SLP's therapeutic recommendation of 1 teaspoon per spoonful. The researchers found that the CNAs consistently presented the patient with significantly more food than what was recommended (Hall & Gillikin, 2015).

Because dysphagia may occur for a variety of reasons, an individual may need different restrictions placed based on performance during the dysphagia evaluation. Medical professionals adhere to the notion that thin liquids, such as water, are prone to create unsafe conditions for people with dysphagia due to their propensity to flow at a rapid rate (Logemann, 1988). One investigation found that healthy, elderly participants had pharyngeal transit times found to be less than 1.2 seconds for 10 milliliters of a liquid bolus (Hamlet, Muz, Patterson, & Jones, 1989). The velocity of the transfer from the oral cavity through the pharynx may be too swift for the individual to engage airway closure before the bolus reaches the level of the larynx and airway. For this population, thickened liquids are frequently recommended so that the speed of the liquids is sufficiently slowed to provide ample time for airway closure (Clave, et al., 2006). A review of the literature on the effect of increasing bolus viscosity found that when the viscosity of a bolus was increased from thin liquids to nectar or pudding, the prevalence of penetrations and aspirations was decreased (Newman, Vilardell, & Clave, 2016).

In contrast, very thick liquids and solid foods require greater strength from the structures of the chewing and swallowing mechanisms. For instance, when a bolus is being propelled to the oropharynx, greater strength is required for tongue propulsion of a bolus composed of solids than for a bolus made of liquids. In addition, a patient is at risk for pharyngeal residue within the crevices of the structures within the pharynx if the individual has reduced tongue strength or reduced pharyngeal muscle strength (Steele & Huckabee, 2007).

In regards to mastication, those who lack sufficient muscular strength and functional dentition may find chewing solid food too taxing an endeavor. For an individual who presents with either, or both of these components, reduced tongue strength or reduced pharyngeal muscle strength. Common therapeutic recommendations to modify the consistency of solid foods to enable them to be easier to orally process and swallow include dicing, chopping, mincing, or pureeing (Steele, et al., 2015).

Statement of the Problem and Purpose of the Present Study

The review of the literature demonstrates that there is a breadth of research available to demonstrate the importance of dysphagia evaluation and management. However, there is little evidence of how clinicians are implementing the research in the field. An SLP may evaluate for dysphagia using various measures that have been shown to be effective. While this is a benefit, this also leads to a lack of standardization across clinicians and facilities. Different SLPs will use varying consistencies and amounts when presenting challenge boluses to their patients. In addition, no research has been conducted which determines the accuracy of clinicians when they implement their preferred dysphagia evaluation protocols.

The purpose of this study was to seek two answers. Because the estimation of bolus sizes greatly impacts SLPs' recommendations, the first objective was to determine whether SLPs who conduct FEES, MBSS, and CSEs demonstrate accuracy when estimating specific bolus sizes. In addition, the frequency of using measuring spoons during cooking influenced accuracy was further explored to see if this experience influenced accuracy. Secondly, because there is no standardized protocol predominately, the types and amounts of food and liquid used by SLPs when performing FEES, MBSS and CSEs was explored.

CHAPTER III

METHOD

The purpose of this research was to answer the following questions: What are the types and amounts of food and liquids used by speech-language pathologists (SLPs) during swallowing evaluations? Do the estimated amounts given (e.g. 1 tsp) really reflect that actual measured amount?

General Experimental Design

Participants

To be included in this study, the participants needed to be licensed, certified SLPs with at least two-years of experience performing fiberoptic endoscopic evaluations of swallowing (FEES), modified barium swallow studies (MBSS), and/or clinical swallow evaluations (CSEs) on adult patients. Furthermore, only SLPs who reported that over the past 12 months they routinely performed swallowing evaluations as part of their daily clinical activities were included in this study. A total of 14 SLPs participated in this study. The average age of the participants was 38.36 years (SD=11.72) The mean length of experience conducting swallowing evaluations was 9.11 years (SD= 7,18). . Five of the participating SLPs reported their evaluation protocols for CSE, 5 reported their protocols when conducting FEES, and 4 reported their protocol for MBSS. The demographical information for each participant may be located in Appendix A The data was collected at a location that was convenient to the participant, typically their place of employment. Each participant was explained the purpose of the study and provided a signature denoting informed consent before the data was collected as well as a copy of this form. Data collected from each participant was de-identified so that only the examiner for this investigation could link specific data to a participant. Specifically, each participant was assigned a number and was referred to only by that number during data collection and analysis. Data was secured in a locked portable case and transported to a locked cabinet that was only accessible to the researcher and thesis advisor.

Questionnaire

All participants were interviewed using a questionnaire developed specifically for this investigation. The data collection form including the questionnaire may be found in Appendix H. The questions focused on the SLPs' experience performing objective swallow studies and about any training they may have received related to feeding and/or swallowing. Participants were asked to identify the swallow study protocol(s) they use during objective clinical swallowing evaluations, if any. If the participants used different protocols between evaluation assessments (i.e. CSE versus FEES), they were instructed to answer questions based on which assessment protocol involved the most real food. In addition, the SLPs were asked to describe any cooking experience or training they may have had. This information was recorded to identify whether this experience was a factor in measurement accuracy. All responses from participants were recorded onto the questionnaire form by the examiner.

Materials

Standard, consistent materials were used for all data collection. These were 9-ounce Solo plastic cups, standard plastic spoons, and food/liquids in varying viscosities. Cups and spoons from the batch were used in all measurements. The researcher provided the same viscosities to all participants which were thin liquids (water), nectar thick liquids (original V8), thick puree (Hunt's snack pack vanilla pudding), and thin puree (Motts applesauce). With the exception of water, all the foods were individually packaged.

Two Unishow 500 x 0.01 Professional Digital Table Top Jewelry Scales were used to measure the weight of each food/liquid to calculate volume. The scales were calibrated using scale calibration check weights ranging from 100 grams to 0.01 grams to ensure that measurements taken from either scale would provide comparable measurements. In addition, the scales manufacturers' specifications stated that each scale was accurate up to 0.01 grams. Calibrations using the weights prior to data collection demonstrated each scale was accurate and consistent up to 0.01 grams with a margin of error of +/- 0.04 grams.

Previous research (Hall & Gillikin, 2015) suggested that care should be taken to limit residue remaining on the scale after each measurement to insure accuracy. Therefore, a disposable section of wax paper was also used and placed on the scale surface to ensure residue was limited. In addition, the scale was zeroed out before each new weight was placed on to minimize inaccuracies due to residue.

Each volume for each consistency was initially weighted in order to determine exact amounts of the volumes tested and their corresponding weights in grams. A dosing syringe was used to measure out ½ teaspoon, and 1 teaspoon, 1 tablespoon amounts of each consistency. The following formula on Table 4 was used:

Table 4. Actual Weight Values of Targeted Consistencies

Measure	Equivalent	Consistency	Actual Weight
2.5 mL	½ teaspoon	Water	2.6 g
		Nectar Thick Liquid (V-8)	2.8 g
		Thin Puree (apple sauce)	3.0 g
		Thick Puree (pudding)	2.65 g
5.0 mL	1 teaspoon	Water	5.35 g
		Nectar Thick Liquid (V-8)	5.55 g
		Thin Puree (apple sauce)	5.8 g
		Thick Puree (pudding)	5.4 g

15 mL	1 tablespoon	Water	14.8 g
		Nectar Thick Liquid (V-8)	15.05 g
		Thin Puree (apple sauce)	15.8 g
		Thick Puree (pudding)	15.5 g

Procedures

The participants were seated with the following items in front of them: a cup filled with 4 ounces of water, a cup with 4 ounces of nectar thick liquid (V-8), a container of applesauce, and a container of pudding. To measure the water, an empty plastic cup was placed on the scale and the cup weight was removed from the calculation by pressing the zero button on the scale. They were instructed to measure out a ½ teaspoon of water from the cup containing 4 ounces of water and to pour the ½ tsp of water into the empty cup on the scale. The weight of the measured water was recorded in grams. The investigators followed the same procedure for measuring the 1 teaspoon of water and 1 tablespoon of water. The same procedure was used to calculate the volumes for nectar thick liquid.

