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Current Practices for Evaluation of Resonance Disorders in North America

by

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This thesis is humbly dedicated to Paul Hagler and Carol Boliek.

Thirty-eight clinicians were surveyed regarding their current clinical practices in assessing, tracking treatment and determining discharge criteria for clients with resonance disorders. When these results were compared with recommendations from the literature for best practices, it was found that: (a) most clinicians were using low-tech assessment tools (such as perceptual assessment) at least some of the time, (b) many clinicians were not using high-tech assessment tools (such as videofluoroscopy) simply because they lacked access to such tools, and (c) clinicians are remarkably similar in their clinical practices across a wide variety of circumstances (such as age, and employment setting). The primary recommendation accruing from these findings was that more high-tech assessment tools should be routinely available to clinicians practicing in this area. More consistent use of sophisticated assessment devices would exemplify contemporary thinking about transfer of knowledge to practice in the area of resonance disorders assessment and improve patient outcomes.

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Introduction

Resonance disorders are debilitating to those people who suffer from them. These individuals' altered speech is noticeable to laypersons and professionals alike and may leave listeners with mistaken impressions of their social characteristics. For example, people have been known to assume that they are drunk or less intelligent than others who do not have a resonance disorder (Rieger et al., 2006; Marsh, 2003; Witt, Miller, Marsh, Muntz, Grames & Pilgram, 1997). These negative perceptions are likely to impact the individual's social life, emotional health, and work and career opportunities (Lallh & Rochet, 2000; Marsh, 2003). Additionally, people with resonance disorders may be unintelligible and may fatigue easily (Trost, 1981). Improving treatment outcomes for this population is a priority for many speech-language pathologists (SLPs), but unfortunately, there exists a very limited understanding of the practices SLPs are using to assess resonance disorders and monitor treatment effects with those clients. A better understanding of those practices would inform management and funding decisions within clinics and influence policy decisions at the institutional level. This improved understanding may also influence policy at the national level by informing decisions about which clinical procedures health insurance will cover and providing information for educational standards in speech-language pathology. Given that clinicians from both Canada, with a public healthcare system, and the United States, with a private

healthcare system, will be surveyed, it is possible that differences in routine clinical care may be attributable to differences between the two systems.

Literature Review

This literature review was a preparatory step for a descriptive study consisting of a survey that focused on how North American clinicians are assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders. This literature review has four objectives: (a) to define the necessary terminology, (b) to make clear the need for such a study, (c) to describe recommended practices in this area, and (d) to inform the development of a survey tool. Following is a discussion of these four topics, followed by a description of the overall aims and objectives of the completed study and its specific research questions.

Definitions

- Resonance Disorders**:** These are disorders that occur if there is obstruction in one of the cavities (oral or nasal) causing hyponasality or cul-de-sac resonance; or if there is velopharyngeal dysfunction/incompetence (VPD/VPI) causing hypernasality and/or nasal emission.
- Assessment**:** Assessment is a process used to ascertain the presence of a resonance disorder and, if one is present, to characterize it, supplemented by the client's medical history, oral mechanism exams, and standardized

test results, that often contribute to a diagnosis of hypernasality, hyponasality, mixed nasality or cul-de-sac resonance.

- Tracking treatment**:** Tracking treatment is the process of monitoring the results of therapy; the process of confirming positive/negative changes in clients' conditions.
- Discharge criteria**:** Discharge criteria are the amount of change a client needs to demonstrate to be released from therapy, as defined by the individual clinician.
- Current practices**:** A current practice refers to the clinical procedures that professionals are engaged in at the moment, regardless of whether or not those procedures are supported by the literature.
- Best practices**:** Best practices are systematically developed statements to assist healthcare professionals' and patients' decisions about appropriate healthcare for specific clinical circumstances. Best practice guidelines combine scientific evidence with patients' preferences, practitioners' experience, and the availability of resources to assist with decision making, but they are not a substitute for clinical judgment (McQueen & Dennis, 2007).

Lacuna in the Research

There is a lack of published information regarding clinicians' current practices in assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders. The American

Speech-Language-Hearing Association (ASHA, 2004) has published a preferred practice pattern for the clinical process involved in assessing resonance disorders, but that is a general document, providing limited information regarding specific techniques and does not address ways of tracking treatment outcomes or determining discharge criteria. The association's recommendations are reproduced in the following paragraphs.

> Assessment may be static (i.e., using procedures designed to describe current levels of functioning within relevant domains) or dynamic (i.e., using hypothesis testing procedures to identify potentially successful intervention and support procedures) and includes the following:
>
> - Review of auditory, visual, motor, and cognitive status.
> - Relevant case history, including medical status (e.g. structural or neurological abnormalities, medical or dental treatment), education, vocation, and socioeconomic, cultural, and linguistic backgrounds.
> - Perceptual and instrumental measures used to assess the oral, nasal, vocal, and velopharyngeal functions as they pertain to speech production (e.g., perceptual and acoustic analyses of the speech signal, speech articulation testing, aerodynamic measures, and imaging techniques such as videofluoroscopy and endoscopy).
> - Articulatory or phonatory phenomena that may be causally related to impaired velopharyngeal function.

> Videofluoroscopy and endoscopy may be conducted as part of the assessment. Collaboration with physicians, dental specialists, and other professionals is advantageous to assessment and treatment planning.
>
> Standardized measures for resonance and nasal airflow assessment are selected with consideration for documented ecological validity.
>
> Individuals with identified resonance and nasal airflow impairments receive follow-up services to monitor status and ensure appropriate intervention and support. (ASHA, 2004)

The Canadian Association of Speech-Language Pathologists and Audiologists (CASLPA) (2004) published similarly general guidelines in their *Assessing and Certifying Clinical Competency: Foundations of Clinical Practice for Audiology and Speech-Language Pathology*. This document describes the clinical skills that newly certified speech-language pathologists should possess. As such, it is effective in informing educational practice, but is not designed to be interpreted as a list of best practice guidelines.

Also lacking in the literature is information regarding clinicians' opinions on what best practices in this area are or should be. Outlined below are the reasons why this is a lacuna that needs to be filled.

Standards for Education

Pannbacker (2004) pointed out that services provided to clients with resonance disorders are heterogeneous and vary in quality, because there is significant variation among training programs, both in academic course work and practical clinical experiences. To improve client care quality, evaluate treatment outcomes, identify pre-service training needs and smooth the progress of continuing education, it is important to consider speech-language pathologists' qualifications and the risks associated with velopharyngeal dysfunction. Without standards/guidelines for best practices in the area of resonance disorders, it is difficult to assess clinicians' competencies and weaknesses in the areas of assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with management of such disorders. The completed study will inform educational standards by informing the development of best practice guidelines.

Knowledge of Diagnostic Practices

In today's clinical environments, it is becoming increasingly important to support one's choice of treatment approaches with evidence from well-conducted research studies. In fact, measuring treatment efficacy is now considered a basic requirement of health care delivery (Sellars, Carding, Deary, MacKenzie & Wilson, 2002). According to McQueen & Dennis (2007), good quality evidence-based guidelines are developed to improve the quality of patient care, enhance patient outcomes, control healthcare costs/improve

cost-effectiveness, specify and standardize processes of care to decrease practice variation, disseminate best practices information based on systematically appraised scientific evidence, assist patients in making informed choices, provide a point of reference for professional/hospital audits, and influence public policy by drawing attention to underserved populations or under-recognized health problems.

Clinicians are ideally situated to provide support for their diagnostic and therapeutic practices, to give good reason for the provision and continuation of clinical services, and to seek financial support and reimbursements (Vallino-Napoli & Reilly, 2004). All of these activities are most effectively done when they are able to draw on evidence-based practices. The question is, "How are these practices most effectively developed in the field of speech-language pathology?"

Behrman (2005) stated that measuring treatment effectiveness involves three steps. First, there is a need to acquire knowledge of diagnostic practices among experienced therapists, which may be helpful in clarifying some of the issues that require further attention. Second, there is a need to conduct a review of the literature to establish an understanding of what options are available for measurement, as well as to guide the selection of appropriate treatments to evaluate. Third, an experiment is designed specifically to assess the efficacy of the selected treatments. More work is needed in each of these three steps in the area of resonance disorders. The completed study is a direct response to the first need, to acquire knowledge

of clinicians' diagnostic practices, and a partial response to the second need, to survey the literature.

Such knowledge is valuable, not only to researchers as a first step in developing evidence for therapeutic practices, but also to the clinicians themselves. Sharing professional knowledge allows for consistency across therapists in therapeutic design as well as professional development. Both skills are vitally important to individuals who want to be effective clinicians.

Accountability

"The health industry is now concerned with treatment outcomes and accountability to patients, payers, and referral sources" making it vital for clinicians to be aware of the best practices available to them in the treatment of any disorder (Light, 1997, p. 388).

There are two aspects to accountability within the realm of speech-language pathology: financial accountability and professional accountability. Financial accountability is of greatest concern to whoever is paying for the service, be it the health care system, private insurance, or the clients themselves. It is important that the service provided be of good quality, and it should provide value for the money paid. The most effective way to demonstrate this value to the purchaser is through treatment efficacy which can be shown in well-conducted research.

Treatment efficacy also is the clearest way for clinicians to be professionally accountable. Within the realm of medicine, the ethical

standard is that treatment should be as beneficial to the client as possible. Fundamentally, this describes professional accountability in any area of healthcare practice. Development of standards for best practice will help ensure that the greatest numbers of clients are receiving the best possible treatment.

Bridging Research and Practice

It is frustratingly common to see a disconnect between research and practice in the health sciences. According to Small (2005), the "most common issue raised by practitioners is that the scientific findings and related theory are not very relevant to situations of practice," while scientists complain that "practitioners often do not utilize current scientific knowledge to guide their practice, programs, or policies" (p. 320). Given that researchers and practitioners have different time orientations (i.e., practitioners tend to work on short-term goals, researchers on more long-term ones), primary cognitive resources (i.e., researchers tend to rely on empirical evidence, practitioners tend to rely more on personal experience), values/definitions of excellence, patterns of communication and daily lifestyles, it is not surprising that it can be difficult to maintain the open lines of communication necessary for a symbiotic relationship (Myers-Walls, 2000). This lack of communication means that research findings may not reach those who need them and that researchers may focus on small, well-formed questions that do not accurately reflect the open-system problems that most practitioners face (Small, 2005).

Reilly (2004) stated that there are "disparities between clinical practice and the research evidence" in speech-language pathology that exist for a number of reasons, such as workplace restrictions on the number or structure of therapy sessions (p. 117). The completed study lays a foundation for a bridge between research and practice in the area of resonance disorders by accurately describing both what the literature recommends as best practice and what clinicians are currently doing in this area, as well as their expectations for future directions.

Best Practice

According to McQueen & Dennis (2007), there are three methods that may be used to develop best practice guidelines: expert opinion, consensus, and evidence-based methods. While evidence-based methods are considered the gold-standard because of their lack of bias, there simply is not enough research completed in many health science areas (resonance disorders included) to always permit the use of these methods (Lohmander & Olsson, 2004). In that case, expert opinion and consensus are the remaining options. The completed study begins filling the lacuna in the research regarding knowledge of clinicians' methods of assessing, tracking treatment for, and discharging clients with such disorders by using expert opinion to develop a sense of what experienced clinicians believe are the best practices in the field.

Recommended Best Practices

The literature provides us with currently recommended best practices, practices shown through case studies and experiments to be therapeutically effective. According to Reilly (2001), best practices are evidence-based practices that incorporate three elements: clinical expertise, the patient's wishes, and best evidence from systematic research. Generally speaking, recommended best practices in the literature usually have been developed in highly controlled environments with more homogeneous groups of subjects than the average clinician would have as a caseload. Because of this, it is suspected that these best practices may be overly representative of systematic research, with less coverage given to clinical expertise or patients' wishes. It may be that clinicians' current practices not only look very different but need to be very different from these recommended practices. To compare practices in the literature with clinicians' current practices, it is vital to review what the literature says is optimal in the area of assessing, tracking treatment progress, and determining discharge criteria for clients having a resonance disorder.

It is important to note that there are four factors that have mitigated the rapid growth of evidence-based practice in the field of speech-language pathology in general. First, the fact that evidence-based practice grew out of the medical field, in particular the acute care setting, has caused some SLPs to question its application to a field that is more typically concerned with rehabilitation and long-term outcomes. Second, evidence-based practice

relies heavily on quantitative research, and speech-language pathology is a field that has made an early move to embrace qualitative research, a methodology that has, to some extent, been viewed with a jaundiced eye by medical researchers. Third, the 'gold standard' for evidence-based practice, the large-N randomized controlled trial (RCT), is often very difficult to conduct in speech-language pathology. Given the prevalence of disorders with low numbers of sufferers and the often heterogeneous groups of clients diagnosed with the same disorder, it is difficult to apply a large-N randomized controlled trial methodology when researching these disorders (Reilly, 2004).

Another concern is that not all SLPs fully understand their current beliefs and how these beliefs inform their clinical practice. Without understanding their existing beliefs and assumptions, it is difficult to assume that evidence-based practice is their best option in the care of their clients (Beecham, 2004). It is vital that clinicians examine their assumptions about science, clinical practice, and norms (e.g., do absolute norms of human communication exist?) before they accept a particular form of best practice, even one that is evidence-based (Beecham, 2004).

In the following sections on recommended best practices from the literature, it is important to realize that there will be very few RCTs and other forms of experimental intervention and that other ways of knowing may be just as valuable.

Based on a review of the literature, Kummer (2001) developed an outline of the most effective way to assess a resonance disorder and logically organized the outline into six sub-headings. These sub-headings are included below, with the addition of a seventh (MRI). The information under each heading is *not* taken solely from Kummer's work, but is a synthesis of information obtained from a current review of the literature and presented in a format similar to Kummer's. Rudnick & Sie (2008) and Eblen & Sie (2002) also organized evaluation of velopharyngeal function in a similar manner, providing additional support for the categorization of strategies for assessment of resonance disorders used in this current research. The seven sections are detailed, as they formed a basis for the focus group and one-on-one interviews that were used in the current research, and they also serve as the basis for the field results-to-literature comparisons.

Perceptual Assessment

Making use of the clinician's eyes and ears, a perceptual assessment involves carefully observing a client's speech behaviors and vocal quality, usually in a non-standardized manner (Marsh, 2003). While some clinicians believe that any assessment of a suspected resonance disorder will begin with a perceptual evaluation, the goal of which is to determine whether or not an abnormality is present, and if one is, to determine the type and severity of the disorder, not all clinicians subscribe to this belief (Kummer, 2001; Whitehill, Lee, & Chun, 2002; Dudas, Deleyiannis, Ford, Jiang, & Losee, 2006). Whitehill, Lee and Chun (2002) cautioned that listeners are

systematically biased when they use interval scales for many phenomena, the result of which is that they subdivide the lower end of the scale into smaller intervals than the upper end. They also suggested that listeners struggle to divide hypernasality into equal-appearing intervals, because the phenomenon is one that is psychophysical. Zraick and Liss (2000) stated that nasality is a phenomenon that cannot be validly rated using equal-appearing interval (EAI) scaling (e.g., 5-, 7-, or 9-point rating scales). Should clinicians still wish to use some form of perceptual rating, Zrack and Liss suggested that direct magnitude estimation[1] (DME) scaling be used. Another concern with assessing hypernasality with a rating scale is the potential interference of other speech characteristics (e.g., articulatory errors, disturbances in voice quality, etc.) which may affect listeners' assigned ratings (Whitehill, Lee & Chun, 2002; Watterson, Lewis, Allord, Sulprizio & O'Neill, 2007; Imatomi, 2005). Warren, Dalston & Mayo (1994) found that hypernasality ratings were only somewhat correlated with the size of the velopharyngeal orifice, nasal airflow rate, and nasal airflow duration, possibly because so many factors may potentially influence a listener's perception of resonance balance.

