

Evidence-Based Practice Guidelines for Dysarthria: Management of Velopharyngeal Function

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The Academy of Neurologic Communication Disorders and Sciences (ANCDS) established a writing committee to develop evidence-based practice guidelines for speech-language pathologists who treat individuals with dysarthria. The current guidelines draw from both the research literature and expert opinion and address the issues of management of velopharyngeal impairment in dysarthria. A search of electronic databases (PsychINFO, MEDLINE, and CINAHL) and hand searches of relevant edited books yielded 33 intervention studies in the categories of prosthetics, surgery, and exercise. A summary of quality of evidence is provided along with a clinical decision-making flow-chart for the management of velopharyngeal impairment in both degenerative and stable/recovering dysarthria. Palatal lift intervention was found to be effective in selected individuals with dysarthria. The best candidates have a flaccid soft palate, pharyngeal wall movement, good oral articulation and respiratory support, and a stable disease course. Recommendations for future research are provided.

BACKGROUND

Dysarthria is a heterogeneous group of neurological speech disorders whose characteristics reflect abnormalities in the strength, speed, range, timing, or accuracy of speech movements as a result of pathophysiologic conditions such as weakness, spasticity, ataxia, rigidity, and a variety of involuntary movements (e.g., dystonia, tremor). Dysarthrias can affect the respiratory, laryngeal, velopharyngeal, and oral articulatory subsystems, singly or in combination. The impact of dysarthria ranges from a barely appreciable speech disorder to a reduction in the intelligibility of speech to an inability to speak. This group of disorders varies along a number of dimensions, including age of onset (congenital or acquired at any age), cause (vascular, traumatic, neoplastic, and so on), natural course (developmental, recovering, stable, degenerative, and so on), site of lesion (many sites in the central or peripheral nervous system or both), neurologic diagnosis (Parkinson disease, traumatic brain injury, cerebral palsy, amyotrophic lateral

sclerosis, and so on), and pathophysiology (flaccidity, spasticity, ataxia, rigidity, and so on). The challenges inherent to the clinical management of persons with dysarthria are numerous. Speech-language pathologists are faced with a myriad of assessment approaches and treatment techniques—many with potential utility for an individual client—but some with dubious validity and utility. Converging evidence in the research literature can serve as the foundation for the development of guidelines for clinical practice.

Mission Statement

The Writing Committee for Practice Guidelines in Dysarthria is charged by the Academy of Neurologic Communication Disorders and Sciences (ANCDS) with developing evidence-based practice guidelines for speech-language pathologists. (For a review of evidence-based practice and practice guidelines as applied to the field of speech-language pathology see Yorkston et al., 2001.) These practice guidelines stem from an evidence-based review that draws

from the research literature as well as expert opinion. They address some of the major issues in the management of children and adults with dysarthria. Practice guidelines are intended for use in making clinical decisions about the management of specific clinical problems. In this article, guidelines for the management of velopharyngeal impairment in dysarthria are reviewed.

Justification

The Writing Committee of Practice Guidelines for Dysarthria developed a list of clinical questions faced by speech-language pathologists caring for individuals with dysarthria. The topic of management of velopharyngeal impairment was selected for a number of reasons. First, it is a common manifestation of dysarthria and can complicate all aspects of speech production. Second, variation in approaches to management exists in clinical practice. Finally, the intervention literature is substantial and dates back to the 1960s.

Terminology

Through the years, a number of terms have been used to describe velopharyngeal disorders in the cleft palate and motor speech populations. These include velopharyngeal impairment, inadequacy, insufficiency, incompetency, and dysfunction. In a recent state of the art review, Kuehn and Moller (2000) suggest that there is no universal agreement on distinctions among these terms. They suggest use of the term *velopharyngeal impairment* because it encompasses a wide variety of velopharyngeal disorders and because it is consistent with terminology used in the World Health Organization's classification system (World Health Organi-

zation, 1999). The term *velopharyngeal impairment* refers to any failure of the *velopharyngeal mechanism* to open or close in a normal fashion for speech (Tomes & Kuehn, 1996).

PROCEDURES: REVIEWING THE EVIDENCE

Development of practice guidelines can be viewed as a process of translating evidence from both research literature and expert opinion into recommendations for clinical practice. To evaluate the quality of any practice guideline, it is important to document exactly how they were developed. The development process typically involves a series of steps (Trombly, 1995) as summarized in Table 1. The following section provides specifics about the experts (including both the writing committee and the reviewers), the searches, criteria for inclusion of studies, and rating of evidence.

The Writing Committee

First, a group of experts (the writing committee) was convened. These individuals represented a broad range of clinical experience in the management of dysarthria. The initial tasks of the writing committee were to clarify assumptions upon which the guidelines are based, to identify pertinent clinical questions, and to define the scope of the literature to be evaluated.

The Searches

Next, an intensive literature search was conducted and appropriate intervention articles were retrieved. The following electronic databases were

TABLE 1. The sequence of activities for development of practice guidelines.

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- A panel of experts (the writing committee) is convened
 - Assumptions are clarified and pertinent questions are identified
 - An intensive literature search is conducted and pertinent articles are retrieved
 - Intervention studies are rated for quality of evidence
 - A technical report is drafted that summarized the research literature as well as the expert opinion of the writing committee
 - Expert opinion is obtained
 - Recommendations are drafted, reviewed, and revised
 - Guidelines are distributed.
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searched: PsychINFO covering 1,300 journals (1967 to July 2000), MEDLINE covering 3,900 journals (1966 to July 2000), and CINAHL covering 600 journals (1982 to July 2000). The initial searches were keywords paired with the term *dysarthria*, for example, *dysarthria and velopharyngeal*, *dysarthria and hypernasality*, *dysarthria and resonance*. Later searches paired terms such as *velopharyngeal*, *hypernasality*, and *resonance* with the terms *speech* and *treatment*. Because the intent was to carry out the broadest possible search, other sources of evidence were also sought. In addition to the electronic searches, hand searches of relevant edited books in the field of dysarthria and ancestral searches of extant references (e.g., studies cited within an article or chapter) were conducted.

Criteria for Inclusion of Studies

The general search on the topic of dysarthria yielded 1,042 references. From this large search, references related to velopharyngeal function were identified, and those related to intervention were obtained and rated. Intervention studies were defined as those focusing on treatment of the velopharyngeal system that was applied to at least one person with dysarthria. Thus, articles were excluded that (a) described but did not treat velopharyngeal function in dysarthria, (b) applied treatment approaches to individuals without impairment, and (c) studied techniques for management of velopharyngeal impairment associated with disorders other than dysarthria, (e.g. cleft palate). Review articles and chapters that surveyed intervention served as supportive documentation for a flowchart of management decisions described later in this article.

Rating the Evidence

Each intervention study was analyzed for methodological rigor. Strength of evidence was rated according to principles outlined by the American Psychological Association (Chambless & Hollon, 1998) and was determined by asking the following series of questions:

How well were the subjects described?

How well was the treatment described?

What measures of control were imposed in the study?

Were the consequences of the intervention well described?

The rating scheme is described more fully elsewhere (Yorkston et al., 2001). A table of evidence was then created that contained a summary of each study and allowed comparisons among studies and over time.

Expert Reviews

The quality of evidence found in the intervention literature along with the expert opinion of the writing committee was summarized in a technical report. A draft of this report was made available to a larger panel of expert reviewers. In the case of these practice guidelines for management of velopharyngeal impairment, the technical report was reviewed by 28 experts in addition to the writing committee. A majority of these individuals hold doctoral degrees (61%). The average length of clinical practice was 19 years. Although most of the expert reviewers were members of ANCDs (68%), the opinion of reviewers from outside of the organization's membership with known expertise on velopharyngeal function was also sought. The comments of the expert reviewers were carefully considered and used to modify the technical report. Finally, the guidelines were distributed in the form of both a technical report, made available on the websites of ANCDs (<http://www.duq.edu/ancds/>) and ASHA (<http://www.asha.org/>), and published in this clinically focused article.