For the puree consistencies, a small piece of wax paper was placed on the scale with an empty spoon. The weights were removed from the calculation by pressing the zero button on the scale. The participant was then asked to measure out a ½ teaspoon of thin puree from the applesauce container and place it in the middle of the scale. The weight of the thin puree was recorded. This same procedure was used to calculate 1 teaspoon and 1 tablespoon of amounts and for measuring the thick puree consistency (pudding). After defining the exact weight, the wax paper was discarded to remove any residue.

Inter-rater Training

To ensure consistent data collection, research procedures were administered to volunteers who were not participants in this study, but who provided voluntary consent to participate. The identical procedures for obtaining measurements were performed by researcher and thesis advisor for training purposes. Reliability was not calculated as the estimates of volumes varied among the pilot study volunteers. However, 100% agreement was reached regarding the calculation of weights.

CHAPTER IV

RESULTS

The purpose of this study was twofold. Because the estimation of bolus sizes greatly impacts speech-language pathologists' (SLPs') recommendations, the first objective was to determine whether SLPs who conduct fiberoptic endoscopic evaluations of swallowing (FEES), modified barium swallow studies (MBSS), and clinical swallow evaluations (CSEs) demonstrate accuracy when estimating specific bolus sizes. Information was also gathered regarding experience in measuring food/liquids via spoon as a possible factor that influenced accuracy of measurements. Secondly, because no one standardized dysphagia protocol is used by all clinicians, the researchers gathered information about the types and amounts of food and liquid used by SLPs when performing FEES, MBSS and CSEs as part of their protocols.

Data Analysis

The difference between actual and observed weight (in grams) was used to compare the accuracy in measurements across the bolus textures and measurement values. The difference between the actual weight for each consistency tested at each volume and the estimated amount given by each participant was used to calculate a mean and standard deviation for all consistencies and amounts. Multiple one-sample *t*-tests with a Bonferroni correction ($\alpha = .008$) were used to determine which consistency, if any, was accurately measured. It was hypothesized that the actual amount and observed amount would be the same, thus the difference score between them would be 0. The individual and group data are presented in Appendix A.

How Accurate are SLPs when Measuring ½ Teaspoon Amounts?

The average and standard deviations for total amounts and differences between the actual amount and observed amounts for ½ teaspoon are presented in Table 5. Estimates for the liquids (thin and nectar thick) were .42 less than the actual amount while estimates for the puree was more than the actual amount (1.98 for the thin puree and 2.34 for the thick puree).

Table 5. Mean (SD) for ½ Teaspoon Measurements of Liquid and Puree Consistencies

Consistency	Observed	Actual	Difference
Thin Liquid	2.17 (0.10)	2.60	-0.43 (0.11)
Nectar	2.37 (0.79)	2.80	-0.43 (0.79)
Thin Puree	4.98 (4.15)	3.00	1.98 (0.29)
Thick Puree	4.99 (1.28)	2.65	2.34 (1.28)

The statistical results suggest that the SLP measurements for the thin (M=.428, SD=.106) was significantly less than the actual ½ teaspoon $t(13)=1.77$, $p<.0001$. This was also true for the nectar thick liquids (M=.426, SD=.792) which was less than ½ teaspoon; $t(13)=1.77$, $p<.0001$. Inspection of the individual data (see Appendix A) as well as group data reveals the considerable variability among the SLPs estimates of the puree consistencies. Despite the large standard deviations, the average estimates for both the thin puree [$t(13)=4.09$] and thick puree measures of half-teaspoon amounts [$t(13)= 3.66$] were significantly larger than actual measures ($p<.001$).

Regardless of statistical significance, it is important to bear in mind the meaningful difference of the data. When taking into account the standard error of measurement of the scale used (±.05 grams), calculations were made of the number of SLPs whose estimates fell within ±.05 of the actual measure. When applying this method of data inspection, (See Appendix C, for thin liquid, only 2/14 (14%) overestimated the amount while the majority 11/14 (79%) underestimated the amount and 1/14 (7%) identified the exact amount. Regarding nectar thick liquid, 3/14 (21%) of the SLPs overestimated the amount while 11/14 (79%) underestimated the amount. Next, for thin puree, 11/14 (79%) overestimated the quantity while 1/14 (7%) underestimated the amount and 2/14 (14%) measured the exact amount. Finally, 12/14 (86%) of participants overestimated their measurement of thick puree while 2/14 (14%) underestimated the amount. These results suggest that SLPs were fairly accurate and consistent when administering ½ teaspoon amounts. Estimates for the puree consistencies were more than five times greater than the estimates for the liquid consistencies and there was considerable variability among the participants. Furthermore, the only level of measurement where the SLPs precisely measured the desired quantity was the thin liquids.

How Accurate are SLPs when Measuring 1 Teaspoon Amounts?

The accuracy of SLP measurements of the 1 teaspoon amounts across the 4 viscosities are presented in Table 2. When looking at the group data, the actual weight of the thin liquid (water) was 5.35 grams and the average observed measurement by the SLPs was 4.31 grams, a difference of 1.036. The SLPs significantly underestimated 1 teaspoon amounts of thin liquids $t(13)=7.053$, $p<.0001$. Similarly, the actual amount of 1 teaspoon of nectar thick liquids (5.55 grams) was underestimated (4.1 grams) by a difference of 1.447 grams. This difference was also found to be significant $t(13)=6.229$, $p<.0001$.

Table 6. Mean (SD) for 1 Teaspoon Measurements of Liquid and Puree Consistencies

Consistency	**Observed**	**Actual**	**Difference**
Thin Liquid	4.31 (1.17)	5.35	-1.04 (1.17)
Nectar	4.1 (0.78)	5.55	-1.45 (0.78)
Thin Puree	7.64 (0.95)	5.8	1.84 (0.95)
Thick Puree	7.98 (1.75)	5.4	2.58 (1.75)

Data for group observations may be found in Table 6. The actual weight of 1 teaspoon of thin puree (applesauce) is 5.8 grams, but the observed SLP average was 7.637, an overestimation of 1.837 which was found to be significant $t(13)=4.03$, $p<.001$. Finally, the actual weight of 1 teaspoon of thick puree (5.4 grams), was overestimated by SLPs (7.98 grams) by 2.58 grams. This difference was also found to be significant $t(13)=XXX$, $p<.0001$.

When looking at the individual data, which may be located in Appendix A, there was considerable variability amount the different participants' perceptions of each amount. Again, using the criteria of ± .05 grams around the actual weight to denote a meaningful difference, for thin liquid, 4/14 (29%) overestimated the amount while 10/14 (71%) underestimated the amount. In regards to nectar thick liquid, 14/14 (100%) underestimated the amount. Next, for thin puree, 11/14 (79%) overestimated the amount while 3/14 (21%) underestimated the amount. Finally, 12/14 (86%) of participants overestimated their measurement of thick puree while 2/14 (14%) underestimated the amount. These results highlight the inconsistent variations across the consistencies by the SLPs. Appendix D presents a hierarchy of difference scores based from overestimated to underestimated. Appendix C shows the percentage of SLPs with accurate, below, and above estimates for each consistency.

How Accurate are SLPs when Measuring 1 Tablespoon Amounts?

