13
Rehabilitation of Speech, Language and Swallowing Disorders

PEGGY KRAMER, DEENA SHEIN, AND JENNIFER NAPOLITANO

The speech-language pathology team is a dynamic component of the interdisciplinary neuro-rehabilitation team and is involved in many facets of care. The ultimate goal of this discipline is the restoration of communication competence, resolution of dysphagia, and improvement of oral motor function. The speech-language pathologist (SLP) works collaboratively with the acquired brain injury (ABI) survivor, family, and clinical team to create a comprehensive rehabilitation plan of care aimed at improving functional gains, independence, and quality of life.

Of critical importance in the neuro-rehabilitation process is the restoration of the survivor's communication competence. Without a means of communicating even the most basic needs, safety and well-being can be compromised, and the survivor's frustration can build very quickly, resulting in verbal outbursts or a shutting down of all attempts to communicate. Also of vital importance to the survivor is the restoration of swallowing function. Dysphagia, or disruption of swallowing, can compromise both the health and quality of life of individuals following an ABI and must be addressed early on in rehabilitation.

It is essential that the SLP be aware of evidence-based practice and best-practice recommendations when evaluating and treating survivors of ABI. As this is a rapidly advancing field, it is critical to remain up-to-date on research regarding effectiveness of treatment strategies (e.g., cognitive rehabilitation), and new technological developments (e.g., electrical stimulation, augmentative communication).

Evaluation

The evaluation process is initiated by a referral from the physician. SLPs begin their assessment when first greeting the survivor and his/her significant others. The combination of clinical interview, coupled with objective measures, will provide the foundation for a comprehensive evaluation. The interview includes obtaining information about social, educational, vocational, and medical history, as well as orientation status. Review of medical records is essential, as many ABI survivors are not able to report their history or current status accurately.

Interviewing family members is also important, as they can report observations regarding changes in communication which are not reflected in records, and of which the survivor may be unaware. Additional information is obtained regarding native language, handedness, need for eyeglasses, and present diet, including any restrictions or alternative consistencies for solids and liquids. Finally, eliciting comments from survivors related to their primary complaints regarding their communication competence provides information about their level of insight. The person's diagnosis, age, severity of impairment, and observations made during the interview, will determine which objective tests are chosen for the assessment.

An audiologic screening can help identify individuals that have hearing impairments that would interfere with their communication function. Pure tones are presented bilaterally via earphones at 1,000, 2,000, and 4,000 Hz at 25 dB for adults (ASHA, 2004). If the screening is failed, the individual can be referred for a comprehensive audiologic evaluation by an ear, nose, and throat (ENT) specialist or audiologist. Follow-up testing will determine the severity of the hearing loss and the need for aural rehabilitation.

An oral peripheral examination is an essential part of the evaluation following an acquired brain injury. Movement and strength of structures including the tongue, jaw, and lips as well as velopharyngeal sufficiency need to be assessed. Taping a survivor's voice during the evaluation is helpful for assessing vocal quality, including pitch, volume, prosody, and speaking patterns, and can serve as a tool for providing feedback to the individual regarding his/her vocal quality. In survivors with known or suspected dysphagia, a swallowing evaluation will also be performed, as will be addressed in a later section of this chapter.

There are a number of evaluation tools that have been developed for the assessment of language/communication and cognition in the neurologically impaired individual. These include the Apraxia Battery for Adults, Second Edition (Dabul, 2000); Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1983); Brief Test of Head Injury (Estabrooks & Hotz, 1991); Frenchay Dysarthria Assessment (Enderby, 1983); Measure of Cognitive-Linguistic Abilities (Ellmo et al., 1995); Minnesota Test for Differential Diagnosis of Aphasia (Schuell, 1965); Porch Index of Communicative Ability (Porch, 2001); Ross Information Processing Assessment, Second Edition (Ross-Swain, 1996); Scales of Cognitive Ability for Traumatic Brain Injury (Adamovich & Henderson, 1992); and Western Aphasia Battery (Kertesz, 1982). A complete listing of assessment tools can be found at the ASHA website (www.asha.org, "Directory of Speech-Language Pathology Assessment Instruments").

Communication/Language Deficits Following ABI

The results of the evaluation will lead to the formulation of the functional diagnosis, severity of the impairment, goals, and treatment plan. Communication deficits post-ABI can result from impairments in both the motor aspects of speech and/or the

ability to use and understand language. The former include dysarthria and apraxia. The latter include various types of aphasia, cognitive impairments (e.g., memory, problem solving), and impairments in social communication (e.g., pragmatics).

Motor Speech Disorders

Motor speech disorders, apraxia and dysarthria, are caused by neurological impairments resulting in disorders of voice, resonance, articulation, and/or respiration. ASHA (2004) has identified a preferred practice pattern related to motor speech intervention in adults, which supports interventions including "improving accuracy, precision, timing and coordination of articulation." Apraxia is characterized by deficits in programming of sequential and volitional movement of the articulators (e.g., jaw, lips, tongue, cheeks) and is not caused by muscle weakness (Beukelman & Yorkson, 1991). Oral apraxia, where the survivor demonstrates groping behaviors, may be present (Gillis, 1996). Apraxia is not structurally related, as there is no weakness or slowness of movement or discoordination of articulators. The diagnosis of oral apraxia is most common in survivors with left-hemisphere cerebrovascular involvement and common among those diagnosed with aphasia (Beukelman & Yorkston, 1991).

Treatment approaches include rate modification, imitation of phoneme, and words and phrases of increasing length. As an example, using key words, such as "cook," facilitates the production of /k/ in initial and final position and aids in the kinesthetic awareness of tongue placement during phoneme production. Tapping of fingers or using pacing boards aids with establishing proper rate of speech. Prosody improvements can be targeted by drills using contrasting stress to improve variation of intonation and rhythm—for example, "*I* am hungry"; "I *AM* hungry"; "I am *HUNGRY!"* (Chapey, 2001).

Dysarthria refers to disruption of speech intelligibility due to "disturbances in muscle control over the speech mechanism due to damage of the central or peripheral nervous system" (Darley, et al. 1969). Diagnosing dysarthria is difficult in that the survivor's speech may be compromised by weakened muscle strength, reduced range of motion of the articulators, reduced speed of motion, and imprecise articulatory contact. In addition, acoustic changes may include reduced prosody, vocal quality, pitch, and volume due to respiratory insufficiency.