SUMMARY OF EVIDENCE FROM INTERVENTION STUDIES

A total of 33 intervention studies were identified, obtained, and rated by at least two members of the writing committee. A summary of the table of evidence in which the studies were rated can be found in the technical report. The following section provides an overview of the evidence, including the types of interventions and management of velopharyngeal impairment in dysarthria.

What Interventions Are Reported in the Research Literature?

The intervention studies were classified into three categories: prosthetic, surgical and exercise. Prosthetic intervention included palatal lifts, nasal, or nasopharyngeal obturators and palatal desensitization associated with palatal lift fitting. Surgical intervention included pharyngeal flap surgery,

pharyngeal implants, and teflon injections. Exercise included palatal training devices and resistance exercises with continuous positive airway pressure (CPAP). Table 2 contains a summary of the types of interventions for velopharyngeal impairment reported in research articles over a 30-year period. Also included in Table 2 is the number of subjects in each category. The largest category was prosthetic intervention with 21 studies (61% of the total) followed by the surgical category with 9 articles (27% of the total), and the exercise category with 2 articles (6% of the total). When intervention options were compared in terms of the number of cases or subjects reported, palatal lift intervention was by far the most common with 83% of subjects (186 of 224) receiving palatal lifts. Sixteen percent of subjects received pharyngeal flap surgery. However, since 1990, only 2 cases of pharyngeal flap surgery were reported.

It is also important to note interventions that were not documented in the literature. This extensive search of the published literature found no evidence supporting the following techniques: pushing techniques; strengthening exercises, such as blowing and sucking; tasks that encourage the patient to control and modify the airstream using balls, whistles, candles, fluff, powder, paper, bubbles, straws, and so on; and inhibition techniques, such as prolonged icing, pressure to muscle insertion points, slow and irregular stroking and brushing, and desensitization.

A review of the current research suggests that there is not sufficient evidence to assess the effectiveness of surgical management or exercise for velopharyngeal impairment in dysarthria. In the area of exercise, only two case reports have been published. In the area of surgical intervention, evidence is insufficient to make recommendations. Early reports draw from the field of cleft palate. In fact, the first report of pharyngeal flap intervention in neurologic populations was entitled, "Cleft palate-

type speech in the absence of cleft palate" (Randall, Bakes, & Kennedy, 1960). Other studies published prior to 1970 are called "preliminary" reports (Hardy, Rembolt, Spriestersbach, & Jaypathy, 1961) and lack both the detailed case descriptions and comprehensive outcome measures needed for documentation of effectiveness. Often surgical intervention was described in complex cases, such as the case reported by Johns (1985) of an individual with a gunshot wound to the left frontal lobe and the mandible or in cases where behavioral and prosthetic intervention had already failed. Thus, the complexity of the cases makes generalization to a broader population difficult. Palatal lift intervention was first reported as a response to apparent dissatisfaction with pharyngeal flap surgery. Hardy and his colleagues, who had in 1961 authored one of the first reports of pharyngeal flap surgery, published a study of palatal lift intervention in 1969. As a rationale for the palatal lift intervention, they cited difficulty in predicting the successful outcome with pharyngeal flap surgeries. Thus, recommendations for the appropriateness of surgical intervention cannot be offered at this time given the insufficient foundation of applicable research.

Evidence for the Effectiveness of Prosthetic Intervention

Because intervention studies in the area of prosthetic management are the most common and provide an adequate picture of candidates and outcomes of intervention, the following sections will highlight the effectiveness prosthetic intervention.

Who Is a Good Candidate for Prosthetic Intervention?

Because dysarthria represents a heterogeneous group of disorders, identifying good candidates for intervention is dependent in part upon the quality

TABLE 2. Number of articles in various intervention categories and total number of participants.

Timeframe	Prosthetic	Surgical	Exercise	Total
< 1970	3 (12)	3 (9)		6 (21)
1970s	8 (77)	3 (18)	1 (1)	12 (96)
1980s	6 (63)	1 (1)		7 (64)
1990 thru 7/00	4 (34)	2 (6)	1 (2)	7 (42)
Total	21 (186)	9 (35)	2 (3)	33 (224)

Parentheses indicate the total number of subjects.

of the description of subjects. Studies reviewed here included descriptions of subject characteristics that ranged from comprehensive to minimal. The following characteristics were reported in at least 50% of the studies: age, gender, medical diagnosis, time post onset, speech characteristics, treatment history, severity of dysarthria, physiologic data, and data from the neurologic examination.

Intervention for velopharyngeal impairment was studied most frequently in individuals with traumatic brain injury (TBI), cerebrovascular accident (CVA), and cerebral palsy (CP). Although motor neuron disease was only reported in 5 of the 32 articles (16%), a recent study (Esposito, Mitsumoto, & Shanks, 2000) reported the results of palatal lift fitting in a group of 25 speakers with amyotrophic lateral sclerosis.

The type of dysarthria was not specified for some or all of the subjects in 75% of the articles. However, when the type of dysarthria was specified (as it was in 37% articles), flaccidity was a component in most cases. The second most common type of dysarthria was a mixed flaccid/spastic dysarthria. The relatively low rate of reporting dysarthria type likely reflects the historical development of the field. The first study reporting type of dysarthria (flaccid reported in Netsell and Daniel, 1979) occurred only after the publication of the classic Mayo Clinic studies of differential diagnosis in dysarthria (Darley, Aronson, & Brown, 1969a, 1969b; Darley, Aronson, & Brown, 1975).

In reviewing the description of candidacy and the rationale for intervention contained in the studies, the following general categories emerged:

Speech Characteristics. Several speech characteristics were associated with candidacy including hypernasality, nasal emission, and severe reduction in intelligibility.

Physiologic Factors. The deficient functioning of the velopharyngeal mechanism was identified frequently as a rationale for intervention under this category. This included characteristics such as velopharyngeal incompetence, palatopharyngeal paralysis, inconsistent soft palatal contact with the pharyngeal wall, and inability to achieve adequate oral pressure. Poor respiratory support also was indicated as a physiologic rationale for management.

Resolution of Symptoms. The notion that resolution of the velopharyngeal incompetence would lead to speech improvement was cited as a rationale

for intervention. At times, this premise was expressed in procedural phrases, such as "improved production of plosives and fricatives with manual occlusion of the nares" (Stewart & Rieger, 1994, p. 151).

History of Previous Intervention. The history of previous interventions was a common rationale for decisions made about the chosen course of therapy. For example, behavioral speech treatment had been unsuccessful or progress had plateaued at the time when intervention was undertaken.

Natural Course of the Disease. The course of the disease also was used to determine candidacy. For example, cases with the diagnosis of traumatic brain injury were reported where the time post onset suggested that no further speech recovery was likely.

Professional Judgment. Generic statements about professional judgments also served as a rationale for intervention. These included statements such as a "multidisciplinary evaluation was used to determine candidacy" (Stewart & Rieger, 1994, p. 151). The category of professional judgments also included statements such as "other approaches such as surgery were contraindicated" (Gonzalez & Aronson, 1970, p. 92) and "interventions were judged to be effective for other populations particularly those with craniofacial abnormalities" (Crikelair, Kastein, & Cosman, 1970, p. 182).

Patient Preferences. Statements that can be categorized as patient preferences also emerged in discussions of candidacy (e.g., the patient was not satisfied with the palatal lift, the palatal lift was inconvenient and embarrassing in social situations, and the patient desired to permanently reduce the impairment).

How Do We Know That Treatment Works?