The accuracy of SLP measurements of the 1 tablespoon amounts across the 4 viscosities are presented in Table 3. When looking at the group data, the actual weight of the thin liquid (water) was 14.8 grams and the average observed measurement by the SLPs was underestimated to be 8.566 grams. The SLPs underestimated tablespoon measures of thin liquids by an average of 6.234 [$t(13)=7.332$, $p<.00001$]. Next, 1 tablespoon of nectar thick liquid (original V8 Juice) was found to have an actual weight of 15.05 grams. The average SLP estimate was 8.25, which represents a significant difference of +6.80 [$t(13)=10.98$, $p<.00001$]. Thin puree (applesauce) weighed 15.8 grams, whereas the observed SLP average was 13.25. This represents a significant difference of +2.55 [*t*(13)=6.767, *p*<.00001]. Finally, the weight of 1 tablespoon of thick puree (pudding), which was found to be 15.5, was underestimated by SLPs to be 14.17, which demonstrates a significant difference of +1.33 [*t*(13)=7.052], *p*<.00001].

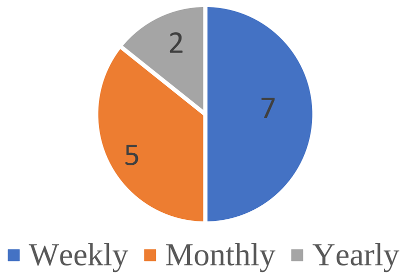
Table 7. Mean (SD) for 1 Tablespoon Measurements of Liquid and Puree Consistencies

Consistency	Observed	Actual	Difference
Thin Liquid	8.57 (2.35)	14.8	-6.23 (2.35)
Nectar	8.25 (2.19)	15.05	-6.79 (2.2)
Thin Puree	13.25 (2.74)	15.8	-2.55 (2.74)
Thick Puree	14.17 (4.35)	15.5	-1.33 (4.35)

When looking at the individual data, which may be located in Appendix A, there was less variability for the participants' perceptions of each amount. Data for group observations may be found in Table 7. For thin liquid, 14/14 (100%) underestimated the amount. In regard to nectar thick liquid, 14/14 (100%) again underestimated the amount. However, for thin puree, 5/14 (36%) overestimated the amount while 9/14 (64%) underestimated the amount. Finally, 6/14 (43%) of participants overestimated their measurement of thick puree while 8/14 (57%) underestimated the amount. These results demonstrated that SLPs were fairly accurate and consistent when administering 1 tablespoon amounts. Appendix D presents a hierarchy of difference scores based from overestimated to underestimated. Appendix D demonstrates the percentage of SLPs with accurate, below, and above estimates for each consistency.

Does Cooking Experience Affect Accuracy of Measurement?

Figure 2. Participant Cooking Experience



The SLPs were also surveyed on their experience with measuring specific amounts of food as a part of cooking. This was evaluated to explore whether the level of reported experience making specific food and liquids measurements with measuring spoons was a factor in the accuracy of the estimates made by SLPs in this study. The participants were surveyed whether they use measuring spoons during cooking "weekly," indicating greater experience or "monthly/yearly," indicating less experience. Of those surveyed, 7/14 (50%) used measuring spoons weekly, 7/14 (50%) used measuring spoons monthly/yearly. This information is presented on Figure 2.

Table 8. Average Estimates of SLPs who Cook with Measuring Spoons Weekly (SD)

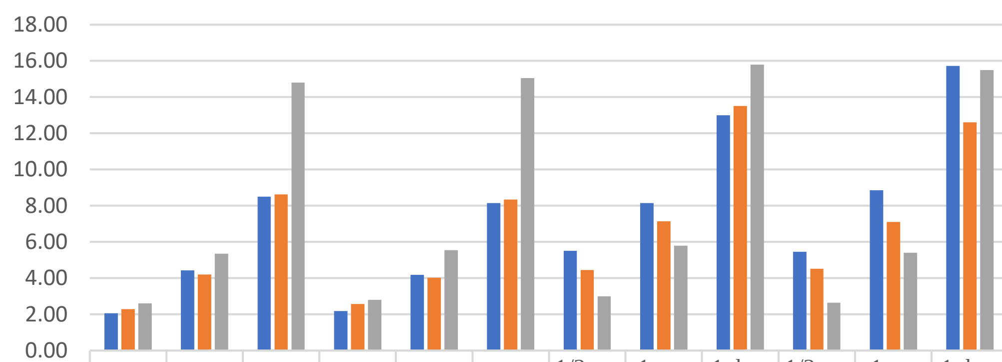
Amount	**Actual Weight (grams)**	**Estimates of SLPs who Cooked Weekly (grams)**	**Difference Scores**
1/2 Teaspoon Thin Liquid	2.600	2.287	-0.31 (0.05)
1 Teaspoon Thin Liquid	5.350	4.204	-1.15 (0.24)
1 Tablespoon Thin Liquid	14.800	8.624	-6.18 (1.69)
1/2 Teaspoon Nectar Thick	2.800	2.565	-0.24 (0.41)
1 Teaspoon Nectar Thick	5.550	4.016	-1.53 (0.58)
1 Tablespoon Nectar Thick	15.050	8.349	-6.70 (0.14)
1/2 Teaspoon Thin Puree	3.000	4.451	+1.45 (2.11)
1 Teaspoon. Thin Puree	5.800	7.133	+1.33 (1.53)
1 Tablespoon Thin Puree	15.800	13.507	-2.29 (3.39)
1/2 Teaspoon Thick Puree	2.650	4.526	+1.88 (2.45)
1 Teaspoon Thick Puree	5.400	7.097	+1.68 (2.14)
1 Tablespoon Thick Puree	15.500	12.611	-2.89 (5.25)

Table 9. Average Estimates of SLPs who Cook with Measuring Spoons Monthly/Yearly			
Amount	**Actual Average (grams)**	**Estimates of SLPs who Cooked Monthly/Yearly (grams)**	**Difference Scores**
1/2 Teaspoon Thin Liquid	2.600	2.056	-0.54 (0.27)
1 Teaspoon Thin Liquid	5.350	4.424	-0.93 (0.42)
1 Tablespoon Thin Liquid	14.800	8.509	-6.29 (0.08)
1/2 Teaspoon Nectar Thick	2.800	2.183	-0.62 (1.0)
1 Teaspoon Nectar Thick	5.550	4.190	-1.36 (0.37)
1 Tablespoon Nectar Thick	15.050	8.153	-6.90 (0.69)
1/2 Teaspoon Thin Puree	3.000	5.511	+2.51 (3.61)
1 Teaspoon. Thin Puree	5.800	8.141	+2.34 (0.16)
1 Tablespoon Thin Puree	15.800	12.999	-2.80 (0.56)
1/2 Teaspoon Thick Puree	2.650	5.461	+2.81 (0.14)
1 Teaspoon Thick Puree	5.400	8.864	+3.46 (2.88)
1 Tablespoon Thick Puree	15.500	15.724	+0.22 (3.09)

The data regarding accuracy compared to cooking experience may be located on Tables 8 and 9. When comparing group difference scores, the SLPs who cooked weekly, that is, with more experience making measurements, were closer in their estimations to the actual weights in 9/12 (75%) estimation opportunities than the SLPs who cooked monthly/yearly who were closer in 3/12 (25%) measuring opportunities. However, the majority of variance in the difference scores between these groups lay at or below 1 gram for 10/12 (83%) of the desired estimation amounts. The comparison of the difference scores by amount may be found on Table 10 and Figure 3. The least difference lay in the measurement of 1 tablespoon of water (difference score=0.12). The greatest average disparity was found in their estimations of 1 tablespoon of pudding (difference score=3.11).