Treatment of dysarthria focuses on restoration, compensatory strategy implementation—or, in the event of poor prognosis for speech recovery—assessment and development of an augmentative communication system. Of paramount importance is education related to the disorder to aid with comprehension of the deficit, the rationale behind treatment, and counseling to help with adjustment to potential lifelong deficits. Goals include improving awareness of speaking habits, posturing, breathing patterns, rate of speech, and prosody. Yorkston (1996) reviewed the effectiveness of therapeutic intervention for dysarthria. Treatment may include prosthetic devices such as a palatal lift prosthesis to aid velopharyngeal closure, reduce hypernasality, and increase intraoral pressure. Pacing boards and metronomes can be utilized to slow speaking

rate. Other strategies/techniques may include sitting, positioning, and pushing or bearing down to improve breath support; reducing rate of speech; and improving articulatory contact using oral motor exercises to strengthen and improve range of motion of articulators. Using audio and visual recordings is an excellent form of feedback and often useful in improving awareness of behaviors related to the disorder (Duffy, 1995). Word production drills, such as contrasting word pairs (e.g., bat, hat; map, lap; match, catch) and rapid changing word lists (e.g. may, me, my, mow, moo) are examples of additional treatments.

Augmentative/Alternative Communication (AAC)

According to ASHA's position statement (ASHA, 1991), AAC is an area of clinical research and educational practice for SLPs and audiologists that attempts to compensate and facilitate temporarily or permanently for the impairment and disability patterns of individuals with severe expressive and/or language comprehension disorders. AAC may be required for individuals demonstrating impairments in gestural, spoken and or written modes of communication. Acquired brain injury survivors may have severe communication impairments of this nature, and many could benefit from using AAC strategies (Glennen & DeCoste, 1997). These individuals exhibit significant difficulty effectively communicating with their families, friends, and co-workers. AAC is used when verbal expression is not considered to be a functional means of communication, and the ABI survivor is willing to consider alternative means of communicating. The goal of an AAC team working with an individual with an ABI is to provide communication assistance so that he or she is able to participate effectively in a rehabilitation program and be able to communicate ongoing needs (Beukelman & Mirenda, 1998).

Manual Systems vs. Electronic Systems

AAC devices can be divided into two general classifications, manual or electronic (see Table 13.1). Manual devices include object boards, single switch communicators, picture communication boards, wordbooks, and letter boards. By contrast, electronic devices employ the use of computerized software programs displayed on dynamic screens.

TABLE 13.1. Manual vs. Electronic Augmentative Communication Devices

Manual (light tech)	Electronic (high tech)
No technical problems	More independent
Customized/individualized	Accumulated Vocabulary to be used
Inexpensive	Societal perception that person is more intelligent
Ready for immediate use	Faster output/opportunities for more communication partners
Portable	

Major Features of AAC Devices

Mode of Access or Selection

Direct selection is a mode of access that requires the use of an upper extremity (hand, finger) or the head (eye gaze, optical pointer, mouth stick) to select the intended target. Indirect selection refers to the use of auditory or visual scanning to choose the intended target. Scanning involves the movement of a pointer or cursor that is automatic and continuous according to a present pattern. User indicates a selection by activating a switch to interrupt the cursor in order to make a selection (Cohen, 2004).

Language Characteristics

Most AAC devices operate via a symbol set or symbol system. Examples of typical symbol systems in hierarchical order from most to least concrete include: use of common objects, color photographs, line drawings, printed words or letters (Glennen & DeCoste, 1997; Cohen, 2004).

Output

Output refers to how the listener receives the message and can be in spoken or written form. Almost all currently available electronic AAC systems provide the user with the capability of producing spoken messages. Speech output allows the user to project voice and to communicate with many partners across distances. Two basic types are digitized (recorded human voice) and synthesized (speech is artificially produced). Some AAC devices have paper output consisting of small strip printers to keep the device small and portable. Computer-based AAC systems can use standard printers for output (Glennen & DeCoste, 1997). In addition, technologically advanced AAC devices have ways to enhance the rate of output (i.e., use of abbreviation, coding, word-prediction, and vocabulary storage).

Assessment

The AAC evaluation process should be performed as a team effort involving the patient, SLP, OT, PT, psychologist, and family member or caregiver (Glennen & DeCoste, 1997). Evaluation procedures range from naturalistic observations of the individual, to the use of formal and informal tests, including computerized assessment systems (Glennen & DeCoste, 1997). Naturalistic observation helps the SLP build a system based on the survivor's non-verbal communication strengths, which include gestures, facial expression, pointing, yes/no indication, and crying and/or laughing. Assessments include obtaining pertinent background information, speech, language and cognitive communication abilities, limitations of current system and communication needs, sensory function, postural and motor abilities, access selection techniques, symbol form, vocabulary storage, and rate-enhancement techniques (Cohen, 2004). The heterogeneous nature of this population requires the ongoing adjustment of evaluation and training procedures to meet the ultimate goal

of communicative competence within a variety of functional contexts (Fletcher, 1997).

Acceptance

Individuals who receive an AAC system often follow a pattern of adoption and abandonment (Fletcher, 1997). It is vital that the individual be actively involved in the selection of an AAC system following a comprehensive evaluation process. Consequently, they will be more likely to use the system effectively, feel a greater sense of commitment, and be less likely to abandon the device. Training communicative partners (e.g., spouses, caregivers) is essential to facilitate carryover and may increase long-term acceptance of the AAC device (Fletcher, 1997). SLPs should educate the family/ caregiver on the benefits of AAC, to provide an outlet, reduce frustration, and facilitate communication rather than impede verbal communication. Survivors and families should also be counseled that the use of an AAC system might be temporary. While serving to increase immediate functional communication, it can be used as a bridge to the re-acquisition of speech.

Dysphagia

Historically, the assessment and treatment of dysphagia, or swallowing disorders, was not considered to be within the scope of practice of a speech-language pathologist (SLP). Today, however, dysphagia is in the forefront of the field and the management of swallowing disorders is considered to be a predominant aspect of the speech-language pathologist's role across neuro-rehabilitation settings.

Dysphagia and Its Causes

Dysphagia can be defined as when any one or more of the stages of swallowing becomes impaired due to changes in sensation, muscle strength, and coordination, whereby the patient can no longer safely or efficiently swallow (Logemann, 1998). Dysphagia can range from mild to severe and can be caused by physical and/or cognitive impairments with implications including malnutrition, dehydration, and aspiration pneumonia. There are many different diagnoses which can cause dysphagia, including cerebrovascular accident (CVA), traumatic brain injury (TBI), spinal cord injury, Guillian-Barre syndrome, tracheostomy and/or ventilator dependency, brain tumors, multiple sclerosis, Alzheimer's disease or other dementias, and movement disorders such as Parkinson's and Huntington's diseases.