One of the traditional ways of evaluating the quality of evidence that treatment works is to rate the type of study. Studies that randomly assign subjects into groups are generally considered the highest quality. Nonrandomized group studies or case subjects are generally considered to provide less powerful evidence. Given the heterogeneity of the dysarthria population, rating of evidence by type of study has been called into question. (See Yorkston et al., 2001, for a more complete discussion of the merit of various systems for rating evidence.) In

the current group of intervention studies focusing on prosthetic management, 186 individuals with dysarthria were included.

The psychometric adequacy of measurement was assessed by indicating whether information was provided regarding reliability and stability of the measurement of the outcomes. For example, inter- or intra-rater reliability, dispersion of judges' scores, and comparison of measures to a gold standard were all considered evidence of psychometric adequacy. Unfortunately, this type of evidence was often lacking. Although a trend over time toward more rigorous measures was noted, the majority of current studies do not report evidence of psychometric adequacy. Overall, approximately 20% of the studies provided data about the psychometric adequacy of the measures used.

Another way of rating the quality of evidence is to evaluate the strength of control imposed by the study. In other words, does support exist for the assertion that the treatment of interest was responsible for the change in behavior/outcome measures rather than some other explanation? Several studies reported comparisons of measures of speech adequacy with and without the palatal lift. This can provide strong evidence of internal validity (i.e., the palatal lift was responsible for the change in outcome). Among other indicators that interventions such as palatal lifts were successful was the fact that speech performance had not improved with many years of behavioral intervention. Therefore, improvements could be attributed to palatal lift intervention. The trajectory of the disease also was cited as support of the effectiveness of intervention. For some, the disease course was degenerative and intervention maintained a given level of speech production in the face of progression of the underlying impairment. For others, improvement in chronic and stable conditions was cited as support of intervention effectiveness.

What Risks or Complications of Palatal Lifts Were Identified?

The benefit of any intervention must be weighed against the risks or complications inherent to the treatment. Generally, the risks or complications of palatal lift fitting were minor. Some studies suggested that tooth movement or injury to the soft tissue were risks, but none of the studies reported its occurrence in any subjects. The most common complication of palatal lift fitting was intolerance in the form of initial discomfort, inability to inhibit a gag, and prosthesis retention difficulty. Some negative speech-related changes were also reported,

such as difficulty with articulation, due to increased tonicity in laryngeal/pharyngeal musculature in some patients with severe spasticity. Increased swallowing difficulty and hypersalivation for short periods were also reported. Finally, some authors reported a patient's lack of acceptance of the device and unrealistic expectations.

What Were the Outcomes of the Intervention Studies?

Generally, the studies of palatal lift fitting reported positive outcomes. Although criteria for success vary, treatment was judged successful 76% of the time in a series of 25 cases reported by Bedwinek and O'Brian (1985). Optimum results were obtained in 32% and positive outcomes in 96% of 44 cases reported by LaVelle and Hardy (1979). Some of the most common outcomes included improved articulation, improved speech intelligibility, decreased hypernasality, and more efficient use of respiratory support for speech. A more complete description of potential outcome measures can be found in the measurement of outcomes section that follows. Palatal lift fitting was found to be successful, but more difficult, in individuals who were edentulous or had a spastic palate. The best results were reported when the soft palate was flaccid and when good pharyngeal wall movement was present. Most improvement was noted in individuals who wore their lifts the longest.

Some of the early descriptions of palatal lift fitting (e.g., Mazaheri & Mazaheri, 1976) posed a number of questions for further investigation. For example, what is the relationship between the palatal stimulation offered by palatal lift fitting and the degree of neuromuscular function and recovery? Although many clinicians have worked with individuals who have experienced improvement in neuromuscular function after palatal lifts were fitted, studies of groups of patients fitted with palatal lift prostheses did not support a strong association between palatal lift fitting and recovery of velopharyngeal function (Witt et al., 1995).

Personal testimonies of speakers with dysarthria who use a palatal lift are also a source of information about treatment outcomes. Two of the individuals with ALS who participated in the Esposito et al. study (2000) were interviewed by CBS Healthwatch (URL: www.cbshealthwatch.medscape, accessed 6/00). Both linked use of the lift to their continued ability to work. One individual, a financial planner, stated, "My livelihood is based on my communication skills. It is vital for me to be able to ex-

press my thoughts." The other, a business manager, stated, "I doubt if I could work very effectively without the palatal lift."

CLINICAL DECISION MAKING

The following presents an overview of clinical decision-making about management of velopharyngeal impairment in dysarthria. It is derived from conclusions drawn from the evidence examined earlier along with expert opinion both from the published literature and a panel of reviewers. Figure 1 illustrates a clinical decision-making flowchart for the management of velopharyngeal impairment in dysarthria. The following section provides a detailed explanation of various aspects the flowchart as well as a review of assumptions about the management of dysarthria.

Assumptions

Before describing the flowchart, it is necessary to review some of the assumptions upon which it is based. These assumptions are presumed to be true as they relate to the practice of speech-language pathology.

Goal of Intervention. Enhancement of speech and communication function is a fundamental target of intervention.

Uniqueness of Speech. Speech motor control is unique and different from other motor systems. Therefore, it must be assessed as part of a comprehensive physical examination and cannot be presumed from neurologic deficits in other systems, such as in limb function.

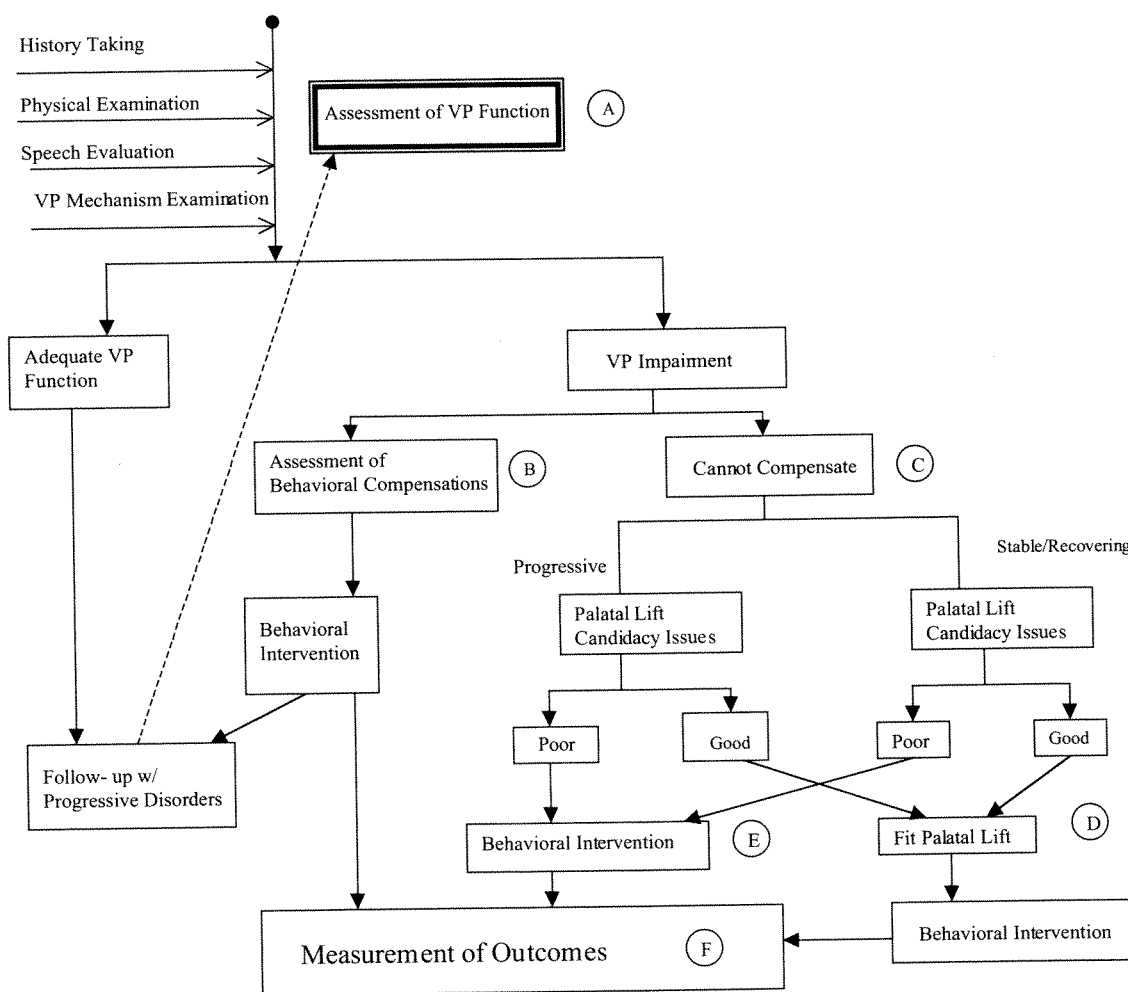


Figure 1. Diagram for clinical decision making for management of velopharyngeal impairment in dysarthria.