Table 10. Comparison of Difference Scores		
Amount	**Weekly**	**Monthly/Yearly**
1/2 Teaspoon Thin Liquid	-0.313	-0.544
1 Teaspoon Thin Liquid	-1.146	-0.926
1 Tablespoon Thin Liquid	-6.176	-6.291
1/2 Teaspoon Nectar Thick	-0.235	-0.617
1 Teaspoon Nectar Thick	-1.534	-1.360
1 Tablespoon Nectar Thick	-6.701	-6.897
1/2 Teaspoon Thin Puree	+1.451	+2.511
1 Teaspoon. Thin Puree	+1.333	+2.341
1 Tablespoon Thin Puree	-2.293	-2.801
1/2 Teaspoon Thick Puree	+1.876	+2.811
1 Teaspoon Thick Puree	+1.697	+3.464
1 Tablespoon Thick Puree	-2.889	+0.224

Figure 3. Cooking Experience Comparison of Accuracy



	1/2 tsp Thin	1 tsp Thin	1 tbsp Thin	1/2 tsp Nectar	1 tsp Nectar	1 tbsp Nectar	1/2 tsp Thin Puree	1 tsp. Thin Puree	1 tbsp Thin Puree	1/2 tsp Thick Puree	1 tsp Thick Puree	1 tbsp Thick Puree
Monthly/Yearly	2.06	4.42	8.51	2.18	4.19	8.15	5.51	8.14	13.00	5.46	8.86	15.72
Weekly	2.29	4.20	8.62	2.56	4.02	8.35	4.45	7.13	13.51	4.53	7.10	12.61
Actual Averages	2.6	5.35	14.8	2.8	5.55	15.05	3	5.8	15.8	2.65	5.4	15.5

Monthly/Yearly   Weekly   Actual Averages

What Consistencies and Amounts were used by practicing SLPs?

The participating SLPs utilized one of the three objective dysphagia evaluations. This information on assessment tool utilized by the participants is presented in Figure 4. Of the surveyed participants, 5 SLPs identified either FEES or CSE as their preferred evaluation method. MBSS was the objective instrumental choice for 4 of the SLPs. However, the consistencies and amounts varied even within a particular assessment tool. A comprehensive listing of the viscosities used during protocols is found on Figure 5. All SLPs (14/14) administered thin liquid and nectar consistencies during their evaluations. In addition, 13/14 SLPs (93%) utilized purees and solid food during their evaluations. Fifty-seven percent (8/14) use mechanical soft foods, 7/14 (50%) utilize mixed consistency textures, and 6/14 (43%) of SLPs administer honey consistencies during dysphagia evaluations. Five participants (36%) include pt. controlled food and liquids. Finally, 2/4 (50%) of SLPs who administer MBSS evaluations utilize barium pills during dysphagia evaluations.

Figure 4. Assessment Type used by SLPs in Study

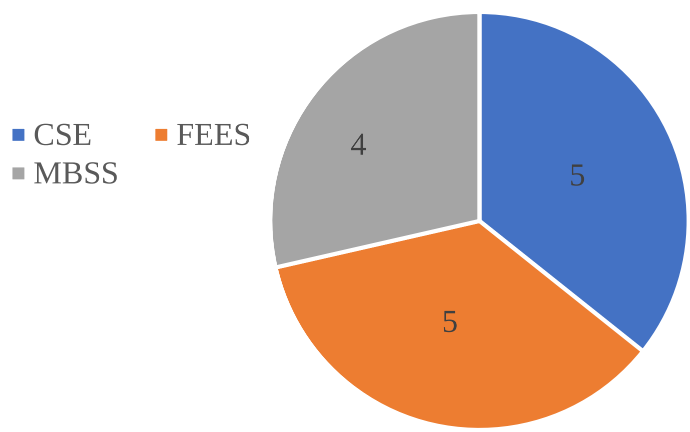
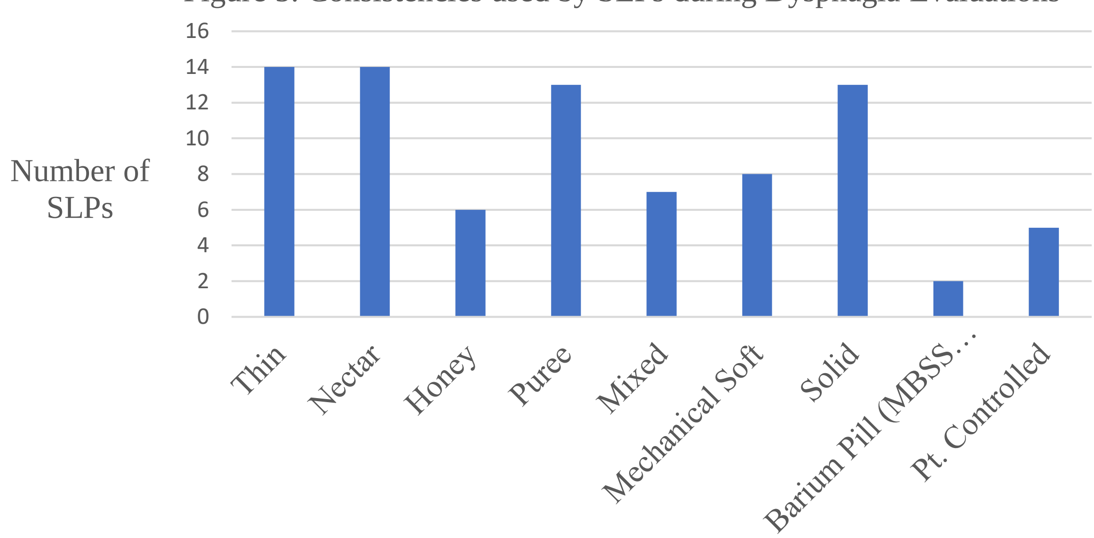


Figure 5. Consistencies used by SLPs during Dysphagia Evaluations



CHAPTER V

Discussion

The primary purpose of this study was to investigate the accuracy of bolus size estimates made by experienced speech-language pathologists (SLPs). This is important because the estimation of bolus sizes greatly impacts SLPs' recommendations. Secondly, because there is no accepted standardized protocol used by clinicians conducting swallowing evaluations, this study sought to add to our understanding of the types and amounts of food and liquid used by SLPs when performing fiberoptic endoscopic evaluations of swallowing (FEES), modified barium swallow studies (MBSS), and clinical swallow evaluations (CSEs). As a post hoc analysis, this study also examined experience with measuring food/liquids with spoons as a part of cooking experience as a possible factor that affected the results.

Importance of Accurately Measuring Bolus Sizes of Food and Liquids

Across the dysphagia literature, researchers investigating normal and disordered swallowing typically used very specific and standard amounts of food and liquids. These range in specified volumes of 2.5 ml (1/2 teaspoon), 5 ml (1 teaspoon), 10 ml (2 teaspoons, and 15 ml boluses (1 tablespoon) that are exactly measured using a dosing syringe (e.g. Dantas ,de Aguiar Cassiani, dos Santos, Gonzaga, Alves, & Mazin 2005;

Kim, McCullough, & Asp, 2005; Robbins, Hamilton, Loff, & Kempster, 1992; Youmans & Stierwalt, 2011; Nicosia, Hind, Roecker, Carnes, Doyle, Dengel, & Robbins J. 2000; Tracy, Logemann, Kahrilas, Jacob, Kobara, Krugler, 1989). The consistency and accuracy in measuring standard amounts allows for comparison of results across studies investigation the physiology of normal and disordered swallowing. This is why most scientific studies of swallowing function require the examiner to accurately measure the exact volume to be tested using a measured syringe.

This level of standardization is lacking in the current clinical and instrumental evaluations of swallowing where the use of dosing syringes is absent. One of the first published descriptions of a protocol for swallowing studies that specified the importance of exact measurements using a dosing syringe was presented by Jeri Logemann in 1983. This protocol recommended trials of each amounts of 2 ml liquid barium, 2 ml of paste barium, ¼ of a cookie coated with barium. Swallowing strategies and maneuvers were then introduced and volumes were increased via spoon as tolerated by the patient (Logemann, 1983). More recently, Martin-Harris and colleagues (2008) published a standardized protocol for conducting modified barium swallow studies called the Modified Barium Swallow Impairment Profile (MBSImP). In this protocol, eleven single swallows of standardized, commercial preparation of barium contrast agents are obtained in two trials of 5 ml via spoon, cup sip, and sequential swallows from a cup of thin liquids, nectar thick liquids, honey thick liquids, pudding thick (5 ml via spoon), and one-half portion of a Lorna Doone shortbread cookie coated with 3 ml of pudding-thick barium were completed by each patient when appropriate. To allow for flexibility in clinical decision making, compensatory strategies, including increasing amounts to 10-15 ml via spoon or tablespoon are included. All measurements are made by the SLPs and their ability to accurately measure out, for example, 5 ml is based on “clinical experience” (Martin-Harris, Brodsky, Michel, Castell, Schleicher, Sandridge, Maxwell, & Blair (2008).