When working in a neurological rehabilitation setting with patients who have concomitant diagnoses of an acquired brain injury (ABI) and dysphagia, impairments such as disorientation, agitation, impulsivity, decreased level of alertness, initiation, mood, attention, memory, problem solving skills, safety judgment, visual-perceptual deficits, insight, and poor motor planning can affect a patient's potential for carryover. According to Halper et al. (1999), the severity of the cognitive communicative deficits will determine the type of management program

and its functional outcomes rather than the integrity of the physiological swallowing mechanism. Therefore, it is essential to involve the patient, his or her family, and the entire interdisciplinary rehabilitation team to enable a successful recovery.

Anatomy and Physiology of a Normal Swallow

A normal swallow includes four phases: the oral preparatory phase, the oral phase, the pharyngeal phase, and the esophageal phase. During the *oral prep phase* the lips, tongue, mandible, dentition, soft palate, and buccal cavity are engaged in order to arrange, chew, and mix with saliva to form and prepare the bolus of food that will eventually be swallowed. The *oral phase* is a transfer phase consisting of moving the cohesive bolus anterior to posterior using the tongue. The tongue propels the food posterior until the pharyngeal swallow is triggered. This phase is approximately 1 second in duration. The *pharyngeal phase* is an involuntary phase. During this phase the swallow reflex is triggered and the airway closes off at several levels (epiglottis, false and true vocal folds) to prevent a bolus from entering the airway. This phase is also approximately 1 second in duration. The final stage is the *esophageal phase*. This phase consists of the bolus continuing through the esophagus into the stomach via peristalsis. This phase is between 8 and 20 seconds in duration.

The normal swallow is an intricate dynamic process that involves sensation, range of motion (ROM), strength, and involuntary reflex response. In order to achieve normal swallow function, all of the phases must occur in a timely, coordinated manner. If there is a breakdown at any point along the mechanism during the swallow process, total swallow integrity may be compromised.

Dysphagia and Aspiration

Aspiration and aspiration pneumonia are major risks associated with dysphagia. Aspiration refers to a food or liquid bolus falling below the level of the vocal folds, into the airway. Breakdowns in the normal swallow process can result in bolus penetration into the larynx, which increases the risk of aspiration. Aspiration can occur before, during, or after the pharyngeal swallow (Lazarus, 1989). Saliva can also be aspirated; therefore proper oral hygiene is critical to reduce the risk of aspiration of oral bacteria. As a result of ABI, patients may have impaired sensation of the swallow mechanism. Therefore, signs and symptoms of aspiration may be delayed or silent. *Silent aspiration* refers to aspiration of a bolus with no overt behavioral signs or symptoms. According to estimates, silent aspiration may occur in up to 40% of patients with dysphagia, and it is not generally identifiable during the bedside swallow evaluation (Murray & Carrau, 2001).

Evaluation of Swallowing Disorders

Subjective Assessment Procedures

The bedside clinical evaluation assesses both structure and function of the swallow mechanism at the oral preparatory, oral, and pharyngeal phases of the swallow.

This involves assessing sensation, strength, and ROM (both volitional and reflexive responses) of the oral-pharyngeal structures. Assessment includes gathering a full medical history, noting pulmonary history, gastrointestinal history, nutrition and hydration status, current medications, and surgical history. A bedside evaluation also includes assessing the patient's cognitive-linguistic, voice, speech, and behavioral status as they impact current swallow function. During the bedside evaluation, the SLP may work with the occupational therapist to further assess a patient's positioning and self-feeding abilities.

Presentation of Food/Liquid During Bedside Evaluation

During the swallow assessment, the SLP assesses a variety of consistencies and textures with the aim of recommending the least restrictive safe and appropriate diet. The SLP assesses as many consistencies as possible given the patient's current level of alertness, cognitive, and physical impairment. Ideally, an evaluation should be conducted within the context of a full meal, as opposed to an isolated event, in order to simulate the patient's everyday naturalistic environment.

The following illustrates the signs and symptoms of dysphagia found during a bedside evaluation,

Bedside Findings: Signs and Symptoms of Dysphagia

General Findings

1. Facial asymmetry
2. Refusal/avoidance of specific foods
3. Abnormal head or body position
4. Reduced appetite or weight loss of unknown origin
5. Fever of unknown origin (possibly as result of aspiration)

Oral Findings

1. Hyper- or hypo-tonicity in oral facial structures
2. Decreased oral sensation (taste and smell)
3. Decreased lip, tongue, cheek ROM and strength
4. Food or liquid loss from mouth
5. Drooling
6. Slowed or inadequate chewing, biting, manipulation, transfer of bolus
7. Increased or decreased saliva production
8. Poor oral hygiene (gums, dentition)
9. Residue on tongue and/or pocketing in mouth
10. Expectorating/removing food from the mouth

Pharyngeal Findings

1. Delayed or absent swallow reflex
2. Decreased laryngeal elevation and excursion
3. Wet or gurgly vocal quality

4. Coughing before, during, after swallowing
5. Sneezing or watery eyes
6. Frequent throat clearing
7. Pharyngeal stridor
8. Regurgitation through the nose and/or mouth
9. Complaints of pain upon swallow or food getting "stuck"
10. Change in respiratory status

Objective Assessment Procedures

Modified Barium Swallow Study (MBS)

The SLP collaborates with a radiologist when performing a Modified Barium Swallow Study (also referred to as a Videofluorographic study). The MBS is a comprehensive, dynamic evaluation of all phases of swallowing requiring technical instrumentation and clinical expertise to interpret results. The recommendation of an MBS often follows the identification of dysphagia risk factors found during the clinical bedside evaluation (Murray & Carrau, 2001). The patient is presented with a variety of food and liquid consistencies, which have been impregnated with barium. The barium enables the pathway of the food and liquid to be visualized on a monitor through each stage of the swallow. "The modified barium swallow study is designed to assess not only whether the patient is aspirating, but also why, so appropriate treatment can be initiated" (Logemann, 1998). The study serves to identify abnormalities in the anatomy and physiology of the swallow mechanism, as well as the etiology and severity of potential aspiration. Furthermore, it helps to determine the safest diet texture as well as compensatory techniques to facilitate the safest most efficient swallow.