Perhaps because of the multitude of factors that can influence the perception of nasality, it has been noted in the literature that clinician experience in rating nasality has a significant impact on the reliability of the

[1] Direct magnitude estimation: listeners assign a rating to the first speech sample they hear, then rate subsequent samples with numbers in proportion to the first rated sample. The first sample may either be given a number by the investigator or rated by the listeners themselves (Whitehill, Yee & Chun, 2002).

rating (Laczi, Sussman, Stathopoulos & Huber, 2005; Sell, Harding & Grunwell, 1999).

For those clinicians who believe in the value of a perceptual assessment, Kummer comments that the result of some of these observations will be recommendations for additional, instrument-based assessments to determine a more specific physiological cause of the problem. Those methods may include nasometry, videofluoroscopy, and nasopharyngoscopy, among others discussed in later sections of this paper. Dudas, Deleyiannis, Ford, Jiang, and Losee (2006) found that difficulties with phonation were correlated with a lesser degree of velopharyngeal closure but not correlated closely enough to render further anatomical studies irrelevant. Perceptual judgment techniques are best used to infer likely underlying physical or functional abnormalities when evaluating abnormal speech behaviour; these inferences then should be verified via instrumental tests (Bzoch, 1979; Marsh, 2004; Conley, Gosain, Marks, & Larson, 1997).

There is currently no standardized perceptual assessment procedure being used in North America, though there are standardized speech assessments and general suggestions available in the literature (Lohmander & Olsson, 2004; Sell, Harding, & Grunwell, 1999; American Cleft Palate-Craniofacial Association, 1993; John, Sell, Sweeney, Harding-Bell, & Williams, 2006; Rudnick & Sie, 2008). Even when not following a standardized procedure, the first step in a perceptual assessment often is a diagnostic interview which may have been sent in the form of a questionnaire to the

client in advance of the first appointment. To help the clinician prepare for the diagnostic interview aspect of an evaluation, clients answer questions regarding their current speech concerns, developmental/medical history, and treatment history.

The next step in a perceptual evaluation is to determine the type of resonance (normal, hypernasal, hyponasal, denasal, mixed, or cul-de-sac) by listening to the client's connected speech. According to a study done by Kummer, Briggs, and Lee (2003), perceptual characteristics of speech alone predicted the velopharyngeal gap size for 70% of the 173 study participants. Most accurate for large and small gaps, these characteristics were less accurate in predicting the size of medium gaps (only 46%). These results suggest that a perceptual assessment may indicate whether or not therapy is recommended for people with the 'best' and the 'worst' resonance, but may be less clear with regard to clients who fall in the middle ground. Also, given that it is sometimes velopharyngeal gap size, not the speech distortion severity, that determines the treatment direction, it is important that clinicians be able to estimate this orifice size (Kummer et al., 2003).

In a perceptual assessment task, the connected speech should consist of sentences loaded with oral and nasal sounds. Sentences loaded with high pressure oral sounds provide the opportunity for clients with hypernasality to demonstrate weakened oral pressure, as well as overly nasal vowels, while sentences loaded with nasal sounds provide opportunities for clients with hyponasality to demonstrate nasals with excessively low nasal pressure and

acoustic transfer (e.g., 'm' may sound more like 'b'). Sentences are vital to the assessment procedure, as research indicates that shorter utterances, such as single words or isolated vowels, are less reliably judged as having abnormal resonance than sentence-length utterances (Counihan & Cullinan, 1970). Clinicians typically rank the severity of the disorder on a five-point or seven-point rating scale or with a qualifier such as 'moderate' or 'severe.'

Interestingly, Keuning, Wieneke, Wijngaarden, and Dejonckere (2002) found that the *severity* of hypernasality was more correlated with raters' scores of intelligibility than with their scores of the hypernasality itself. This indicates that it is not just the identification of the presence of hypernasality that is influenced by many factors such as articulation and voice quality, but also the determination of its severity.

Clients also may be diagnosed with the general term of 'velopharyngeal dysfunction' or, more specifically, 'velopharyngeal insufficiency' or 'velopharyngeal incompetence.' Velopharyngeal insufficiency denotes "the deficiency of tissue in the area of the velopharyngeal (VP) valve that results in the failure of VP closure during speech production with its associated hypernasal resonance and inappropriate nasal air emission" (Seagle, Mazaheri, Dixon-Wood, & Williams, 2002, p.464). Velopharyngeal incompetence specifies "a neurological etiology without a tissue deficiency" (p.464).

Two terms that are beginning to be used more in practice and in the literature are 'almost but not quite,' and 'sometimes but not always' (Morris,

1972, 1984). The 'almost but not quite' group consists of clients who fall between the two extremes of velopharyngeal adequacy and inadequacy and exhibit a different profile from clients at those two points, most often a consistent, mild hypernasality. The 'sometimes but not always' group is made up of clients who demonstrate inconsistent and inappropriate nasalization during speech that may be related to phonetic context or the complexity of the speaking task (Jones, Morris, & Van Demark, 2004). When used in tandem with a diagnosis of 'hypernasal resonance,' these terms provide additional clarity.

At this point in the assessment, clinicians also may choose to do an articulation test, either formal (following a published protocol) or informal (a general assessment 'by ear' of the client's articulation). One published protocol is the Iowa Pressure Articulation Test, a part of the Templin-Darley Tests of Articulation (Templin & Darley, 1960) which was designed to test for velopharyngeal incompetency. An example of an informal test would be asking the client to repeat a pressure-sensitive phoneme, such as /pa/ to stress the system.

One speech deviation associated with hypernasality is compensatory articulation. Several types of compensatory articulation are commonly seen: glottal stop, pharyngeal fricative, velar fricative, pharyngeal stop, mid-dorsum palatal stop, and posterior nasal fricative (Trost, 1981). It has been demonstrated that, when a compensatory articulation is used in place of a target phoneme, the correct manner of articulation is maintained while the

correct place of articulation is sacrificed (Counihan, 1956, 1960; Spriestersbach, Moll, & Morris, 1961 as cited in Trost, 1981). Therefore, during an articulation test, the clinician could expect to observe glottal stop substitutions for stop consonants, pharyngeal fricative substitutions for sibilant fricatives, for example. Trost (1981) recommended that clinicians use narrow whole word transcription to outline the presence and type of compensatory articulations and to describe overall error patterns. This transcription is important, because surgical and prosthetic management should always be preceded by high-quality diagnostic therapy.

Following assessment of resonance and articulation, phonation is assessed. This is important, as individuals with velopharyngeal dysfunction may use laryngeal hyperfunction as a compensatory strategy. The clinician will listen for dysphonic characteristics (e.g., hoarseness, breathiness, glottal fry, limited pitch range, diplophonia, and/or inappropriate volume), while the client produces a sustained /a/ and a vowel glide up and down a scale. Quality of breath support also should be assessed at this point. Breath support is the amount of air an individual is able to take into the lungs and effectively use for speech by controlling its flow on exhalation. Breath support is important, because it is the foundation upon which speech is built. A lack of breath support for speech may result in short breath groups and may affect vocal quality (e.g., breathy or strained-strangled voice).

Following this basic assessment, a clinician moves on to supplemental tests to more clearly identify the type of resonance. These tests are more

refined than the above tests and more specific to a unique diagnosis (e.g., the Cul-de-Sac Test for the diagnosis of cul-de-sac resonance) (Bzoch, 1997). Detection options available for these tests fall into three categories: visual, auditory, and tactile. An example of a visual test would be to place a strip of paper under clients' noses while they repeat sentences with no nasal sounds present. If the paper is moved by a stream of air flowing through the nose, it is clear that the velopharyngeal port is not functioning as it should, regardless of how the speech sounds to the clinician's ear. An auditory test might involve placing one end of a piece of tubing in clients' noses and the other in the clinician's ear, permitting the clinician to hear any nasal air emission when clients produce sentences containing no nasal sounds. An example of a tactile test would be the clinician holding a finger under clients' noses, to feel any air flow being emitted nasally during the production of non-nasal sentences.

Orofacial Examination

Whereas not all clinicians agree that a perceptual evaluation is necessary, the majority of them will agree that an examination of the oral structures is vital. The examination should focus on the form of the palate, uvula, tonsils, and dentition (Rudnick & Sie, 2008). Given that knowledge of the oral structures and their effect on resonance is extremely important for treatment recommendations, an intraoral examination always should be done when evaluating resonance. Information derived from a thorough examination of orofacial structures will direct the clinician's approach to the

next assessment procedure. There are several published guidelines for the performance of this examination, for example the Dworkin-Culatta Oral Mechanism Exam (1996).

An intra-oral examination typically will not permit visualization of velopharyngeal function, as closure usually occurs above the level of the oral cavity. However, it does permit clinicians to assess the integrity of the hard and soft palates and to make note of any fistulae. The clinician also should be able to comment on the length and mobility of the velum, the patient's dentition (e.g., crossbite), and signs of an undiagnosed submucous cleft (e.g., bifid uvula, bluish/transparent velum, v-shaped notch in the hard palate) (Kummer & Lee, 1996).

Nasometry

As a computer-based instrument that provides data regarding the acoustic results of velopharyngeal function, the Nasometer (Kay Elemetrics) is an excellent tool for the assessment of resonance disorders. Consisting of microphones on either side of a horizontal sound separator plate that rests on the upper lip, the Nasometer provides a 'nasalance' score that reflects the relative amount of nasal acoustic energy in a subject's speech (Dalston, Warren & Dalston, 1991a). Excessively high nasalance scores typically reflect hypernasality, while excessively low scores typically reflect hypo-nasality or de-nasality.

Once the machine has been calibrated, the clinician places the headgear on the client and makes the necessary adjustments according to the

manufacturer's recommendations (Dalston & Seaver, 1992). Following this, the client typically is asked to read a standardized passage (Dalston, Neiman, & Gonzalez-Landa, 1993). Fletcher (1978), upon whose work the development of the Nasometer was based, recommended that clients read three standardized passages: the Zoo Passage, the Rainbow Passage, and a series of sentences loaded with nasal sounds. These passages can be found in the Nasometer software provided by the manufacturer.

The Zoo Passage is a brief paragraph that contains no nasal phonemes whatsoever, and it is considered valuable in identifying clients with velopharyngeal impairment (Dalston & Seaver, 1992). Clinicians expect to see very low nasalance scores for this passage, so higher scores indicate some degree of hypernasality or nasal air emission. The 'nasal sentences' are phrases with a higher than typical ratio of nasal to non-nasal phonemes. This passage has been shown to assist in the identification of clients with hyponasality (Dalston & Seaver, 1992). Clinicians expect to see a relatively high nasalance score, so a low(er) score indicates some degree of hyponasality. The Rainbow Passage is a paragraph that is designed to represent typical conversational speech in terms of its ratio of nasal to non-nasal sounds. Originally thought to provide nasalance information regarding a client's 'every day' speech, its usefulness is currently a subject of debate. Dalston & Seaver (1992) determined that "subject performance on the Rainbow Passage was of no additional value in providing useful clinical information about velopharyngeal function of upper airway patency" (p.20).

The authors concluded that it was "reasonable to suggest that clinicians may consider removing the Rainbow Passage from their clinical protocol without compromising the information about patient performance that can be gleaned from the Nasometer" (p.21).

Dalston et al. (1991a) reported that, when the clinical assessment of hypernasality (as determined by a single clinician, with no inter- or intra-rater reliability scores calculated) is used as the benchmark against which the Nasometer test results were compared, nasometry demonstrated a sensitivity of 0.89 and a specificity of 0.95, with an overall efficiency of 0.93. Hardin, Van Demark, Morris and Payne (1992) found that 91% of their nasometry-based classifications were consistent with listener judgments of *hypo*nasality. Also, 91% of their nasometry-based classifications were consistent with listener judgments of *hyper*nasality in a group of subjects who had not had pharyngeal flaps. The numbers from these two studies suggest that the Nasometer can be used with confidence to corroborate clinical impressions of hypernasality.

Nellis, Neiman, & Lehman (1992) reported a *lack* of correlation between nasalance scores and hypernasality ratings and between hypernasality ratings and hyponasality ratings (e.g., a higher hypernasal score was not necessarily correlated with a lower hyponasal score and vice-versa). They feel this may have been due to asking listeners to rate each sentence for both parameters or perhaps due to the small number of subjects (16). Nevertheless, this research indicates that nasalance scores alone should

not be used to make a diagnosis of a resonance disorder, as they do not always correlate with expert listeners' opinions. Hardin et al. (1992) reported that the consistency of the nasometry-based classification with listener judgments of hypernasality dropped from 91% to 82%, when subjects with pharyngeal flaps were included. They cautioned that "it is imperative that users interpret nasalance scores cautiously when making inferences about velopharyngeal function," and "the Nasometer should not be used as the sole instrumental tool in clinical assessment of patients with suspected velopharyngeal dysfunction" (p.350).

In a study by Dalston, Warren and Dalston (1991c), results indicated that some hyponasal patients obtain high nasalance scores because the nasal microphone falsely interprets audible nasal emission of air as nasal consonants/vowels. The authors stated that this is an error most trained listeners would not make. This is additional evidence to support the recommended best practice of coupling nasometry with clinical judgment.

Given that there is clearly evidence for short-term variability in nasalance scores, Lewis, Watterson, and Blanton (2008) sought to determine whether or not these scores are characterized by long-term variability. Their study found that long-term variability was greater than short-term variability, but not substantially. Also, this variability did not increase with time. Once the initial variability occurred, it did not become greater. The authors recommend that a difference of roughly five nasalance points

between two of a client's scores should account for typical variability in most clients.

A study done by Karnell, Schulz, and Canady (2001) reported that elevated nasometry measures were found for some subjects in low pressure sentences (sentences containing no phonemes requiring high intra-oral pressure to produce) despite their nasometry measures being normal during high pressure sentences (sentences loaded with high intra-oral phonemes). This finding indicates that taking nasometry measures for both a high pressure and a low pressure task may help identify clients who are suspected of having mild/marginal velopharyngeal insufficiency. The findings are not robust enough, however, to justify using differences between high and low pressure nasometry measures to make assumptions about velopharyngeal physiology or hypernasality.

Perhaps one of the most useful features of the Nasometer is the fact that research has been done to develop norms for nasalance scores. Seaver, Dalston, Leeper and Adams (1991) developed norms for four different dialectical groups: Mid-Atlantic, Southern, Mid-Western, and Ontario Canada. These norms provide clinicians with general guidelines regarding what is 'acceptable' as a nasalance score within a particular dialect. However, the authors caution that "the Nasometer is not be used as a substitute for sound clinical judgments, which include the perceptual determination of abnormal nasalization in a subject's speech" (pp. 720-721). They promote the use of the Nasometer in quantifying clinical judgments and facilitating information

sharing regarding patients. In short, the Nasometer may have more use as a tool for tracking treatment, than for assessing resonance disorders.

Given the above mixed results concerning the reliability of the Nasometer as a tool for assessing hyper- and hypo-nasality, it appears that the Nasometer is "a useful tool for confirming hypernasality ratings made by experienced judges working in a clinical setting" (Dalston et al., 1993, p.288-9). The literature recommends that best practice consists of a combination of instrumental assessment and clinical evaluation when assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders.

Speech Aerodynamics

Aerodynamic techniques have a place in the assessment of resonance, as they provide objective data on intraoral pressures, rates of nasal air emission, and estimates of velopharyngeal orifice size. The method assumes that an orifice's area can be determined if one simultaneously measures the differential pressure across the orifice and the rate of airflow through it (Warren & DuBois, 1964). The main advantage of this method is that all of the characteristics related to velopharyngeal function (pressure, airflow, orifice size and speech characteristics) can be concurrently assessed and evaluated. One disadvantage is that a large orifice size cannot be calculated, if the airflow in the orifice is low. This method is commonly referred to as the pressure-flow method/technique. It also can provide information regarding velopharyngeal timing and the patency of the nasal airways during breathing.