Despite progress in determining reliable and valid protocols for the standardized administration of food/liquids during modified barium swallow studies, the type of contrast and amount of food/liquids given during swallowing studies are dependent on the individual facility (Groher & Crary, 2016). Thus, although most swallowing evaluations include a protocol for administering foods and liquids, either alone or mixed with barium or food coloring, in small and larger amounts, these protocols vary. Regardless of protocol, increasing or decreasing the volumes presented during swallowing evaluations are used to drive therapeutic recommendations for the safe volumes that should be given during feeding. Specifically, if a larger bolus tested (e.g. 15 ml) leads to aspiration, but a smaller bolus (5 ml) does not, then the recommendation for safe swallowing precautions would include recommendations to limit bite sizes to the safe 5 ml amount. The importance in being able to accurately estimate the amounts tested and recommended appears obvious.

The results of this study showed a large variability in the measurements of food and liquids in varying amounts suggesting that overall, SLPs are not consistent in their measurements of food and liquids used during swallowing evaluations. Of the 168 observations (14 participants x 3 amounts x 4 consistencies) only 3 were accurate. The participants underestimated the liquids (thin or thick) and overestimated the pastes (thin or thick). These findings add to previous research that suggests that therapeutic bite sizes vary among speech-language pathologists and caregivers feeding patients with dysphagia (Hall & Gillikin, 2015).

The variations in the measurements are comparatively small in real life; however, it is important to note that the greater the amount presented, the wider the margin is for error. For example, on average, the SLPs underestimated all tablespoon quantities. This plays an important aspect in diet recommendations and potential safety risks. The SLP may erroneously believe that they are clearing a patient to consume 1 tablespoon boluses even though the "1 tablespoon" amount given during the evaluation was closer to a teaspoon. Therefore, if a caretaker or certified nursing assistant (CNA) feeds the patient boluses around a tablespoon, then their serving size exceeds the quantity tested during the evaluation. This may develop into a safety risk because the bolus size may be too large for the patient to completely clear, which may lead to residue and aspiration.

Cooking experience with measuring spoons was also investigated to determine if the accuracy of the estimated evaluation quantities was influenced by the frequency of cooking. SLPs who were categorized as experience (e.g. "weekly") or less experience e.g. "monthly/yearly") made consistent over- or under-estimation of each of the measured quantities. The SLPs who identified that they used measuring spoons during cooking weekly were closer to the accurate weight value in 75% of all values. However, the majority of variance in the difference scores lay at or below 1 gram in 83% of opportunities. Therefore, while the SLPs who used measuring spoons weekly were more accurate in their estimations, the difference in accuracy between them and those who used measuring spoons monthly or yearly was not of great significance.

The second aspect of the research was to determine what viscosities and quantities of food and liquid were used by SLPs when performing FEES, MBSS and CSEs. Of the possible food types and viscosities, only thin liquid and nectar thick liquid were reportedly administered to patients by all of the SLPs who participated in the study. Other consistencies were used in differing combinations by SLPs suggesting considerable variations in the protocols used across the clinicians. The explanation behind the SLPs decisions of what food and liquid to include during their dysphagia evaluation protocols was not explored, so their reasoning is unknown and is a possible limitation of the current study. It should be noted that during the qualitative probing for information regarding amounts given during evaluations, the majority of SLPs would responded that they would not administer precise measurements and instead administered patient controlled “sips” or “bites.” However, all of the SLPs reported that they would make a therapeutic recommendation to limit bite and sip sizes to “one teaspoon or less” or to specifically use ½ teaspoon amounts for feeding based on the patient’s response to the dysphagia evaluation. Finally, none of the SLPs surveyed reported that they used dosing syringes to determine the precise amounts during dysphagia evaluation trials.

Limitations

There are a number of limitations in the present investigation that warrant discussion. First, this research was conducted using a small sample size the research results should be further investigated on a larger scale. A larger sample of practicing SLPs would provide researchers with more data to analyze and determine the accuracy of a larger group. While there was a fairly even split between participants who used MBSS, FEES, and CSE, the results would have provided greater significance to SLPs if more participants who used each of the 3 evaluation methods were included. For example, SLPs who use MBSS as their dysphagia evaluation tool may use barium pills in their protocols, which other evaluation methods would not require. A second limitation is that the data was collected at the participant's convenience in various settings. Due to the difficulty obtaining individual IRB approval for the inclusion of patients with dysphagia in participation at each of the facilities where the SLPs worked, data was not collected regarding the actual amounts given by SLPs as they were actually conducting dysphagia evaluations to patients. Instead, this study was limited to asking the participants to "show me what you do" and measure out stated amounts. Furthermore, the participants described their dysphagia protocols and administered the amounts to be weighed in a setting that was different from their typical administering conditions. The consistency between the participants administering the amounts in a low-stress environment versus accuracy of administration during actual evaluations is unknown. In addition, for participants who utilize MBSS as a dysphagia tool, they are required to add barium to their viscosities so that it will appear on the x-ray. The added volume of the barium to each of the consistencies during an MBSS will likely skew the data toward those amounts weighting more than those of FEES or CSEs. This demonstrates that it would have been difficult to achieve comparable data from participants who use MBSS because of the added weight of the barium to the consistencies, even if the researches had been able to collect data during evaluations. The third limitation is that the researchers provided all of the supplies to the participants. The researchers asked the participants to measure the food and liquid amounts using spoons and cups that may have been of a different size than those used by the SLPs at their facilities. The researchers provided the tools so that there would be consistency across all participants; however, SLPs may have proved to be more accurate when measuring if they had been using familiar items of measurement. Depending on the setting, SLPs may vary their dysphagia evaluation protocol based on what is available in the moment and at the facility. For example, one SLP reported that while she would sometimes use a protocol containing certain quantities and viscosities, she might also utilize whatever the patient was already planning on eating during a meal. This information demonstrates the lack of the use of standard dysphagia protocols and that some are against the idea of standardizing protocols, because it limits their evaluation strategies. However, this this also complicates the reporting of what SLPs actually administer in the field, because viscosities and amounts will vary by evaluations between patients.

The fourth limitation that should be considered is the method of measurement. Because the scales needed to be transported to different sites, the precise scientific scales from the science department could not be utilized for this research. Instead, the researchers measured the consistencies via two Unishow 500 x 0.01 Professional Digital Table Top Scales. Each of the scales was found to be accurate within +/- 0.04 grams when trialed with test weights. This variability may have caused some scores to fluctuate, which is a limitation when the amounts being tested are of such minimal amounts. It should be noted, a conservative estimate of "accuracy" was determined by using ±.05 of the actual weight when calculating the results.