Individual Assessment. The pattern and severity of impairment in the various speech subsystems varies from one population to another and from one individual to another within each population. Therefore, the pattern and severity of impairment must be assessed individually.

Individual Intervention. Interventions vary as a function of type of dysarthria, severity of dysarthria, and co-existing factors. Therefore, individual intervention plans must be developed.

Staging of Intervention. Dysarthria often is not a stable condition. For example, children with developmental dysarthria may experience physiologic changes affecting speech production as they mature. Adults with acquired dysarthria may experience phases of recovery, as in dysarthria associated with traumatic brain injury, or phases of degeneration, as in dysarthria associated with amyotrophic lateral sclerosis. Therefore, the staging of intervention (i.e., the timing of treatment) is critical for successful outcomes.

Appropriate Referrals. Practice will be conducted by competent speech-language pathologists who refer to other disciplines when appropriate (e.g., for prosthodontic consultation when a palatal lift prosthesis is considered appropriate).

Clinical Competence. Practice will be conducted by competent speech-language pathologist in an appropriate and efficient manner.

Disclosure. Clinicians will communicate both the benefits and risks (including financial) of the treatment.

Assessment of VP Function

Assessment of velopharyngeal function in speakers with dysarthria assumes an understanding of normal function. While it is beyond the scope of this article to review normal velopharyngeal function, excellent sources of information are available (e.g., Kuehn & Moller, 2000). The following section summarizes the components of an assessment of velopharyngeal function in dysarthria that may be considered depending on the constellation of deficits and the desired outcomes of each client. Assessment consists of four components: history taking, speech evaluation, physical examination, and examination of the velopharyngeal mechanism.

History Taking

This phase of the assessment involves gathering pertinent information from the patient, the medical records and the referral source. Information should be gathered on areas such as the following:

- the onset of symptoms and medical/dental history
- the nature, duration, and natural course of velopharyngeal (VP) impairment
- reports of previous treatment
- the level of concern about the problem (Netsell, 1988)
- the patient's motivation relative to treatment (Wolfaardt, Wilson, Rochet, & McPhee, 1993)

Speech Evaluation

Determining the severity of the velopharyngeal impairment and the degree to which the velopharyngeal impairment disrupts speech production is critical to establishing the need for intervention and for accurate therapeutic intervention (Krummer & Lee, 1996). The perceptual assessment of speech includes an examination of the following:

- stimulability for improved speech production
- perceptual judgment of presence and degree of hypernasal resonance, audible nasal emission, loudness (as possibly diminished by damping effects of the nasal cavity) and "strength" and precision of pressure consonants as a function of velopharyngeal closure
- connected speech with ratings across audiences (e.g., untrained versus familiar listeners)
- phonation
- performance on articulation tests including relative differences in the accurate production of nasals and pressure consonants (Yorkston, Beukelman, Honsinger, & Mitsu-da, 1989; Yorkston, Beukelman, & Traynor, 1988).
- difference in intelligibility, pressure consonants, speaking effort, syllables per breath group, and resonance with nares occluded versus unoccluded

Physical Examination

This involves an assessment of the structure and function of the oral mechanism, including the following:

- the velopharynx at rest and during movement
- the modified tongue-anchor test (Duffy, 1995)
- dental occlusion
- the sensitivity of the gag reflex
- swallowing ability and saliva management
- signs of a submucous cleft (Krummer & Lee, 1996; Wolfaardt et al., 1993).

Instrumental Examination of the Velopharyngeal Mechanism

Instrumental examination of the velopharyngeal mechanism is necessary to directly observe and measure velopharyngeal activity (Duffy, 1995; Till, Jafari, & Law-Till, 1994; Wolfaardt et al., 1993). Instrumentation may include videofluoroscopy, nasoendoscopy, aerodynamic (pressure-flow) assessments, and acoustic assessment. This instrumentation allows for the evaluation of

- intraoral air pressure and nasal airflow during production of pressure consonants
- palatal movement
- lateral pharyngeal wall movement
- sphincteric activity during speech
- nasal airflow and intraoral air pressure
- the timing of velopharyngeal movements

Behavioral Intervention

The assessment of velopharyngeal function leads to one of two conclusions (see Figure 1): adequate velopharyngeal function or velopharyngeal impairment. If velopharyngeal function is judged to be adequate, those individuals with progressive disorders are followed and reassessed. If velopharyngeal impairment is identified, then decisions are made about the appropriateness of behavioral interventions. Generally, those individuals who are appropriate for behavioral intervention are those who can compensate (or will be able to compensate if recovery continues) for the velopharyngeal impairment (Netsell & Rosenbek, 1985). The question of whether or not speakers are able to compensate for velopharyngeal impairment can be addressed by evaluating stimulability (the ability to improve performance under certain conditions). The following techniques can be used to assess stimulability:

- changing speaking rate (e.g., slowing the speaking rate)

- changing the level of effort (e.g., increasing effort for an individual with mild velopharyngeal weakness or decreasing effort for individuals with ataxia who exhibit a pattern of excess effort)
- monitoring excess nasal airflow and resonance features
- increasing the precision of speech by exaggerating articulatory movements ("clear speech")

Decisions about how to treat patients with velopharyngeal impairment of moderate severity can be difficult. For example, expert opinion differs somewhat regarding the timing of palatal lift intervention in moderately severe cases. Some argue that velopharyngeal management should be carried out prior to phonation, articulation, and/or prosody exercises for speakers who are recovering function. Others would suggest that velopharyngeal management should occur only after the speaker can phonate voluntarily. The clinician needs to consider several factors, including the relative severity of involvement in other functional components, to determine whether treatment of the velopharynx would enhance function in other areas (e.g., tax respiration less), and whether velopharyngeal function would benefit from treating other components first or from modifying the patient's speaking rate or effort (Netsell & Rosenbek, 1985).

Techniques Focusing on Speech Production

A variety of behavioral interventions have been recommended for individuals with dysarthria. Because velopharyngeal impairment may be mild and part of a pattern of impairment crossing multiple speech subsystems, this type of intervention is considered the most common treatment of velopharyngeal impairment in dysarthria. It should be noted that most behavioral interventions for velopharyngeal impairment suggested here arise from expert opinion rather than from research findings. It should also be noted that there is little guidance from the evidence or expert opinion about how long these interventions should be applied before either an effect can be expected or the intervention abandoned. These techniques will be reviewed in more detail in subsequent modules of the Practice Guidelines for Dysarthria. Generally, the behavioral techniques include the following:

Modifying the Pattern of Speaking. Examples of such modifications include producing speech with increased effort (Liss, Kuehn, & Hinkle, 1994) or a slower rate (Yorkston & Beukelman, 1981; Yorkston, Beukelman, Strand, & Bell, 1999). Speakers can also be trained to produce clear speech by mimicking the overarticulated speech of a trained talker. Overarticulated speech can be elicited by prompting with comments like, "open your mouth more," "speak more clearly," "overarticulate," and "talk slowly" (Picheny, Durlach, & Braida, 1985).