Flexible Endoscopic Evaluation of Swallowing (FEES) and Flexible Endoscopic Evaluation with Sensory Testing (FEESST)

In 1992, Flexible Endoscopic Evaluation of Swallowing (FEES) was put into ASHA's Scope of Practice and Policy Statement. Under the supervision of an otolaryngologist the SLP may perform a FEES, a test which involves a fiber optic endoscope that passes through the nasal cavity to a position above the epiglottis. It serves to examine the anatomy and physiology of the oral cavity and the pharynx from above, before and after the swallow (Aviv, 2000). Anatomical structures obstruct the camera's view during a brief period of airway closure, commonly referred to as the "white-out" phase.

The FEESST refers to the addition of sensory testing via an air pulse presented above the level of the vocal folds. This provides insight into the patient's ability to protect the airway and prevent aspiration.

Both the MBS and the FEES are used to gain objective information that cannot be obtained by the bedside evaluation alone, and serve to guide the SLP in appropriate diet progression. Both procedures are generally well tolerated, recorded on VCR or CD, begin with small graduated amounts and end with more challenging swallows

TABLE 13.2. Comparison of FEES vs. MBS

FEES	MBS
Regular food, actual meal tray (no barium)	Barium-impregnated foods
No radiation	Radiation
Can be used therapeutically	Limited therapeutic use
Portable	Radiology necessary
More cost effective	May view oral, pharyngeal and esophageal stages
View pharyngeal stage only	
Assess eating fatigue as risk factor	Time limited exam
Bedside or in chair	Videofluoroscopic imaging chair
More accessible	Not invasive
Can test patients difficult to transport (vent dependent, obese patients)	Indirect view
Direct view of surface anatomy, excellent view of larynx	Minimal risk factors
Useful for biofeedback	
Can be performed on cognitively impaired	
Patients do not have to follow directions	Cannot measure sensory threshold; however, silent aspiration/penetration is indicative of decreased sensation
No radiologist necessary, easier to schedule	

of each consistency (Aviv, 2000). In the field of speech-language pathology, MBS is seen as the gold standard and is most often recommended since it enables all phases of the swallow to be assessed. FEES is contraindicated for people who are on blood thinners, have uncontrolled seizure disorders, or acute cardiac problems (Aviv, 2000). However, FEES is useful in gaining direct information regarding vocal fold adduction (airway protection) during phonation and breath hold, which cannot be seen on the MBS. Table 13.2 highlights the primary differences between FEES and MBS.

The assessment of dysphagia is an ongoing, dynamic process, as patients demonstrate improvements and/or regressions in functioning, and may require frequent objective and/or subjective reevaluations on a case-by-case basis.

Treatment of Swallowing Disorders

A treatment plan can be developed and implemented following the completion of assessment procedures. A multidisciplinary approach is essential in order for the treatment plan to be carried out effectively. The team includes the SLP, occupational therapist, dietician, dentist, nurse, social worker, physician, family members, and/or caregivers. Patient and family education is an integral aspect of the treatment plan.

The SLP utilizes multiple approaches to swallow safety, including restorative therapy, compensatory techniques, and diet modification. An important decision needs to be made regarding whether to provide direct or indirect therapy. Direct therapy refers to the use of food and/or liquid during treatment, whereas indirect

therapy restricts the use of food or liquid as a treatment modality. This decision is based on formal test results regarding both frank aspiration and the risk of aspiration.

Restorative Therapy Techniques

Oral-Pharyngeal Exercises

Oral-pharyngeal exercises are widely used to improve awareness, strength, movement, coordination, and volitional control of the lips, tongue, cheeks, mandible, larynx, and vocal folds. Vocal fold closure is a key factor in preventing aspiration; therefore vocal fold adduction exercises are important for patients whose vocal folds fail to close sufficiently. Bolus control and chewing exercises can also be used to improve fine motor coordination of the tongue. However, only limited data is available to demonstrate the efficacy of oral-pharyngeal exercises on positive clinical outcomes (i.e., weight gain, reduced aspiration), for patients with neurological impairments (Murray & Carrau, 2001).

Swallow Maneuvers

In addition to oral-pharyngeal exercises, the patient can be trained to perform specific maneuvers that are employed to improve volitional control over various aspects of the pharyngeal phase of the swallow. These include the following:

- Supraglottic—used to improve airway (vocal fold) closure and increase pharyngeal swallow reflex triggering
- Super-supraglottic—used to increase airway closure
- Effortful swallow—used to increase posterior movement of tongue base
- Mendelsohn—used to increase laryngeal movement and coordination of swallow

These maneuvers require alertness, physical effort, and the ability to follow specific complex directions. Therefore, they may not be a feasible treatment modality for patients who exhibit significant cognitive-linguistic impairments.

Thermal Stimulation

The purpose of this technique is to increase sensory awareness in the oral cavity prior to the swallow and to increase the timeliness of the pharyngeal swallow reflex response. Thermal stimulation requires the use of a laryngeal mirror, held in ice water for approximately 10 seconds, then used to stimulate the anterior faucial arches 4 or 5 times in rapid fashion. This is followed by a command to swallow saliva. Ideally, stimulation will be repeated 3–4 times a day for ten trials. It is theorized that touch with thermal stimulation provides heightened oral awareness and an alerting stimulus to the brainstem and brain to trigger the pharyngeal swallow faster than it would in the absence of stimulation (Rosenbek et al., 1998).

Deep Pharyngeal Neuromuscular Stimulation (DPNS)

Deep pharyngeal neuromuscular stimulation is defined as a systemized therapeutic method for pharyngeal dysphagia that utilizes direct neuromuscular stimulation to the pharyngeal musculature to restore muscle strength, endurance, reflex response, and reflex coordination for a restored, coordinated swallow. DPNS utilizes iced lemon glycerin swabs applied directly to eleven specific stimulation points in the oral-pharyngeal cavities. The interaction of cold temperature, sour taste, and deep pressure applied by the SLP works to elicit a motor response (i.e., tongue base retraction, velopharyngeal closure, laryngeal elevation, pharyngeal wall constriction, vocal fold closure, swallow reflex trigger, and saliva production) (Stefakanos, 1999, revised 2005).

Neuromuscular Electrical Stimulation for the Swallow (NMES)

Electrical stimulation is a restorative treatment modality that has traditionally been used by physical and occupational therapists. It has recently been gaining increased attention as a treatment for dysphagia and is currently being used in conjunction with traditional dysphagia therapy. NMES is the use of electrical stimulation for the activation of muscles via stimulation of intact peripheral motor nerves through a transcutaneous medium. The major treatment goals are to strengthen weak muscles, maintain or gain ROM, facilitate voluntary motor control, and increase sensory awareness (Wijting & Freed, 2003). The basic underlying principle of NMES is forced intervention, which refers to using an external source of energy, such as an NMES device, to move the muscles to a greater degree than a patient could on his own with traditional exercise, and dynamically simulate a total swallow. NMES begins by introducing a low-level stimulus to elicit a sensory response. The intensity of the stimulus is then increased in order to achieve a motor response (contraction). Over time the treatment aims to build patient's tolerance for increased intensity of contractions. Electrical stimulation may be paired with traditional therapy and food and/or liquid trials, as appropriate.

VitalStim® (Wijting & Freed, 2003) is an FDA-cleared method to promote swallowing through the application of neuromuscular electrical stimulation. Questions remain in the field regarding the type of electrical current used, manipulation of parameters within NMES devices, and electrode placement and size. Further research is needed to determine the efficacy of various NMES devices and methods in the treatment of dysphagia.

Compensatory Treatment Techniques

Two categories of compensatory techniques are used in conjunction with restorative dysphagia therapy as part of a holistic treatment plan.

Postural Techniques

A compensatory strategy such as the use of a head, neck, or body postural change generally requires less physical effort on the part of the patient and potentially

TABLE 13.3. Diet consistencies

Least restrictive to most restrictive consistencies	
Food	Liquid
Unrestricted diet	Thin
Mechanically altered	Nectar
Ground	Honey
Puree	
Therapeutic Feeding by SLP only	
NPO	

temporarily changes the dimensions of the pharynx and the direction of food flow. Postural changes have been shown to improve oral-pharyngeal transit times, reduce the risk of aspiration, and decrease the amount of residue after the swallow (Logemann, 1998). Widely used postures include chin tuck, head back, head rotation to the weaker side, and lying down on one side. In general practice, carryover of postural techniques may be compromised in patients with moderate–severe cognitive impairments. Further compensatory strategies for a patient with oral and pharyngeal deficits may include an SLP's recommendations to remain upright for 30 minutes post-meal to reduce risk of aspiration, take controlled bites and sips, alternate solids and liquids, cueing the patient to perform multiple swallows, and training the patient to clear or remove food pocketing in the mouth. These strategies also may help improve the patient's management of food orally and his or her ability to clear possible pharyngeal residue to reduce the risk of aspiration.

Diet Modifications

Diet modification is another component in the treatment of dysphagia; however, this should be considered as a last resort in treatment planning. Oral nutrition and hydration is the ultimate goal for patients with dysphagia. Currently there are attempts being made to develop a nationally recognized dysphagia diet (Murry & Carrau, 2001). However, at the present time, dysphagia diets vary across facilities. Even though there is variation, diets are typically developed in a stepwise progression of bolus consistencies. It is the goal of the SLP to improve the patient's swallow integrity in order to progress to the least restrictive, safe and appropriate diet. Table 13.3 demonstrates the progression of diet textures.

Quality of Life

Oral vs. Non-Oral Feeding

Since it is unsafe for certain patients to eat by mouth, it is determined that they must receive nutrition and hydration via alternative, non-oral means, a status known as NPO, or non-perioral. The decision of whether to have a feeding tube inserted for non-oral feeding is a crucial one for patients and families and they often do not understand that feeding tubes can be temporary. In these cases, counseling

should clearly emphasize the benefits to the patient (i.e., good nutrition and hydration enabling them to do better in therapy) rather than the loss of oral feeding. It is important to note that aspiration does not always lead to aspiration pneumonia. A patient may evidence aspiration, however be tolerating a perioral (PO) diet that is against the recommendations of the rehabilitation team without developing aspiration pneumonia. Patients and families may choose to go against the recommendations for a specific dysphagia diet, and it is the SLP's responsibility to educate them regarding the potential health risks of aspiration.

HV is a 60-year-old male status post right-side CVA with left-sided weakness. Prior to the CVA, HV was independent and worked as a custodian. Moderate receptive and mild expressive language deficits included difficulty with auditory processing, word finding, and verbal fluency. Cognitive deficits were demonstrated in memory, attention, problem solving, and impulsivity. An MBS study done while in acute inpatient rehabilitation revealed decreased oral motor control, premature spillage, delayed swallow trigger with silent penetration on all liquid consistencies. Silent aspiration with delayed cough was noted on thin liquids. Head turn to the left eliminated aspiration. Upon admission to the subacute rehab unit, initial bedside evaluation results indicated moderate oro-pharyngeal dysphagia characterized by facial asymmetry and deficits in oral motor strength and ROM, mastication, bolus formation and transfer, and anterior food loss from lips on the left side. Pharyngeally, delayed swallow trigger, decreased laryngeal elevation, and audible swallow were noted. Wet vocal quality with cup sip trials of nectar and coughing on cup sip trials of thin liquid were evident. Honey thick liquids were tolerated without overt behavioral signs/symptoms of aspiration. Diet recommendations were for mechanical soft foods with honey thick liquids.

Compensatory strategies taught included remaining upright 30 minutes post-meal, small bites/sips, checking mouth for pocketing, and alternating solids/liquids. Restorative treatment goals included performing OMEs to improve oral motor strength and ROM, laryngeal elevation for airway protection, and NMES to improve swallow integrity. HV demonstrated difficulty isolating tongue/jaw movements. During therapy he required repetition, cues to decrease impulsivity, and increase attention. Carryover improved over time. Vital Stim® therapy was used for NMES. Over time, HV demonstrated increased tolerance for electrical stimulation, but continued to demonstrate decreased sensation on his left side. He tolerated NMES for 30–50 min a day, paired with an "effortful" swallow and head turn to the left with trials of thin liquids. Increased management of thin liquids was evident after 9-12 days of this therapy regimen. Repeat MBS revealed an improvement in swallow function, with mild oral-pharyngeal dysphagia characterized by decreased tongue base retraction and untimely swallow causing premature spillage; however, no penetration or aspiration was noted. Diet recommendations were regular foods cut up into small pieces, and cup sips of thin liquids. Recommendations for compensatory techniques were modified to include no straws, remaining upright 30 minutes post-meal, dry swallows to clear any residue in oro-pharynx, and monitoring for signs/symptoms of aspiration, pulmonary problems, and nutrition. HV was discharged to home with recommendations for outpatient ST.

Cognitive-Communication

According to Muma (cited in Chapey, 2001) there are three components of language: cognitive, linguistic, and communicative. The cognitive component refers

to information processing, including recognition, comprehension, memory, convergent thinking, divergent thinking, and problem-solving. The linguistic component relates to the form (phonology, morphology and syntax) and content (topic, subject and meaning) of language. The purpose of using language refers to the communicative component of language (Chapey, 2001). All three components are interrelated. The American Speech Language Hearing Association (ASHA) has adopted the term "cognitive-communication" to describe deficits in communication. Coelho and DeRuyter (1996) note, "cognitive communicative impairments are the result of deficits in linguistic and nonlinguistic cognitive functions." There is an interdependent relationship between cognitive and communication skills, and it is important for an SLP to address cognitive deficits as these difficulties can interfere with the ability to use strategies to improve deficits in motor speech, swallowing or language.

The speech-language pathologist evaluates expressive (verbal and written) and receptive (verbal and written) language elements, as well as pragmatic (social) aspects of language. Cognitive-communication skills are also assessed, including attention, memory, planning, organizational skills, reasoning, and problem-solving (Gillis, 1996). Collaboration and sharing evaluation results between the neuropsychologist and occupational therapist helps to develop a comprehensive understanding of the ABI survivor's language, cognitive and functional impairments, and forms a basis for the development of a holistic treatment plan.

SLPs participate in the rehabilitation of cognitive deficits by assisting the ABI survivor to develop compensatory techniques and strategies to interact more effectively with those around them, and function more independently. For example, survivors can be taught to use aids or devices (e.g., daily planners, digital recorders/reminders) to facilitate the ability to organize and remember important information. There is evidence to support such strategy training (Cicerone et al., 2005) and that these can be beneficial to individuals many years post-brain injury (Ownsworth & McFarland, 1999).

CI, a 32-year-old married mother of a two young children status post aneurysm rupture, attended a neuro-rehabilitation inpatient program for 9 months and then received 3 months of home therapy. She was very friendly and social, calling everyone "girlfriend" (as she could not recall names) and would have two breakfasts (having forgotten she'd eaten) and call her family members numerous times between the hours of 8:00 and 9:00 A.M. *looking for assurance that they would be there at dinnertime.*

Each time she called, it was the same exact discussion. Her family was reluctant to give her feedback about her repetitiveness, as they didn't want to upset her. She was unaware of the severity of her memory difficulties, though she was putting on weight and constantly patting herself with powder because she couldn't recall whether she put on deodorant. Her family had recently moved to a new address and CI could only recall her former address. Her short-term memory was virtually nonexistent.

Using a memory book that contained highly structured sections including 12 hours to write specific tasks and activities (e.g., taking medication), places to keep track of incoming and outgoing phone calls, and calendars to aid with orientation were specifically designed for CI. Therapy included daily use of this book, including functional memory assignments,

such as remembering to call her SLP at a certain day and time to tell her about the a story from the evening news. Through repetitive use of this book, CI began to demonstrate a greater ability to function independently. She became a very good compensator for a severe memory deficit.

Structured problem-solving training has been found to be an effective approach for rehabilitation of executive function deficits following ABI (Cicerone, 2005). Such training can be provided during individual or group sessions. When facilitated by a SLP, such sessions can address multiple goals, including receptive, expressive and social communication skills. Group feedback can also provide an opportunity to develop awareness and insight.

Aphasia

According to Holland et al. (1996), aphasia is defined as a language impairment associated primarily with focal brain damage, which usually involves the language-dominant cerebral hemisphere. In the large majority of individuals, this is the left hemisphere of the brain. Brain tumors, closed-head injuries, infection, and trauma may be causes of aphasia; however the predominant cause is stroke. According to the American Heart Association and the American Stroke Association's Fact sheet (2006) there are 700,000 strokes, new or recurrent, in America each year.

Aphasia disrupts a person's ability to communicate, both receptively (reading and listening) and expressively (writing and speaking), affecting not only words but numbers as well. Aphasic deficits are often accompanied by physical ramifications such as weakening or paralysis of upper and/or lower extremities. Chapey (2001) describes the aphasic survivor as having "lost functional, spontaneous language, or the ability to use connected language . . . " Aphasia affects the survivor and his or her caregivers. It can be extremely disruptive to one's social, vocational, and educational life, causing feelings of frustration, depression, and isolation.

Assessment of Aphasia

Assessment of aphasia begins with a thorough analysis of the survivor's ability to produce and understand language in all modalities: speaking, listening, reading, and writing. A language sample is a valuable tool to identify *paraphasias* that, according to Damasio (as cited in Chapey, 2001), refer to incorrect or unintended word or sound substitutions (e.g., "pea" instead of "peach"), or *neologisms* in which a novel word is substituted (e.g., "froxil" instead of "finger"). The term *jargon* is used to describe a condition in which most of the survivor's speech is filled with paraphasias. Proper diagnosis of type of aphasia is essential in order to determine appropriate treatment interventions. The general term "fluent aphasia" refers to a variety of specific conditions, including conduction aphasia, Wernicke's aphasia, and transcortical sensory aphasia. Conduction aphasics are described as fluent, with repetition of words more difficult in comparison to their spontaneous speech. According to Goodglass and Kaplan (as cited in Chapey, 2001), the primary impairment lies in the proper choice and sequencing of phonemes. Wernicke's

aphasia is characterized by articulate speech with impaired comprehension; sound and word substitutions are typical, as are difficulties with writing, reading, and word finding. Transcortical aphasics are articulate with jargon and neologisms but have difficulty with auditory comprehension although they have intact repetition abilities.

The category of "nonfluent aphasias" includes Broca's, transcortical motor, and global aphasia. Goodglass and Kaplan (as cited in Chapey, 2001) describe Broca's aphasia as characterized by impaired articulation, restricted vocabulary, and grammar, but with relatively intact auditory comprehension. Transcortical motor aphasia is characterized by intact repetition, perseverativeness in behavior, poor auditory comprehension yet good confrontation naming (Goodglass and Kaplan, as cited in Chapey, 2001). In global aphasia, the survivor demonstrates limited verbalizations (that may only be automatized phrases or words) as well as impairments in comprehension (Wepman and Jones, as cited in Chapey 2001). This condition can be extremely disabling, as the individual has no communicative strengths on which to build.

Treatment of Aphasia

As outlined in Chapey (2001), treatment approaches for aphasia can be categorized as either stimulatory or compensatory. Stimulation approaches include auditory comprehension by matching pictures and/or eliciting responses (e.g., yes/no), while verbal expression targets "associating meaning with speech movements" (Chapey, 2001). Compensatory approaches include use of synonyms, word associations, and communication boards, designed to substitute for verbal responses for those individuals who are unable to communicate verbally (see Augmentative Communication section of this chapter).

Different types of language impairments require different treatment approaches. In Broca's aphasia, speech is typically halted, fragmented, and effortful; content is rich for nouns but limited for verbs, prepositions, and pronouns. Treatment methods include verbal cuing by providing initial phonemes and visual cuing such as presenting the object or a picture of the object in single words, phrases and sentences. Gestures can further facilitate word production. Melodic Intonation Therapy (MIT; Sparks et al., 1974) is a technique thought to access the uninvolved, non-dominant hemisphere by incorporating prosodic elements, and can enable the aphasic individual to express words/phrases that would otherwise not be possible.

BJ, a 55-year-old male s/p CVA 9 months ago was unable to state his address verbally. Numbers were particularly difficult for him to produce, so the therapist cued him to utter his house number ("thirty-nine") in a singsong voice. The therapist also used head motion to facilitate the retrieval of the house number, modeling for the survivor to move his head side-to-side. A combination of phonemic ("long.....") and gestural cues (drawing out the thumb and index finger across the air) helped him to produce the name of his town ("Longmont"), and he developed the ability to use the gesture independently to self-cue.

Global aphasia treatment targets basic functional communication strategies. Incorporating the family or other caregivers into treatment by having them provide

background/biographical information, information on interests/hobbies, and photographs can make therapy more meaningful to the survivor. Multimodal communication is emphasized, including verbal (e.g., yes/no, carrier phrases), visual (pictures, drawings) and gestural (e.g., head nods/shakes, pointing) strategies.

The efficacy of therapeutic interventions for aphasia has been reviewed by Holland et al. (1996) and Cicerone et al. (2000, 2005). In their review, Holland et al. concluded that "generally, treatment for aphasia is efficacious," though noted that larger, more well-designed studies are needed. Based on their review, Cicerone et al. (2005) generated practice standards, including a recommendation that cognitive-linguistic therapies be included during acute and post-acute rehabilitation for individuals with language impairments secondary to left hemisphere stroke. Additionally, practice guidelines included cognitive interventions for specific language impairments (e.g., reading comprehension, language formulation) for individuals with left hemisphere stroke and TBI.

The effects of group treatment on linguistic and communicative performance in adults with chronic aphasia was studied by Elman and Bernstein-Ellis (1999). This study compared stroke survivors with aphasia receiving group communication treatment with age, education and severity-matched wait-listed control subjects. They found that those survivors receiving the group communication treatment had significantly higher scores on communicative and linguistic measures following treatment than those who did not receive the treatment. Finally, evidence supports the notion that greater intensity of treatment results in improved outcomes (Denes et al., cited in Cicerone, 2005).

Pragmatic Language

Pragmatic language involves the individual's use of language for communication purposes related to social interaction. The parameters of pragmatic language include topic choice, topic maintenance, and topic termination, turn taking, lexical selection, prosody, eye contact, body language and personal space. These interpersonal skills are interrelated during discourse and frequently disrupted in the ABI population. Survivors may go off on tangents, and anaphoric reference is frequently absent (e.g., when a speaker enters a conversation with pronoun reference that the listener has not had prior exposure to), causing confusion on the part of the listener. Perseveration, the repetition of the same idea or remark, is often demonstrated as well as difficulty "reading" the listener's facial expression and understanding nonverbal communication. Invasion of personal space may be demonstrated as self-regulation of behaviors is sometimes reduced or absent.

The primary goal of pragmatic language intervention is to heighten the speaker's awareness of inappropriate pragmatic language performance with gradual improvement secondary to feedback and training. Therapeutic intervention can be addressed within individual and/or group settings. One-on-one intervention, where there are fewer distractions and attention is more readily focused, is optimal in developing awareness of pragmatic language behaviors. This can be accomplished

by role-playing of functional activities (e.g., a conversation at a picnic). Use of video and audiotaping can facilitate the survivor's ability to identify deficits and develop strategies to improve function. Group sessions, where education regarding appropriate pragmatic language function can be reviewed, provide the opportunity for the survivor to receive feedback from peers as well as the therapist. Specific goals can be addressed during each session with handouts provided related to terminology. A self-assessment tool can be utilized at the start of the session to determine the participant's self-awareness and serve as a basis for increasing insight. Each session can focus on a specific area such as nonverbal communication, topic maintenance, initiation, awareness of listener's comprehension, and cohesiveness of the message (Sohlberg & Mateer, 1990).

LK was 33 years old when an allergic reaction precipitated anaphylactic shock with a resulting diagnosis of anoxia. LK was fluent, but on initial testing, was judged to be severely impaired in both receptive and expressive language areas. Cognitively, LK was easily confused when presented with complex information, and had significant impairments in attention. When overwhelmed cognitively, she became easily agitated and verbally disruptive. Pragmatic language was severely impaired as well. She would perseverate, interrupt, and had great difficulty with both topic maintenance and set shifting. She required maximal cuing to follow and maintain the flow of conversation.

Treatment sessions focused on reducing perseveration, establishing appropriate distance when speaking with others, following one- to two-step verbal directions, and diminishing outbursts and inappropriate interruptions. As a result of individual and group communication sessions, LK learned to respond to verbal prompts (e.g., "focus") and visual cues (e.g., a raised finger) and began to self-monitor through improved awareness of appropriate vs. inappropriate behaviors.

Conclusion

As part of the comprehensive neuro-rehabilitation team, speech-language pathologists are responsible for evaluating, educating, and providing restorative or compensatory therapy for a broad spectrum of disorders including dysphagia, motor speech, cognitive-communication, and pragmatic language disorders. In each of these areas, it is essential to involve the family as partners in the therapy process, providing education and training to enable carryover into home and community-based settings. Maintaining an evidence-based practice approach is necessary in order to provide the best quality of care to the survivors of brain injury whom we serve.

References

Adamovich, B.B., Henderson, J. (1992) *Scales of Cognitive Ability for Traumatic Brain Injury (SCATBI).* Austin, TX: Pro-Ed.

American Heart Association (©2001–06). CDC/NCHS. Available at http://www.americanheart.org

American Speech-Language Hearing Association. (1991) Report: Augmentative and alternative communication. *ASHA* 33(Suppl. 5):9–12.

American Speech-Language-Hearing Association. (2004) *Preferred Practice Patterns for the Profession of Speech-Language Pathology*. Available at http://www.asha.org/.

American Speech-Language-Hearing Association. (2006) *Directory of Speech-Language Pathology Assessment Instruments.* Available at www.asha.org.

Aviv, J.E. (2000) Prospective, randomized outcome study of endoscopy versus modified barrium swallow in patients with dysphagia. *Laryngoscope* 110:563–574.

Beukelman, D.R., Mirenda, P. (1998) *Augmentative and Alternative Communication: Management of Severe Communication Disorders in Children and Adults*, 2nd ed. Baltimore: Paul H. Brooks Publishing Co.

Beukelman, D.R., Yorkston, K.M. (1991) *Communication Disorders Following Traumatic Brain Injury: Management of Cognitive, Language and Motor Impairments*. Austin, TX: Pro-ed.

Chapey, R. (2001) *Language Intervention Strategies in Aphasia and Related Neurogenic Communication Disorders*. 4th ed. Baltimore: Williams & Wilkins.

Cicerone, K.D., Dahlberg, C., Kalmar, K., Langenbahn, D.M., Malec, J.F., Bergquist, T.F., Felicetti, T., Giacino, J.T., Harley, J.P., Harrington, D.E., Herzog, J., Kneipp, S., Laatsch, L., Morse, P.A. (2000) Evidence-based cognitive rehabilitation: Recommendations for clinical practice. *Archives of Physical Medicine & Rehabilitation* 81: 1596–1615.

Cicerone, K.D., Dahlberg, C., Malec, J.F., Langenbahn, D.M., Felicetti, T., Kneipp, S., Ellmo, W., Kalmar, K., Giacino, J.T., Harley, J.P., Laatsch, L., Morse, P.A., Catanese, J. (2005) Evidence-based cognitive rehabilitation: Updated review of the literature from 1998 through 2002. *Archives of Physical Medicine & Rehabilitation* 86:1681–1691.

Coelho, C.A., DeRuyter, F. (1996) Treatment efficacy: Cognitive-communicative disorders resulting from traumatic brain injury in adults. *Journal of Speech and Hearing Research* 39:S5–S17.

Cohen, C.S. (2004) *Augmentative and Alternative Communication: Assessment and Integration. . . .the Basics and Beyond*. June 3–4, 2004. Hampton Cares, NY.

Dabul, B.L. (2000) *Apraxia Battery for Adults*, 2nd ed. Austin, TX: Pro-Ed.

Darley, F.L., Aronson, A.E., Brown, J.R. (1969) Differential diagnostic patterns of Dysarthria. *Journal of Speech and Hearing Research* 12:246.

Duffy, J.R. (1995) *Motor Speech Disorders Substrates, Differential Diagnosis and Management*. St. Louis: Mosby.

Ellmo,W., Graser, J., Krchnavek, B., Hauck, K., Calabrese, D. (1995) *Measure of Cognitive-Linguistic Abilities (MCLA).* Vero Beach: The Speech Bin.

Elman, R.J., Bernstein-Ellis, E. (1999) The efficacy of group communication treatment in adults with chronic Aphasia. *Journal of Speech, Language, and Hearing Research* 42:411–419.

Enerby, P. (1983) *Frenchay Dysarthria Assessment*. Austin, TX: Pro-Ed

Estabrooks, N., Hotz, G. (1991) *Brief Test of Head Injury (BTHI)* Austin, TX: Pro-Ed.

Fletcher, P.P. (1997) AAC and adults with acquired disabilities**.** In Glennen, S.L., DeCoste, D.C. (eds.): *Handbook of Augmentative and Alternative Communication*: *A Handbook of Principles and Practices*. Needham Heights, MA: Allyn and Bacon.

Gillis, R. (1996) *Traumatic Brain Injury Rehabilitation for Speech-Language Pathologists*. Boston: Butterworth-Heinemann.

Glennen, S.L., DeCoste, D.C. (1997) *Handbook of Augmentative and Alternative Communication: A Handbook of Principles and Practices*. Needham Heights, MA: Allyn and Bacon.

Goodglass, H., Kaplan, E. (1983) *Boston Diagnostic Aphasia Examination*. Philadelphia: Lea & Febiger.

Holland, A.L., Fromm, D.S., De Ruyter, F., Stein, M. (1996) Treatment efficacy: Aphasia. *Journal of Speech and Hearing Research* 39:S27–S36.

Halper, A.S., Cherney, L.R., Cichowski, K., Zhang, M. (1999) Dysphagia after head trauma: the effect of cognitive-communicative impairments on functional outcomes. *Journal of Head Trauma Rehabilitation* 14(5): 486–496.

Kertesz, A. (1982) *Western Aphasia Battery*. Austin, TX: Pro-Ed.

Lazarus, C.L. (1989) Swallowing disorders after traumatic brain injury. *Journal of Head Trauma Rehabilitation* 4(4):34–41.

Logemann, J.A. (1998) *Evaluation and Treatment of Swallowing Disorders*. Austin, TX: Pro-Ed.

Murry, T., Carrau, R.L. (2001) *Clinical Manual for Swallowing Disorders*. San Diego, CA: Singular.

Ownsworth, T.L., McFarland, K. (1999) Memory remediation in long-term acquired brain injury: Two approaches in diary training. *Brain Injury* 13:605–626.

Porch, B. E. (2001) *Porch Index of Communicative Ability–Revised (PICA-R) Albuquerque: PICA Programs*.

Ross-Swain, D.G. (1996) *Ross Information Processing Assessment*, 2nd ed. Austin, TX: Pro-Ed.

Schuell, N.M. (1965) *The Minnesota Test for Differential Diagnosis of Aphasia*. Minneapolis: University of Minnesota Press.

Sohlberg, M.M., Mateer, C.A. (1990) In Kreutzer, J.S., Wheman, P. (eds.): *Community Integration Following Traumatic Brain Injury*. Baltimore: Paul H. Brookes Publishing Co.

Sparks, R., Helm, N., Albert, M. (1974) Aphasia rehabilitation resulting from melodic intonation therapy. *Cortex* 10:303–316.

Stefakanos, K.H. (1999, revised 2005) *Comprehensive DPNS: A Dysphagia Workshop on Deep Pharyngeal Neuromuscular Stimulation. Resource text*. The Speech Team, Inc.

Wijting, Y., Freed, M.L. (2003) *VitalStim® Therapy Manual*. Hixson, TN: Chattanooga Group.

Yorkston, K.M. (1996) Treatment efficacy in Dysarthria. *Journal of Speech and Hearing Research* 39:S46–S57.