The findings from this research suggest that future research regarding clinical and instrumental evaluation of dysphagia is warranted. The lack of use of a standard protocol for dysphagia evaluations in the field allows for great variation between experienced SLPs administering FEES, MBSS, and CSE. Exploration with surveying more SLPs to determine actual dysphagia evaluation protocols will aid researchers in identifying trends of quantities and viscosities used during evaluations. This will aid in carryover of services from one setting (i.e. acute) to the next facility the patient is transferred to (i.e. skilled nursing facility (SNF)) where another SLP will manage dysphagia treatment. Future research should be conducted with investigators measuring bolus sizes while SLPs are administering dysphagia protocols. Furthering research in this area will provide investigators with a more accurate idea of what SLPs are administering during objective dysphagia evaluations with patients. Additionally, comparisons should be made to the bolus sizes administered during dysphagia evaluations with what the patient receives post-evaluation. The SLP's diet recommendation is a crucial element for determining what the patient will be given during future meals. However, little is known about the carryover from recommendation to actual bolus administration from a caretaker or CNA. For example, the patient may be cleared to consume 1 teaspoon of thin puree bolus; however, the caretaker may be administering 1 tablespoon of thin puree at a time. Therefore, future research should be conducted to determine whether SLP diet recommendations are feasible to be carried out following the recommendation. Many avenues of research have yet to be explored within this topic. Dysphagia evaluations are a vital aspect of patient care, yet relatively little is known about what boluses are intended to be used and the accuracy of the estimates. Further research is necessary in developing better practice patterns and understanding what is currently being administered in the field. The ultimate goal of SLPs is to provide the highest quality of care to the patients.

Future research will better enable SLPs to meet this objective by improving the dysphagia evaluation process and analyzing how the recommendations will be feasible when implemented.

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Appendix A

Raw Group Data

Participant Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Age	26	41	35	44	51	29	27	37	58	31	33	34	63	28
# of SLP years	2	17	4	27	21	4	2.5	13	30	7	11	11	35	4
Years of Dysphagia exp.	2	2	4	13	21	4	2.5	13	25	7	11	11	9	3
Exp. using measuring spoons f	Weekly	Monthly	Monthly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Yearly	Monthly	Monthly	Monthly	Yearly
1/2 tsp Water	1.91	2.11	1.72	2.6	3.1	1.98	2.57	1.87	1.98	3.09	2.1	1.42	1.89	2.06
1 tsp Water	4.62	7.72	3.45	2.5	5.9	5.95	2.49	3.69	4.28	3.85	4.05	2.88	6.05	2.97
1 tbsp Water	8.9	12	7.23	4.45	13.8	11.9	4.79	5.24	11.29	9.66	7.34	6.07	11.68	5.58
N. Sip Water	8.45	10	8.01	11.22	14.07	7.93	11.19	17.61	15.25	15.25	9.97	15.44	12.74	7.54
L. sip Water	24.25	30.2	21.9	19.01	18.97	47.91	19.36	13.28	23.53	23.53	26.33	26.87	17.76	12.97
1/2 tsp Nectar Thick	1.59	1.43	1.52	1.92	4.78	2.01	1.91	3.58	2.164	2.72	2.94	2	1.96	2.71
1 tsp Nectar Thick	4.17	4.15	4.02	2.98	5.25	3.3	2.96	4.46	4.99	4.68	3.49	5.23	4.69	3.07
1 tbsp Nectar Thick	9.83	9.05	7.86	5.5	14.17	6	5.52	7.39	10.03	8.17	6.89	8.75	9.63	6.72
N. sip Nectar Thick	9.4	15.36	18.24	8.01	8.16	9.9	7.06	7.39	5.56	7.93	14.02	11.68	5.39	6.5
L. sip Nectar Thick	31.2	35.47	28.76	24.01	16.65	23.7	16.01	10.42	17.32	17.32	18	26.97	17.93	15.39
1/2 tsp Applesauce	4	3	1.13	3	5.72	4.9	3.07	3.48	6.99	8.15	6.24	9.77	5.88	4.41
1 tsp. Applesauce	7.21	6.24	7.34	4.81	10.13	8.6	4.76	5.04	9.38	11.62	7.12	11.54	7.26	5.87
1 tbsp Applesauce	12.91	17.59	10.15	8.9	17.76	18	8.87	10.41	17.7	18.01	9.36	13.88	12.97	9.03
1/2 tsp Pudding	4.59	5.13	3.13	2.49	7.52	3.01	2.52	3.5	8.05	8.77	3.33	5.72	9.37	2.78
1 tsp Pudding	8.3	7.5	5.49	4.3	10.31	5.12	4.29	6.03	11.33	11.93	9.56	9.74	12	5.83
1 tbsp Pudding	13.76	17.2	18.1	8.45	19.43	9.19	8.43	7.83	21.19	22.2	13.73	18.21	13.02	7.61
Type of Protocol Used	FEES	FEES	MBSS	CSE	CSE	MBSS	CSE	CSE	MBSS	MBSS	FEES	FEES	CSE	FEES

Appendix B

Raw Group Data Basic Statistics

	Data Mean	Actual Weight	St. Deviation	Difference
1/2 tsp Water	2.171428571	2.6	0.106066017	0.428571429
1 tsp Water	4.314285714	5.35	1.166726189	1.035714286
1 tbsp Water	8.566428571	14.8	2.347594514	6.233571429
N. Sip Water	11.76214286	N/A	0.643467171	N/A
L. sip Water	23.27642857	N/A	7.976164492	N/A
1/2 tsp Nectar Thick	2.373857143	2.8	0.791959595	0.426142857
1 tsp Nectar Thick	4.102857143	5.55	0.777817459	1.447142857
1 tbsp Nectar Thick	8.250714286	15.05	2.199102089	6.799285714
N. sip Nectar Thick	9.614285714	N/A	2.050609665	N/A
L. sip Nectar Thick	21.36785714	N/A	11.17935821	N/A
1/2 tsp Applesauce	4.981428571	3	0.28991378	-1.981428571
1 tsp. Applesauce	7.637142857	5.8	0.947523087	-1.837142857
1 tbsp Applesauce	13.25285714	15.8	2.743574311	2.547142857
1/2 tsp Pudding	4.993571429	2.65	1.279863274	-2.343571429
1 tsp Pudding	7.980714286	5.4	1.74655375	-2.580714286
1 tbsp Pudding	14.16785714	15.5	4.348706704	1.332142857

Appendix C

Accuracy and Consistency of the Estimates by the Participants

	Thin Liquid			Nectar Thick Liquid			Thin Puree			Thick Puree		
	Accurate	Below	Above	Accurate	Below	Above	Accurate	Below	Above	Accurate	Below	Above
½ teaspoon	1/14 (7%)	11/14 (79%)	2/14 (14%)	N/A	11/14 (9%)	3/14 (21%)	2/14 (14%)	1/14 (7%)	11/14 (79%)	N/A	2/14 (14%)	12/14 (86%)
1 teaspoon	N/A	10/14 (71%)	4/14 (29%)	N/A	14/14 (100%)	N/A	1/14 (7%) / N/A	11/14 (79%) / 3/14 (21%)	2/14 (14%) / 11/14 (79%)	N/A	2/14 (14%)	12/14 (86%)
1 tablespoon	N/A	14/14 (100%)	N/A	N/A	14/14 (100%)	N/A	N/A	9/14 (64%)	5/14 (36%)	N/A	8/14 (57%)	6/14 (43%)

Appendix D

Difference Scores Hierarchy

Quantity and Viscosity	**Data Average**	**Actual Weight**	**Difference Score**	**Standard Deviation**
1/2 tsp pudding	4.99	2.65	-2.34	1.28
1 tsp pudding	7.98	5.4	-2.58	1.746
1/2 tsp applesauce	4.98	3	-1.981	0.29
1 tsp. applesauce	7.63	5.8	-1.837	0.95
1/2 tsp nectar thick	2.37	2.8	0.426	0.792
1/2 tsp water	2.17	2.6	0.429	0.106
1 tsp water	4.31	5.35	1.036	1.167
1 tbsp pudding	14.17	15.5	1.332	4.35
1 tsp nectar thick	4.1	5.55	1.457	0.778
1 tbsp applesauce	13.25	15.8	2.55	2.74
1 tbsp water	8.57	14.8	6.23	2.35
1 tbsp nectar thick	8.25	15.05	6.8	2.2