Warren, Dalston and Mayo (1993) cautioned that, in some exceptional patients, there may be discrepancies between aeromechanical measurements of velopharyngeal adequacy and listener perception of function. For example, clinicians may perceive hypernasality even though measurements of velopharyngeal closure are within normal limits. Thus, it is vital that clinicians use multiple techniques when assessing this subsystem.

One commonly found piece of equipment is the PERCI-SAR (MicroTronics Corporation P.O. Box 399, Carrboro, NC 27510), a hardware and software interface for assessing speech aerodynamics. Designed to measure oral and nasal air pressure and flow, nasal patency, and laryngeal resistance, the PERCI-SAR allows clinicians to make inferences about velopharyngeal function through the simultaneous measure of oral and nasal air pressure and flow. Taken together, these measurements provide an estimated size of the velopharyngeal orifice.

> The system can be easily configured for specific sampling modes by selecting from a set of MicroTronics supplied sample designs or sample types (i.e. VP area, Nasal area etc,). The user has the option to modify the supplied sample designs and/or create their own sample designs and sample protocols. The SAR system has the ability to store patient information files for later retrieval when patients return for subsequent visits. Users also have the option to modify and create data fields used in the patient information screen. MicroTronics supplies a tutorial CD which covers system board installation,

pressure and flow calibration, and a general information lecture on results obtained from pressure flow analysis in the cleft palate population. SAR system Versions 3.31 and 3.43 (USB) now have built in Help Systems (retrieved from http://microtronics-bit.com/Perci-sar.htm, 29 October 2007).

Also, the SAR system is supplied with a microphone that has been system calibrated for SPL (sound pressure level). There is an option to use real time data display for subject targeting and biofeedback as well as a journaling capability for measurement record keeping and report generation. The user can create spectral plots, and it is possible to store data in a statistical format for research purposes.

The PERCI-SAR has several advantages over more traditional measures of speech aerodynamics. It permits calibrations and has a voicing channel that allows for timing comparisons (e.g., the onset of voicing, peak nasal airflow, and peak oral air pressure). It is also highly reliable. Tests with known inputs showed that correlation coefficients, r, for pressure and flow rate between the PERCI-PC (an earlier version of the PERCI-SAR system) and the known inputs were determined to be very nearly 1 (Campbell, Linville, & Yates, 1991).

Typically, the measurements are taken while the client produces a series of speech outputs, usually including repetition of the syllable string/papa/ and the word 'hamper.' The syllable /pa/ is used because the /p/ sound creates an aerodynamic state that changes directly with the

amount of velopharyngeal closure achieved, and therefore, the pressure measured during the production of this sound is representative of how closed the velopharyngeal port is (Warren, 1979). The word 'hamper' is used because the nasal-plosive blend /mp/ stresses the palatal mechanism and closely approximates the degree of closure that occurs during continuous speech (Warren et al., 1994).

Combining information regarding PERCI and the advantage of developing norms regarding velopharyngeal competency, Warren (1979) reported that, except in extremely rare cases, competency had a range that was less that 0.2 cm^2. Openings in the range of 0.10 cm^2 and 0.20 cm^2 fell into the category of borderline competency. This information is extremely helpful for clinicians, as it permits them to compare their clients' results with population norms. This assists clinicians with assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders.

Dalston, Warren and Dalston (1991b) found that nasometry has a low sensitivity (~0.30) and a higher specificity (~0.85) when used to detect the presence/absence of a nasal airway obstruction in adults. Accordingly, it seems that neither a 'high' nasalance score nor the seeming absence of hyponasality ruled out the possibility of nasal airway impairment. At this time, it appears that the best option for assessing clients with potential airway impairments is through the use of a direct airway measurement.

Videofluoroscopy

To effectively treat disorders related to velopharyngeal insufficiency (such as hypernasality), clinicians need accurate information regarding the function of the velopharyngeal mechanism and the size of the velopharyngeal gap. Both videofluoroscopy and nasopharyngoscopy (see next section) are instrumental techniques that enable clinicians to acquire this information and are sometimes recommended for concurrent use (Seagle et al., 2002; Pigott, 2002). These techniques enable clinicians to assess structure, movement, extent of closure, and timing as they relate to the velopharynx, and videofluoroscopy may provide complementary information that makes up for limitations in nasopharyngoscopy (e.g., patient compliance and suboptimal visualization) (Karnell & Seaver, 1990; Rudnick & Sie, 2008).

Unfortunately, there is limited uniformity in the methods currently used for measuring and reporting observations made using videofluoroscopic techniques (Golding-Kushner et al., 1990). Therefore, December 1988 saw the meeting of an International Working Group that convened to create a "system for quantifying, recording, and describing movements of the velum, lateral pharyngeal walls, and posterior pharyngeal wall, as well as for the size, shape, symmetry, and location of velopharyngeal gaps" (p.338). The group created a report consisting of general principles of both a quantitative and qualitative nature, and this report has been used as a guiding document for many years. However, its age may now be a major limitation, given the technological developments that have occurred over the

past twenty years, and it now may serve better to *inform* new best practice guidelines as opposed to *being* the best practice guidelines. The report's recommendations are inserted in appropriate places throughout the following sections.

For both videofluoroscopy and nasopharyngoscopy, the Working Group recommends the use of movement ratios as opposed to absolute measurements, which are difficult to accomplish and potentially not clinically relevant. These ratios are computed by analyzing the structure at rest and at its maximum displacement.

According to Kummer et al. (1992), multiple view videofluoroscopy is a technique that will provide a comprehensive view of the mechanism by using several projections. It is a radiographic procedure that allows visualization of all aspects of the velopharyngeal portal during speech, through the use of several views (Kummer, 2001). It permits examiners to assess anatomical and physiological abnormalities that cause velopharyngeal dysfunction to help clinicians determine the best possible treatment for the client.

There are three advantages and three disadvantages to the videofluoroscopic procedure. The three advantages are that the necessary equipment is present in any radiological department, only minimal operator expertise is needed, and obtaining patient cooperation is usually easy. The three disadvantages are that the barium does not always coat the pharyngeal walls cleanly which leads to the production of sub-optimal images; the client

is exposed to radiation, making it difficult to recommend repeating the process; and the various components are measured on different projections, not all in one unified view (Coffey, Hamilton, Fitsimons, & Freyne, 1993; Lam, Starr, Perkins, Lewis, Eblen, Dunlap & Sie, 2006). Addressing one of these limitations, it is encouraging to note that computerized image processing is able to retrieve poor quality videofluoroscopic images through the use of contrast and enhancement techniques (Coffey et al., 1993).

The International Working Group's document goes into more explicit detail regarding the standardized procedures for videofluoroscopy than is necessary for this review. For additional details, the reader may refer to the original article (Golding-Kushner, 1990). However, following is a brief summary of the recommendations regarding what should be assessed and subsequently included in the clinician's report:

- General: movement of the head should be avoided; the field of radiation should be as narrow as possible; the process should be completed as quickly as possible; the examination should include at least a frontal projection and a lateral projection, with other views (Towne[2], base[3], or oblique) added as needed.

[2] Towne view: also known as a half-axial antero-posterior view, a projection where the mid-saggital plane is parallel to the film, the head is tilted (opinions vary regarding how much tilt is optimal), and the X-ray beam is aimed at the foramen magnum (Jager, Sanders, Murray, & Stevens, 2001).

[3] Base view: also known as a submentovertical view, a projection for which that patient is supine, with the neck fully hyperextended such that the anthropological line (the line from the bottom of the eye socket to external auditory meatus) is parallel with the film, and the X-ray beam is centered on the mandible, under the chin (Jager, Sanders, Murray, & Stevens, 2001).

- □ En face views (base and Towne): specify the view and indicate if it is true; analyze the degree of displacement of the velum, lateral and posterior pharyngeal walls, and of the size/shape/position of the gap.
- □ Frontal view: analyze lateral pharyngeal wall movement in the area of the velopharyngeal orifice in terms of displacement, contour, direction, and symmetry; do *not* analyze the gap in this view; note any barium blowing through the sphincter.
- □ Lateral view: analyze the degree, contour, and direction of velar and posterior wall movement; analyze abnormal compensatory lingual, velar, and pharyngeal movements; specify the position that the head is in during these analyses; do *not* assess palatal length/thickness or pharyngeal depth.
- □ Speech sample: the sample used should represent the full phonemic repertoire of the language; each institution should use a core standard speech sample that includes sounds in isolation, consonant-vowel combinations, and phrases.

Videofluoroscopic measurements of velopharyngeal gap size have been shown to be significantly different between patients who have hypernasality (with or without nasal emission of air) and patients who have nasal rustle/turbulence (audible and distracting emission of air through the nose) (Kummer et al. 1992). These results also indicated that a relatively larger velopharyngeal gap is associated with hypernasality, demonstrating that this instrumental assessment may be used alongside perceptual assessment

when diagnosing hypernasality. These results also serve to guide therapy. A relatively large velopharyngeal gap will not be corrected by speech therapy alone; surgical intervention likely will be required.

In the process of a videofluoroscopy assessment, it is well-established procedure to take both lateral and frontal projections (Henningsson & Isberg, 1991; Skolnick, 1970). Additional information may be gained from taking a base projection, but this requires clients to hyperextend their necks, which may exacerbate a possible insufficiency, and it is difficult to assess velar function in this view. Clear base views are also difficult to obtain if the client has large adenoids. In this instance it is recommended that a Towne's view be obtained instead.

Nasopharyngoscopy

Nasopharyngoscopy, also known as nasendoscopy, nasoendoscopy, or videonasopharyngoscopy, is a minimally invasive endoscopic procedure that allows the anatomy and physiology of the velopharyngeal mechanism to be observed and analyzed from above without disturbing the airflow needed for speech, as well as permitting the identification of the tonsils, adenoids, palatal fistuale, submucous clefts and/or pharyngeal scarring (Henningsson & Isberg, 1991; Kummer, 2001; Ramamurthy, Wyatt, Whitby, Martin, & Davenport, 1997; Lam et al., 2006; Pigott, 1969). It may be limited by optical distortion and so is typically used for qualitative measurements of palatal and lateral pharyngeal movement (Lam et al., 2006; Pigott, 2002).

New research is suggesting that nasopharyngoscopy may be used for more than just the traditional assessment of the velopharynx. Pegoraro-Krook, Dutka-Souza, & Marino (2008) found that SLPs were able to use nasopharyngoscopy as a feedback system to optimize information about how much velopharyngeal closure could be achieved with prompts and cues, moving it from a basic assessment strategy to diagnostic therapy.

Nasopharyngoscopy may be done with a rigid or flexible scope. The rigid scope permits clinicians to know precisely where the tip of the scope is in relation to the palatal plane but is limited to a single level of observation. The flexible scope permits a more thorough observation of the full height of the pharynx but makes it difficult for clinicians to know precisely where the tip is (Henningsson & Isberg, 1991). The International Working Group recommends that "all endoscopic observations should be based on views where all or most of the [velopharyngeal] orifice is seen in a single field of view" (Golding-Kushner et al., 1990, p. 338).

Nasopharyngoscopy is "generally regarded as the 'gold standard' investigation modality because it permits direct visual inspection of the nasopharyngeal wall during phonation and at rest," and it may be superior to videofluoroscopy in assessing the degree of velar movement (Coffey et al., 1993, p.260; Lam et al., 2006). A survey of cleft palate teams suggests that directly visualizing the velopharynx and its function along with perceptually evaluating speech is becoming a standard practice, when they evaluate and manage velopharyngeal insufficiency (D'Antonio, Achauer, & Vander Kam,

1993). It has some limitations, though. The primary limitations are that: (a) it is very dependent on operator expertise, (b) there is relatively limited availability of the necessary equipment to many clinicians, and (c) it is difficult to establish consistent co-operation in the pediatric population. Its final limitation is that it does not consistently study how the complete vocal tract works as a physiological entity, instead isolating the velopharyngeal valve.

Once the procedure has been explained to the client, the endoscope is moved through the middle nasal meatus to obtain a panoramic view of the velum and lateral and posterior pharyngeal walls. Once the endoscope is correctly positioned, the client is asked to perform a number of speech tasks and nonverbal activities so that the movement of the various structures can be observed (Ramamurthy et al., 1997). This method allows clinicians to assess both anatomical and physiological abnormalities that cause velopharyngeal dysfunction that can, in turn, guide them to the best possible treatment options for their clients.

The nasal cavity may or may not be anesthetized prior to the procedure (Frosh, Jayaraj, Porter, & Almeyda, 1998, Ramamurthy et al., 1997). While cocaine has been used traditionally, there have been reports of severe adverse reactions and occasionally deaths with its use (Lennox, Hern, Birchall, & Lund, 1996). Lennox et al. (1996) compared co-phenylcaine, an uncontrolled drug, with cocaine and found that it had similar anesthetic and vasoconstrictor effects while being significantly cheaper and easier to access

and, therefore, concluded that co-phenylcaine is an appropriate alternative to cocaine in flexible nasopharyngoscopy.

However, it is becoming more and more common to not anesthetize at all prior to the nasopharyngoscopic procedure. In a double-blind randomized control comparing co-phenylcaine and a placebo, Georgalas, Sandhu, Frosh, and Xenellis (2005) found no significant difference between the two groups in terms of overall unpleasantness or pain. Interestingly, the co-phenylcaine group rated the unpleasantness of taste significantly higher than the placebo group, indicating that the anesthetic experience actually may have been *less* comfortable than the placebo experience. The authors concluded that, given cost and possible side-effects, it is not necessary to routinely use co-phenylcaine during nasopharyngoscopic procedures. Similarly, when Frosh et al. (1998) compared the use of lidocaine, saline, and no spray at all, they found that the 'no spray' group experienced significantly less unpleasantness and pain than the lidocaine group and a significantly better experience than the saline group. Also, the participants indicated that the lidocaine tasted significantly more unpleasant than the saline solution, which may have contributed to the overall worse experience. Frosh et al. concluded that topical anesthetics should not regularly be used prior to nasendoscopic procedures.

It is common for clinicians to use a lubricant when performing the procedure, yet this may not be for the reason expected. A randomized controlled trial by Pothier, Awad, Whitehouse and Porter (2005) found that

lubrication did not reduce the pain of insertion or its discomfort. However, lubrication greatly increased the ease of passing the scope through the meatus. Unfortunately, standard lubricants (e.g., KY Jelly®) tend to compromise the quality of the view obtained (Pothier et al., 2005; Pothier, Raghava, Menteiro, & Awad, 2006). In a randomized controlled trial by Pothier et al. (2006), it was found that patients felt no difference in pain, when water was used instead of the standard KY Jelly®, and the process had the added benefit of improved image clarity. The one disadvantage was that the clinicians found the ease of insertion better with a standard lubricant as opposed to water. However, the improved clarity of the image was considered a worthwhile trade off.

The International Working Group's document goes into explicit detail regarding the standardized procedures for nasopharyngoscopy, the length of which is more than is required for this review. For further details, please refer to the original article (Golding-Kushner, 1990). However, following is a brief summary of their recommendations regarding what should be assessed and subsequently included in the clinician's report:

- Velar movement: define the midpoint of the musculus uvulae or the midline of the velum; observe movements for symmetry, consistency, and style of closure.
- Lateral pharyngeal wall movement: construct a line to intersect the most medial position of the lateral pharyngeal wall on each side at rest; determine maximum movement; describe symmetry and consistency;

describe direction of movement as medial, posteromedial, anteromedial or outward.