Resistance Treatment During Speech. Continuous positive airway pressure (CPAP) is an emerging intervention technique reported to be an effective means of exercising the soft palate during speech in two individuals with traumatic brain injury. The technique provides a resistance against which the muscles of velopharyngeal closure must work (Kuehn, 1997; Kuehn & Wachtel, 1994). A theoretical rationale for strength training is available (Liss, Kuehn, & Hinkle, 1994).

Feedback. The use of biofeedback techniques for therapy has been suggested for velopharyngeal impairment in dysarthria. Some speakers may benefit from feedback from a mirror, nasal flow transducer, or nasoendoscope during efforts to decrease nasal air flow and hypernasality (Rosenbek & LaPointe, 1985). The following are some of the instrumental feedback techniques discussed in a chapter by Murdoch, Thompson, and Theodoros (1997) on spastic dysarthria:

- flexible endoscope (provides visual feedback of the movements of the lateral pharyngeal wall)
- fiberoptic nasopharyngoscopes (obtains close observations of VP sphincter during connected speech)
- Exeter Bio-Feedback Nasal Anemometer (EBNA; Bioinstrumentation LTD Exeter)

Techniques Focusing on Nonspeech Movements

Therapy techniques appear in the literature that are based primarily on nonspeech movements of the velopharyngeal mechanism. These have generally *not* been endorsed by experts for several reasons: (a) speech and nonspeech velopharyngeal closures involve different underlying mechanisms; (b)

no evidence exists that increasing soft palate strength improves speech performance; and (c) most of the methods do not provide the patient with information on the timing of articulatory gestures during speech (Murdoch et al., 1997). Evidence and expert opinion suggest that the following techniques for improving velopharyngeal function are not effective (Brookshire, 1992; Duffy, 1995; Dworkin & Johns, 1980; Hageman, 1997; Johns, 1985; Murdoch et al., 1997; Netsell & Rosenbek, 1985; Yorkston et al., 1999):

- Pushing techniques (particularly for patients with spastic dysarthria)
- Strengthening exercises, such as blowing and sucking
- Tasks that encourage the patient to control and modify the airstream using balls, whistles, candles, fluff, powder, paper, bubbles, straws, etc.
- Inhibition techniques, such as prolonged icing, pressure to muscle insertion points, slow and irregular stroking and brushing, and desensitization.

Prosthetic Intervention

Candidacy for Palatal Lift Fitting

If assessment reveals that velopharyngeal impairment is present and the speaker is not able to compensate for that impairment, a palatal lift prosthesis may be considered for selected cases, especially those with a flaccid soft palate. A palatal lift is a rigid acrylic appliance fabricated by a prosthodontist. It consists of a retentive portion that covers the hard palate and fastens to the maxillary teeth by means of wires and a lift portion that extends along the oral surface of the soft palate. Issues regarding candidacy for palatal lift fitting have been described extensively (Bedwinek & O'Brian, 1985; Duffy, 1995; Esposito et al., 2000; Murdoch et al., 1997; Netsell, 1998; Yorkston et al., 1999). Because timing of intervention is different for individuals with progressive as opposed to stable-recovering dysarthrias, candidacy in each population will be discussed separately.

Progressive Dysarthria. Table 3 illustrates characteristics of better versus poorer candidates for palatal lift fitting in progressive dysarthria. Better candidates are those with a slow rate of disease progression and intact cognition, memory, judg-

TABLE 3. Characteristics of better and poorer candidates for palatal lift fitting in progressive dysarthria.

	Better Candidates	Poorer Candidates
Neurophysiology of the soft palate	Flaccidity	Severe spasticity
Rate of neurologic change	Slow	Rapid
Respiratory/phonatory function	Adequate	Poor
Articulation	Adequate	Poor
Change in plosion/resonance with occlusion	Present	Absent or minimal
Difference between intelligibility of pressure and other consonants	Pressure consonants much less intelligible than others	No or minimal difference between pressure and other consonants
Able to inhibit gag	Yes	No
Swallowing and saliva management	Adequate	Reduced
Dentition	Adequate	Poor
Cognition/memory/judgment	Intact	Reduced
Manual dexterity	Able to insert and remove lift	Unable to insert or remove lift
Patient goals for speech	Maintenance of functional speech is important to the speaker	Decreased function is acceptable

ment, swallowing, and manual dexterity. Respiratory/phonatory and oral articulatory function is adequate in these individuals, while the soft palate movement is impaired by weakness from flaccidity versus severe spasticity. Speech is characterized by a disproportionately reduced ability to produce pressure consonants. Maintenance of functional speech is critical to the speakers. Because only in rare cases are all of these candidacy issues positive, clinical judgment is needed to weigh positive versus negative factors.

Stable or Recovering Dysarthria. Table 4 illustrates characteristics of better versus poorer candidates for palatal lift fitting in stable or recovering dysarthria. As in degenerative dysarthria, the better candidate has a stable or slow rate of change. Those with rapid improvement are typically not considered good candidates because enough function may soon return to support good speech without prosthetic intervention. Unlike progressive dysarthria, good articulation is not as critical for individuals with a recovering pattern because articulation and respiratory function can be expected to improve once the lift is fitted, especially with concurrent speech treatment. In better candidates, speech is characterized by disproportionately reduced ability to produce pressure consonants.

Palatal Lift Fitting Procedures

The following provides an outline of the typical steps taken to construct a palatal lift (Yorkston et al., 1999). Variations of the procedures will occur (Netsell, 1998; Wolfaardt et al., 1993). Discussions of the use of instrumentation as part of palatal lift design also are available (Turner and Williams, 1991; Karnell, Rosenstein, & Fine, 1987).

- The speaker's teeth and gums are checked and needed restoration is completed.
- Orthodontic bands or acrylic ridges are secured to selected teeth (optional).
- An oral cavity desensitization program is begun for those speakers with hyperactive gag reflexes (Daniel, 1982).
- An impression mold of the maxillary arch is taken.
- A dental retainer (the portion covering the hard palate) of the lift is fabricated with a wire loop extending posteriorly as an anchor for the posterior portion of the lift.
- The posterior portion of the lift is customized to meet the needs and tolerances of the individual speaker.
- Follow-up visit are conducted with the prosthodontist and speech-language pa-

TABLE 4. Characteristics of better and poorer candidates for palatal lift fitting in stable or recovering dysarthria.

	Better Candidates	Poorer Candidates
Neurophysiology of the soft palate	Flaccidity	Severe spasticity
Rate of neurologic change	Stable or slow improvement	Rapid improvement
Respiratory/phonatory function	Adequate or recovering	Poor
Articulation	Adequate or recovering	Poor
Change in plosion/resonance with occlusion	Present	Absent or minimal
Difference between intelligibility of pressure and other consonants	Pressure consonants much less intelligible than others	No or minimal difference between pressure and other consonants
Able to inhibit gag	Yes	No
Swallowing and saliva management	Adequate	Reduced
Dentition	Adequate	Poor
Cognition/memory/judgment impairment	WNL or mild to moderate	Less than LOCF V
Manual dexterity	Able to insert and remove lift	Unable to insert or remove lift
Patient goals for speech	Improved speech is critical	Decreased function is acceptable

thologist to adjust the length and torque of the lift to maximize fitting.

- Follow-up visits are planned to monitor the adequacy of the fitting. According to Esposito and colleagues (2000), prosthetic treatment for progressive disorders must be ongoing. Modifications to the prosthesis are made on a regular basis to accommodate for the progression of the disease. It is common to make changes to the lift and the augmentation of the hard palate portion for speakers with increasingly severe dysarthria.

Behavioral Intervention for Poor Candidates for Palatal Lifts

If the speaker is judged to be a poor candidate for palatal lift fitting, several behavioral strategies are available to establish or maintain communicative function (Hustad & Beukelman, 2000; Yorkston et al., 1999). Behavioral intervention may be employed so that speakers can improve the effectiveness of their communication. The following specific techniques will be reviewed in subsequent modules of the Practice Guidelines for Dysarthria:

- Alphabet supplementation is a technique to improve intelligibility in severe

dysarthria. The speaker points to the first letter of each word as that word is spoken.

- Partner techniques are strategies initiated by the communication partner including maintaining the topic identity, paying undivided attention, and piecing together cues from the speaker with dysarthria.
- Speaker strategies are used to heighten the intelligibility of severely dysarthric speech, including the use of gestures, selecting a conducive communication environment, and using turn maintenance signals.
- Augmentative and alternative communication techniques include use of devices to replace or supplement highly distorted speech (Beukelman, Yorkston, & Reichle, 2000).

Surgical Intervention

Surgical management for velopharyngeal impairment in dysarthric speakers also has been reported. Generally, it is considered less beneficial than prosthetic management and is contraindicated in children with cerebral palsy (Hardy et al, 1961; Lotz & Netsell, 1989). Johns (1985), however, summarized his positive experiences with a substantial number of dysarthric speakers with velopharyngeal impairment who had superiorly based pha-

ryngeal flaps. Because of the drawbacks to surgery (e.g., risks inherent to the procedure itself, permanence of the procedure, possibility of new speech/resonance problems, and so on), it is typically considered only after behavioral and prosthetic management have been tried and failed. Surgical management of velopharyngeal impairment warrants further study especially for those speakers with severe and stable impairment.

MEASUREMENT OF OUTCOMES

It is increasingly important to document the outcomes of intervention. A variety of outcome measures may be obtained (Table 5) and can be categorized using terminology from the World Health Organization model of disablement (World Health Organization, 1999; Frattali, 1998).

Impairment

An impairment is a loss or abnormality of body structure or of a physiological or psychologic function. For example, airflow through the velopharyngeal port during production of pressure consonants may be measured. Physiologic or psychophysical measurements of behavioral change should be considered whenever possible (Netsell, 1978; Netsell & Rosenbek, 1985; Johns, 1985). These include aero-

dynamic assessments, which is perhaps the most direct means of documenting the impact of a palatal lift (McHenry, Wilson, & Minton, 1994; Yorkston et al., 1999); radiographic measurements (Aten, McDonald, Simpson, & Gutierrez, 1984; Kipfmeuller & Lang, 1972); and acoustic analyses (Johns, 1985).

Activity Limitations

Activity is the nature and extent of functioning at the level of the person. Activities may be limited in nature, duration, and quality. For example, measures of the intelligibility, speaking rate, and naturalness of speech may be used as a measure of functioning in dysarthria. Activity limitations are typically measured perceptually. Listener perceptions frequently are assessed through phoneme intelligibility and/or sentence intelligibility, but may also include perceived changes in hypernasality and nasal emission. Phoneme intelligibility allows an examination of articulatory error patterns with and without the lift in place (e.g., Yorkston, Beukelman et al., 1989). Sentence intelligibility is one of the best means of assessing the functional changes brought about by the palatal lift (Yorkston et al., 1999).

Participation Restriction

Participation is the nature and extent of a person's involvement in life situations in relation to impairments, activities, health conditions, and contextual factors. As with activity limitations, participation may be restricted in nature, duration, and quality. For example, report of use of speech in natural communication situations, such as public speaking, may be used as a measure of participation. Measures of participation are not commonly reported in the intervention literature. They are, however, important. As stated by Johns (1985), speech pathologists are urged to measure, as objectively as possible, changed aspects of a patient's psychological status, that is, his/her adaptation to the environment.

TABLE 5. Examples of outcome measures used to evaluate velopharyngeal management in dysarthria.

Impairment

- Radiographic
- Physical examination results
- Aerodynamic measures
- Phonation time
- Rating of severity by speech subsystem
- Pulmonary function tests

Activity Limitation

- Perceptual changes in hypernasality
- Perceptual changes in articulation
- Perceptual changes in voice
- Perceptual changes in intelligibility
- Reduction in effort

Participation Restriction

- Return to work
 - Speaking without fatigue
 - Reports of self-confidence, self-esteem
 - Reports of improved quality of life
-

SUMMARY

A variety of techniques are available for the management of velopharyngeal impairment in dysarthria. This summary is based on a review of the intervention studies that emerged from a search of the literature and from expert opinion. It suggests the following:

1. Prosthetic intervention, particularly palatal lift fitting, has a long history associated with improved speech function in selected individuals with dysarthria.
2. Surgical intervention is generally not considered unless all other interventions have failed. Currently, there is not sufficient evidence in the literature to make recommendations about surgical intervention for the general dysarthria population.
3. Exercise as a treatment of velopharyngeal impairment in dysarthria has been reported in a small number of cases, but evidence is so preliminary that recommendations for its use cannot be made at this time.

Because dysarthria is a heterogeneous disorder, a single intervention or type of intervention cannot be expected to be effective for all speakers with dysarthria. Palatal lift intervention has been the most carefully studied. Even in this case, making general statements about the appropriateness of palatal lift fitting in dysarthria is difficult. Rather, it is more useful to describe a candidacy profile. The better candidates for palatal lifts have the characteristics listed in Tables 3 and 4. The most critical indicator of candidacy is weakness in the soft palate that prevents closure of the velopharyngeal mechanism during speech. Other candidacy indicators include pharyngeal wall movement, good oral articulation and respiratory support, and a relatively stable clinical course. Some nonspeech factors that may also contribute to being a good candidate include intact swallow, cognition, and manual dexterity along with the desire to maintain or regain speech. For individuals with all of these characteristics, palatal lift fitting would be strongly recommended as a standard of practice. Most dysarthria speakers do not fit the profile of the "better candidate." Therefore, as the characteristics of the speakers move away from the ideal, the recommendation for palatal lift fitting becomes less and less strong. For an individual with all of the characteristics of a "poorer candidate," palatal lift fitting would not be an appropriate clinical option.

The preponderance of palatal lift interventions found in the literature does not reflect the distribution of interventions found in typical clinical practice. In fact, palatal lifts are fitted only in the minority of speakers with dysarthria, specifically those with a particular candidacy profile. In the majority of speakers with dysarthria, velopharyngeal impairment is part of a complex pattern of subsystem involvement and affects many aspects

of speech production. Behavioral intervention is appropriate in these individuals, and includes such strategies as rate and effort modification, monitoring of emission/resonance, and exaggerated articulation.

The following is a listing of some needs of future research in the management of velopharyngeal impairment:

- Better descriptions of fitting protocols
- More complete description of current clinical practice focusing on prevalence of various types of intervention
- Better descriptions of speech function (other than palatal function)
- A more comprehensive set of outcome measures (including measures of communicative participation)
- Better description of the psychometric adequacy of the outcome measures
- Efficacy studies focusing on post-fitting behavioral intervention and distinguishing the natural accommodation to palatal lift placement from the benefits of additional behavioral speech treatment
- Studies of the timing of intervention, for example, a comparison of early versus later palatal lift fitting in individuals with traumatic brain injury
- Documentation of the best techniques for palatal lifting fitting in challenging cases, such as children with mixed dentition, adults with dentures, individuals with hyperactive gag reflexes, and so on
- Better documentation of the impact of behavioral intervention and other treatment approaches including surgical management
- We need to determine the relative effectiveness of various treatments or "what works best and for whom" by comparing different approaches to management of velopharyngeal impairment (e.g., palatal lift versus behavioral management versus both; behavioral nonspeech techniques versus speech techniques.)

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REFERENCES

(Asterisks indicate articles included as an intervention study.)

- *Aten, J., McDonald, A., Simpson, M., & Gutierrez, R. (1984). Efficacy of modified palatal lifts for improved resonance. In M. McNeil, J. Rosenbek, & A. Aronson (Eds.), *The Dysarthrias: Physiology, Acoustics, Perception, Management*, (pp. 231–242). Boston: College-Hill Press.
- *Bedwinek, A. P., & O'Brian, R. L. (1985). A patient selection profile for the use of speech prosthesis in adult disorders. *Journal of Communication Disorders*, 18(3), 169–182.
- Beukelman, D. R., Yorkston, K. M., & Reichle, J. (Eds.). (2000). *Augmentative and alternative communication for adults with acquired neurologic disabilities*. Baltimore, MD: Paul H. Brookes Publishing.
- *Brand, H. A., Matsko, T. A., & Avart, H. N. (1988). Speech prosthesis retention problems in dysarthria: Case report. *Archives of Physical Medicine and Rehabilitation*, 69, 213–214.
- Brookshire, R. (1992). *An introduction to neurogenic communication disorders* (4th ed.). St Louis: Mosby-Year Book.
- Chambless, D. L., & Hollon, S. D. (1998). Defining empirically supported therapies. *Journal of Consulting and Clinical Psychology*, 66(1), 7–18.
- *Crikelair, G. F., Kastein, S., & Cosman, B. (1970). Pharyngeal flap for post-traumatic palatal paralysis. *Plastic and Reconstructive Surgery*, 45, 182–185.
- *Daniel, B. (1982). A soft palate desensitization procedure for patients requiring palatal lift prostheses. *Journal of Prosthetic Dentistry*, 48, 565–566.
- Darley, F., Aronson, A., & Brown, J. (1969a). Clusters of deviant speech dimensions in the dysarthrias. *Journal of Speech and Hearing Research*, 12, 462–496.
- Darley, F., Aronson, A., & Brown, J. (1969b). Differential diagnostics patterns of dysarthria. *Journal of Speech and Hearing Research*, 12, 224.
- Darley, F. L., Aronson, A. E., & Brown, J. R. (1975). *Motor speech disorders*. Philadelphia: W. B. Saunders.
- *Denny, A. D., Marks, S. M., & Oliff-Carneol, S. (1993). Correction of velopharyngeal Insufficiency by pharyngeal augmentation using autologous cartilage: A preliminary report. *Cleft Palate-Craniofacial Journal*, 30(1), 46–54.
- Duffy, J. R. (1995). *Motor speech disorders: Substrates, differential diagnosis, and management*. St. Louis: Mosby.
- Dworkin, J. R., & Johns, D. F. (1980). Management of velopharyngeal incompetence in dysarthria: A historical review. *Clinical Otolaryngology*, 5, 61.
- *Esposito, S. J., Mitsumoto, H., & Shanks, M. (2000). Use of palatal lift and palatal augmentation prostheses to improve dysarthria in patients with amyotrophic lateral sclerosis: A case series. *Journal of Prosthetic Dentistry*, 83, 90–98.
- Frattali, C. (1998). Outcomes measurement: Definitions, dimensions, and perspectives. In C. Frattali (Ed.), *Measuring Outcomes in Speech-Language Pathology*, (pp. 1–27). New York: Thieme.
- *Gibbons, P., & Bloomer, H. (1958). The palatal lift: A supportive-type prosthetic speech aid. *Journal of Prosthetic Dentistry*, 8, 362–369.
- *Gonzalez, J., & Aronson, A. (1970). Palatal lift prosthesis for treatment of anatomic and neurologic palatopharyngeal insufficiency. *Cleft Palatal Journal*, 7, 91–104.
- Hageman, C. (1997). Flaccid dysarthria. In M. R. McNeil (Ed.), *Clinical Management of Sensorimotor Speech Disorders*, (pp. 193–216). New York: Thieme Medical Publishers.
- *Hardy, J., Netsell, R., Schweiger, J., & Morris, H. (1969). Management of velopharyngeal dysfunction in cerebral palsy. *Journal of Speech and Hearing Disorders*, 34, 123–137.
- *Hardy, J., Rembolt, R., Spriestersbach, D., & Jaypathy, B. (1961). Surgical management of palatal paresis and speech problems in cerebral palsy: A preliminary report. *Journal of Speech and Hearing Disorders*, 26, 320–325.
- *Heller, J. C., Gens, G. W., Moe, D. G., & Lewin, M. L. (1974). Velopharyngeal insufficiency in patients with neurologic, emotional, and mental disorders. *Journal of Speech and Hearing Disorders*, 39(3), 350–359.
- *Holley, L. R., Hamby, G. R., & Taylor, P. P. (1973). Palatal lift for velopharyngeal incompetence: Report of case. *Journal of Dentistry for Children*, 467–470.
- Hustad, K. C., & Beukelman, D. R. (2000). Integrating AAC strategies with natural speech. In D. R. Beukelman, K. M. Yorkston, & J. Reichle (Eds.), *Augmentative and Alternative Communication for Adults with Acquired Neurologic Disabilities*, (pp. 89–113). Baltimore, MD: Paul H. Brookes Publishing.
- Johns, D. F. (1985). Surgical and prosthetic management of neurogenic velopharyngeal incompetency in dysarthria. In D. F. Johns (Ed.), *Clinical Management of Neurogenic Communicative Disorders*, (2nd ed., pp. 168–173). Boston: Little, Brown, and Co.
- Karnel, M. P., Rosenstein, H., & Fine, L. (1987). Nasal videoendoscopy in prosthetic management of palatopharyngeal dysfunction. *The Journal of Prosthetic Dentistry*, 58(4), 479–484.
- *Kerman, P., Singer, L., & Davidoff, A. (1973). Palatal lift and speech therapy for velopharyngeal incompetence. *Archives of Physical Medicine and Rehabilitation*, 54, 271–276.
- *Kipfmüller, L. J., & Lang, B. R. (1972). Treating velopharyngeal inadequacies with a palatal lift prosthesis. *Journal of Prosthetic Dentistry*, 27, 63–72.

- Krummer, A. W., & Lee, L. (1996). Evaluation and treatment of resonance disorders. *Language, Speech, and Hearing Services in Schools, 27*, 271-281.
- *Kuehn, D. P. (1997). The development of a new technique for treatment hypernasality: CPAP. *American Journal of Speech-Language Pathology, 6*(4), 5-8.
- Kuehn, D. P., & Moller, K. T. (2000). Speech and language issues in the cleft palate population: The state of the art. *The Cleft Palate Craniofacial Journal, 37*(4), 348-383.
- Kuehn, D. P., & Wachtel, J. M. (1994). CPAP therapy for treating hypernasality following closed head injury. In J. A. Till, K. M. Yorkston, & D. R. Beukelman (Eds.), *Motor Speech Disorders: Advances in Assessment and Treatment*, (pp. 207-212). Baltimore: Paul H. Brookes Publishing.
- *Lang, B. R., & Kipfmüller, L. J. (1969). Treating velopharyngeal inadequacy with the palatal lift. *Plastic and Reconstructive Surgery, 43*(5), 467-477.
- *LaVelle, W. E., & Hardy, J. C. (1979). Palatal lift prostheses for treatment of palatopharyngeal incompetence. *Journal of Prosthetic Dentistry, 42*, 308-315.
- *Lawshe, B., Hardy, J., Schweiger, J., & Van Allen, M. (1971). Management of a patient with velopharyngeal incompetency of undetermined origin: A clinical report. *Journal of Speech and Hearing Disorders, 36*, 547-551.
- *Leeper, H. A., Ahmad, D., Sills, P. S., & Gallie, A. (1989). Pulmonary function characteristics of selected individuals with dysarthria: The effects of a palatal lift appliance. *Human Communication Canada, 13*(4), numbered.
- *Lewy, R., Cole, R., & Wepman, J. (1965). Teflon injection in the correction of velopharyngeal incompetency of velopharyngeal insufficiency. *Annals of Otolaryngology and Laryngology, 78*, 874.
- Liss, J. M., Kuehn, D. P., & Hinkle, K. P. (1994). Direct training of velopharyngeal musculature. *Journal of Medical Speech-Language Pathology, 2*(3), 243-251.
- *Lotz, W. K., & Netsell, R. (1989). Velopharyngeal management for a child with dysarthria and cerebral palsy. In K. M. Yorkston & D. R. Beukelman (Eds.), *Recent Advances in Clinical Dysarthria*, (pp. 139-144). Boston: College-Hill Publications.
- *Marshall, R. C., & Jones, R. N. (1971). Effects of a palatal lift prosthesis upon the speech intelligibility of a dysarthria patient. *Journal of Prosthetic Dentistry, March, 327-333*.
- Mazaheri, M., & Mazaheri, E. H. (1976). Prosthodontic aspects of palatal elevation and palatopharyngeal stimulation. *Journal of Prosthetic Dentistry, 35*, 319-326.
- *McHenry, M. A., Wilson, R. L., & Minton, J. T. (1994). Management of multiple physiological deficits following traumatic brain injury. *Journal of Medical Speech-Language Pathology, 2*, 58-74.
- *Minami, R. T., Kaplan, E. N., Wu, G., & Jobe, R. P. (1975). Velopharyngeal incompetence without overt cleft palate: A collective review and experience with 98 patients. *Plastic and Reconstructive Surgery, 55*(5), 573-587.
- Murdoch, B. E., Thompson, E. C., & Theodoros, D. G. (1997). Spastic dysarthria. In M. R. McNeil (Ed.), *Clinical Management of Sensorimotor Speech Disorders*, (pp. 287-310). New York: Thieme Medical Publishers.
- Netsell, R. (1988). Velopharyngeal dysfunction. In D. E. Yoder & R. D. Kent (Eds.), *Decision Making in Speech-Language Pathology*, (pp. 150-151). Philadelphia: B. C. Decker.
- *Netsell, R., & Daniel, B. (1979). Dysarthria in adults: Physiologic approach to rehabilitation. *Archives of Physical Medicine and Rehabilitation, 60*, 502-508.
- Netsell, R., & Rosenbek, J. C. (1985). Treating the dysarthrias. *Speech and Language Evaluation in Neurology: Adult Disorders*. New York: Grune & Stratton.
- Netsell, R. W. (1998). Speech rehabilitation for individuals with unintelligible speech and dysarthria: The respiratory and velopharyngeal systems. *Journal of Medical Speech-Language Pathology, 6*(2), 107-110.
- Picheny, M., Durlach, N., & Braida, L. (1985). Speaking clearly for the hard of hearing I: Intelligibility differences between clear and conversational speech. *Journal of Speech and Hearing Research, 28*(1), 96-103.
- *Randall, P., Bakes, F. P., & Kennedy, C. (1960). Cleft palatal-type speech in the absence of cleft palate. *Plastic and Reconstructive Surgery, 25*(5), 484-495.
- Rosenbek, J. C., & LaPointe, L. L. (1985). The dysarthrias: Description, diagnosis, and treatment. In D. Johns (Ed.), *Clinical Management of Neurogenic Communication Disorders*, (pp. 97-152). Boston: Little Brown.
- *Shifman, A., Finelstein, Y., Nachmani, A., & Ophir, D. (2000). Speech-aid prostheses for neurogenic velopharyngeal incompetence. *Journal of Prosthetic Dentistry, 83*, 99-106.
- *Stewart, D. S., & Rieger, W. J. (1994). A device for the management of velopharyngeal incompetence. *Journal of Medical Speech-Language Pathology, 2*(2), 149-155.
- Till, J. A., Jafari, M., & Law-Till, C. B. (1994). Accelerometric difference index for subjects with normal and hypernasal speech. In J. A. Till, K. M. Yorkston, & D. R. Beukelman (Eds.), *Motor Speech Disorders: Advances in Assessment and Treatment*, (pp. 119-134). Baltimore: Paul H. Brookes Publishing.
- Tomes, L. A. I., & Kuehn, D. P. (1996). Velopharyngeal impairment. *Current Opinion in Otolaryngology, Head and Neck Surgery, 4*, 155-165.
- Trombly, C. (1995). Clinical practice guidelines for post-stroke rehabilitation and occupational therapy practice. *The American Journal of Occupational Therapy, 49*(7), 711-714.
- *Tudor, C., & Selley, W. G. (1974). A palatal training appliance and a visual aid for use in the treatment of hypernasal speech: A preliminary report. *British Journal of Disorders of Communication, 9*(2), 117-122.

- Turner, G., & Williams, W. (1991). Fluoroscopy and nasoendoscopy in designing palatal lift prostheses. *The Journal of Prosthetic Dentistry*, 66, 63-71.
- *Upton, L. G., & Berger, M. K. (1995). Use of pharyngoplasty to improve resonance in adult closed-head injury patients: Report of cases. *Journal of Oral and Maxillofacial Surgery*, 53, 717-719.
- Witt, P. D., Roxelle, A. A., Marsh, J. L., Marty-Grame, L., Muntz, H. R., Gay, W. D., & Pilgram, T. K. (1995). Do palatal lift prostheses stimulate velopharyngeal neuromuscular activity? *The Cleft Palate Craniofacial Journal*, 32(4), 469-475.
- Wolfaardt, J. F., Wilson, F. B., Rochet, A., & McPhee, L. (1993). An appliance based approach to the management of palatopharyngeal incompetency: A clinical pilot project. *Journal of Prosthetic Dentistry*, 69(2), 186-195.
- World Health Organization. (1999). ICIDH-2: A manual of dimensions of disablement and health. Available: <http://www.who.int/msa/mnh/ems/icidh/> [5/6/99].
- Yorkston, K. M., & Beukelman, D. (1981). Ataxic dysarthria: Treatment sequences based on intelligibility and prosodic considerations. *Journal of Speech and Hearing Disorders*, 46, 398-404.
- Yorkston, K. M., Beukelman, D. R., Duffy, J. R., Golper, L. A., Miller, R. M., Strand, E. A., Spencer, K. A., & Sullivan, M. J. (2001). Evidence based medicine and practice guidelines: Application to the field of Speech/Language Pathology. *Journal of Medical Speech-Language Pathology*, 9(4), 000-000.
- Yorkston, K. M., Beukelman, D. R., Honsinger, M. J., & Mitsuda, P. A. (1989). Perceived articulatory adequacy and velopharyngeal function in dysarthric speakers. *Archives of Physical Medicine and Rehabilitation*, 70(4), 313-317.
- Yorkston, K. M., Beukelman, D. R., Strand, E. A., & Bell, K. R. (1999). *Management of motor speech disorders in children and adults*. Austin, TX: Pro-Ed.
- Yorkston, K. M., Beukelman, D. R., & Traynor, C. D. (1988). Articulatory adequacy in dysarthric speakers: A comparison of judging formats. *Journal of Communication Disorders*, 21, 351-361.
- *Yorkston, K. M., Honsinger, M. J., Beukelman, D. R., & Taylor, T. (1989). The effects of palatal lift fitting on the perceived articulatory adequacy of dysarthric speakers. In K. M. Yorkston & D. R. Beukelman (Eds.), *Recent Advances in Clinical Dysarthria*, (pp. 85-98). Boston: College-Hill Press.