Appendix E

t-Test Data Analysis

t-Test: Two-Sample Assuming Unequal Variances

	1/2 tsp Water	*Actual Average*
Mean	0.57	0
Variance	0.090215385	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	6.477792897	
P(T<=t) one-tail	1.03713E-05	
t Critical one-tail	1.770933396	
P(T<=t) two-tail	2.07426E-05	
t Critical two-tail	2.160368656	

t-Test: Two-Sample Assuming Unequal Variances

	½ tsp Nectar	*Actual Average*
Mean	0.975714	0
Variance	0.638903	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	4.333347	
P(T<=t) one-tail	0.000406	
t Critical one-tail	1.770933	
P(T<=t) two-tail	0.000812	
t Critical two-tail	2.160369	

t-Test: Two-Sample Assuming Unequal Variances

	½ tsp Thin Puree	*Actual Average*
Mean	2.248571429	0
Variance	4.154705495	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	4.035844973	
P(T<=t) one-tail	0.000706737	
t Critical one-tail	1.770933396	
P(T<=t) two-tail	0.001413473	
t Critical two-tail	2.160368656	

t-Test: Two-Sample Assuming Equal Variances

	1/2 tsp Thick Puree	*Actual Average*
Mean	2.382857	0
Variance	5.917991	0
Observations	14	14
Pooled Variance	2.958996	
Hypothesized Mean Difference	0	
df	26	
t Stat	3.665007	
P(T<=t) one-tail	0.000556	
t Critical one-tail	1.705618	
P(T<=t) two-tail	0.001113	
t Critical two-tail	2.055529	

t-Test: Two-Sample Assuming Unequal Variances

	1 tsp Water	*Actual Average*
Mean	6.233571	0
Variance	9.955717	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	7.332754	
P(T<=t) one-tail	2.86E-06	
t Critical one-tail	1.770933	
P(T<=t) two-tail	5.72E-06	
t Critical two-tail	2.160369	

t-Test: Two-Sample Assuming Unequal Variances

	1 tsp Nectar	*Actual Average*
Mean	1.443571	0
Variance	0.685179	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	6.299287	
P(T<=t) one-tail	1.37E-05	
t Critical one-tail	1.770933	
P(T<=t) two-tail	2.75E-05	
t Critical two-tail	2.160369	

t-Test: Two-Sample Assuming Unequal Variances

	1 tsp Thin Puree	*Actual Average*
Mean	2.235714	0
Variance	3.639919	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	4.286586	
P(T<=t) one-tail	0.000443	
t Critical one-tail	1.770933	
P(T<=t) two-tail	0.000885	
t Critical two-tail	2.160369	

t-Test: Two-Sample Assuming Unequal Variances

	1 tbsp Water	*Actual Average*
Mean	6.233571	0
Variance	9.955717	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	7.332754	
P(T<=t) one-tail	2.86E-06	
t Critical one-tail	1.770933	
P(T<=t) two-tail	5.72E-06	
t Critical two-tail	2.160369	

t-Test: Two-Sample Assuming Unequal Variances

	1 tbsp Nectar	*Actual Average*
Mean	6.799286	0
Variance	5.282469	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	10.98761	
P(T<=t) one-tail	2.98E-08	
t Critical one-tail	1.770933	
P(T<=t) two-tail	5.97E-08	
t Critical two-tail	2.160369	

t-Test: Two-Sample Assuming Unequal Variances

	1 tbsp Thin Puree	*Actual Average*
Mean	3.967143	0
Variance	4.690345	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	6.767543	
P(T<=t) one-tail	6.63E-06	
t Critical one-tail	1.770933	
P(T<=t) two-tail	1.33E-05	
t Critical two-tail	2.160369	

t-Test: Two-Sample Assuming Unequal Variances

	1 tbsp Thick Puree	*Actual Average*
Mean	4.665	0
Variance	5.994565	0
Observations	14	14
Hypothesized Mean Difference	0.05	
df	13	
t Stat	7.052724	
P(T<=t) one-tail	4.32E-06	
t Critical one-tail	1.770933	
P(T<=t) two-tail	8.64E-06	
t Critical two-tail	2.160369	

Appendix F

Statistical Significance of Comparisons of Similar Amounts

	1/2 tsp water	*1/2 tsp nectar*		*1/2 tsp water*	*1/2 tsp thin puree*
Mean	0.57	0.975714286	Mean	0.57	2.248571429
Variance	0.090215385	0.638903297	Variance	0.090215385	4.154705495
Observations	14	14	Observations	14	14
Pooled Variance	0.364559341		Pooled Variance	2.12246044	
Hypothesized Mean Difference	0		Hypothesized Mean Difference	0	
df	26		df	26	
t Stat	-1.777809428		t Stat	- 3.048379585	
P(T<=t) one-tail	0.043567434		P(T<=t) one-tail	0.002615784	
t Critical one-tail	2.559117449		t Critical one-tail	2.559117449	
P(T<=t) two-tail	**0.087134869**		P(T<=t) two-tail	**0.005231568**	
t Critical two-tail	2.855688667		t Critical two-tail	2.855688667	

	1/2 tsp water	*1/2 tsp thick puree*		*1/2 tsp nectar*	*1/2 tsp thin puree*
Mean	0.57	2.382857	Mean	0.975714	2.248571
Variance	0.090215	5.917991	Variance	0.638903	4.154705
Observations	14	14	Observations	14	14
Pooled Variance	3.004103		Pooled Variance	2.396804	
Hypothesized Mean Difference	0		Hypothesized Mean Difference	0	
df	26		df	26	
t Stat	-2.76729		t Stat	-2.17527	
P(T<=t) one-tail	0.005137		P(T<=t) one-tail	0.019446	
t Critical one-tail	2.559117		t Critical one-tail	2.559117	
P(T<=t) two-tail	**0.010273**		P(T<=t) two-tail	**0.038891**	
t Critical two-tail	2.855689		t Critical two-tail	2.855689	

	1/2 tsp nectar	*1/2 tsp thick puree*		*1/2 tsp thick puree*	*1/2 thin puree*
Mean	0.975714286	2.382857143	Mean	2.382857	2.248571
Variance	0.638903297	5.917991209	Variance	5.917991	4.154705
Observations	14	14	Observations	14	14
Pooled Variance	3.278447253		Pooled Variance	5.036348	
Hypothesized Mean Difference	0		Hypothesized Mean Difference	0	
df	26		df	26	
t Stat	-2.056142028		t Stat	0.158315	
P(T<=t) one-tail	0.024968318		P(T<=t) one-tail	0.437716	
t Critical one-tail	2.559117449		t Critical one-tail	2.559117	
P(T<=t) two-tail	**0.049936635**		P(T<=t) two-tail	**0.875432**	
t Critical two-tail	2.855688667		t Critical two-tail	2.855689	

	1 tsp water	*1 tsp nectar*
Mean	1.638571	1.443571
Variance	0.710105	0.685179
Observations	14	14
Pooled Variance	0.697642	
Hypothesized Mean Difference	0	
df	26	
t Stat	0.617685	
P(T<=t) one-tail	0.271078	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.542156	
t Critical two-tail	2.855689	

	1 tsp water	*1 tsp thin puree*
Mean	1.638571	2.235714
Variance	0.710105	3.639919
Observations	14	14
Pooled Variance	2.175012	
Hypothesized Mean Difference	0	
df	26	
t Stat	-1.07126	
P(T<=t) one-tail	0.146947	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.293895	
t Critical two-tail	2.855689	

	1 tsp nectar	*1 tsp thin puree*
Mean	1.443571	2.235714
Variance	0.685179	3.639919
Observations	14	14
Pooled Variance	2.162549	
Hypothesized Mean Difference	0	
df	26	
t Stat	-1.42518	
P(T<=t) one-tail	0.083	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.166	
t Critical two-tail	2.855689	