- □ Posterior pharyngeal wall/Passavant's ridge: construct a line between the posterior pharyngeal wall and the midpoint of the velum; determine maximum movement; note pharyngeal wall pulsations; comment on adenoids.
- □ Velopharyngeal gap: calculate/estimate the size of the gap during maximum movement during speech; describe the shape of the gap using 'coronal,' 'saggital,' 'circular,' or 'other' plus a drawing; make note of the gap's location.
- □ Other: describe the instrument used, the nostril thorough which the scope was passed, which meatus the scope was passed through, the type of anesthesia used; note any fistulas or scarring; describe tonsils.

It is common to describe the movement of the velopharynx according to Croft, Shprintzen and Rankoff's four patterns: coronal, saggital, circular, and circular with Passavant's ridge (as cited in Ramamurthy et al., 1997). These descriptions are based on the various contributions of the velum, posterior and lateral pharyngeal walls to velopharyngeal closure. Another method of description sometimes used is a five-point rating description, where five is the maximum movement of the velum to the posterior pharyngeal wall and lateral walls to the midline (D'Antonio, Muntz, Marsh, Marty-Grames, & Backensto-Marsh, 1988). A third option is that of rating 'velopharyngeal adequacy' as 'adequate,' where the subject consistently achieves appropriate

closure, 'inadequate,' where the subject does *not* consistently achieve appropriate closure, or 'marginal,' where the subject's closure is not consistently appropriate or inappropriate (Karnell et al., 2001).

Several investigators have raised questions about the values of videofluoroscopy and nasopharyngoscopy in relation to one another. Given that both procedures require some client discomfort, as well as expensive equipment, the issue raised is whether or not both instrumental assessments are really necessary.

Results of a study by Havstam, Lohmander, Persson, Dotevall, Lith, & Lilja (2005) call into question the need for both a lateral and a frontal view in videofluoroscopy. Clinicians' recommendations for treatment were compared according to how much information they had: a videofluoroscopic image in the lateral view; videofluoroscopic images in the lateral and frontal views; a videofluoroscopic image in the lateral view and nasoendoscopy (another term for 'nasopharyngoscopy'); or videofluoroscopic images the lateral and frontal views and nasoendoscopy. The results show that 68% of the patients received the same recommendations for therapy, regardless of the amount of information provided to the clinicians. In view of reasonably consistent recommendations irrespective of the source of the diagnostic information, it appears that these patients need not have undergone such a rigorous assessment to determine the optimal therapy plan. Therefore, the authors recommend that videofluoroscopy in the lateral view be the first step in visualizing the function of the velopharynx, followed by

nasoendoscopy when further investigation is needed. An exception to this is a client with a suspected submucous or occult submucous cleft palate, who should be investigated primarily with nasoendoscopy.

There is an important caveat to keep in mind regarding the above study. According to Sommerland (2005), the various clinicians in the study were all part of a team and had worked together in the past according to an established protocol. Therefore, it is not surprising that they reached consensus, and a more valid method might have been to use team members from different teams. Keeping this in mind, it still seems that the recommendations made by Havstam et al. (2005) have value in determining the best practice guidelines for assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders.

Henningsson and Isberg (1991) compared videofluroscopy and nasopharyngoscopy in terms of the information clinicians were able to gather regarding lateral pharyngeal wall movement, velar movement, and posterior pharyngeal wall movement. They found that, when disagreements arose, fluoroscopy always showed better lateral pharyngeal wall movement than did nasopharyngoscopy. This was due to a less than optimal placement of scope despite clinicians believing that the scope was in the best position possible. They also found that the degree of velar movement could only be seen in videofluoroscopy, as it could not be determined through nasopharyngoscopy. The investigators' final conclusion was that

videofluoroscopy is an "indispensable procedure for assessing velopharyngeal function" with the implication that nasopharyngoscopy is less ideal (p.413).

A final, vital point must be taken into consideration when using nasopharyngoscopy, and that is sterilization. If the scope is not well sterilized, cross-contamination can occur. Scopes may be sterilized either by immersion in a sterilizing solution, or by placing the scope in a sheath. A study by Winter, Thirwell & Jervis (2002) found that there is no significant difference in the image quality with a scope that has a sheath on versus an unsheathed scope. Given that disposable sheaths are somewhat easier to use (they do not require a sterilization procedure), this suggests that sheaths may provide a simple and effective way of preventing cross-contamination. Unfortunately, these sheaths are quite costly and are not viable for use on rigid endoscopes (Street, Hamann, & Harries, 2006). It is expected that each institution will weigh the pros and cons of the sterilization options and choose the one best suited to its needs.

Magnetic Resonance Imaging (MRI)

One of the most recent additions to the assessment of resonance disorders is magnetic resonance imaging. MRI is non-invasive, repeatable, and reproducible, characteristics that many clinicians look for in assessment techniques (Rowe & D'Antonio, 2005, Kuehn & Moller, 2000). MRI can provide information regarding static and functional anatomy and possible occult submucous cleft palates. It also permits assessment of a wider

oropharyngeal area than videofluoroscopy, thus permitting clinicians to visualize muscle fibres from origin to insertion (Rowe & D'Antonio, 2005).

There are several disadvantages to MRI as well. First, depending on the protocol, some MRIs are two-dimensional; limiting how much detail can be seen. Second, the frame rate is typically too slow to capture connected speech movements. Third, they require significant patient cooperation. Fourth, MRIs require patients to lie on their backs. Doing so allows gravity to assist velopharyngeal closure and may make patients' systems look more competent than they truly are. Fifth, if patients have prostheses that contain metal, they cannot wear them while being assessed. This seriously limits the amount of information available to the clinician about the efficacy of the prostheses. Sixth, the equipment is costly and may not be available to many practicing clinicians (Rowe & D'Antonio, 2005, Marsh 2003). Finally, the administration of an MRI requires specialized training, such that clinicians would not be able to administer one personally, even under the supervision of a physician.

Best practices regarding the use of MRI to assess and track treatment of resonance disorders and determine discharge criteria for clients with such disorders are limited in the literature, as this is a relatively new development.

Survey Development

Traditional Strategies

While all of the above instruments are described in the literature, it is unknown whether or not clinicians consider them to be best practice or even use them routinely. Therefore, it is difficult to assess how great the gap between research and clinical practice is and what effect it might have on policy. As a first step in addressing this need for information, the principle investigator sought out an acceptable method for determining what clinicians' current practices and beliefs about best practice are, so as to compare these to recommended best practices in the literature.

It is widely accepted that large scale surveys are an effective method of gathering considerable amounts of data on professionals' opinions. Therefore, it was decided that the most effective and efficient method of determining clinicians' opinions regarding how to assess and track treatment of resonance disorders and determine discharge criteria for clients with resonance disorders would be such a survey.

It is unfortunate that the few published articles regarding surveys within the area of resonance disorders contain very little information regarding their development. Okada et al. (2007), Pannbacker, Lass and Stout (1990), and Behrman (2005b) make no reference to how they decided which general themes and specific items should be included in their respective surveys. The lead investigator, therefore, based the survey development

process for the proposed study on more general guidelines regarding questionnaire development that were available elsewhere in the literature.

Survey development frequently incorporates both quantitative and qualitative methods. According to Morgan (1998), a smaller qualitative study can help guide the larger quantitative study by developing content for the questionnaire. This method uses the strengths of qualitative methods in the exploratory stage to ensure that the survey covers the important topics and asks about them in an appropriate manner.

Related Research

Pannbacker et al. (1990) conducted a survey of speech-language pathologists' opinions on the management of velopharyngeal insufficiency (VPI). Whereas the main focus was on the treatment of VPI, several of the questions touched on assessment. Results indicated that:

- 79.2% of respondents thought a peri-oral examination was of value for assessing velopharyngeal function, whereas 20.8% thought that such an examination was of little or no value.
- 90.8% of respondents thought endoscopic evaluations were valuable.
- 98.3% of respondents thought radiographic evaluations of velopharyngeal function were valuable.
- 83.8% of respondents always or frequently referred patients with VPI for instrument-based assessment, however Pannbacker did not define this type of assessment in the survey document.

- 98.2% of respondents believed information about lateral pharyngeal wall movement is important in making management decisions about VPI.

Pannbacker's survey, while effectively laying a foundation of information regarding the treatment of VPI, was not broad enough to answer many of the questions that still exist around VPI and resonance disorders in general. Pannbacker touched only briefly on the assessment of resonance disorders and did not discuss discharge criteria nor the tracking of change during therapy.

It is unfortunate that Pannbacker did not comment on the development process of her survey. There was no information regarding the source of her questions or their prioritization. For example, why ask about lateral pharyngeal wall movement but not posterior pharyngeal wall movement? It is also unclear as to whether or not those questions related to the issues in VPI management that experts in the field considered important. To address that weakness, the survey used in the current study was developed on the basis of a literature review and information gathered from focus groups and one-on-one interviews with expert clinicians.

Behrman (2004b) surveyed clinicians to determine the common practices of speech-language pathologists when evaluating patients with voice disorders. Whereas voice disorders and resonance disorders are not the same condition in any way, parallels exist between Behrman's survey and the survey used in the current study. Behrman analyzed the results using descriptive statistics, frequency counts, percentages and the Kruskal-Wallis

one-way analysis of variance, all statistical procedures that were utilized at the completion of the data collection process in the current study.

Behrman's results indicated that 81% of the respondents were using stroboscopy, a newer objective diagnostic technique. It is therefore predicted that a similar number of clinicians specializing in resonance disorders also will be making use of technology, such as videofluoroscopy or nasal endoscopy. Interestingly, the vast majority of Behrman's respondents indicated that subjective measures such as patient perception and clinician evaluation of vocal quality were vital in the assessment of voice disorders. Therefore, it is expected that these subjective measures also will be popular with experts in the area of resonance disorders.

Behrman's study also fails to discuss the development of the questionnaire, so it is impossible to know whether or not that survey queried issues that experts in the field considered to be important. The current study used focus groups and one-on-one interviews with expert clinicians to help inform the scope and breadth of the survey.

Strategies for this Project

When developing a survey on client-centered rehabilitation Cott, Teare, McGilton, and Lineker (2006) used item generation and reduction as a first step in development. As their survey required standardization for repeated uses and validation for future decision-making purposes, they employed more steps in development than would be necessary for a survey intended for single-use descriptive purposes. Their first stage consisted of

using a literature review, focus groups, and expert reviewers to create survey items and subsequently reduce them to the most parsimonious set possible. The same process was used in the current study. A literature review, focus group session and interviews informed the development of survey items, after which an expert review guided the elimination of any items deemed unnecessary.

Focus groups are an effective and inexpensive means of interviewing multiple people at one time. They require little investigator manipulation, yet still produce valuable data on new research topics. They also permit the investigator to hear the varying viewpoints that inevitably are expressed, when group members respond to each other's comments. Focus groups contribute to the development of a quantitative study in two ways. First, their data can inform the content of the survey questionnaire, including its wording, item topics/categories, and the nature of the items (e.g., questions, statements, phrases, lists, multiple choice responses, etc.) that affect its design. Second, focus groups can provide investigators with an understanding of what the project means to members of the study population. (O'Brien, 1993).

Interviews are also effective and inexpensive means of gathering information, but they focus on one person at a time. Interviews permit investigators to obtain specific information on the population of interest, as well as to learn from the participant's insights into the population of which s/he is a member (Food and Agriculture Organization of the United Nations,

1990). Interviews encourage a two-way dialogue between the respondent and the interviewer, and they provide opportunities for respondents to not only answer questions, but to describe why they answered in that way.

Overall Aim/Objective

The current study will describe the state-of-the-art for assessing resonance disorders and tracking treatment and will explain best practices as supported by the literature. Clinicians from North America were surveyed to determine their current practices for assessment and clinical tracking of treatment goals and outcomes to develop a description of 'best practice' in this area. Survey results were summarized and may be used to inform funding and management decisions within clinics and influence educational practice and policy decisions at the institutional level.

Research Questions

- What are current clinical practices for assessing resonance disorders, tracking treatment, and determining discharge criteria?
- What are considered to be best practices for assessing resonance disorders, tracking treatment, and determining discharge criteria?
- Ideally, what clinical assessment practices would clinicians prefer to use with patients who have resonance disorders?
- What are barriers to clinicians' use of best practices?
- What effect do clinician demographics (e.g., work setting, work location [urban/rural/remote], educational program/degree, etc.) have on assessment and tracking practices?

Methods

Participants

As this study used human participants, it was reviewed by, and received approval from, the Health Research Ethics Board at the University of Alberta. The final approval letter from the Senior Administrator (Panel B) is attached (Appendix A). Participants fell into two groups: (a) focus group or individually interviewed participants and (b) survey participants. All participants were practicing speech-language pathologists (SLPs in North America) who were registered with a professional organization (e.g., CASLPA, ASHA) and who had been working professionally for a minimum of one year. These SLPs had recent experience diagnosing and treating clients with resonance disorders. Focus group and interviewed participants engaged in an open discussion about these issues and their ideas guided development of the survey instrument. Survey participants (who likely included the focus group and interviewed participants) completed the survey, thereby providing the data necessary for analysis.

Focus Group and Individually Interviewed Participants

All focus group and interviewed participants met the above stated participant criteria, and they were considered to be information-rich participants (Patton, 2002). These participants were found via professional networks at the University of Alberta.

Survey Respondents

All survey participants met the above stated participant criteria and were located via invitations to participate posted on the voice/resonance listserv of ASHA and the Cleft Palate-Craniofacial Association listserv. Participants ranged in age from 25-29 years old to 65 and up, with most falling into the 35-39 year old category. Significantly more females (92.1%) than males (7.9%) filled out the survey. Participants had been practicing anywhere from one year to over 25 years, with most having practiced for either 11-15 years or 25+ years. The majority of respondents' highest professional degree was a Master's degree, though 23.7% possessed a doctoral degree. Caseloads ranged from 0-10% of clients having a resonance disorder to 81-90% of clients having a resonance disorder, though most respondents stated that their caseloads were made up of only 0-10% clients with these disorders. The majority of participants worked mainly with children, though several worked with adults, and most of the replies indicated that the participant worked in an urban or suburban area (not rural or remote). Participants worked in a variety of settings, including acute care, long-term care, rehabilitation hospitals, health centres, university settings and hospitals. When divided into hospital and non-hospital settings, participants were relatively evenly divided – 52.6% worked in a hospital setting, and 47.4% worked in a non-hospital setting. As one can see from these demographics, the survey respondents represented a wide range of clinician characteristics.

Materials/Measurement Instruments

Materials included:

- Basic supplies for focus group meetings and interviews: pens, pads of paper, flipchart, permanent markers, digital audio recorders, and omni-directional microphone to facilitate meetings and keep results organized and accessible;
- Refreshments for focus group participants;
- Microsoft Word and Microsoft Excel to develop the necessary documents;
- SPSS to visually inspect and statistically analyze the data; and
- Web hosting for the survey (provided by SurveyMonkey, www.surveymonkey.com).

Procedures

Introduction

The purpose of this research was to describe current and best practices in assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders. To accomplish this, the investigator followed a four-step process. First, a literature review described best practices in this area and informed the development of a survey tool. Second, experts in the area met in a focus group or with the investigator in a one-to-one interview to discuss aspects of clinical practice they considered relevant to best practices for assessment, treatment tracking, and determination of discharge for clients with resonance disorders. Third, a survey was developed, and fourth, North American

clinicians completed the survey to determine their current practices in above-listed areas of clinical practice. They also described what they personally thought best practices were, the directions in which they saw the field heading in the future, and what tools and instruments they felt were vital in an ideal clinical setting. The results of this survey combined with the foundation laid in the literature review resulted in a final document that may inform funding and management decisions within clinics, influence policy decisions at the institutional and national level, and influence educational practices.

Describing Best/Ideal Practices

A literature review informed a description of both current and best practices as generally described within the field of speech-language pathology. It described the current and best practices specifically affiliated with assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders. In addition, the literature review described survey development techniques as a foundation for the second step of the completed study.

Survey Development

The themes that emerged from the literature review informed the development of a survey framework. The framework was fleshed out with specific survey items based on input from focus groups and one-on-one interviews. The ultimate survey tool contained items generally based on the frequency with which clinicians engage in certain practices, when they assess

and track the treatment of a resonance disorder, and when they determine discharge criteria for clients with these disorders. The questions also sought to determine why certain practices were not used (e.g., because clinicians were unfamiliar with them, because clinicians thought they are unimportant, because clinicians lacked access to the necessary technology, etc.). A subset of items focused on future practice, such as the directions in which clinicians saw it heading and the tools and instruments they believed to be vital to a clinical environment in which resonance disorders are routinely diagnosed and treated.

The focus group and interviews were held following the completion of the literature review and the development of the survey prototype. The focus group session was face-to-face, as were most of the interviews, but one interview was conducted over the phone. Detailed study information was provided to participants in an information letter (Appendix B), and informed consent was provided in writing (Appendix C). The literature review provided information about recommended practices associated with resonance disorders, but it was not well suited to describe exactly what clinicians are doing in more realistic settings and how their practices compare and contrast with recommended procedures. Focus group and interviewed participants were able to describe how they adapt commonly used techniques for their particular work settings. Participants also were able to provide insight regarding 'tricks of the trade' they have discovered with their years of experience.

Focus group and interviewed participants were found via professional networks with contacts at the University of Alberta. These participants met with the principal investigator to discuss the issues and practices they thought were relevant in describing the current and best practices of clinicians working with clients who have resonance disorders. Although a standard set of guiding questions (Appendix D) was used during the focus group and the interviews, participants were always encouraged to cover any topics they considered relevant. Participants were provided with items to assist brainstorming (e.g., pads of paper and pens), and the discussion facilitator (principle investigator) brought flipcharts and markers to the focus group for the same reason. The sessions were audio recorded and subsequently analyzed to determine general themes and specific issues the clinician-informants believed should be incorporated into the survey. These themes and issues then were integrated into the prototype survey.

In areas of disagreement, decisions about which themes and issues to include were to be made based on: (a) careful consideration of the literature and its suggestions regarding what is critical to best practice and (b) conclusions the majority of clinicians believed to be the best option. However, no such areas of disagreement arose.

Following the focus group and interviews, the investigator performed a basic qualitative analysis on the participants' responses, looking for overall themes that emerged from data. These themes were highly congruent with

the results of the literature review and were used to refine the prototype survey questions.

The focus groups were highly valuable to the study as a whole for several reasons. First, the focus group and interviews supported the survey's face validity, ensuring that it was studying what it was meant to study. Second, they confirmed the content validity of the survey that was developed from the literature, affirming that the survey addressed all aspects of evaluation of resonance disorders. Third, they indicated that members of the population of interest considered the study and the information that it would eventually provide to be interesting and of value.

Participants in the focus group and interviews saw themselves and the future survey respondents as: (a) engaged in a joint enterprise, (b) mutually engaged with one another, and (c) having a shared interest in the results and their capacity to confirm a *community of practice* in the area of resonance disorders (Wenger, 1998). The practices that are followed by members of a *community of practice* reflect those members' understanding of what is important. Therefore, the descriptive results from the survey can be assumed to accurately reflect what SLPs practicing in the area of resonance disorders consider to be important.

The prototype survey was considered a penultimate draft after participants' opinions were integrated into it. This draft of the survey was made available to an expert clinician (determined by clinician consensus in the focus group and interviews), who provided final verification of the edited

survey's items and its overall style. When this verification was completed, the hard copy was developed into a web-based survey via SurveyMonkey, a secure and reputable service provider (**www.surveymonkey.com**).

Survey Distribution

While the web-based survey was being developed, the American Speech-Language-Hearing Association (ASHA) and the American Cleft Palate-Craniofacial Association (ACPA) were contacted and asked to inform their members of the survey. They were asked to post an invitation (Appendix E) on their website or on one of their listservs. One week after the invitation was posted, a reminder (Appendix F) was posted. One week following the reminder, the survey was closed. Information regarding the security of the web-based survey, the confidential nature of the respondents' data, and the respondents' guaranteed anonymity was available to each special interest group.

After development of the web-based survey and after several trial runs for de-bugging, a full information package was made available for each group that expressed interest. This package reiterated the security information, described how to access the survey, explained the purpose of the survey, included an example item from the survey, and estimated the time required for completion of the survey. Contact information for the researcher also was provided, so that comments, questions, and concerns could be addressed. Clinicians willing to complete the survey were able to visit the survey website and complete the survey online. Survey participants

were practicing speech-language pathologists, who were registered with a professional organization and who had been working professionally for a minimum of one year. These SLPs had recent experience diagnosing and treating clients with resonance disorders.

On the first screen of the online survey was the information letter (Appendix G). The second screen was the consent letter (Appendix H), which stated the completion and submission of the survey would be taken as each participant's informed consent. Each screen had three buttons: "Previous," "Next," and "Exit survey." Before completing the survey, a final screen reminded participants that their completion and submission of the survey would be taken as their informed consent.

Survey Responses

The online survey's second screen addressed informed consent issues as discussed above. Each screen thereafter contained the instructions for that section and sample questions (Appendix I). All survey responses were kept confidential, and no identifying information was stored with the data. The data were encrypted to ensure their confidentiality and participants' privacy.

Ethical Considerations

This study used human participants and required review by the Health Research Ethics Board (HREB) (Appendix A). The topics addressed were not expected to be distressing or negative in any way. All responses were treated as confidential and participants are anonymous. Participants in interviews were asked to provide signed, informed consent. In statements at

the beginning and end of electronic submission, participants in the survey portion of the study were reminded of the voluntary nature of their participation and advised that their identities could not be known to the investigator. That statement indicated that their submission of the completed questionnaire would be taken as their consent to participate. Information was provided regarding whom to contact, if participants had concerns about the conduct of the research.

This survey did not collect information of a personal or confidential nature, nor any information that might be used in a fraudulent manner. The survey information was collected by a secure and reputable website (www.surveymonkey.com), and it was seen only by the principal investigator. As such, the study was of minimal risk to participants.

Data Analysis

Data were compiled automatically in Excel and later visually inspected by the principal investigator. Following compilation and preliminary cleaning, data were imported into SPSS for analysis. Descriptive statistics (e.g., frequency counts, modes, medians) were carried out and used to address anomalies. Missing data were replaced with the mode. Replacements were made for 0.01% of the total data points collected.

Following the data analysis, the various reasons for respondents having selected the response "I never do this" (e.g., "I am unfamiliar with it.", "I do not have access to it.", or "I think it is unimportant.") were analyzed.

Underlying patterns were revealed regarding why clinicians did not use a specific practice.

Data also were analyzed according to clinician demographics to determine whether or not these demographics had a relationship with clinicians' practices in assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders.

The research questions above were answered through these analyses of the data. Limitations in the conduct and findings of this research and suggestions for future related research are discussed below.

Results

The results obtained from these analyses are presented in the following sections. Results from the focus group and interviews and their impact on the survey's development are described first. Then, current practices are described, followed by best practices, ideal practices, and barriers to practice. Comparative results based on clinicians' characteristics conclude this section. The section describing best practices includes interpretations as they relate to and are informed by the available literature.

Focus Groups and Interviews

A thematic analysis of the focus group and interview data revealed three themes. First, participants described their evaluations of resonance disorders using the same categories as Kummer (2001) and, therefore, in the same way that the survey was organized. All assessment tools discussed fitted into one of the seven categories (perceptual assessment, orofacial

examination, nasometry, speech aerodynamics, videofluoroscopy, nasopharyngoscopy and MRI). This supported the survey's content validity (i.e., that it covered all the relevant facets of evaluating a resonance disorder). Second, many of the participants in the interviews and focus group emphasized the importance of a well-trained professional ear when assessing and treating resonance disorders. This is something not explicitly discussed in the literature, and it was extremely valuable that the respondents were able to capture it. Questions regarding the importance of a well-trained ear were subsequently incorporated into the survey document. Third, participant responses emphasized again how important a good quality assessment is in the management of resonance disorders. As such, it also affirmed the value of this study, insofar as respondents were highly interested in the information that would accrue from the survey.

Current Clinical Practice

Frequency counts, modes and medians were calculated for each of the survey items. For 21 of the items, the 'never' response was not used (i.e., all of the respondents performed the action at least some of the time). Table 1 displays the items for which all respondents replied that they used the action at least on occasion when assessing resonance disorders.

Table 1

Items with No 'Never' Responses (n=38)

Percentage of respondents who performed the action:					
	R	O	U	AA	A
I hold an interview with the client.	0	0	5.3	7.9	86.8
I record a speech sample.	13.2	13.2	10.5	36.8	26.3
I ask my client to repeat syllables.	0	23.7	23.7	34.2	18.4
I elicit counting/rote speech.	5.3	7.9	21.1	26.3	39.5
I elicit nasally-loaded sentences.	10.5	2.6	10.5	23.7	52.6
I elicit spontaneous, connected speech from my client.	0	0	7.9	15.8	76.3
I listen for compensatory articulation errors.	0	5.3	5.3	13.2	76.3
I note obligatory articulation errors.	0	7.9	5.3	15.8	71.1
I make note of weak consonants.	2.6	5.3	5.3	23.7	63.2
I make note of short utterance lengths.	2.6	10.5	23.7	15.8	47.4
I assess my client's stimulability.	0	0	15.8	18.4	65.8
I listen for dysphonia.	2.6	0	7.9	26.3	63.2
I attempt to determine the source or cause of the resonance problem	0	0	7.9	15.8	76.3
I evaluate the morphology of the lips.	5.3	7.9	31.6	18.4	36.8

I examine the morphology of the velum.	0	0	5.3	34.2	60.5
I evaluate velar length and mobility.	2.6	2.6	13.2	31.6	50.0
I evaluate the tonsils.	2.6	10.5	21.1	26.3	39.5
I evaluate dentition and occlusion.	2.6	2.6	13.2	34.2	47.4
I evaluate the structure of the tongue.	5.3	7.9	7.9	44.7	34.2
I evaluate the function of the tongue.	0	7.9	10.5	34.2	47.4
I assess oral-motor function.	5.3	10.5	7.9	28.9	47.4

Note. R – Rarely, O – Occasionally, U – Usually, AA – Almost Always, A – Always

Note. All values are percentages of respondents.

An interesting, but logical, trend emerged from the data collected on tracking treatment and determining discharge criteria for clients with resonance disorders. Practices used during assessment also tended to be the practices for tracking treatment and determining discharge criteria, but were used less frequently. Frequency of use was also higher for determining discharge than for tracking treatment progress. The most thorough evaluation of a resonance disorder apparently occurred during the initial assessment, with a subset of assessment practices utilized over the course of treatment and to determine discharge eligibility. For example, 39.5% of respondents indicated that they 'always' or 'almost always' use a nasometer during the initial assessment, while only 21.0% use it to track treatment progress, and 29.0% use it to determine discharge criteria.

It was interesting to note that 76.3% of respondents indicated that 'yes,' they used nasopharyngoscopy. This was the only form of instrumental assessment for which more than two-thirds of respondents stated that they used it.

For a second subset of 13 items, over one-third of the respondents selected 'no,' they do not use a specific instrument or they 'never' perform a specific clinical action when assessing resonance disorders. Table 2 itemizes these actions.

Table 2

Items with over One-Third 'No' or 'Never' Responses (n=38)

Item	'No' or 'Never'
Do you use nasometry?†	42.1
Do you use the pressure/flow method (e.g., PERCI)? *†	76.3
Do you use videofluoroscopy? †	47.4
Do you use MRI? *†	92.1
I refer my clients to a professional who performs flexible nasopharyngoscopy.	34.2
I rely on an audiorecording in combination with nasopharyngoscopy.	36.8
I assess the length of the velopharyngeal valve.	34.2
I suction the client's nose if necessary.*	76.3

I ask the client to produce a sustained /i/.	34.2
I ask the client to read standardized passages.*	52.6
I interpret the nasopharyngoscopic study myself.*	52.6
Someone else interprets the nasopharyngoscopic study.*	57.9
I report my nasopharyngoscopy results in numeric/scalar form.*	68.4

Note. All values are percentages of respondents who stated 'no' or 'never' in response to the statement.

*Over 50% of respondents chose 'never' as their response.

†As over 1/3 of respondents chose 'no,' they do not use the instrumentation in general, all items regarding specifics of its use also had more than 1/3 of respondents state that they 'never' do it.

It is recommended that a study should have at least 100 participants to use factor analysis, and beyond that, there should be more participants than variables (Brace, Kemp & Snelgar, 2006). Given that there were only 38 completed surveys in this study, and significantly more variables than that, it was not appropriate to use factor analysis with these data. Future work for the principal investigator will be to continue acquiring respondents with an aim to accumulate enough data to complete a factor analysis.

Best Clinical Practices

There are three methods that may be used to develop best practice guidelines: expert opinion, consensus, and evidence-based methods (McQueen & Dennis, 2007). While evidence-based methods are considered the gold-standard because of their lack of bias, there simply is not enough

research completed in many health science areas (resonance disorders included) to always permit the use of these methods (Lohmander & Olsson, 2004). The literature review above sought to comprehensively summarize the available research on the assessment of resonance disorders, limited as it may be. Expert opinion and consensus are the remaining options. The following section weaves together expert opinion (gained through the survey results) with the literature review to develop a sense of what experienced clinicians believed are the best practices in the field.

Perceptual Assessment

The goal of a perceptual assessment is to determine whether or not a velopharyngeal abnormality is present and, if it is, to determine its nature and severity (Kummer, 2001). As the majority of survey respondents indicated that they engaged in many of the perceptual assessment practices at least some of the time, there is a good fit between recommended best practices in the literature and the use of these practices by expert clinicians (see Table 1).

Survey results indicated support for beginning a perceptual assessment with an interview with the client and, if necessary, the caregiver, with 94.7% of respondents indicating that they do this 'always' or 'almost always'. The second step of listening to a client's connected speech is also supported by the survey's results. A total of 92.1% of respondents reported 'always' or 'almost always' eliciting spontaneous, connected speech from the client for the evaluation of resonance.' A total of 76.3% of clinicians

reported 'always' or 'almost always' eliciting nasally-loaded sentences from their clients, and 86.9% reported eliciting sentences loaded with high-pressure oral sounds. When evaluating resonance, only 52.7% of clinicians stated that they 'always' or 'almost always' use a rating scale of severity. Given the debate in the literature over which types of rating scales are most valid and reliable, it is reasonable that not all clinicians are choosing to utilize such scales on a regular basis.

The final step in a perceptual assessment is supplemental tests, such as the cul-de-sac test for cul-de-sac resonance. As these types of tests are only used on an as-needed basis, it is not surprising that only 47.3% of clinicians reported routine use of this test with clients.

Once the perceptual assessment is completed, 92.1% of clinicians reported attempting to determine the source or cause of the resonance disorder. Many clinicians also then engage in some form of further instrumental assessment to gain more knowledge regarding the client's velopharyngeal mechanism.

Orofacial Examination

The survey results indicated that the majority of respondents complete some form of orofacial examination during assessment. This finding supports the literature's view that such an examination is vital, given that it provides needed knowledge regarding the oral structures and their effect on resonance. Ninety-two percent (92.1%) of respondents 'always' or 'almost always' visually inspect the oral cavity, though only 51.9% 'always' or

'almost always' use a tongue blade to assist them in this. Surprisingly, only 34.2% of clinicians 'always' or 'almost always' palpate the palate, a step generally considered important in the literature for assessment of palatal integrity (Kummer, 2001). A disconnect may exist between what the literature recommends and what clinicians reported routinely doing with regard to palatal palpation. However, only 7.9% of respondents stated that they 'never' palpate the palate, indicating that the others likely saw some value in it, as they reported engaging in the practice at least on occasion. Respondents reported examining clients' eyes, ears, noses, lips, and facial profile at least occasionally, with 34.2 – 55.2% of them stating that they do this 'always' or 'almost always.'

There were some practices that no clinician reported 'never' doing. With regard to evaluating the velum, the tonsils, dentition/occlusion, and the tongue, 65.8 - 94.7% of participants reported that they 'always' or 'almost always' do this.

Nasometry

There is a great deal of support in the literature for using nasometry as a tool to aid in the assessment of resonance disorders. It is a highly useful tool that experienced clinicians can make use of to confirm their hypernasality judgements and to quantitatively track change over time (Dalston et al., 1993). It was surprising, therefore, that 42.1% of respondents indicated that 'no,' they do not use nasometry. Sixty-eight percent (68.8%) of

these clinicians indicated that they did not have access to a nasometer, and 62.5% of these would use nasometry if provided access.

As with any instrument, calibration is important, yet of those clinicians who stated that they use it, only 36% 'always' or 'almost always' calibrate the Nasometer (Dalston & Seaver, 1992). It is hoped that perhaps calibration is the responsibility of a colleague or another professional and not that the instrument is not being calibrated on a regular basis.

One of nasometry's strengths is that there are published norms for nasalance scores (Seaver, Dalston, Leeper, & Adams, 1991; MacKay & Kummer, 1994). In order to make use of the norms for adults, a clinician must administer the standardized passages: the Zoo Passage, the Rainbow Passage, and a series of nasal sentences (Dalston, Neiman, & Gonzalez-Landa, 1993; Fletcher, 1978). Only 41% of the clinicians who stated that they use nasometry also stated that they ask their clients to read standardized passages. Perhaps it was because so many respondents worked mainly with children who are not yet adept enough with literacy to easily read these passages or perhaps because practicing clinicians did not find these published norms useful for their daily practice and were using the Nasometer's results for another purpose, such as a tool for quantifying clinical judgments and sharing information regarding clients (Seaver, Dalston, Leeper, & Adams, 1991). Sixty-three percent (63.6%) of clinicians reported utilizing the SNAP test, a simplified standardized assessment for the Nasometer, typically used with children (MacKay & Kummer, 1994). Overall,

86.4% of clinicians reported comparing their clients' results with normative data; it simply appears that more clinicians were using the SNAP test as opposed the Zoo Passage, the Rainbow Passage, and the nasal sentences, again, perhaps because more clinicians were working with children than with adults. In the end, it is important to remember that collecting some form of standardized data from the nasometer (either from the standardized passages or the SNAP test) is best practice.

Overall, it appeared that those clinicians who have access to a Nasometer were using it on a regular basis, and it was providing valuable information. It seems imperative that more clinicians have this vital tool available for routine use.

Speech Aerodynamics

A total of 76.3% of respondents do not make use of the pressure/flow method, most frequently utilized via one of the PERCI systems (either PERCI P-SCOPE, or PERCI-SAR system). Sixty-nine percent (69.0%) were not using it, because they did not have access to the needed equipment. Moreover, of this group, 70.0% would use the pressure-flow measures if they had access to the necessary supplies.

The pressure-flow method is valuable because it permits the concurrent assessment of all salient characteristics of velopharyngeal function, including pressure, airflow, orifice size and speech characteristics (Warren & DuBois, 1964). By using the PERCI-SAR system, as 33.3% of survey respondents who use the pressure-flow method do, one is also able to

make timing comparisons for measurements of voice onset, peak nasal airflow, and peak oral air pressure (Campbell, Linville, & Yates, 1991).

Warren (1979) published norms regarding the size of the velopharyngeal orifice and velopharyngeal competence. Despite the fact that these norms may well provide information regarding clinical management of velopharyngeal impairment, none of the clinicians surveyed reported 'always' or 'almost always' comparing estimated orifice size results with standardized norms. The survey data indicated that practicing clinicians did not find this information useful and were using the pressure-flow method for other purposes, perhaps simply to determine orifice size (without comparing it to norms) or to determine the potential for airway impairment (Dalson, Warren, & Dalston, 1991b). Regardless, it appears that clinicians want access to the needed instruments to make use of the pressure-flow method in their assessment of resonance disorders.

Twenty-one percent (20.7%) of respondents indicated that they were not familiar with the pressure-flow method. Given the above description of the value of the information provided via this method, it appears that educational reform may be needed. SLPs should be taught about the pressure-flow method during their training.

Videofluoroscopy

Videofluoroscopy provides accurate information regarding the function of the velopharyngeal mechanism and the size of the velopharyngeal gap, and permits clinicians to assess structure, movement, extent of closure

and timing as they relate to the velopharynx (Seagle et al., 2002; Pigott, 2002; Karnell & Seaver, 1990; Rudnick & Sie, 2008). Fifty-three percent (52.6%) of survey respondents report using videofluoroscopy in their assessment of clients with resonance disorders. For the 47.4% who are not using videofluoroscopy, 50.0% do not have access to it. Eighty-eight (88.9%) of those who are lacking access to videofluoroscopy would use it, if they had access to such a system – a clear indication of support for the use of videofluoroscopy in the assessment of resonance disorders.

A total of 20.0% of clinicians who reported using videofluoroscopy 'always' or 'almost always' perform the study at their own place of work, while another 20.0% 'always' or 'almost always' refer clients to another centre. Sixty-five percent (65.0%) of clinicians provide their clients with information about the videofluoroscopic procedure prior to the appointment, as is recommended in the literature (Kummer, 2001). It may be that, for those who do not supply this information for their clients, a colleague such as an otolaryngologist provides such information.

Multi-view videofluoroscopy provides a comprehensive view of the velopharyngeal mechanism by using several projections (e.g., lateral, frontal). The types of projections used, along with the frequency of their use, are listed in Table 3.

Table 3

Videofluoroscopic Views and their Frequency of Use (n=38)

	Never	Rarely	Occasionally	Usually	Almost Always	Always
Lateral	5.0	5.0	10.0	25.0	10.0	45.0
Frontal	10.0	15.0	20.0	15.0	10.0	30.0
Base	25.0	40.0	5.0	0	0	15.0
Towne's	40.0	15.0	10.0	25.0	5.0	5.0
Oblique	45.0	25.0	10.0	5.0	5.0	0

Note. All values are percentages of clinicians who stated 'yes,' they use videofluoroscopy.

According to the literature, it is well-established procedure to take lateral and frontal projections, and the survey respondents reported these to be the two most used views (Henningsson & Isberg, 1991; Skolnick, 1970; see Table 3). Other views may provide additional information but are less commonly used, both in the literature and in clinical practice. It also is common in the literature for a contrast material to be used for image enhancement. A total of 85.0% of clinicians surveyed reported 'always' or 'almost always' using a contrast material in their videofluoroscopic studies, suggesting support for this practice as a best practice. It is also interesting to note that most clinicians (60%) reported 'always' or 'almost always' working with another professional to interpret the resulting images, with fewer (25%) interpreting them alone, or allowing another professional to interpret them alone (10%). Working as a team to interpret the images is also

supported by the literature and should be considered best practice (Kummer, 2001; Canadian Association of Speech-Language Pathologists and Audiologists, 2007).

Nasopharyngoscopy

Nasopharyngoscopy permits the direct visualization of the anatomy and physiology of the velopharyngeal mechanism without disturbing the airflow necessary for speech (Henningson & Isberg, 1991; Kummer, 2001). Given that nasopharyngoscopy is often regarded as the 'gold standard' instrumental assessment, it is exciting to see that a majority of practicing clinicians reported making use of it (Coffey et al., 1993). Seventy-six percent (76.3%) of respondents indicated that they use nasopharyngoscopy as part of their assessment practices, making it the most used instrumental assessment among surveyed clinicians. For the 23.7% who did not report making use of nasopharyngoscopy, 100% of them stated they do not use this instrument because they do not have access to it, and 66.7% indicated that, if they had access, they would use nasopharyngoscopy.

The majority of clinicians perform the nasopharyngoscopy themselves (51.7% do it 'usually,' 'almost always,' or 'always'), while a smaller group refers clients on to another centre (6.9% do this 'usually,' 'almost always,' or 'always'). It is recommended in the literature that these studies be recorded for later viewing, either by the SLP or by other professionals, or even the clients or their families (Kummer, 2001). A total of 75.9% of surveyed clinicians reported relying on video recording and/or audio recording in

combination with nasopharyngoscopy which provided support for this practice as a best practice.

Ninety percent (90.0%) of surveyed clinicians indicated that they thoroughly brief their clients about the scoping procedure, a practice strongly supported in the literature (Kummer, 2001). The contents of this briefing are likely to vary by clinician, as scoping practices are different among different clinicians. For example, the literature is divided on the topic of nasal anaesthesia, with some researchers supporting its use and others suggesting it is not necessary (Forsh, Jayaraj, Porter, & Almeyda, 1998; Ramamurthy et al., 1997; Lennox et al., 1996; Georgalas, Sandhu, Frosh, & Xenellis, 2005). A randomized controlled trial study indicated that nasal anaesthesia was unnecessary (Georgalas, Sandhu, Frosh, & Xenellis, 2005). Of the clinicians surveyed, 96.6% provided their clients with nasal anaesthesia 'almost always' or 'always,' indicating that expert opinion holds that anaesthetic is of value. The question then arises: Do clinicians utilize nasal anaesthesia because they consider it of value regardless of alternate opinions in the literature, or do they utilize it because they are not aware that the literature is suggesting otherwise? A second area of dispute in the literature is over the value of lubricant in the scoping procedure. There is debate over whether or not it eases scope insertion, and if it does, whether the risk of a blurred image is worth the benefit of easier scoping. A total of 75.9% of clinicians surveyed stated that they use a lubricant when

performing nasopharyngoscopy, again supporting its popularity if not its clinical utility.

The literature provides detailed recommendations about what should be studied during nasopharyngoscopy (Golding-Kushner et al., 1990; Kummer 2001). The suggested structures are listed in Table 4, along with how frequently clinicians reported assessing them.

Table 4

Frequency of Structures Assessed in Nasopharyngoscopy (n=38)

	N	R	O	U	AA	A
Laryngeal valve depth	10.3	3.4	3.4	20.7	10.3	51.7
Laryngeal valve width	10.3	6.9	6.9	10.3	10.3	55.2
Laryngeal valve length	13.8	10.3	6.9	6.9	10.3	51.7

Note. All values are percentages of clinicians who stated 'yes,' they use nasopharyngoscopy. N – Never, R – Rarely, O – Occasionally, U – Usually, AA – Almost Always, A – Always.

Roughly 60% of clients who use nasopharyngoscopy reported 'always' or 'almost always' studying laryngeal depth, width and length, just as is suggested in the literature.

The literature also provides a number of suggestions regarding what the speech sample should be for a nasopharyngoscopic study (Golding-Kushner, 1990; Kummer, 2001). These are displayed in Table 5, along with how frequently clinicians reported asking their clients to produce them.

Table 5

Frequency of Items Used in a Nasopharyngoscopic Speech Sample (n=38)

	N	R	O	U	AA	A
High-pressure words	0	3.4	0	13.8	6.9	75.9
Pressure-sensitive sentences	0	0	0	10.3	31.0	58.9
Nasal sentences	6.9	10.3	17.2	6.9	20.7	37.9
Sustained /i/	13.8	10.3	17.2	3.4	20.7	34.5
CV – high-pressure consonants	3.4	3.4	6.9	6.9	17.2	34.5
60-70	3.4	6.9	13.8	41.4	13.8	20.7
Sustained /s/	0	6.9	13.8	20.7	41.4	17.2
Standardized passages	37.9	13.8	24.1	10.3	6.9	6.9

Note. All values are percentages of clinicians who stated 'yes,' they use nasopharyngoscopy. N – Never, R – Rarely, O – Occasionally, U – Usually, AA – Almost Always, A – Always.

As can be seen in Table 5, high-pressure words and pressure-sensitive sentences were the two speech samples most often ranked as 'always' used by clinicians in the survey. Standardized passages were rarely used, which may be because there are no norms in nasopharyngoscopy available for comparison.

Suctioning the nose when necessary is recommended by the literature, yet only 6.9% of clinicians surveyed say that they 'always' or

'almost always' do this. They gave a number of reasons for not doing so. Some were unfamiliar, others considered it unnecessary, and yet others did not have access to the necessary equipment. Because of this range of responses, it is hard to be certain whether or not suctioning the nose is or is not best practice.

When it comes time to interpret the results from nasopharyngoscopy studies, 20.1% of clinicians interpret them alone 'almost always' or 'always,' 13.8% have someone else interpret it for them 'always' or 'almost always,' and 89.7% work with another professional 'always' or 'almost always.' The survey results indicated that interpretation of nasopharyngoscopic studies was similar to survey results on the interpretation of videofluoroscopic studies, that indicated the best practice is to interpret these tests with other professionals, as a team.

Finally, it is interesting to note that, despite the International Working Group's recommendation that nasopharyngoscopic study results be reported in a numeric, ratio form along with qualitative information, only 6.9% of surveyed clinicians reported 'always' or 'almost always' reporting their data in a numeric or scalar form (Golding-Kushner, 1990). On the other hand, 75.9% of respondents said they 'always' or 'almost always' report their data in a narrative form. Of those who stated that they 'never' use the numeric form, 41.2% commented that they never use it, because it is 'unfamiliar' to them. A reform in the educational standards for clinicians may be suggested here, such that SLPs learning to perform and/or interpret

nasopharyngoscopic studies would at least have the knowledge necessary to make numeric reporting a viable option.

MRI

As only three clinicians stated that 'yes,' they use MRI, it is not possible at this time to couple the results with the literature to provide best practice suggestions. The literature in this area is also limited, with few researchers studying MRI and its application to the assessment of resonance disorders. Future research should focus on the viability of this procedure.

Ideal Practices

Clinicians were asked to rate various items according to how important they were considered to be to a well-equipped resonance lab. These items were ranked on a scale from 1 (not at all important) to 5 (essential). The modes are presented in Table 6. Items with modes of 4 or 5 are items considered by clinicians to be 'very important' or 'essential', and it is recommended that clinicians have these items available to them for daily clinical practice.

Table 6

Item Importance to a Well-Equipped Resonance Lab (n=38)

Item	Mode
Computer and acoustic software	5
Dental mirrors	5
Nasometer	5
Nasopharyngoscopic system	5
Snap Test (MacKay & Kummer, 1994)	5
Tongue blades	5
Videofluoroscopic system	5
Well-trained professional ear	5

Uni-directional microphone	4
Bzoch Error Pattern Diagnostic Articulation Tests (Bzoch, 1979)	3
Camcorder	3
DAT recorder	3
Mini-disc recorder	3
Iowa Pressure Articulation Test (Templin & Darley, 1960)	3
See-Scape	3
Bi-directional microphone	2
CD recorder	2
MRI system	2
Omni-directional microphone	2
PERCI SAR System	2
Pneumotachometer-pressure transducer	2
U-tube manometer	2
Wet spirometer	2
Cassette recorder	1
PERCI P-Scope	1
Round-the-house device	1

Barriers to Best Practices

Clinicians may choose not to engage in particular practices for any number of reasons. Perhaps they feel it is unnecessary or patient insurance will not cover the cost. Perhaps it is too complicated or requires patient compliance that is difficult to obtain. Maybe they are unfamiliar with a practice or do not have access to the necessary equipment. Choosing not to do something because one believes it is unnecessary is very different than choosing not to do something because one does not have access to the necessary supplies.

A total of 42.1% of survey respondents indicated that 'no,' they do not use nasometry. The number one reason these clinicians reported for not

using this instrument was that they did not have access to it (68.8%). Of these clinicians, 62.5% would use nasometry, if they had access to it.

A total of 76.3% of clinicians surveyed stated that 'no,' they do not use the pressure-flow method (e.g., PERCI SAR system), and of these, 69.0% reported not using it, because they do not have access to the needed equipment. Of this 69.0%, 70.0% of them would make use of pressure-flow measures, if they had access to the necessary supplies. Another 20.7% of respondents indicated that they never use the pressure-flow method because they are not familiar with it.

A total of 47.4% of respondents stated that 'no,' they do not use videofluoroscopy. Exactly one-half of these non-users stated that they do not use this instrument, because they do not have access to it. 88.9% of those who are lacking access to videofluoroscopy would use it, if they had access to such a system.

Only 23.7% of clinicians surveyed stated that 'no,' they do not use nasopharyngoscopy. All respondents (100%) of this group stated they do not use this instrument, because they do not have access to it. Members of this group who indicated whether or not they would use nasopharyngoscopy indicated that yes, they would, and this was by a large majority (66.7%). Several of the respondents did not answer the question regarding whether or not they would use it if they had access. As such, the result must be interpreted with caution.

A total of 92.1% of survey respondents stated that 'no,' they do not use MRI. Unfortunately, data were not gathered on why they are not using this technology. There may be several reasons why MRIs are not being used regularly by clinicians. First, some MRIs are two-dimensional, limiting how much detail can be seen. Second, the typical frame rate is too slow to capture connected speech movements. Therefore they capture only structure and not function. Third, MRIs require significant patient cooperation that may be difficult to achieve in pediatric or brain-injured populations. Fourth, MRIs require patients to lie supine, permitting gravity to assist velopharyngeal closure. In this position, patients' systems may look more competent than they truly are. Fifth, if patients possess prostheses with metal elements, they cannot wear them while being assessed. This seriously limits the amount of information available to the clinician about the efficacy of the prostheses. Sixth, the equipment is costly and may not be available to many practicing clinicians (Rowe & D'Antonio, 2005, Marsh 2003). Finally, the administration of an MRI requires specialized training, such that the typical clinician would not be qualified to administer one, even under the supervision of a physician.

Effects of Clinician Characteristics and Employment Circumstances on Current Practices

SLPs differ from one another in a wide variety of ways. They have been working for different periods of time, they work in different parts of the world or in different employment settings, they have different amounts of education, and so on. It was predicted that these clinician characteristics

might affect the frequency with which clinicians engage in certain clinical practices. Surprisingly, for the most, no such differences were noted. A series of multi-dimensional chi-square tests were run on the data to determine whether or not clinician characteristics had an effect on specific clinical actions taken (e.g., using nasometry, using nasopharyngoscopy, etc.). These chi-square tests provided no significant results with regard to clinician age, length of practice, percentage of caseload with a resonance disorder, proportion of adults to children on caseload, location (Canada or the United States), or the rural or urban nature of the practice. Use of nasometry, the pressure-flow method, nasopharyngoscopy, videofluoroscopy, and MRI did not differ according to these characteristics.

In this exploratory research, two promising trends emerged: (1) level of education had an impact on nasometry use, and (2) setting (hospital or non-hospital) had an impact on the use of nasopharyngoscopy. These differences were significant at $p \leq 0.05$ which might be defensible given the exploratory nature of this research. However, more conservative approaches such as a Bonferroni correction or a Holm's adjustment would require an alpha level of $p \leq 0.001$. At this alpha level, the observed differences were not significant.

Level of education did not affect use of the pressure-flow method, nasopharyngoscopy, videofluoroscopy, or MRI, but it did appear to affect clinicians' use of nasometry. It appears that clinicians with a doctoral degree use nasometry more often than would be predicted by the number of

respondents with such a degree, while clinicians with a Bachelor's or Master's degree use nasometry less often than expected, given the number of respondents with this level of education.

Work setting (hospital or non-hospital) did not affect use of nasometry, the pressure-flow method, videofluoroscopy, or MRI, but it did appear to have an effect on SLPs' use of nasopharyngoscopy. SLPs in a hospital setting seem to use nasopharyngoscopy more than would be expected, given the number of respondents working in this setting, while SLPs in a non-hospital setting use it less often than predicted by the number of respondents working in this setting.

Discussion

The results from a survey of practicing SLPs regarding their current practices in assessing, tracking the treatment of, and determining discharge criteria for clients with resonance disorders, revealed three major findings. First, all of the respondents are using some aspect of perceptual assessment and orofacial examination (both low-tech assessment strategies) at least some of the time in their current practice. Second, many respondents indicated that they are not using certain instrumental assessment devices, mostly because they do not have access to them. If they did have access to these instruments, a large portion of respondents would use them in their assessment of resonance disorders. Third, participants' responses were strikingly similar across various demographics (e.g., location, employment

setting, length of practice, etc.), indicating that many SLPs are engaging in similar clinical practices regardless of specific clinician characteristics.

Perceptual assessment and orofacial examination are low-tech assessment techniques that require little or no instrumentation. With a few basic supplies (e.g., dental mirror, tongue blades, etc.), clinicians are able to garner knowledge about types of resonance disorders and their potential causes. Because these two assessment procedures are simple and informative, it is logical that all respondents indicated they were using them, at least to some extent,.

The literature indicates that there is some disagreement about the value of a perceptual assessment when working with a client who has a resonance disorder (Kummer, 2001; Whitehill, Lee, & Chun, 2002; Dudas, Deleyiannis, Ford, Jiang, & Losee, 2006). The clinicians in this study indicated that they place a relatively high value on this assessment tool. High numbers of respondents indicated that they 'almost always' or 'always' engage in certain perceptual assessment practices (see Table 1). When looking at both the literature *and* expert opinion, it appears that best practice involves a perceptual assessment of clients' speech.

When doing a perceptual assessment, the literature combined with professional opinion indicates that five 'must-have' elements are:

1. Hold an interview with client and, if necessary, his or her caregiver.
2. Elicit spontaneous, connected speech from the client.

3. Elicit nasal and high-pressure consonant loaded syllables, sentences, and paragraphs from the client.
4. Listen specifically for compensatory articulation errors in the client's speech.
5. Endeavor to identify the source or cause of the resonance disorder.

High numbers of respondents indicated that 'no,' they do not use instrumental measures such as nasometry, the pressure-flow method, videofluoroscopy, and nasopharyngoscopy.[4] When asked why they do not make use of these assessments, not having access to them was the primary answer. Well over half of the respondents for each type of instrumentation would use that particular instrument, if they had access to it.

A return to the literature (see Recommended Best Practices, above) indicates that each of these instruments has value for assessing clients with resonance disorders. The nasometer is a useful tool when used by experienced clinicians to confirm hypernasality ratings or to provide numerical data with which to track change over time (Dalston et al., 1993). The pressure-flow method permits the concurrent assessment of all the characteristics related to velopharyngeal function (including pressure, airflow, orifice size, and speech characteristics such as resonance and voice) (Warren & DuBois, 1964). It is also the best option for assessing clients with

[4] MRI would also be considered an instrumental assessment. However, given its relatively recent introduction into use for the assessment of resonance disorders and the limited literature available on its use in such a capacity, it will not be included in this portion of the discussion.

potential airway impairments. Videofluoroscopy provides a comprehensive view of the velopharyngeal mechanism and permits examiners to assess anatomical and physiological abnormalities that cause velopharyngeal dysfunction (Kummer, 2001). Finally, nasopharyngoscopy is seen as the 'gold standard' assessment tool, because it permits direct visual inspection of the velopharyngeal mechanism during phonation and at rest and can be used to determine the degree of velar movement (Coffey et al., 1993, Lam et al., 2006).

It is clear that all of these instrumental assessment tools have something to contribute in the assessment and tracking of treatment of resonance disorders and determining discharge criteria for clients with such disorders. Yet, despite the value of their contributions, many practicing clinicians are unable to use them, because they have no access to such instruments. Both the literature and expert opinion (i.e., the respondents in this survey) suggested that these instruments – nasometry, the pressure-flow method, videofluoroscopy and nasopharyngoscopy – should be available to clinicians working in this area of specialization.

Overall, clinicians stated that they were engaging in a broader range of activities for the initial assessment of velopharyngeal impairment and the resulting resonance disorders than for tracking treatment progress and determining discharge eligibility. Also, assessment practices are more frequently used when determining discharge criteria than when tracking treatment progress. It seems probable that more tools may be required to

initially identify and evaluate resonance disorders, fewer to follow clients' progress over time, and a middling amount to determine discharge criteria.

The literature does not tend to discuss assessment tools in terms of when they should be implemented, but rather in terms of how effective each tool is at helping clinicians evaluate resonance disorders in general. Therefore, it is difficult to draw conclusions from the literature about best practices for tracking treatment progress and determining discharge criteria for clients with resonance disorders, and no precise best practices have been established yet in these two areas. Furthermore, the current findings indicated that clinicians do not necessarily engage in different techniques for assessment, tracking treatment, and determining discharge criteria, but rather in different frequencies of the same techniques. It is appropriate to suggest that best practices are the same for all three purposes, but the frequency of their use is currently determined by the clinicians' professional opinions. Additionally, it seems intuitive to recommend that 'more is better,' and that clinicians should utilize a full evaluation arsenal as frequently as is possible when tracking clients' progress and determining their readiness for discharge.

It is interesting that clinicians did not vary significantly in their use of instrumental assessments regardless of their age, how long they had been practicing, what percentage of their caseload had a resonance disorder, whether they worked primarily with adults or children, whether they lived in Canada or the United States, and whether they worked in an urban or rural

area. For the most part, they also did not differ in practices regardless of whether they worked in a hospital or non-hospital setting or whether they had differing levels of education. The relative uniformity in clinical practices reassures us that clinicians are, for the most part, 'on the same page'. Given the fit of these findings with the available literature, it appears that many clinicians are engaging in best practices, and of those who are not, many would like to be but lack access to the necessary equipment (see Best Clinical Practices above).

The results of this survey indicate that North American SLPs are engaging in, or would like to engage in, similar types of clinical practices. The major concern that holds some of these clinicians back is a simple lack of access to the necessary instruments. It is highly recommended that these instruments be made available to SLPs who are working in the area of resonance disorders, so they are optimally equipped to improve treatment outcomes for their patients/clients.

Making these instruments available to clinicians may require policy changes at the institutional level with regard to how funds are allocated, but given the value of these instruments in best practices, such changes would seem to be of utmost importance. [5]

As previously mentioned, McQueen & Dennis (2007) stated that good quality, evidence-based guidelines are developed to improve the quality of

[5] It was suspected that insurance coverage might have an impact on the assessment tools utilized by clinicians in the United States. While several respondents did suggest that they did not engage in certain practices because insurance did not cover it, these data were few and preliminary and should be more thoroughly investigated in future research of this type.

patient care, enhance patient outcomes, control healthcare costs/improve cost-effectiveness, specify and standardize processes of care to decrease practice variation, disseminate best practices information based on systematically appraised scientific evidence, assist patients in making informed choices, provide a point of reference for professional/hospital audits, and influence public policy by drawing attention to underserved populations or under-recognized health problems. The results from this study point to ways to help ensure the quality of patient care by providing practitioners with information they can use to align their own practices with current thinking regarding best practices. Therefore, the results also help to specify and standardize practices in care and may be disseminated to practitioners in an effort to ensure the community of practice is sharing the information. Also, the results serve to provide a basis for hospital audits by 'painting a picture' of what ideal practice should look like. Practices within individual medical facilities may then be compared to this standard.

Patient outcomes are enhanced, when the most effective assessment practices possible are used to provide an accurate diagnosis and determine the etiology of the disorder. These practices are described in the 'Results' section above. Healthcare costs are best controlled, when clinicians engage in the most effective practices available. Again, with the description of best practices in the 'Results' section above, clinicians are able to determine which practices are most vital to making a diagnosis as quickly and accurately as possible, thereby spending healthcare dollars wisely. When

clinicians are engaging in best practices, they are able to provide their patients with information regarding the various tests and assessments used and the reasons why these practices are valuable. As such, patients have access to the information that is necessary for them to participate in educated decisions about personal and clinical management of their resonance disorders. Therefore, the results of this study indirectly increase patients' ability to make informed decisions about their medical care.

Finally, these results should influence policy at several levels. First, clinical institutions should strive to make more sophisticated instrumentation available to their clinicians, adjusting budgetary decisions as necessary. Second, educational institutions should strive to educate future SLPs about all available forms of instrumentation, including perceptual assessment, orofacial examination, nasometry, speech aerodynamics, nasopharyngoscopy, videofluoroscopy, and MRI. If clinicians lack adequate knowledge of the comparative advantages and limitations of these methods (especially those of an instrumental nature), they are less likely to: (a) value the information each can provide, (b) know which device to use and when to use it with a particular client, and (c) defend effectively their requests for purchase of the best and most up-to-date equipment. The long-reaching negative effect would be a clinical culture in which instrumentation is devalued and less often included in educational curricula or in clinical practice. Instead, the goal should be to educate all SLPs about the value of

the instruments, such that they are able to make informed decisions about whether or not they wish to use a certain assessment tool.

Schiavetti and Metz (2006) list eight factors that might impact the internal validity of a study: history, maturation, reactive pretest, instrumentation, statistical regression, differential subject-selection, mortality, and interaction of factors. Of these factors, only mortality is of concern in this study. Sixty-four participants started the survey, but only thirty-eight completed it. The twenty-six who failed to complete the survey may have been significantly different than the clinicians who completed the survey, but there is no way of knowing if they were or not.

There are four factors listed by Schiavetti and Metz that might impact the external validity of a study: subject-selection, interactive pretest, reactive arrangements and multiple-treatment interference. Two of these are of potential concern for this study. First, subject-selection is possibly a threat to external validity, as only thirty-eight respondents completed the survey. It is impossible to know how many clinicians in North America would self-identify as clinicians who work with resonance disorders. This also means that it is impossible to know how well this sample of thirty-eight respondents represents the population (i.e., all clinicians working in this area). Second, there is a chance that there may have been a reactive arrangement, whereby the survey itself affected clinicians' responses. For example, respondents may have felt that they 'should' engage in certain practices more often than they

do, and therefore, they may have stated that they engage in those practices at higher frequencies than they actually do in their clinical setting.

There are potential limitations to this study's generalizability to the broad population of SLPs working with clients who have resonance disorders, yet the data indicate that these clinicians are widely engaging in similar practices and are mainly limited by their access to specific instrumentation. For low-tech tools like perceptual assessment and orofacial examination, all of the respondents are engaging in some of the practices at least some of the time, and it would be of great benefit to clients if clinicians were able to utilize instrumental assessments with the same uniformity and consistency.

Conclusions

Improving treatment outcomes for people with resonance disorders is a priority for the SLPs who work with this population. To be able to do this, clinicians must be able to implement assessment strategies that are consistent with 'best practices' and that are considered as such both by the literature and by expert clinicians. The results of this survey, coupled with the literature, provide clinicians with the first data-based evidence regarding what best practices for assessing resonance disorders are in the areas of perceptual assessment, orofacial examination, nasometry, speech aerodynamics, videofluoroscopy, and nasopharyngoscopy.

In order for clinicians to use these best practices, they require access to the necessary instrumentation. Lack of access was repeatedly indicated as

the reason why clinicians were not using tools such as nasometry, the pressure-flow method, videofluoroscopy and nasopharyngoscopy, and clinicians stated multiple times that they would use the instruments if they but had access to them. It seems clear that changes at the institutional level regarding funding for these instruments are a necessity.

As clinicians do not have access to higher-tech instrumentation and because perceptual assessment and orofacial examination are 'quick and dirty,' the latter are being heavily used in the assessment of resonance disorders. These low-tech tools are the foundation for any assessment, but they should be complemented by instrumental assessment, when the SLP deems it necessary. To effectively treat disorders related to velopharyngeal insufficiency (such as hypernasality), clinicians need accurate information regarding the function of the velopharyngeal mechanism and the size of the velopharyngeal gap, if it exists. Given that velopharyngeal impairment can be caused by a range of anatomical and physiological concerns, multiple types of assessment may be necessary to identify the cause of a resonance disorder (Kummer, 2001). Nasometry, speech aerodynamics, videofluoroscopy and nasopharyngoscopy are instrumental techniques that enable clinicians to acquire this information and are sometimes recommended for concurrent use (Seagle et al., 2002; Pigott, 2002; Kummer, 2001; Warren & DuBois, 1964; Dalston, Warren & Dalston, 1991a).

Despite coming from different locations, settings, and backgrounds, clinicians are working in remarkably similar ways to assess resonance

disorders. It is encouraging to note that many clinicians appear to be working in sync with the literature's recommended practices, indicating that many clients are being provided with best practices. With further access to high-tech instrumentation, these clients would be served in the best manner possible.

It is recommended that this research be continued in the future. Collecting more responses to the same survey would help ensure representativeness of the sample and permit more confident generalizations from the data, as well as permitting factor analyses to be completed to look for trends in assessment, tracking treatment gains and patient discharge. Also, future research in the area of MRI and its viability in the assessment of resonance disorders would be beneficial. Establishing best practices for tracking clients' change and progress, as well as determining their readiness for discharge is an additional area for future research. This particular area of research would be well served if addressed by both qualitative and quantitative research methods. Finally, research into the question of why clinicians use nasal anaesthesia, when the literature suggests it is not useful, is also recommended.

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Appendix A

Ethics Approval

May 30, 2008

Dr. Paul Hagler
Speech-Language Pathology & Audiology File# B-300408
348R Corbett Hall

Re: A Survey of Current Clinical Practices for Evaluation of Resonance Disorders in North America

Dear Dr. Hagler:

Thank you for your correspondence received May 27th, 2008, which addressed the requested revisions to the above-mentioned study. These changes have been reviewed and approved on behalf of the Research Ethics Board. Your approval letter is attached.

Next year, a few weeks prior to the expiration of your approval, a Progress Report will be sent to you for completion. If there have been no major changes in the protocol, your approval will be renewed for another year. All protocols may be subject to re-evaluation after three years.

For studies where investigators must obtain informed consent, signed copies of the consent form must be retained, and be available on request. They should be kept for the duration of the project and for a full calendar year following its completion.

Approval by the Health Research Ethics Board does not encompass authorization to access the patients, staff or resources of Capital Health or other local health care institutions for the purposes of research. Enquiries regarding Capital Health administrative approval, and operational approval for areas impacted by research, should be directed to the Capital Health Regional Research Administration office, #1800 College Plaza, phone 407-6041.

Sincerely,

Charmaine N. Kabatoff
Senior Administrator
Health Research Ethics Board (Panel B)

Appendix B

Focus Group Information Letter

A Survey of Current Clinical Practices for Evaluation of Resonance Disorders in North America.

Principal Investigator(s): Paul Hagler, PhD.; Thesis Supervisor
Sub-Investigator: Elizabeth Huebert, BA; Thesis Student

Background: A better understanding of clinical practices for the evaluation of resonance disorders would inform management and funding decisions within clinics and influence policy decisions at the institutional level. This improved understanding may also influence policy at the national level by informing decisions about which clinical procedures health insurance will cover, and providing information for educational standards in speech-language pathology. North American speech-language pathologists (SLPs) will be surveyed to determine their current practices in assessing and tracking treatment of resonance disorders and determining discharge criteria for clients with such disorders. They also will describe what they personally think best practices are, the directions in which they see the field heading in the future, and what tools and instruments they feel are vital in an ideal clinical setting.

Purpose: Input from practicing SLPs is required in order to develop the survey. You will be asked to describe the topics you feel are important to include in the document, and to provide input regarding how questions might be worded.

Procedures: Participating in this study will involve:
a) attending one focus group, or receiving one telephone call (both approximately 60-90 minutes in length);
b) discussing clinical practices in the area of resonance disorders.

Possible Benefits: The possible benefits to you for participating in this study are that you may learn about other clinicians' clinical practices in the area of resonance disorders. Also, once the surveys' results have been analyzed, you may learn more about large-scale trends in clinical practice.

Possible Risks: It is unlikely that participating in this focus group presents any risks.

Confidentiality: Personal records relating to this study will be kept confidential. Any research data collected about you during this study will not

identify you by name, only by your initials and a coded number. Your name will not be disclosed outside the research clinic. Any report published as a result of this study will not identify you by name. While we will do all we can to ensure the confidentiality of what you have said, we cannot guarantee that others from the group will do the same.

Voluntary Participation: You are free to withdraw from the research study at any time.

Reimbursement of Expenses: You will be reimbursed $5 for your visit, to cover parking.

Contact Names and Telephone Numbers: The plan for this study has been reviewed for its adherence to ethical guidelines and approved by the Health Research Ethics Board (HREB) at the University of Alberta. If you have concerns regarding participant rights and ethical conduct of this research, contact the Chair of the HREB c/o *Charmaine Kabatoff at 780.492.0302.*

Please contact either of the individuals identified below if you have any questions or concerns:

Elizabeth Huebert, BA	780.492.7256
Paul Hagler, PhD	780.492.9674

Appendix C

Focus Group Consent Form Participants

Title of Project: A Survey of Current Clinical Practices for Evaluation of Resonance Disorders in North America.

Principal Investigator(s):	Phone Number(s):
Elizabeth Huebert	780.492.7256
Co-Investigator(s):	**Phone Number(s):**
Carol Boliek, PhD	780.492.0841
Paul Hagler, PhD	780.492.9674

	Yes	No
Do you understand that you have been asked to be in a research study?	☐	☐
Have you read and received a copy of the attached Information Sheet?	☐	☐
Do you understand the benefits and risks involved in taking part in this research study?	☐	☐
Have you had an opportunity to ask questions and discuss this study?	☐	☐
Do you understand that you are free to withdraw from the study at any time, without having to give a reason?	☐	☐
Has the issue of confidentiality been explained to you?	☐	☐
Do you understand who will have access to the information you provide?	☐	☐

Who explained this study to you? _____

I agree to take part in this study: YES ☐ NO ☐

Signature of Research Subject: _____

(Printed Name): _____

Date: _____

Signature of Witness: _____

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator or Designee: _____ Date: _____

THE INFORMATION SHEET MUST BE ATTACHED TO THIS CONSENT FORM AND A COPY GIVEN TO THE RESEARCH SUBJECT

Appendix D

Guiding Questions for Focus Groups

1) What are the steps in assessing a resonance disorder? Tracking its treatment? Determining discharge criteria for clients?

2) What equipment do you need to assess a resonance disorder? To track its treatment? To determine discharge criteria for clients?

3) What would you like to know about the practices of other SLPs who have clients with resonance disorders on their caseloads?

Appendix E

Listserv/Website Posting

Participants are needed for a research project about resonance disorders. If you are a practicing SLP who has been working professionally for one year or longer with experience diagnosing, treating and determining discharge criteria for clients with resonance disorders, you are among a small subset of clinical professionals whose expertise is urgently needed to help develop best practice recommendations for working with resonance disorders. Please consider participating in this study. Additional information and the electronic survey are available at: https://www.surveymonkey.com/s.aspx?sm=h9s5J8dpe2oQOOeN7DUwYA_3d_3d . The deadline for participating is 21 April 2009.

Appendix F

Listserv/Website Reminder

Just a reminder - participants are needed for a research project about resonance disorders. If you are a practicing SLP who has been working professionally for one year or longer with experience diagnosing, treating and determining discharge criteria for clients with resonance disorders, you are among a small subset of clinical professionals whose expertise is urgently needed to help develop best practice recommendations for working with resonance disorders. Please consider participating in this study. Additional information and the electronic survey are available at: https://www.surveymonkey.com/s.aspx?sm=h9s5J8dpe2oQOOeN7DUwYA_3d_3d . The deadline for participating is 21 April 2009.

Appendix G

Survey Respondent Information Letter

A Survey of Current Clinical Practices for the Evaluation of Resonance

Information Letter

Principal Investigator: Elizabeth Huebert, BA, Graduate Student

Supervisor: Paul Hagler, PhD.

Background: Better understanding clinical practices for the evaluation of resonance disorders may inform: (a) management and funding decisions within clinics, (b) policy decisions at the institutional and national levels, and educational standards in speech-language pathology.

Purpose: This survey will allow you to describe your current practices in evaluation of resonance disorders as well as tools and instruments you believe should be available in an ideal clinical setting.

Procedures: Your participation in this study will involve completing the online survey. The average SLP will take 20-25 minutes to complete this survey. The SLP with access to many types of instrumentation (e.g., videofluoroscopy, nasopharyngoscopy, etc) may take 35-40 minutes.

Possible Benefits: After results have been analyzed, you may learn more about large-scale trends in clinical practice in the area of resonance disorders.

Possible Risks: It is unlikely that completing this survey presents any risks.

Confidentiality: You will not be required to provide any identifying information such as your name, date of birth, etc. Survey Monkey (the survey host) will encrypt the data to help protect your privacy. Only the study investigators will have access to the survey data, and all data will be kept in a password-protected file or locked cabinet.

American participants, please note that Survey Monkey cannot offer complete anonymity, particularly as it pertains to the Patriot Act of the United States.

Voluntary Participation: You may decline to participate, or you may withdraw from participating at any time prior to submitting your completed survey.

Contact Names and Telephone Numbers: This project has been reviewed for its adherence to ethical guidelines and approved by the Health Research Ethics Board (HREB) at the University of Alberta. If you have concerns regarding participant rights and ethical conduct of this research, contact the Chair of the HREB c/o Charmaine Kabatoff at 780.492.0302.

If you have general questions or concerns about your own participation, please contact either of the individuals identified below:

Elizabeth Huebert, BA: 780.492.7256

Paul Hagler, PhD: 780.492.9674

Submission of this completed survey will be taken as your informed consent to participate.

Appendix H

Survey Respondent Consent Letter

A Survey of Current Clinical Practices for the Evaluation of Resonance

Consent Letter

I have read the Information Letter and I hereby consent to:

- Participate in this survey.

I understand that:

- I may stop completing the survey at any time.
- My participation is entirely voluntary.

- I may choose not to answer any particular question.

- Once my survey is submitted, the data become anonymous. No one will be able to connect my data with any identifying information, and I will be unable to withdraw my data past this point.

- All information gathered will be treated confidentially and will only be accessed by the researchers.

- I will not be identified in any documents resulting from this research.

- I may receive a copy of the research report if I wish. (Please contact Elizabeth Huebert with the information provided on the Information Letter.)

I also understand that the results of this research may be used for:

- Presentations and publications.
- Teaching purposes that use anonymous data.

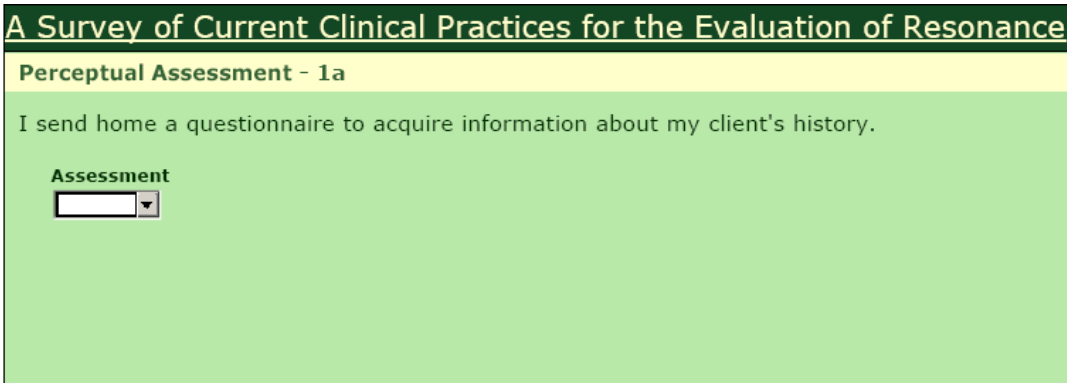
Submission of this completed survey will be taken as your informed consent to participate.

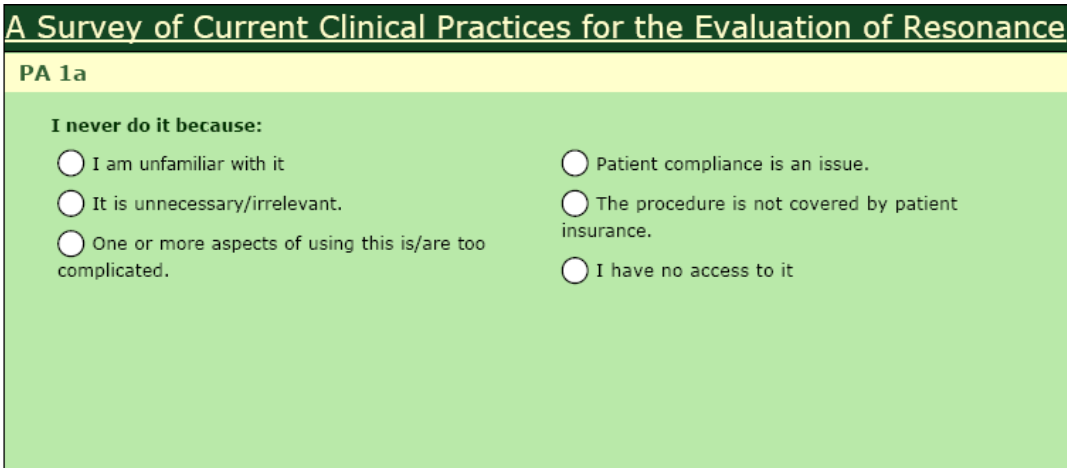
If you have any questions, please contact Elizabeth Huebert (Phone: 780.492.7256, Email: ehuebert@ualberta.ca) at 2-70 Corbett Hall, Faculty of Rehabilitation Medicine, The University of Alberta, Edmonton, AB, T6G 2G4.)

The plan for this study has been reviewed for its adherence to ethical guidelines and approved by the Health Research Ethics Board (HREB) at the University of Alberta. If you have concerns regarding participant rights and ethical conduct of this research, contact the Chair of the HREB c/o Charmaine Kabatoff at 780.492.0302.

Appendix I

Survey Sample Questions





Appendix J

Budget

Research Staff	
Research assistants	n/a
Technicians	n/a
Other personnel	n/a
Meetings	
Facility rental ($50 x 4 occasions) – In kind contribution by the Faculty of Rehabilitation Medicine - $200	nil
Travel	n/a
Healthful snacks and beverages for 1-2 focus groups ($60 - $110/group, depending on size of group)	$150
Stationary for 1-2 focus groups ($30 - $40/group, depending on size of group)	$75
Long distance charges for teleconferencing – In kind contribution by the Faculty of Rehabilitation Medicine - $50	nil
Other (please provide details)	
Website Creation and Maintenance	$600
Printing (5 - 7 bound copies of final report and questionnaire)	$50
Parking for participants ($5/participant)	$50
Miscellaneous	$150
Total	$1,075