	1tsp thick puree	*1 tsp thin puree*
Mean	2.935714	2.235714
Variance	5.912734	3.639919
Observations	14	14
Pooled Variance	4.776326	
Hypothesized Mean Difference	0	
df	26	
t Stat	0.847423	
P(T<=t) one-tail	0.202247	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.404493	
t Critical two-tail	2.855689	

	1 tsp water	*1tsp thick puree*
Mean	1.638571	2.935714
Variance	0.710105	5.912734
Observations	14	14
Pooled Variance	3.31142	
Hypothesized Mean Difference	0	
df	26	
t Stat	-1.88595	
P(T<=t) one-tail	0.03526	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.070521	
t Critical two-tail	2.855689	

	1 tsp nectar	*1tsp thick puree*
Mean	1.443571	2.935714
Variance	0.685179	5.912734
Observations	14	14
Pooled Variance	3.298956	
Hypothesized Mean Difference	0	
df	26	
t Stat	-2.17356	
P(T<=t) one-tail	0.019516	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.039033	
t Critical two-tail	2.855689	

	1 tbsp nectar	*1tbsp thick puree*
Mean	6.799286	4.667142857
Variance	5.282469	6.00572967
Observations	14	14
Pooled Variance	5.644099	
Hypothesized Mean Difference	0	
df	26	
t Stat	2.374477	
P(T<=t) one-tail	0.01262	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.02524	
t Critical two-tail	2.855689	

	1 tbsp water	*1 tbsp nectar*
Mean	6.233571429	6.799285714
Variance	9.955717033	5.282468681
Observations	14	14
Pooled Variance	7.619092857	
Hypothesized Mean Difference	0	
df	26	
t Stat	-0.542243722	
P(T<=t) one-tail	0.296134146	
t Critical one-tail	2.559117449	
P(T<=t) two-tail	0.592268292	
t Critical two-tail	2.855688667	

	1 tbsp nectar	*1 tbsp thin puree*
Mean	6.799285714	3.967142857
Variance	5.282468681	4.690345055
Observations	14	14
Pooled Variance	4.986406868	
Hypothesized Mean Difference	0	
df	26	
t Stat	3.355601037	
P(T<=t) one-tail	0.001221573	
t Critical one-tail	2.559117449	
P(T<=t) two-tail	**0.002443146**	
t Critical two-tail	2.855688667	

	1 tbsp water	*1 tbsp thin puree*
Mean	6.233571	3.967143
Variance	9.955717	4.690345
Observations	14	14
Pooled Variance	7.323031	
Hypothesized Mean Difference	0	
df	26	
t Stat	2.215877	
P(T<=t) one-tail	0.01783	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.035661	
t Critical two-tail	2.855689	

	1 tbsp water	*1tbsp thick puree*
Mean	6.233571	4.667142857
Variance	9.955717	6.00572967
Observations	14	14
Pooled Variance	7.980723	
Hypothesized Mean Difference	0	
df	26	
t Stat	1.467028	
P(T<=t) one-tail	0.077181	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.154361	
t Critical two-tail	2.855689	

	1tbsp thick puree	*1 tbsp thin puree*
Mean	4.667143	3.967142857
Variance	6.00573	4.690345055
Observations	14	14
Pooled Variance	5.348037	
Hypothesized Mean Difference	0	
df	26	
t Stat	0.800848	
P(T<=t) one-tail	0.215239	
t Critical one-tail	2.559117	
P(T<=t) two-tail	0.430478	
t Critical two-tail	2.855689	

Appendix G

Voluntary Informed Consent Form

Project Director: Dr. Kellyn Hall Graduate Student Clinician: Joyanna Struzzieri

Participant's Name: ___________________________________

What this study is about:
This research project is associated with Communication Sciences and Disorders program at Longwood University. Joyanna Struzzieri, as supervised by Dr. Kellyn Hall, is measuring bite and sip size estimates of various food and liquids consistencies from Speech-Language Pathologists (SLP) who administer FEES and MBSS. We are also collecting information from SLPs who work with adult patients with dysphagia to find out what factors, if any, influence the food/liquid amounts that these SLPs deem therapeutically appropriate to give to patients with swallowing problems.

What will you ask me to do if I agree to be in the study?
As part of this study you will be asked to measure out various volumes of different consistencies (thin liquid, nectar thick liquid, applesauce, pudding thick, and a solid) that you typically use when testing swallowing function in patients with dysphagia during a FEES, MBSS, or clinical swallowing exam. We will ask you to measure these consistencies by pouring and/or spooning the volumes into cups which will be measured on a scale by the examiners. No follow-up procedure is expected.

The study should take approximately 10 to 20 minutes to complete. We will ask you to complete a questionnaire listing information such as age, number of years of practice, etc. These questionnaires will be coded to insure your identity is kept confidential.

Possible good that may come out of this study
This study may potentially provide normative data for bite and sip sizes administered by SLPs during swallow studies. This may help to better raise awareness and inform training procedures for SLPs in regards to swallow studies.

Possible risks that may occur in this study
This study poses minimal risk to participants.

Will I get paid for being in the study? Will it cost me anything?
There are no costs to you or payments made for participating in this study.

All of my questions
Joyanna Struzzieri and/or Dr. Kellyn Hall has answered all of your current questions about you being in this study. Any other questions, concerns, or complaints about this

project or benefits or risks associated with being in this study can be answered by Dr. Kellyn Hall who may be contacted at (434) 395-4847 or at hallkd@longwood.edu or Joyanna Struzzieri at struzzierij@longwood.edu. You acknowledge that you have the opportunity to obtain information regarding this research project, and that any questions you have will be answered to your full satisfaction.

Leaving the study

You are free to refuse to participate or to withdraw your consent to be in this study at any time. There will be no penalty or unfair treatment if you choose not to be in the study. Being in this study is completely voluntary.

My personal information

Your privacy will be protected. You will not be identified by name or other identifiable information as being part of this project. Data collected will not contain any personally identifying information. Data will be kept under lock and key. Any files containing information will be locked and password protected. No information will be presented which will identify you as a subject of this study unless you give permission in writing.

Study approval

Longwood University's Institutional Review Board makes sure that studies with people follows federal rules. They have approved this study, its consent form, and the earlier verbal discussion.

My rights while in this study

If you have any concerns about your rights, how you are being treated or if you have questions, want more information or have suggestions, please contact the Office of Academic Affairs at Longwood University at (434) 395-2010.

By signing this form, you are agreeing that you are 18 years of age or older. You acknowledge that the general purpose of this study, the procedures to be followed, and the expected duration of your participation have been explained to you. You acknowledge that you have read and fully understand this consent form and you sign it freely and voluntarily. A copy of this form will be given to you. You also agree to participate in the study described to you by Joyanna Struzzieri and/or Dr. Kellyn Hall.

____________________________________ ______________

Participant's Signature Date

____________________________________ ______________

Date

Signature of person obtaining consent on behalf of Longwood University

Appendix H

Data Collection Form

Participant Code:	**Date:**	**Examiner:**
Age of participant:		
Number of years as SLP:		
Years of dysphagia/feeding experience:		
Experience using measuring spoons for cooking/baking:		
What is your protocol that you use for MBSS, FEES, or clinical swallow evaluations:		
If you use more than one, which protocol calls for the most food items? List items/amounts of selected protocol:		
Notes:		

Data Collection for our quantities.

Water	**Measurement**			**Nectar Thick**	**Measurement**	
½ tsp				½ tsp		
1 tsp				1 tsp		
1 tbsp				1 tbsp		
	before	after			before	after
Normal Sip				Normal Sip		
Large Sip				Large Sip		
Applesauce	**Measurement**			**Pudding**	**Measurement**	
½ tsp				½ tsp		
1 tsp				1 tsp		
1 tbsp				1 tbsp		

Participant Code:	Date:	Examiner:

SLP Protocol for __________________				
	Measurement			Measurement
	Measurement			Measurement
	Measurement			Measurement

Notes: