TELEHEALTH APPLICATIONS FOR ASSESSMENT AND TREATMENT

PROCEDURES IN SPEECH-LANGUAGE PATHOLOGY:

A MODIFIED NARRATIVE REVIEW

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TELEHEALTH APPLICATIONS FOR ASSESSMENT AND TREATMENT PROCEDURES IN SPEECH-LANGUAGE PATHOLOGY: A MODIFIED NARRATIVE REVIEW

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THESIS ABSTRACT

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A MODIFIED NARRATIVE REVIEW

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The use of telehealth in the field of speech language pathology has steadily increased in recent years and a number of researchers have published articles detailing research findings of the practice. This document is a modified narrative review outlining the current use of telehealth in the field of speech-language pathology. Sixty-two full-text documents were located for inclusion into the study. Methods outlining the document retrieval and document review process are included. Information from the reviewed articles was synthesized and summary information regarding the overall state of the literature is presented. Recommendations for further telehealth practice research are included.

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CHAPTER I

INTRODUCTION

The use of the telephone in the area of medicine began shortly after its invention in 1876 when Alexander Graham Bell placed a call for medical help after he had spilled sulphuric acid on his skin (Car & Sheikh, 2003). Since that time, the telephone has played an important role in many aspects of healthcare. "The use of electronic information and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health, and health administration" has been termed "telehealth" (Health Resources and Services Administration, n.d.). Patients who have utilized the telephone for access to healthcare have reported being very satisfied with the use of the telephone for healthcare communication. Some benefits to patients have included reduced travel costs, less time spent waiting for appointments in doctors' offices, and increased contact with medical professionals. People living in rural areas and those with compromised medical conditions have been especially supportive of healthcare via the telephone (Car & Sheikh, 2003).

Healthcare providers have reported being pleased with the convenience of using telephones and the ability to be in contact with patients more frequently but were particularly concerned about the absence of visual cues and not being able to use touch as a communication aid (Car & Sheikh, 2003). Advances in the area of technology have addressed some clinician concerns. For example, the use of videophones and other high-

tech visual electronic devices have alleviated the concern regarding the absence of visual cues.

Until recent years, speech-language pathologists working in the area of communication disorders have used face-to-face contact as the primary means for carrying out assessment procedures and treatment activities (Hill & Theodoros, 2002). Given the major advances in technology that have been made in recent years, efforts have been made by researchers to incorporate the use of technology such as telephones and videophones into the field of speech-language pathology for a variety of assessment and treatment applications (Brennan, Georgeadis, & Baron, 2002). Telehealth in the area of speech-language pathology has great potential given the advantages of working with a patient in his/her natural environment and will continue to be of increasing importance as the demand for services increases with the aging baby boomer population and the shortage of clinical professionals continues (Mashima, Birkmire-Peters, Holtel, and Syms, 1999).

With the availability of research into the applications of telehealth technology for assessment and treatment of disorders in speech-language pathology increasing, a systematic review of the literature to determine the most effective technology for assessing and treating communication disorders in elderly populations would be useful. However, in spite of the number of telehealth studies available in speech-language pathology, there was a lack of studies pertaining to a specific population and clinical disorder, such as would be needed to conduct a thorough systematic review. The studies that were available were generally those of lower quality of research evidence. Given these issues, this document will present a modified narrative review of the available

literature to assess current telehealth applications being used for assessment methods and treatment procedures within the field of speech-language pathology. Results from this review will provide clinicians with clinical implications for telehealth practices in speech-language pathology and highlight areas related to telehealth practices that are in need of further research.

CHAPTER II

LITERATURE REVIEW

Healthcare costs continue to rise with every passing year and individuals living in rural areas across the country face a shortage of healthcare providers (Whitten & Sypher, 2006). Telehealth has emerged as a possible solution for these problems. Telehealth or telemedicine is the use of information and communication technology to deliver healthcare, provide patient health-related education, and to provide public health and health administration information. Some examples of telehealth technologies currently being used include videoconferencing, the Internet, streaming media, store-and-forward imaging, and wireless communications (Health Resources and Services Administration, n.d.). Videoconferencing is the simultaneous use of two-way video and audio transmissions to allow two or more locations to interact. The Internet is a network of interconnected computer networks that allow for services such as electronic mail, online chat, and interlinked web pages (PC Magazine Encyclopedia, n.d.). Streaming media is video or audio information that is transmitted over a network that users can activate immediately instead of waiting for the entire file/document to download (University of California, Santa Cruz, n.d.). Store-and-forward imaging is the temporary storage of data until its transmission to a destination at a later time. Wireless communication is the transfer of data over a distance via airwaves using a variety of techniques such as infrared, satellite, or microwave technologies. Examples of wireless technology include

cellular phones, personal data assistants, and satellite televisions (PC Magazine Encyclopedia, n.d.). The application of telehealth to provide healthcare services is a growing trend in a variety of healthcare related fields. Technology allows patients to receive a variety of services from the comfort of their home and eases the burden on healthcare professionals, particularly in-home providers, as they can provide services to a larger number of patients in a shorter amount of time.

The need for speech-language pathologists in the United States continues to grow with every passing year. Technology advances in the area of medicine are allowing people to live longer in spite of serious injury or old age. In particular, the survival rate for premature infants and trauma victims continues to increase. Many of these people present with a variety of communication disorders ranging from language loss to motor speech disorders to swallowing difficulties. As the population of people with communication disorders continues to increase, the demand for speech-language pathologists will continue to increase (Mashima et al., 1999).

In recent years researchers have begun investigating the possibility of using telehealth to provide speech-language pathology services to reach a larger number of patients at reduced costs to the patient, their family, or insurance companies (Mashima, Birkmire-Peters, Holtel, & Syms, 1999). The American Speech-Language and Hearing Association (ASHA) released a position statement in 2005 stating that "telepractice is an appropriate model of service delivery for the profession of speech-language pathology." ASHA has defined telepractice as "the application of telecommunications technology to deliver professional services at a distance by linking clinician to client or clinician to

clinician for assessment, intervention, and/or consultation." (ASHA Position Statement, 2005).

While telehealth practices are relatively new in the field of speech-language pathology, long-distance services have been provided in the areas of medicine and other healthcare related fields for a number of years. Whitten and colleagues were the first providers to use telehealth for medical purposes when they performed telepsychiatry consultations via microwave technology between the Nebraska Psychiatric Institute and the state mental hospital in 1959 (Whitten & Sypher, 2006). Since that time, technology has greatly improved and the number of health systems using some type of telecommunication technology to deliver healthcare services can no longer be quantified (Whitten & Sypher, 2006). A few studies from a broad search of the available literature regarding telehealth applications are discussed below.

General Telehealth Use

Several assisted living facilities have been found to be successfully utilizing technologies such as telemedicine, videophones, and computerized care tracking in day-to-day activities (Vickery, 1998), and videophones have been found to be effective in providing home healthcare services to elderly populations (Nakamura, Takano, & Akao, 1999). In a study from 2003 by Lines, McCarroll, Lipton, and Block, telephone screenings were conducted as part of a process to identify patients with amnestic mild cognitive impairment for participation in an experimental study. The paper reported on the utility of telephone screenings for identifying subjects for the study. The final data showed that only 2% of the subjects who initially called the telephone agency met operational criteria for amnestic mild cognitive impairment. However, when looking at

the results from another perspective, approximately 50% of telephone-screened subjects who were later seen in the clinical setting as part of the final stage of the process met the operational criteria for amnestic mild cognitive impairment. Overall, the procedures used in the study were not as effective as desired, as indicated by the small percentage of participants who met operational criteria for the study. The authors reported that further studies examining the effectiveness of telephone screening should be conducted (Lines, McCarroll, Lipton, & Block, 2003). Telehealth has been successfully used to improve physical and cognitive functional outcomes in a patient with TBI (Forducey, Ruwe, Dawson, Scheideman-Miller, McDonald, & Hantla, 2003). Videophones have also proven effective for improving peer support relationships among elderly people through the use of a videophone network (Ezumi, Ochiai, Oda, Saito, Ago, Fukuma, & Takenami, 2003). Videophones and telephones have also been effectively utilized for providing family or caregiver support. One particular study found that conversations via videophone made family members of nursing home patients feel more involved in the caring process and in some cases the patients were more focused and were better participants in the video conversation with their family than they were in face-to-face conversation (Sävenstedt, Brudin, & Sandman, 2003). Additionally, telephones have been used to provide support to caregivers via organized telephone support groups (Smith, Toseland, Rizzo, & Zinoman, 2004). Results of a behavioral telehealth program found that mental health services could be effectively administered to underserved rural populations via telehealth technology (Bischoff, Hollist, Smith, & Flack, 2004). Telephone screenings to determine eligibility for home-based and community-based services matched in-person assessments overall and were found to reduce costs of

providing in-person assessments by 11% (Fries, James, Hammer, Shugarman, & Morris, 2004). Videophone technology has been examined in terms of its use as a training tool for students working with elderly adults. Students were found to respond positively to this method of training (Wood, O'Quin, & Eftink, 2004). In other studies relating to cognitive assessment and treatment, telemedicine has been found to be an acceptable and reliable method for conducting neuropsychological evaluations for elderly people (Munro Cullum, Weiner, Gehrmann, & Hynan, 2006) and for providing cognitive assessment and intervention to elderly people with mild cognitive problems (Poon, Hui, Dai, Kwok, & Woo, 2005). A study by Shepherd and colleagues found that psychological treatment for people with cancer delivered by videoconferencing decreased anxiety and improved quality of life among participants (Shepherd, Goldstein, Whitford, Themes, Brummell, & Hicks, 2006). In a proof – of – concept study from 2006, researchers concluded that telerehabilitation was a viable method for conducting rehabilitation services after being discharged from an acute-care or rehabilitation setting (Tousignant, Boissy, Corriveau, & Moffet, 2006). A study by Smith and colleagues found that televideo monitoring improved medication compliance among persons with mild dementia living at home (Smith, Lunde, Hathaway, & Vickers, 2007).

Speech-Language Pathology Telehealth Use

As stated earlier, a variety of studies investigating the use of telehealth practices in speech-language pathology have been completed. Telehealth research has been investigated within the areas of stuttering (Kully, 2000), neurogenics (Brennan, Georgeadis, Baron, & Barker, 2004; Clarke, Dawson, Scheideman-Miller, & Post, 2002; Hill et al., 2006; Wertz et al., 1992), voice (Mashima et al., 1999; Mashima et al., 2003),

dysphagia (Georges, Potter, & Belz, 2006), and child speech and language disorders (Forducey, 2006). Some studies have addressed assessment techniques (Brennan, Georgeadis, Baron, & Barker, 2004; Duffy, Werven, & Aronson, 1997; Georges, Potter, & Belz, 2006; Guilfoyle et al., 2003; Hill et al., 2006; Wertz et al., 1992) and others have addressed treatment techniques (Clark, Dawson, Scheideman-Miller, & Post, 2002; Forducey, 2006; Kully, 2000; Mashima et al., 1999; Mashima et al., 2003; Vaughn, 1976). Despite the availability of published research regarding telehealth applications in speech-language pathology, there seems to be a lack of cohesion within the research in terms of assessment methods, treatment targets, and telehealth technology used. Some studies investigating assessment methods have used standardized tests to evaluate patients (Brennan, Georgeadis, Baron, & Barker, 2004; Hill et al., 2006; Wertz et al., 1992), some have relied on non-standardized assessment tasks for evaluation (Duffy, Werven, & Aronson, 1997), and others do not specify the assessment tasks used (Guilfoyle et al., 2003). Studies investigating telehealth applications for the treatment of disorders in speech-language pathology have included activities ranging from voice rehabilitation techniques in patients with organic and functional voice disorders (Mashima et al., 1999; Mashima et al., 2003) and speech and language therapy for school children (Forducey, 2006), to aphasia therapy techniques such as auditory comprehension therapy and the teaching of augmentative communication strategies (Clark, Dawson, Scheideman-Miller, & Post, 2002). The type of technology used in these studies, whether assessment or treatment, varied greatly utilizing telephones with handsets, light-weight headphones with lip microphones, and room amplifiers (Vaughn, 1976), real-time videoconferencing and store-and-forward video data (Hill et al., 2006), real-time

computer-based teleconferencing/videoconferencing (Brennan, Georgeadis, Baron, & Barker, 2004; Forducey, 2006; Guilfoyle et al., 2003) hard-wired camera and monitor set-up (Mashima et al., 2003), satellite observations (Duffy, Werven, & Aronson, 1997), telephone with video linkage via television and videophone (Clark, Dawson, Scheideman-Miller, & Post, 2002), and closed circuit television and computer-controlled video laserdisc over a telephone (Wertz et al., 1992). The above studies, in addition to others, will be addressed in an upcoming chapter in greater detail as part of this modified narrative review.

A literature review regarding the use of telehealth applications in the field of speech-language pathology was published in 2002. The review yielded thirteen studies. Three studies found that telehealth was a feasible option for providing services and the remaining studies yielded positive outcomes from telehealth applications. While pleased with these positive results, the authors of the study indicated the need for further research with a more scientific approach (Hill & Theodoros, 2002). While a significant amount of research has been introduced since the 2002 review, there have been no published studies investigating the most appropriate uses of telehealth practices or the most effective technology with which to carry out telehealth assessment and treatment methods in the field of speech-language pathology.

Evidence-Based Practice

The concept of evidence-based practice (EBP) is relatively new to the area of communication disorders. ASHA issued a position statement in 2005 that said that speech-language pathologists (SLPs) should use EBP when making clinical decisions to ensure that the highest quality clinical care is provided to patients (ASHA, 2005).

"Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research." (Sackett, Rosenburg, Gray, Haynes, & Richardson, 2000). EBP is currently used in a variety of health-care areas to maintain "currency of knowledge and state-of-the-art treatment recommendations" (Cox, 2005). The four primary steps involved in evidence-based practice include: "1) framing the clinical question; 2) finding the evidence; 3) assessing the evidence; and 4) making the clinical decision." (ASHA, n.d.) While many SLPs like the idea of evidence based practice, many still are reluctant to look to published research when making clinical decisions, instead relying on clinical experience or advice from other professionals in the field (Baylor & Yorkston, n.d.). Most SLPs report that they do not have the time that is required to locate studies that are relevant to clinical cases (Zipoli & Kennedy, 2005). When working in a clinical practice, it would be helpful for a professional with a clinical assessment or treatment question to have access to a single document that would provide a review of relevant material and provide an answer to his/her question.

Systematic Review

A systematic review is a review in which authors have "searched, analyzed, and synthesized the literature on a topic using specified, predetermined methods to answer a question" (Hargrove, Lund, & Griffer, 2005). When incorporating evidence-based practice into clinical work, systematic reviews are excellent sources of evidence for making clinical decisions as they allow clinicians to read and analyze only one article

when deciding on a course of action for assessment or treatment. The steps involved in the systematic review process are as follows (Kitchenham, 2004):

A) Define the clinical question.

B) Search for applicable literature.

C) Apply inclusion/exclusion criteria to potential sources

D) Complete quality assessment checklists for each study to be included in the review.

E) Complete data extraction.

F) Synthesize extracted data.

G) Interpret results and make recommendations for clinical practice or future research.

Defining a focused clinical question is the first and most important aspect of a systematic review. The question should be relevant to clinicians and researchers in an area of study. A well-designed question involves four primary components. These are: population, intervention, comparison, and outcome. Population should address the characteristics of the population that will be affected by the selected intervention. Intervention should relate to what topic/issue is being addressed in the review (ex: treatment procedure, diagnostic test, etc.). The comparison portion of the question should compare two areas such as two treatment procedures, a treatment procedure as compared to no treatment, or two assessment protocols. Outcomes should indicate what clinical outcome is being investigated within the systematic review. Again, the outcome should be of interest to clinicians and researchers alike (ASHA, 2006).

When beginning the systematic review process, care should be taken to identify all relevant sources of information available for inclusion in the review. It is often helpful

to consult with a librarian to obtain search strategy information on conducting searches of the literature. In order to produce a quality systematic review, it is important that the researcher conduct a thorough review of all available literature. This includes published information from previous reviews related to the clinical question, electronic databases covering the discipline of primary research as well as disciplines that may contain overlapping information regarding the clinical question, and reference lists from related studies. The literature search should also involve consultation with professionals within the area of research interest and gray literature such as conference reports and dissertation abstracts. The search should include up-to-date information and be thorough in an attempt to reduce the possibility of publication bias (Pai, n.d.). The investigator should conduct trial searches on selected databases using randomly selected combinations of key words based on the selected clinical question. Professional contacts within the area of research interest should also be made to gain additional insight into the area related to the research prior to formally beginning selection of literature material (Kitchenham, 2004).

After the literature search has been completed, abstracts of all potentially relevant literature should be obtained. These documents should be assessed for possible inclusion in the review. This process is somewhat subjective so in order to eliminate bias, it is important for two investigators to be independently involved in the process. A third reviewer should be available throughout the process to resolve disputes among the primary researchers. The document sifting process should begin with an initial sift through the titles and/or abstracts to exclude clearly irrelevant documents. The second sift should be completed by having the investigators review full-texts of remaining documents for final inclusion into the study and data extraction. When completing the

second sift, the investigators should apply selected inclusion and exclusion criteria as selected by the primary author(s) of the review (Scottish Intercollegiate Guidelines Network, 2004). The inclusion/exclusion criteria should be based on the focused clinical question and the initial trial searches conducted during the initial literature review search. A trial inclusion/exclusion review should be conducted to be sure that an independent reviewer can interpret the criteria and that studies can be easily classified based on the selected criteria (Kitchenham, 2004).

Once the final documents have been selected for review, two investigators should independently conduct quality assessment reviews on each study. A third reviewer should be available to resolve disputes between the primary investigators. There is not a specified method for assessing study quality and each study quality assessment varies based on the study research design. The Scottish Intercollegiate Guideline Network (SIGN) has an established study quality assessment method that is commonly used in the systematic review process (ASHA, 2006). Based on this system, the investigators should assign each qualifying study a rating based on the SIGN coding system. The system is documented in the table below (SIGN, 2004).

Table 1: Coding System Used in Rating Studies for Quality Assessment – Adapted from the Scottish Intercollegiate Guideline Network.

++	All or most of the criteria have been fulfilled. Where they have not been fulfilled the conclusions of the study or review are thought very unlikely to alter.
+	Some of the criteria have been fulfilled. Those criteria that have not been fulfilled or not adequately described are thought unlikely to alter the conclusions.
-	Few or no criteria. The conclusions of the study are thought likely or very likely to alter.

The quality assessment is performed to address the methodology of each study in terms of how well it minimizes bias and maximizes validity (Kitchenham, 2004). As part of the quality assessment, investigators assign each study a numerical rating based on the study type. The SIGN system provides numerical ratings that are used to determine experimental study designs that are effective in minimizing bias. Randomized controlled trials are assigned the highest rating because of their high level of experimental control. Studies relying on expert opinion receive the lowest rating (SIGN, 2004). All experimental research designs are relevant to EBP and systematic reviews of the literature may be conducted using any type of study. When published research is of poorer quality, the 'best available evidence' approach should be taken and the investigator should "include all studies but use study quality as a 'moderator' in interpreting the review findings" (Booth, 2006).

Table 2: Hierarchy of Study Types for Level of Research Evidence Ratings - Adapted from the Scottish Intercollegiate Guideline Network.

1	Meta analyses; Systematic reviews of RCTs; RCTs
2	Systematic reviews of case-control or cohort studies; Case-control or cohort studies
3	Non-analytic studies, e.g. case reports, case series
4	Expert opinion; Conference report; Clinical experience

Note. RCT = Randomized Control Trial.

After the quality assessment procedures have been completed, the data from each primary study should be extracted. Data extraction involves identification of numerical values and/or additional key information from each study. The primary investigator should develop and pilot a data extraction form to be used in collecting information from each study to assist reviewers in the data extraction process. As in other portions of the

systematic review, the data extraction process should be completed by two investigators with a third reviewer available in the event of disputes (Kitchenham, 2004).

After all relevant information has been extracted from each document, a descriptive synthesis should be developed using the information obtained. The extracted information should be formatted to reflect the clinical question. Major similarities and differences, including aspects of study quality, intervention, population, context, sample sizes, etc., should be formatted into tables so that comparisons can be easily made (Kitchenham, 2004).

The final step in the systematic review process involves interpreting the results and making recommendations to clinicians and to researchers. The author of the review should take great care in interpreting the results of the review and write an unbiased assessment of the research findings (Pai, n.d.). When writing this section, the author should include a discussion on the strength of evidence, applicability of research findings, trade-offs (benefits vs. costs, etc.), and implications for patient care and/or further research (Higgins & Green, 2006).

The original purpose of the present study was to conduct a formal systematic review to investigate the most effective type of telehealth technology being used to assess and treat communication disorders in the elderly population. While conducting the literature review and trial searches for a formal systematic review, it was discovered that research into telehealth applications in the field of communication disorders is highly variable and generally not at a high level of evidence. The varied state of the literature did not lend itself to the investigation of a focused clinical question. Given the current state of the available literature, the author elected to present a modified narrative review

of the literature relating to the current telehealth applications being used for assessment and treatment procedures within the field of speech-language pathology. Table 3 presents a comparison of the characteristics of narrative and systematic reviews.

Table 3: Salient Characteristics of Narrative Reviews and Systematic Reviews – Adapted from Hargrove, Lund, and Griffer (2005).

Characteristic	Narrative Review	Modified Narrative Review	Systematic Review
Contains a focused, clinical question	?	NO	YES
Involves a priori inclusion and exclusion criteria in search	NO	YES	YES
Provides a comprehensive literature review	?	YES	YES
Provides a methods section	NO	YES	YES
Uses explicit, a priori standards in analysis	NO	YES	YES
Provides qualitative synthesis of study results	YES	YES	YES
Provides quantitative synthesis of results	NO	NO	NO

As stated earlier, this study is a modified narrative review. It includes inclusion and exclusion criteria, a literature review, and a methods section. However, it does not address a focused, clinical question because of the varied state of speech-language pathology literature involving telehealth practice.

The information included within this review was guided by the literature itself. As previously stated, while a number of studies relating to telehealth in the field of speech-language pathology were available, they varied greatly in terms of diagnostic or treatment issues addressed, technology used, subject selection, treatment course, outcomes measurements, etc. Regardless of the differences, all pertinent telehealth studies in the field of speech-language pathology for were included for review

CHAPTER III

JUSTIFICATION FOR RESEARCH

As stated in earlier portions of this review, research into telehealth applications in speech-language pathology has continued to increase as the availability of new and better technology has increased. This increase in telehealth practice is supported by ASHA as indicated by their position statement from 2005 that says, "...telepractice (telehealth) is an appropriate model of service delivery for the profession of speech-language pathology." The statement goes on to say that the quality of services being delivered through telepractice must "...be consistent with the quality of services delivered face-to-face." (www.asha.org/policy, 2005). Even prior to ASHA's support of telehealth practice, clinicians and researchers began investigating the use of telehealth in the field of speech-language pathology and as previously stated, a number of studies have been published regarding the use of telehealth for assessment and treatment of communication disorders. Despite ASHA's support of evidence-based practice for speech-language pathology services, the association endorsed telehealth practice which is largely supported by lower levels of research evidence. Many clinical questions regarding topics such as the diagnostic accuracy for specific disorders using telehealth, the effectiveness of therapy techniques for specific communication disorders, and the most effective types of technology for assessment and treatment procedures via telehealth have yet to be answered.

When numerous studies are presented on a practice issue such as telehealth, it is difficult to compare its use and effectiveness when reviewing each study independently. Systematic reviews of the literature are among the best methods available to answer clinical questions regarding the use of assessment or treatment practices such as telehealth applications. Such documents are also highly beneficial for clinicians because they present answers to clinical questions in one reliable document (Baylor & Yorkston, n.d.). Unfortunately, there was a lack of speech-language pathology telehealth studies that focused on specific populations or addressed related assessment and/or treatment methods. The current research available regarding telehealth practices in speech-language pathology did not lend itself to a systematic review of the literature to answer a focused, clinical question.

Given the varying state of the current literature regarding telehealth, the purpose of this study is to present a modified narrative review to investigate telehealth applications for assessment and treatment procedures in speech-language pathology.

CHAPTER IV

METHODOLOGY

The author of this review met with Nancy Noe, instruction coordinator and subject specialist for communication disorders, at the Auburn University Ralph Brown Draughon Library to discuss this project and to gain insight on the appropriate databases to search in order to obtain all necessary information for this review. Literature from the field of speech-language pathology is often published in journals from related fields such as medicine, psychology, education, nursing, and social work (N. Noe, personal communication, January 30, 2007). In order to have a complete view of the current available literature, databases from all of the above areas were used for this study, in addition to on-line ASHA publications.

MEDLINE is the United States National Library of Medicine's database. The database contains over fifteen million references to journal articles. The journal articles relate to life sciences with a primary concentration in biomedicine. The database generally consists of material from 1950 to the present. MEDLINE consists of citations from roughly 5000 journals in a variety of languages (National Library of Medicine, 2006).

The Cumulative Index to Nursing and Allied-Health Literature (CINAHL) database is the primary tool for accessing information in the areas of nursing, allied

health, biomedicine, and healthcare. The database contains information from 1982 to the present and has over 800,000 records (CINAHL Database, The, 2007).

The PsycINFO database provides references to literature in the behavioral sciences and mental health and includes relevant information for professionals in psychology, management, business, education, social science, neuroscience, law, medicine, and social work. The database contains more than twenty-three million cited references. PsycINFO contains information from more than 2,150 scholarly journals (American Psychological Association, 2007).

The Education Resources Information Center (ERIC) is sponsored by the United States Department of Education, Institute of Education Sciences. The database contains more than 1.2 million records to more than 600 journals and other education-associated materials. The database contains information from 1966 to the present (ERIC, 2008).

The CSA Sociological Abstracts database provides access to information in sociology and related disciplines in the social and behavioral sciences. The database contains over 793,105 records from 1952 to the present (CSA Sociological Abstracts, 2007).

The CSA Social Services Abstracts database provides citations for research in social work, human services, and other related areas, including social welfare, social policy, and community development. The database contains over 134,796 records from 1979 to the present (CSA Social Services Abstracts, 2007)

During trial searches for literature using the on-line databases noted above, the author tallied key words from various studies (at least ten different studies) concerning telehealth and speech-language pathology. The following search strings were developed

based on the most commonly used key words. The search strings that were used for this review included: 1) telehealth/speech/therapy, 2) telemedicine/dementia/elderly, 3) telehealth/speech therapy, 4) telehealth/elderly, 5) telemedicine/assisted living, 6) telemedicine/speech/therapy, 7) telehealth/community/therapy, 8) telecare/elderly, 9) telehealth/children, and 10) telehealth/schools. These search strings were entered into each of the databases appropriate for this review to identify studies for use in the review. The same search strings were also used in the on-line search of ASHA publications. The author also completed a search for additional information using previously published studies and literature reviews relating to the topic of telehealth in speech-language pathology. Several contacts were made with professionals (D. Brennan, personal communication, May 25, 2007; J. Brown, personal communication, November 2, 2007 & November 25, 2007; P.A. Mashima, personal communication, May 26, 2007; F. Scott, personal communication, November 2, 2007 & November 25, 2007; A. Tidwell, personal communication, January 23, 2008) involved with speech-language pathology and/or telehealth research. These professionals provided the author with various sources including conference reports and presentations, bibliographies, and unpublished reports/projects that were also used in this modified narrative review.

Once the literature search was completed, the sifting process was initiated to select studies to be included in the review. The author obtained titles and/or abstracts of all potentially relevant literature obtained from the literature search. To eliminate bias during the assessment process, the documents were reviewed by two independent investigators, the author and thesis advisor, with a third reviewer, a member of the thesis committee, available for consultation in the event of disputes. The investigators began

with a review of the titles and/or abstracts that resulted from the initial search in order to eliminate any clearly irrelevant articles. The primary author then obtained full-text copies of the studies that remained from the initial sift. During the second sifting, the two investigators applied selected inclusion and exclusion criteria as determined by the author(s) of the analysis.

Because telehealth is a relatively new practice in clinical work, database searches for studies were conducted for documents published in the past twenty-five years. Therefore, studies retrieved from the on-line database search were only included for review if they were published between January of 1982 and the present. Studies obtained from historical searches, bibliographies, and professional contacts were not subject to date restriction, but if dated prior to 1982, were only included as historical documents. Documents from organizations such as professional associations were included into the study as reference documents. Studies were only included if they related to telehealth applications for conducting assessment or treatment procedures in field of speech-language pathology.

Because this project is a modified narrative review of available literature, formal quality assessment procedures were not completed for all studies included in the review. The primary author and a fellow thesis student, experienced with the systematic review process, sorted the studies that were quality assessment checklist reviewable (i.e. participant/study information included). The primary author reviewed each reviewable document with a quality assessment checklist (Appendix A). Only Level I and II studies included in the analysis received a +/- rating based on the 'Coding System' from Table 1 (Chap. 2) that was used when discussing the overall implications of the findings from the

review. While it is widely recognized that Randomized Control Trials represent the most reliable and respected results in experimental research, these were limited in the preliminary search of telehealth literature in speech-language pathology. These studies require large numbers of participants with very strict subject selection criteria. These studies also require blinding procedures to be implemented which is often not possible with the behavioral-type treatments used in speech-language pathology (Wambaugh, n.d.). However, as previously stated, other experimental research designs are relevant to EBP and this modified narrative review of the literature was conducted using any type of study.

After the primary author evaluated each reviewable article with the quality assessment checklist, a fellow thesis student, experienced with the systematic review process, also completed a quality assessment checklist on each reviewable article to maintain the reliability of the review process. Any discrepancies between the two authors that changed the quality assessment rating (i.e. adequately addressed vs. poorly addressed; adequately addressed vs. not addressed) were resolved by consensus of the two researchers or by a third researcher (thesis advisor).

The author then constructed a descriptive analysis of each reviewable study, including the numerical rating for study type, study participants, selection criteria, outcomes measured, etc (Appendix B). Other information was reported based on the findings of each study.

After each reviewable study was analyzed, the author presented overall conclusions based on the modified narrative review findings. Recommendations were

suggested for clinicians and researchers in the field of speech-language pathology regarding assessment and treatment implications and the need for further research.

CHAPTER V

RESULTS

A total of sixty-two full-text articles were accepted for inclusion into the study. This total includes checklist reviewed articles, non-checklist reviewed articles, historical articles, and reference articles. These sixty-two full-text articles were located from databases, bibliographies, American Telemedicine Association documents, and personal contacts. The following paragraphs detail the search for articles and provide a breakdown of sources from which articles included in this study were obtained.

Database Search

A total of 414 titles and/or abstracts were obtained from the initial Auburn University library database searches (CINAHL, CSA Social Services Abstracts, CSA Sociological Abstracts, Dissertations and Theses, ERIC, MEDLINE, and PSYCINFO) and American Speech, Language, and Hearing Association database search. Table 4 below represents a breakdown of the number of articles resulting from each database search.

Table 4: Number of Articles Resulting from Database Searches.

DATABASE	ARTICLE COUNT
CINAHL	134
CSA Social Services Abstracts	36
CSA Sociological Abstracts	11
Dissertations and Theses	4
ERIC	8
MEDLINE	102
PSYCINFO	76
ASHA Publications	43

Many of the titles and/or abstracts were duplicates of each other. Following removal of the duplicates, 220 titles and/or abstracts were sorted using the selected inclusion criteria which are located on page twenty-four of this document. On occasions when the author and thesis advisor were not in agreement as to whether or not a title and/or abstract should be included for further review, the title/abstract was taken to a third reviewer (member of the thesis committee) for final resolution. A total of ninety-four titles and/or abstracts were selected for full-text review. The full-text copies of the ninety-four titles and/or abstracts were obtained and sorted using the selected inclusion criteria. Any disputes between the independent investigators (author and thesis advisor) were resolved by a third reviewer (member of the thesis committee). A total of twenty full-text articles were accepted for inclusion into the study from the database searches. One of the twenty articles was dated prior to 1982. According to the inclusion criteria established for the study, articles dated prior to 1982 were eligible for inclusion as historical documents but were not eligible for checklist review. Therefore this article was only accepted into the study as a historical reference but was not subjected to the checklist review process.

Primary Bibliography Search

A primary bibliography search of the twenty full-text articles accepted for review and a search of the American Telemedicine Association Spring 2007 bibliography was completed using the selected inclusion criteria. Thirty-one articles were selected for inclusion into the study from the bibliography searches. One of the thirty-one articles was dated prior to 1982 and was accepted into the study as a historical reference but was not accepted for checklist review. Six of the thirty-one articles were professional association documents and were only accepted into the study as reference documents but were not accepted for checklist review.

American Telemedicine Association Document Search

A review of American Telemedicine Association presentations from 2003-2006 was completed using the selected inclusion criteria. Seven presentations were selected for inclusion into the study.

Secondary Bibliography Search and Personal Contacts

Ten additional sources were obtained throughout the research process from secondary bibliography searches and personal contacts and accepted for inclusion into the study.

A total of six full-text articles could not be obtained after exhaustive searching of multiple libraries and universities and personal contacts.

After the full-text articles were accepted for inclusion into the study, two independent investigators (author and fellow thesis student) reviewed the full-text articles to sort those that were quality assessment checklist reviewable (contained participant/study information) and those that were not quality assessment checklist

reviewable (review articles). Any disputes between the investigators were resolved by consensus of the two investigators or a third reviewer (thesis advisor). Twenty-eight articles were selected for quality assessment checklist review (Appendix C) and twenty-six articles could not be reviewed using the quality assessment checklist (Appendix D).

In summary, a total of sixty-two full-text articles were selected for inclusion into the study. Of the sixty-two articles, twenty-eight were accepted for quality assessment checklist review and twenty-six were accepted but not reviewable by the quality assessment checklist. Two articles were included into the study as historical references only (Appendix E) and six articles were included as reference documents only (Appendix F). Neither the historical reference articles nor reference documents were eligible for checklist review. A total of six articles could not be located after exhaustive searching (Appendix G).

Each article accepted for quality assessment checklist review was reviewed by two independent investigators (author and fellow thesis student) using the quality assessment checklist (Appendix A). Each completed checklist was compared by the two investigators. Discrepancies that changed the quality assessment rating (i.e. adequately addressed vs. poorly addressed; adequately addressed vs. not addressed) were resolved by consensus of the two investigators or by a third reviewer (thesis advisor). A total of three documents were taken to the third reviewer for dispute resolution

The following paragraphs are narrative summaries of the twenty-eight articles included into the study that were quality assessment checklist reviewed. These twenty-eight articles are the articles that were determined to be quality assessment checklist reviewable because they contained participant/study information. The summaries are

grouped into child diagnostic summaries, child treatment summaries, adult diagnostic summaries, adult treatment summaries, and multiple combinations of the above. Within each grouping, the article summaries are arranged chronologically from earliest to most recent. For each article summary, specifics regarding the telehealth program being investigated are provided. This information is followed by the author's assessment of the study in terms of study validity in a second paragraph. At the conclusion of this section, five summary tables are included to simplify the information presented in the following summary paragraphs.

Child Diagnostic Summaries

A study by Cole, Martin, Moody, and Miller (1986) investigated the use of the Diverse Uses of Communication Technology (DUCT) program to deliver speech-language pathology services to children in rural school systems in Australia. The system utilized an external loudspeaker, microphone, and telephone. Five children with speech and language problems were assessed using either the Fisher Logemann Test of Articulation Competence (Fisher & Logemann, 1971) or the Renfrew Action Picture Test (Renfrew, 1988). Each test was scored by a remote speech pathologist and an on-site speech pathologist. Following the conclusion of testing, a comparison of the test scores from each speech pathologist was made. The same errors were identified by the clinicians for each participant with the exception of the interdental lisp. Only the on-site speech pathologist recorded this error as he/she was able to use visual cues to note the error production. The remote speech pathologist was not able to identify this error over the telephone. No reliability information was provided for the study. The researchers

concluded that telehealth was a feasible option for providing speech pathology services to children.

Concerns for internal validity included limited participant information (age, gender, previous therapy services, etc.) and limited information on the testing environment used in the study (set-up, speech pathologist training, etc.). Given the limited available information, it was difficult to judge the presence/absence of internal validity effects such as history and experimenter bias. Concerns for external validity related to the small sample size (n = 5).

A study by Waite, Cahill, Theodoros, Busuttin, and Russell (2006) examined the possibility of assessing child speech disorders through an Internet-based telehealth system utilizing videoconferencing and store-and-forward imaging. The study participants (n = 6) were each assessed simultaneously by a telehealth clinician and by a face-to-face clinician. Each participant was assessed using a single-word articulation test. A connected speech sample from each participant was obtained and subsequently rated to determine each participant's intelligibility. Additionally, an oro-motor examination looking at structure and function was also administered to each participant. The results indicated a 92% level of agreement between the on-site and telehealth clinicians on the single-word articulation test. Intra-rater reliability was 94% and inter-rater reliability was 87% for the single-word articulation test. 100% agreement (+/- 1 point on a 7 point scale) was obtained between the two clinicians for speech intelligibility ratings based on a conversational speech sample. Intra-rater reliability was 83% and inter-rater reliability was 100% for the speech intelligibility ratings. An overall 91% agreement level for the two clinicians was obtained for oro-motor examination results. Intra-rater reliability was

76% and inter-rater reliability was 90% for the oro-motor examination results. The researchers concluded that the results of the study provided evidence for the feasibility of telehealth assessment of child speech disorders.

Concerns for internal validity included limited participant information (gender, previous therapy services, professional making initial diagnosis, etc.) and the use of non-standardized assessment tools without established validity and reliability. Concerns for external validity related to the sample size (n = 6) of the study.

Child Treatment Summaries

Harrison, Wilson, and Onslow (1999) reported on a case study involving a five year and ten month old male participant with a fluency disorder. The participant had been stuttering for three years and had received no treatment prior to the study. The speech-language pathologist used an adapted version of the Lidcombe program (Onslow, Andrews, & Lincoln, 1994) which involved telephone consultations approximately every eleven days between the clinician and the participant's mother. During these consultations, the participant's mother was taught aspects of the Lidcombe program such as on-line praise and correction, measurement of stuttering severity, and administration of a maintenance program. Periodically throughout the course of treatment, the participant's mother would mail videotapes and/or audiotapes of the participant in his natural environment to the clinician for evaluation of the mother and participant. The participant completed the treatment phase of the Lidcombe program after 277 days and twenty-five telephone consultations. At twenty-three months post-treatment, the participant was maintaining near-zero stuttering levels (0.1-0.5 percentage of syllables stuttered) with an approximate average of 190 syllables per minute. The participant's mother also noted

improvements in his social life as a result of the successful stuttering treatment program. While the clinicians administering the treatment program judged it to be a success, it was noted that the adapted version of the Lidcombe program did require more clinician time than the traditional face-to-face version of the program and that cost information would need to be considered if distance intervention becomes common practice in the field of speech-language pathology.

The internal validity of this study was not of concern. The authors provided an in-depth description of the participant, including his background of stuttering behaviors and an explanation of the adapted version of the Lidcombe program. Experimenter bias was reduced as the audiotape and videotape mail-ins were evaluated by independent stuttering specialists who were blinded to the study to ensure the reliability of the data. History effects were not a concern as the participant had received no prior therapy services. External validity was of concern, particularly given the small sample size (n = 1) of the study.

McCullough (2001) conducted a non-randomized feasibility study to look at the potential of using telemedicine as an option for speech-language pathology service delivery for pre-school children with special needs. Four children, diagnosed with Down syndrome or Cornelia de Lange syndrome, and their families participated in the study. Telemedicine sessions took place in nursery schools and at the participants' homes. The author of the study was primarily interested in measuring user satisfaction, system reliability, audio-visual quality, and system functionality of the telemedicine system. Surveys concerning the above domains were completed by the parents of the children participating in the study and by the speech-language therapist involved in the study. The

total survey response rate was calculated to be 89%. These surveys, completed at various phases during the trial, found audio and video quality to be good. The telehealth system was reported to be reliable and easy to set up. Parents were pleased with the feedback they received from therapists following the therapists' observation of them playing with their respective children. The author of the study stated that it was too early in the project to report full data on participant progress. However, some information was provided on picture selection, picture naming (signing and speech), and vocal imitation/syllable structure in a table within the article. Communication gains were noted in receptive and expressive vocabulary skills and vocal imitation skills. No reliability information was provided for the study results. However, given that the primary focus of this study was not on participant communication gains, it was difficult to judge the true outcomes of participant performance using telemedicine based on the information provided.

Given that information such as session format (consistent/variable), specific therapy activities, performance measurement tools, etc. was not discussed in the article, internal validity for the study was of concern. Concerns for external validity related to the small sample size (n = 4) and diagnoses (Down syndrome and Cornelia de Lange syndrome) of the participants.

Wilson, Onslow, and Lincoln (2004) from the University of Sydney reported on the use of a telehealth adapted version of the Lidcombe program for stuttering intervention. Five case studies were included in the article. All participants received treatment using a telehealth adapted version of the Lidcombe program. Parental instruction on procedures for carrying out treatment techniques at home was completed using training videos and telephone consultations with a remote clinician. Specified

portions of conversations in a variety of settings were recorded using a video-recorder or audio-recorder and forwarded to the remote clinician for evaluation. All parent-clinician consultations took place over the telephone. To judge the outcomes of the telehealth technique, speech measures and treatment efficacy measures were evaluated following the completion of the study. For speech measures, the researchers noted an increase in the syllables per minute (SPM) produced by each participant and a decrease in the percentage of syllables stuttered (%SS) for each participant following the completion of therapy and at a twelve-month follow-up assessment. Inter-judge reliability measures resulted in a correlation coefficient for the number of SPM of .87 and a correlation coefficient for the %SS of .97. For treatment efficacy measures, the researchers reported that participants ranged from 11 weeks to 40.1 weeks to reach the completion of the Stage I level in the program. The number of consultations needed to reach Stage II in the program ranged from 3 to 34. The mean duration of consultations ranged from 22.3 to 40.5 minutes and the mean total clinician time for consultation was 32.6 to 67.9 minutes. The mean frequency of consultation was every 8.5 days to every 38 days. Overall, parents were satisfied and comfortable with the telehealth program based on parent questionnaire report results. The authors concluded that the telehealth adapted Lidcombe program may be feasible for implementation into clinical practice and may result in satisfactory clinical outcomes. However, the telehealth delivery of the Lidcombe program required more clinician time than standard delivery of the Lidcombe program.

The internal validity of this study was not of concern. The authors provided detailed information regarding the participants included in the study and provided detailed information regarding training procedures used for parents. To eliminate

experimenter bias, reliability measures were calculated by an independent clinician with the order of tape presentation randomized so that the participant's treatment phase wasn't apparent. History effects could have played a role in treatment outcomes as some of the participants had received prior stuttering therapy services. Concerns for external validity related to the small sample size (n = 5) and the limited age range of the study participants (3.5 years – 5.7 years).

Child Diagnostic/Treatment Summaries

Jessiman (2003) reported on the use of telehealth technology to assess and treat two school-age children, ages 7 and 5.4, with articulation disorders. Assessment was completed using the Structured Photographic Articulation Test featuring Dudsberry (SPAT-D) (Kresheck & Tattersall, 1993). The initial assessment, using a room microphone, was found to be inadequate because specific errors were not able to be documented as a result of poor sound quality. The results differed greatly from the face-to-face scoring that was completed at the same time. The assessment was administered a second time using a lapel microphone worn by the client. Sound clarity was greatly improved and only one phoneme was not distinguishable. Results of the second administration were almost identical when comparing face-to-face and telehealth results. Treatment sessions were held two times per week for two months. Initially each session was sixty minutes in duration but as the study participants became more familiar with the equipment, session times were decreased to thirty minutes in duration. Materials for each session were faxed or mailed to each client prior to each session. As the sessions continued, parents of the two children began carrying out treatment activities during the telehealth sessions. At the conclusion of the study, both children had improved (although

one child improved to a greater degree than the other) in their articulation skills. Treatment outcomes were based on informal probes. Reliability measures were not computed for the study results. Parent satisfaction with their child's treatment gains and the telehealth system was reported to be good based on a post-treatment questionnaire. The researchers conducting the study noted some problems/concerns during the study relating to equipment use, time delay between video and audio signals, and room-setup. The authors of this study noted that if the stated problems/concerns were addressed as suggested, telehealth for speech and language assessment and treatment could be an appropriate alternative for service delivery.

The authors of this study did not provide exact specifications of the technology used for this study, nor were specific treatment techniques detailed. Other concerns for internal validity included the authors making no mention of who administered the articulation assessments and conducted treatment sessions. It was also not clear if the assessment and/or treatment administrator(s) was consistent throughout the study or if other individuals were involved. Testing effects were also a concern in this study as the SPAT was administered in a telehealth session and face-to-face session within three days of each other. Informal probes were used to judge treatment progress as opposed to a standard, reliable assessment tool. Concerns for external validity related to the small sample size (n = 2) of the study.

Adult Diagnostic Summaries

Wertz et al. (1987) investigated the use of closed-circuit television and computer-controlled video laserdisc over the telephone for appraisal and diagnosis of neurogenic communication disorders. Participants (n=36) were assessed by one of three clinicians in

three different conditions, face-to-face (FTF), closed-circuit television (T), and computer-controlled video laserdisc (L), using a battery of tests including a motor speech evaluation, the Western Aphasia Battery (WAB) (Kertesz, 1982), the Porch Index of Communicative Ability (PICA) (Porch, 1967), the shortened version of the PICA (SPICA) (DiSimoni, Keith, & Darley, 1980), the Reading Comprehension Battery for Aphasia (RCBA) (LaPointe & Horner, 1979), and portions of informal test protocols from the Mayo Clinic. The SPICA was only used during the video laserdisc testing condition. The overall percent agreement in diagnosis among the three appraisal conditions (FTF, T, and L) was 91%-93%. Using a Kappa analysis (a chance corrected percent agreement analysis with a statistical base), twenty out of twenty-one comparisons were significant, indicating high agreement in diagnosis among combinations of conditions. ANOVA analyses yielded no significant differences in participant performance for any measure among the three conditions. The authors concluded that diagnosis based on appraisal through television or video laserdisc was equivalent to diagnosis based on face-to-face appraisal. Performance scores on standardized assessments were found to be equivalent to performance scores in face-to-face administration. While the authors noted that all evaluations were videotaped for later reliability analysis, reliability information was not reported in the study.

Internal validity was of concern in this study. There was no information provided regarding participant characteristics with the exception of a communication disorders diagnosis. The authors reported that the complete assessment battery takes anywhere from three to ten hours to complete which is an extensive amount of time and likely affected participant performance before the testing process was completed. It is not

known how much time was allotted in between testing in each condition (FTF, T, and L). The researchers randomly ordered the order of conditions the participants were exposed to in order to control for practice effects and clinician bias. External validity was of concern due to the limited information provided in the article, particularly in terms of participant information. The sample size was small (n = 36).

Wertz et al. (1992) investigated the use of closed-circuit television and computer-controlled video laserdisc over the telephone for appraisal and diagnosis of neurogenic communication disorders. Participants (n=72) were assessed by one of three clinicians in three different conditions, face-to-face (FTF), closed-circuit television (T), and computer-controlled video laserdisc (L), using a motor speech evaluation, the WAB, the PICA, the SPICA, and portions of informal test protocols from the Mayo Clinic. The overall percent agreement in diagnosis among the three appraisal conditions (FTF, T, and L) was 93%-94%. Agreement was highest for aphasia (96%-99%) and lowest for dementia (88%-89%). Kappa analysis for diagnosis of all disorders in all conditions was 0.77. Twenty out of twenty-four comparisons for specific disorders in combinations of conditions displayed significant agreement ($p<0.05$). Paired *t*-tests yielded no significant differences for the WAB Aphasia Quotient (AQ) or WAB Cortical Quotient (CQ). There was a significant difference for the PICA score between FTF and L and T and L. The authors noted that this difference could be attributed to the use of both the traditional and shortened versions of the PICA during the video laserdisc testing condition. High correlations (0.89-0.98) were found between combinations of conditions. Reliability information was not provided for the study. The authors concluded that diagnosis based on appraisal through television or video laserdisc was equivalent to diagnosis based on

face-to-face appraisal. Performance scores on standardized assessments were found to be equivalent to performance scores in face-to-face administration.

Internal validity was of concern in this study. There was no information given regarding participant characteristics with the exception of a communication disorders diagnosis. It was not reported how much time was allotted in between each administration of the tests from the assessment battery nor was it reported how much time was allotted in between testing in each condition (FTF, T, and L). The researchers randomly ordered the order of conditions the participants were exposed to in order to control for practice effects and experimenter bias. Despite the larger sample size (n = 72), external validity was of concern due to the limited participant information provided in the article.

A report by Duffy, Werven, and Aronson (1997) from the Mayo Clinic addressed the use of telemedicine in speech and language evaluations of a variety of individuals with varying medical diagnoses. In the multi-part study, eight participants were simultaneously evaluated via digital satellite transmission by a remote and face-to-face clinician. Twenty-four previously video-taped client samples were digitally transmitted via satellite for telemedicine evaluation. Additionally, 150 telemedicine evaluations from a variety of Mayo Clinic practices were transmitted by satellite for evaluation retrospectively. The study participants represented a variety of diagnostic categories. Depending on the participant, a variety of assessment procedures were completed including an oral mechanism examination, motor speech examination, and/or language examination. All of the evaluations were conducted using informal assessment tools. Agreement between the on-site and remote clinicians for the digital satellite

transmissions was 100% for the determined speech diagnosis. Agreement for the retrospective analysis portion of the study using non-compressed, analogue satellite transmission was 96%. In the retrospective analysis, a percentage of participants (n = 13%) received an 'uncertain' diagnosis. This percentage was slightly higher than the percentage of 'uncertain' diagnoses typically encountered in face-to-face assessment setting. All of the participants (outside of those in the retrospective analysis) were reported to be satisfied with the telemedicine evaluation process. The researchers concluded that speech and language consultation via telemedicine was appropriate for diagnosis and management of a variety of communication disorders.

Although the remote clinician was blinded to patient diagnosis information prior to the speech-language assessment, internal validity for this study was poor. The assessment tools used in the study were not established resources with validity and reliability. External validity for the study was adequate considering the large sample size and the wide variety of participant ages, medical diagnoses, and speech-language diagnoses that were included in the study.

Lalor, Brown, and Cranfield (2000) reported on the use of satellite link-up using a videoconferencing unit for a language and swallowing evaluation on a sixty-nine year old participant with a left middle cerebral artery cerebrovascular accident. The participant was diagnosed with global aphasia and dysphagia following a telehealth assessment. Despite some disadvantages such as participant orientation to the satellite therapist and difficulty getting a close-up view of the participant's face, the evaluation was reported to be successfully completed with accurate results regarding the nature and extent of the participant's language and swallowing problems recorded. However, the extensive

swallowing therapy recommended for successful improvement of the participant's dysphagia required on-site therapy services at a rehabilitation hospital. The authors noted six primary disadvantages/problems that occurred during the course of the study. Many of these problems were easily solved with minor adjustments such as participant placement adjustments in relation to the telehealth equipment in the room.

The internal validity for this study was of concern. The authors did not state what specific assessment measures were used to evaluate the participant, nor were the evaluation outcomes clearly defined. Concerns for external validity related to the sample size (n = 1) and the ethnicity of the participant (Aborignese), which also limited the generalization of the study results.

Brennan, Georgeadis, Baron, and Barker (2004) reported on a study conducted at the National Rehabilitation Hospital comparing participant performance on the Story Retelling Procedure (SRP) (Doyle, McNeil, Spencer, Goda, Cotrell, & Lustig, 1998) using the Percent Information Unit (%IU) metric (McNeil, Doyle, Fossett, Park, & Goda, 2001) in both a face-to-face (FF) setting and videoconference-based telerehabilitation (T) setting to determine the possibility of using such technology for speech-language pathology intervention services. The study also investigated the affects that descriptive variables (age, gender, education level, and technology experience) played on participant performance during testing. A complete testing session (prescreening, technology survey, three SRPs in each setting, and post-test exit surveys) took approximately ninety minutes to complete for each participant. All participants (n=40) had medical diagnoses of traumatic brain injury (TBI), right-hemisphere cerebrovascular accident (RCVA), or left-hemisphere cerebrovascular accident (LCVA). All participants were tested in both

settings using six stories (three for each setting) from the SRP. A two-tailed paired samples *t*-test yielded no significant difference ($p = 0.49$) and a high correlation ($r = 0.93$) between telerehabilitation scores and face-to-face scores across subjects. ANOVA analysis yielded no significant difference between telerehabilitation and face-to-face scores among the groups for any of the descriptive variables considered in the study. Age came the closest to yielding statistical significance ($p = 0.12$) with the youngest age group (<36 years) performing better in the face-to-face setting. Inter-rater reliability calculations yielded a 92.8% agreement rate between SRP administrators. The authors concluded that these findings confirm the potential for using videoconferencing for speech-language pathology treatment and indicate a need for further research in this area.

Internal validity for this study was adequate. The participants were highly comparable for multiple descriptive variables but yet not so closely tied to such specific standards that external validity was compromised. Different story sets were selected for each setting and the assignment of testing order was randomized across participants to control for practice and test sequence effects. External validity for this study was adequate. The participants in the study represented a variety of ages, education levels, and medical diagnoses. The sample size ($n = 40$) was adequate for the study design. One concern with this study was that testing was completed in a very controlled environment without outside noise and/or interruptions. It was not known what effect, if any, a typical home environment would have on testing results.

Georgeadis, Brennan, Barker, and Baron (2004) investigated the use of telerehabilitation for assessment and treatment of adults with neurogenic communication disorders using a story retelling task from the SRP. All participants ($n = 40$) were

diagnosed with TBI, RCVA, or LCVA. Participants varied from each other when considering diagnosis, age, education, time post onset, and gender. All participants were determined to be at a moderate to mild aphasia severity level based on an aphasia subtest. Using a videoconferencing system, participants completed the story retell tasks using two different randomly selected story sets in both the face-to-face (FTF) and telehealth settings. Each retell was digitally recorded for future scoring. A standardized scoring metric, the %IU was used to determine participant accuracy on the SRP. Following completion of the study, results revealed no significant difference in scores between the FTF and telehealth settings based on a two-tailed paired samples *t*-test ($p = .495$). A high correlation between results in each setting was found ($r = .93$). The authors of the study calculated inter-judge reliability for 5% of the total number of SRP responses. Inter-judge reliability (using a second certified and trained SLP blinded to SRP setting) was 92.8%. There were some interesting individual diagnostic group differences. The RCVA group performed better in both settings than the LCVA group and the TBI group. The LCVA group performed better in both settings than the TBI group. The RCVA group was the only group to perform better on average in the telehealth setting and a trend toward significance was noted ($p = .064$). An ANOVA 1 was performed to further determine variability across groups using difference scores for each participant (ΔT-FF). A trend towards significance was found among all three groups ($p = .069$). Post hoc testing found a trend towards significance between the RCVA and TBI groups. Based on exit survey results, the LCVA and RCVA groups were favorable of telehealth services in that the majority reported no difference between settings. However, most reported a preference for the FTF setting. TBI participants were the least likely to show interest in future

videoconferencing use. Based on the overall study results, the authors concluded that story retelling performance was not affected by setting.

This study had adequate internal validity. Although patients were assessed in both FTF and telehealth settings, two different story sets were used and the order of settings was randomized across participants. Certified and trained SLPs were used for both test administration and SRP scoring. Effects from maturation and mortality were minimal for this study given that the tests were all completed while the participants were patients at the National Rehabilitation Hospital and tests were completed for both settings over a short period of time. One concern regarding internal validity was that all participants in the study were receiving SLP services at the time of testing. There was a concern as to what impact the type, length, and duration of those services played on patient performance. External validity for this study was adequate. The sample size (n = 40) was adequate for the study design and the participants represented a wide variety of age levels, education experience, and time post onset for all three disorders. There was some question of how well someone with severe neurogenic impairments would perform in the telehealth and FTF settings with this task as all participants in this study were mild to moderately impaired.

Georges, Doolittle, and Ahlers (2004) reported on the use of telehealth for dysphagia therapy in rural regions. In rural areas of states such as Kansas, the availability of speech-language pathologists has been highly limited. The high incidence of stroke and other neurological diseases in this state has increased the commonality of swallowing disorders. To assist in the evaluation of individuals with swallowing disorders in rural communities, telehealth has been used by speech-language pathologists to observe

standard modified barium swallow (MBS) studies over the Kansas Video Network. Twenty-four participants, ranging in age from 10-100 were assessed using the standard MBS protocol. The majority of participants were nursing home residents. Diagnoses varied from cerebrovascular accident to dementia to cerebral palsy to closed head injury. Dysphagia diagnoses ranged from mild to moderately severe in nature and a variety of recommendations were presented to individuals and/or their caregivers. Twelve follow-up studies were completed. The remote swallow studies were well received by participants and the remote sites and the authors reported that the studies were of good quality and appeared to be comparable to onsite MBS studies. The authors reported that no reliability or validity data was obtained.

Concerns for internal validity included the limited participant information (specific diagnoses, ages, gender) made available in the study. External validity concerns related to the small sample size (n = 24) of the study.

Hill et al. (2006) conducted a pilot study at the University of Queensland in Australia exploring the feasibility of using an Internet-based telerehabilitation system for the assessment of motor speech disorders in nineteen individuals with neurological impairment. Assessments included in the study included a 19-item version of the Frenchay Dysarthria Assessment (FDA) (Enderby, 1983), the Assessment of Intelligibility of Dysarthric Speech (ASSIDS) (Yorkston & Beukelman, 1981), perceptual analysis of a speech sample, and an overall severity rating of the dysarthria. Each participant was assessed in a face-to-face environment and in a telerehabilitation environment using real-time videoconferencing with store-and-forward audio and video data. The Bland and Altman (BA) limits of agreement technique (Bland & Altman, 1986)

and percentage level of agreement were used to compare participant performance between the two assessment environments. Percentage of sentence intelligibility from the ASSIDS, severity ratings from a speech sample, and most perceptual ratings were found to be within the acceptable clinical criterion based on the BA technique and percentage level of agreement. Results from sixteen variables from the 19-item version of the FDA did not fall within the clinical criterion based on the BA technique. Explanations for this discrepancy ranged from judge variability to technical issues. However, the majority of variables from the FDA met clinical criterion based on percentage level of agreement. Reliability measures were found to be moderate to high for all areas of assessment. Based on results of the study, the authors concluded that the use of the Internet was feasible for conducting reliable online assessments of motor speech disorders.

Internal validity was no of concern for this study. The SLPs were blinded to the dysarthria ratings previously assigned and noted in medical documentation. The order of assessment environment was randomized across speakers with a span of two to three days in between to minimize test-retest effects and fatigue effects. External validity concerns related to the small sample size (n = 19) of the study. However, the participants that were involved in the study represented a variety of diagnoses, ages, gender, months post onset, and dysarthria severity levels.

Hill, Theodoros, Russell, Ward, and Wootton (2006) presented results of a study evaluating the effectiveness of a PC-based telerehabilitation videoconferencing tool for administering a standardized assessment (Boston Diagnostic Aphasia Examination-3 Short Form) (Goodglass & Kaplan, 1972) to eighteen participants with acquired neurogenic language disorders. There were no significant differences found between the

online and face-to-face scores for twenty-four subtests ($p>.05$). The researchers computed intra-rater and inter-rater reliability for the study participants. Reliability was found to be high and consistent with ratings from the BDAE-2 manual. Participant satisfaction was reported to be very high following the conclusion of the study. The study found that valid and reliable aphasia assessment results of this population can be obtained using PC-based telerehabilitation via the Internet.

While only a conference presentation handout was available for review, the study appeared to be carefully planned out and well executed. The internal validity of the study was adequate. An excellent description of the technology used was provided in the handout. However, the researchers did note some limitations with low speed technology settings that they plan to overcome in the future with system improvements. The authors assessed participants face-to-face and online simultaneously to prevent threats from testing effects, maturation, and mortality. The procedure style (face-to-face vs. online) and SLPs were randomly selected for each participant to prevent experimenter bias. The external validity of the study was poor. The study sample was small ($n = 18$) and only limited participant information was provided in the handout. There was no mention of time post onset of CVA, education history, race, vocation, etc. of the study participants.

Palsbo (2007) reported on the use of videoconferencing to assess patients post-stroke in a randomized double-crossover agreement design using a subset of the BDAE. Functional communication abilities (motor speech, spoken language comprehension, spoken language expression) were rated using the National Outcomes Measurement System (NOMS) (Mullen, 2004) for each of the twenty-four participants. A uniformed set of open-ended questions was used to assess motor speech and speech expression. Study

participants were randomly assigned to either a remote or face-to-face assessment group for assessment. Each participant was simultaneously assessed by a remote and face-to-face SLP. The Bland and Altman (BA) protocol limit of agreement was set at 95% for the study. The percent within the 95% limit of agreement and the percent within one point agreement ranged from 92% to 100% for the remote and face-to-face administration of the BDAE. The percent of exact agreement ranged from 50% to 67% for face-to-face administration and from 8% to 25% for remote administration of the BDAE. The author concluded that speech-language assessments can be successfully administered using videoconferencing.

The study had adequate internal and external validity. The researchers used an assessment tool with established validity and reliability to reduce instrumentation effects. The simultaneous scoring by the remote and face-to-face clinicians reduced effects from testing, fatigue, and experimenter bias. The sample size (n = 24) was adequate for the study design. External validity for the study was good given the variety of ages, races, and time post-onset of stroke for the study participants.

Adult Treatment Summaries

Fitch and Cross (1983) reported on a case study from the University of South Alabama involving use of the Remote Machine Assisted Treatment and Evaluation (REMATE) system to demonstrate the feasibility of using the program in a facility geographically separate from the computer resource center. The fifty-four year old participant had suffered a left subdural hematoma approximately four years prior to initiation of telecomputer treatment. She had been diagnosed with moderately-severe to severe aphasia and severe apraxia of speech. The telecomputer treatment sessions

consisted of activities to improve auditory comprehension skills. The sessions were run entirely by the computer with the exception of the initial contact by the clinician to place the required long-distance telephone call. Neither outcome measures nor reliability measures were reported for the study. However, the authors reported that the participant progressed easily through all of the sessions and responded favorably to the telecomputer system.

Concerns for internal validity related to the limited participant information provided (no mention of education level, caregiver support used at home for technology assistance, previous therapy services, etc.) in the study. The authors did not report the duration of treatment services. While limited information was made available, the treatment tasks discussed seemed to be fairly repetitive from session to session so there was a concern that practice effects could have played a role in improved patient performance. Outcome measures were not provided so it was not possible to evaluate the progress made by the participant during treatment. External validity concerns in this study related to the small sample size (n = 1).

Helm-Estabrooks and Ramsberger (1986) reported on a case study conducted within the Veteran's Administration system involving the use of the Helm Elicited Language Program for Syntax Stimulation (HELPSS) (Helm-Estabrooks, 1982) over the telephone to deliver aphasia treatment services. The participant was a fifty-two year old man who was eleven years post onset of a left cerebrovascular accident. He had received previous speech-language pathology services on multiple occasions. His nonfluent, agrammatic conversational output with relatively intact auditory comprehension made him a good candidate for the HELPSS program. Baseline language abilities were

assessed using the Northwestern Syntax Screening Test (NSST) (Lee, 1969) and the BDAE Cookie Theft Picture Description. Following thirty-four weeks of telephone therapy (3-4 sessions weekly/20-30 minutes each), the participant had slightly increased his receptive and expressive language scores by two and four points respectively on the NSST and increased the number of morphemes produced on both the NSST and BDAE Cookie Theft Picture Description. Reliability information was not reported for the study results. The authors reported that this study demonstrated that aphasia rehabilitation programs may be administered successfully via the telephone.

Internal validity was not a concern in this study. The participant description was excellent and there was a wide span of time between administration of the NSST and BDAE Cookie Theft Picture Description tasks so that testing effects were not likely to have played a role in the improved outcomes of the study. History effects could have played a role in the participant's improved therapy outcomes as the participant received previous speech-language therapy prior to enrollment in the study. External validity concerns related to the sample size (n = 1) of the study.

Vaughn et al. (1987) reported on a study conducted at the Birmingham, Alabama Veterans Administration Medical Center, comparing remote aphasia treatment and traditional face-to-face aphasia treatment. The researchers utilized the TEL-Communicology (TEL-C) clinician-assisted program combined with the TEL-C REMATE computer-assisted program for remote treatment delivery. Following six months of treatment (variable based on client needs), results comparing two randomized and two self-selected groups were reported to be comparable in their improvement. For all four groups, the researchers noted no differences for age, education, or initial aphasia

severity levels. The differences in reported treatment results, albeit small, were in favor of the TEL-C group, although both groups improved. No reliability information was reported for the study. On a monetary savings note, the study also found that face-to-face treatment was 191.4% more expensive than combined TEL-C and TEL-C REMATE treatment for this project.

Internal validity for this study was a concern as little information was available. Group randomization was used for this study which was important. However, it was possible that testing effects played a role in the study given that the assessment language battery used for measuring progress was administered four times prior to the completion of the study. Experimenter bias could have been a factor as it was not clear in the study as to who administered assessments or conducted treatment sessions. It was also not clear what specific therapy techniques were used for participants, nor was it clear if the treatment protocol was consistent across the sessions or if it varied from session to session. External validity was a concern for the study. The sample size was not reported, although the researchers noted it was small. Participant characteristics (i.e. age, gender, aphasia severity, etc.) were not reported for this study.

Burns et al. (1998) reported on a case study involving speech-language pathology treatment for an adult with cerebral palsy. The goal of therapy was to teach the participant to use a new alternative communication device, the DeltaTalker, which utilized Minspeak. Because of transportation and funding difficulties for services to and from the facility, telerehabilitation services were utilized. A videophone with an external camera was selected for the sessions so that the participant could receive services from his group home. The authors reported on several problems and eventual solutions

involving the equipment set-up, session location, and staff reluctance at the participant's group home. Very little attention was given to the actual therapy that was provided to the participant for the alternative communication device training. Additionally, the participant was still receiving services at the time the article was published so the outcome of his therapy services was not reported.

Internal validity was a concern due to the limited information provided in the study. Effects on internal validity such as history, maturation, and instrumentation could not be judged. External validity was of concern due to the sample size (n = 1) of the study. In spite of the limited information that was made available, this study presented an interesting area of opportunity in the field of speech-language pathology for using telerehabilitation.

Kully (2000) reported on a stuttering case that illustrated the use of a videoconferencing system to provide follow-up sessions to a thirty-eight year old male following his completion of an intensive three week therapy program. Participant outcomes were based on auditory information and the sessions were evaluated through patient and clinician report. Reports regarding the use of the equipment and the structure of the sessions were positive. There was no reliability information reported for the study. The author concluded that the use of videoconferencing may be feasible for follow-up therapy services to some individuals who stutter.

Internal and external validity for this study were of concern. Limited participant information was provided, the duration of follow-up services was not reported, and information was not provided on what protocols were followed during each session.

Session outcomes were not measured in a standard, reliable way. The sample size (n = 1) limited the generalization of the study results.

Clark, Dawson, Scheideman-Miller, and Post (2002) reported on a stroke teletherapy case that was managed for seventeen months with good success. Speech-language pathology was a part of the multi-disciplinary team for nine months on this case. The fifty-two year old participant was globally aphasic. After an on-site evaluation, sixty-two teletherapy sessions were conducted for speech-language pathology focusing on improving verbal expression abilities, auditory comprehension skills, reading comprehension skills, augmentative communication strategies, and confidence building for communication situations. A home program was also established for independent practice. A videophone and set-top communication device were utilized for the teletherapy sessions. At the conclusion of speech/language teletherapy sessions, the participant's communication and cognitive functional independence measure (FIM) scores had improved for all domains. Reliability measures were not reported for the study. The authors of the study reported on the cost savings of teletherapy sessions and on the positive rehabilitation outcomes for all disciplines involved. It was noted that some of the participant's improvements could have been a product of natural recovery. The authors concluded that telehealth does work but as an alternative for traditional therapy services rather than a replacement.

The authors of this study gave an adequate description of the participant who received telehealth services and thoroughly explained the technology used by both parties involved in the sessions. More detailed information could have been provided regarding the speech teletherapy sessions. It was not clear how long each session was conducted

for, nor was it clear if each activity/skill was targeted in every session or if certain skills received higher priority than others (i.e. were tasks and stimuli consistent or varied across sessions). To increase the internal validity of this case study, more information regarding the procedures for speech therapy services should have been provided. External validity of the study was of concern given the small sample size (n = 1).

Mashima et al. (2003) conducted a proof-of-concept study to determine if voice therapy services could be delivered effectively via telehealth. The researchers administered traditional voice therapy techniques (yawn-sigh technique, open mouth approach, vocal function exercises, vocal counseling, etc.) to seventy-two participants with a variety of voice disorders. Participants were matched based on diagnostic category and randomly assigned to a control group (for traditional therapy) or an experimental group (for telehealth therapy). It was not possible to match groups for age, gender, and etiology. In addition, voluntary discontinuation of the study by some participants further added to mismatch among the two groups. Post-treatment voice samples were rated as better than pre-treatment samples for 90% of the participants and there were no significant differences between the groups. Statistical analysis of acoustics (jitter and shimmer measures) were completed using ANOVA 2 analysis. Jitter and shimmer measures were improved for the majority of participants following treatment. There were no significant differences between the groups for either measure. Effect size was small for both jitter and shimmer pre- and post-treatment scores. On average, participants from both groups felt their voice had improved and there were no significant differences between the groups based on participant satisfaction ratings. Results of the otolaryngology exams showed improvement for both groups following therapy and there

were no significant differences between the groups. The researchers noted the 'forced-choice' for ENTs could have skewed the results but the definitive improvements of post-treatment examinations compared to pre-treatment examinations and the lack of difference between the two groups tended to lead against this thought. When considering reliability of the results, agreement between two raters judging pre- and post-treatment voice quality was 89% across both groups. A subset of ten samples rated by both raters a second time resulted in 90% agreement. For the fiber-optic laryngoscopic examinations, agreement from two independent ENTs was 72% when evaluating which examination was better. The overall findings of this study indicated that voice therapy delivered via telehealth was as effective as traditional treatment delivery.

Internal and external validity for this study were adequate. The mismatches in participant characteristics for the experimental and control groups presented some concern when considering the internal validity of the study. However, the random assignment of participants to groups, the relatively short duration of treatment, the consistency of treatment techniques for both groups, and the blinding of both raters of perceptual judgments of voice quality and of otolaryngologists ratings of pre- and post-therapy laryngoscopic examinations all increased the internal validity of the study. The external validity of the study was strengthened due to the sample size (n = 72) and the wide range of vocal disorders that were treated in the study.

Halpern et al. (2004) presented information on a PDA device programmed for Lee Silverman Voice Treatment (LSVT) program (Ramig, Bonitati, Lemke, & Horii, 1994) sessions for use as an 'at home' clinician for select sessions in the LSVT program. Sixteen individuals participated in the study. Data collection consisted of dBSPL

averages for sustained phonation, conversation, and reading using a multiple-baseline design. Treatment sessions consisted of traditional LSVT tasks. *t*-tests results indicated significant changes in dBSPL data pre-treatment as compared to post-treatment as compared to follow-up data six months post-treatment ($p<.001$). No reliability information was provided in the presentation. The results indicated that treatment gains were consistent with those recorded in previous studies examining the effectiveness of the traditional LSVT program.

Despite the limited information that was available, the internal validity of the study was not of concern. The researchers ensured that both treatment groups were similar on selected variables and used a reportedly reliable method of data collection. The authors ruled out maturation effects by running an analysis to ensure that no significant changes had occurred in the delayed treatment group prior to beginning treatment. Concerns for external validity related to the sample size for the study ($n = 16$) and the lack of information regarding participant selection for the study.

Carpendo (2006) reported on the Speech Telehealth Program in New York City. The program combined traditional face-to-face sessions with telehealth sessions (if deemed appropriate through screening) for patients with a variety of speech, language, voice, swallowing, and cognitive-communication disorders. Patients who have received services through the program have reported high levels of satisfaction in patient surveys. Included with the primary article was a small excerpt regarding a case study for an eighty-two year old male with Parkinson's disease who completed the five-week LSVT program. Three sessions each week were conducted via telehealth and one session was an

in-home visit. At the end of the program the participant was reported to be >95% intelligible.

The limited information included in this brief case study created concerns for the internal and external validity of the study. It was recognized that the author of the report did not write the case study for inclusion into a peer-reviewed scientific journal and therefore did not include detailed information regarding specific technology, participant selection for the program, participant baseline information, inter-judge reliability data for intelligibility ratings, SPL measurements, etc. However, since the author reported some results from this case utilizing a combined face-to-face and telehealth program, this study was included for review.

Theodoros et al. (2006) conducted a feasibility study at the University of Queensland in Brisbane, Australia to investigate the possibility of providing voice therapy to individuals with Parkinson's disease using the LSVT program through online videoconferencing. Study participants (n = 10) were assessed prior to the beginning of therapy and immediately following the conclusion of therapy to determine the effects of the therapy program. Results of the study indicated that the LSVT program could be successfully administered online to participants with idiopathic Parkinson's disease. Paired *t*-tests revealed significant improvements in loudness levels for sustained phonation, reading, and conversation for the group ($p = .0001$). A significant increase in pitch range was also found following treatment ($p = .032$). Perceptual ratings using the Wilcoxon signed ranks test revealed significant improvements in several parameters including breathiness ($p = .011$), loudness ($p = .008$), pitch variability ($p = .005$), and loudness variability ($p = .008$) when comparing pre-treatment and post-treatment ratings.

These findings were reported to be consistent with previously reported outcomes for the LSVT program administered in a face-to-face setting. Non-significant improvements were noted for hoarseness, speech intelligibility, and articulatory precision. Intra-judge reliability and inter-judge reliability measures were calculated for the perceptual ratings obtained pre- and post-treatment. Intra-judge reliability was high for rater 1 (.92) and rater 2 (.94) as both raters achieved 100% agreement at +/- 1 on the rating scale. Inter-judge reliability was .75 across all seven parameters with agreement between raters ranging from 95%-100% at +/- 1 point on the 5-point rating scale. Based on a post-treatment questionnaire, 70% of participants were more than satisfied with the online LSVT program treatment and 30% of participants were very satisfied.

Internal validity was not a concern for this study. The researchers were careful to ensure that the participants were not impaired by any other neurological, speech, respiratory, or laryngeal disturbance unrelated to Parkinson's disease, given that the LSVT program is specifically designed for individuals with Parkinson's disease. Detailed information was provided on the technology set-up and information was provided on how the patients were assessed pre- and post-treatment. It was not made known if any of the study participants had received previous treatment for their speech disorder since their Parkinson's disease diagnosis. The authors noted that the small sample size (n = 10) could have influenced the results of treatment. The authors recommended that further research be conducted in this area using individuals with a broader range of speech disturbances and using a larger number of participants to increase the external validity of the research.

Tindall and Wright (2006) presented on three single-case design studies at the American Telemedicine Association annual meeting utilizing telehealth for the treatment of anomia in patients with LCVA. The researchers reported positive outcomes in terms of score improvements for informal word list performance and WAB-AQ scores for all three participants. No reliability information was provided in the handout although reliability was noted in an early portion of the presentation.

The conference presentation handout, included for review in this study, contained limited information regarding setting, equipment use, data collection, and the exact procedures used in the research. Given the limited information, it was difficult to assess the level of evidence of the study. The presentation handout only provided limited treatment information (number of sessions) for one participant. The length of sessions was not provided and it was not clear if the provided treatment information was consistent for subjects two and three or if it was only applicable to subject one. It was not made clear if participants in the study had received prior therapy services or if any participant was receiving services in addition to the telehealth services. Another concern was that the WAB-AQ was used to measure progress pre- and post-treatment. Given prior exposure considerations, testing effects could have also affected the internal validity of the study. External validity for the study was of concern given the small sample size (n = 1) for each of the studies.

Child/Adult Diagnostic/Treatment Summaries

Sicotte, Lehoux, Fortier-Blanc, and Leblanc (2003) reported on the use of videoconferencing for the assessment and treatment of stuttering. The use of the telehealth was evaluated based on questionnaires, attendance, a structured interview, and

a percentage of syllables stuttered pre- and post-treatment. All participants (n = 6) attended all sessions during the twelve to twenty week active treatment phase. Each participant also participated in five follow-up sessions over a six month period following completion of the active treatment phase. The technical and clinical quality ratings of the telehealth equipment were positive from both the treating speech-language pathologist and study participants. Geographic accessibility to the telemedicine site, temporal accessibility, and economic accessibility were judged to be acceptable by study participants. The majority of participants and/or their parents reported large improvements in the reduction of stuttering and the acquisition of better communication skills. Based on speech samples, the percentage of dysfluencies decreased from 13%-36% prior to treatment to 2%-26% following treatment. At the end of follow-up, the percentage of dysfluencies ranged from 4%-32% among the participants. No reliability information was provided in this study. The authors concluded that assessment and treatment of stuttering can be performed successfully using telehealth.

There were several concerns with this study. While the authors concluded that assessment and treatment of stuttering could be successfully completed using telehealth, very little detail was reported regarding the specific techniques that were used during the assessment and treatment process. References for numerous treatment options were made available but given the limited information provided, the possibilities of replicating this study in future research were limited. The internal and external validity of this study were of concern. Limited participant information was available (i.e. whether the participants had received previous stuttering therapy) and the sample size was small (n = 6). Given

the extended period of treatment time (up to twenty weeks), maturation could have played a role in treatment outcomes.

The following five tables are provided to present key information from the previous paragraphs in a more concise form. For each of the tables, the first column always contains the author(s) of the document and the year of publication. The second column contains the study design/quality assessment rating assigned to the document during the course of this review. Table 5 (Participant Information Table) provides information regarding the number of study participants, the location of the research study, and the gender, age, diagnosis, technology experience, and education level of the study participants. Table 6 (Technology Table) provides information on the type of technology that was used in each of the checklist-reviewed studies. Table 7 (Diagnosis and Outcome Measures Table) includes the primary diagnosis of study participants, study type (i.e. adult-treatment), and the outcome measure used to measure telehealth effectiveness. Table 8 (Statistics Table) includes a summary of statistics for each of the checklist-reviewed studies that included statistics within the study. Table 9 (Study Procedure and Overall Outcomes Table) includes information regarding the comparisons being made in each study (i.e. pre-treatment vs. post-treatment results), study type (i.e. treatment), and general study conclusions (i.e. positive).

Table 5: Participant Information Table.

Author	QA	Participants	Country	Male/Female	Average Age	Primary Diagnosis	Technology Experience	Education
Brennan et al., 2004	2+	40	US	23 (M)/17 (F)	43.6	TBI; CVA	Yes	Yes
Burns et al., 1998	3	1	US	1 (M)	57	Cerebral Palsy	NR	NR
Carpendo, 2006	3	1	US	1 (M)	82	Parkinson's Disease	NR	NR
Clark et al., 2002	3	1	US	1 (F)	52	LCVA	NR	NR
Cole et al., 1986	3	5	Australia	NR	School-Age	Articulation and Language Delay	NR	NR
Duffy et al., 1997 – Part A	2-	32	US	1 (M)/7 (F)/NR	66	CP; CVA; TBI; MS; Hx of Basilar Artery Aneurysm Repair	NR	NR
Duffy et al., 1997 – Part B	3	150	US	46 (M)/104(F)	56	Otolaryngologic, Neurogenic, Speech-Language, Psychiatric, Internal Medicine Disorders	NR	NR
Fitch & Cross, 1983	3	1	US	F	54	CVA	NR	NR
Georgeadis et al., 2004	2+	40	US	23 (M)/17 (F)	43.6	TBI; CVA	NR	Yes
Georges et al., 2004	3	24	US	NR	73	CVA; Pneumonia; GERD; CP; PD; Mental Status Changes; Glioblastoma; Closed Head Injury	NR	NR
Halpern et al., 2004	3	16	US	8 (M)/8 (F)	64.5	Parkinson's Disease	NR	NR
Harrison et al., 1999	3	1	Australia	1 (M)	5.1	Stuttering	NR	NR
Helm-Estabrooks & Ramsberger, 1986	3	1	US	1 (M)	52	CVA	NR	NR

Table 5: continued.

Author	QA	Participants	Country	Male/Female	Average Age	Primary Diagnosis	Technology Experience	Education
Hill et al., 2006	3	19	Australia	15 (M)/4 (F)	45	TBI; CVA; PD; HypoxicBI; Neurosurgery for Tumor	NR	NR
Hill et al., 2006	2+	18	Australia	12 (M)/6 (F)	59	CVA/TBI	NR	NR
Jessiman, 2003	3	2	Canada	NR	6.2	Articulation and Language Delay	NR	NR
Kully, 2000	3	1	Canada	1 (M)	38	Developmental Stuttering	NR	NR
Lalor et al., 2000	3	1	Australia	1 (M)	69	CVA	NR	NR
Mashima et al., 2003	2+	72	US	34 (M)/38 (F)	45	Voice Disorder	NR	NR
McCullough, 2001	3	4	Ireland	NR	Preschool	Down Syndrome; Cornelia de Lange Syndrome	NR	NR
Palsbo, 2007	1+	24	US	18 (M)/6 (F)	64	CVA	NR	NR
Sicotte et al., 2003	3	6	Canada	NR	3-12 (4); 17-19 (2)	Stuttering	NR	NR
Theodoros et al., 2006	3	10	Australia	8 (M)/2 (F)	73	Parkinson's Disease	NR	NR
Tindall & Wright, 2006	3	3	US	3 (M)	66.7	CVA	NR	Yes
Vaughn et al., 1987	3	NR	US	NR	NR	CVA	NR	NR
Waite et al., 2006	3	6	Australia	NR	4.3 - 6.8	Articulation Disorder	NR	NR
Wertz et al., 1987	3	36	US	NR	NR	Neurogenic Communication Disorder	NR	NR
Wertz et al., 1992	3	72	US	NR	NR	Neurogenic Communication Disorder	NR	NR
Wilson et al., 2004	3	5	Australia	2 (M)/3 (F)	4.2	Stuttering	NR	NR

Table 5: continued.

Note. CP = Cerebral Palsy; CVA = Cerebrovascular Accident; F = Female; GERD = Gastroesophageal Reflux Disease; Hx = History; LCVA = Left Cerebrovascular Accident; M = Male; MS = Multiple Sclerosis; NR = Not Reported; PD = Parkinson's Disease; QA = Quality Assessment; TBI = Traumatic Brain Injury.

Table 6: Technology Table.

Author	QA	Type of Technology Used
Brennan et al., 2004	2+	Videoconferencing
Burns et al., 1998	3	Videophone
Carpendo, 2006	3	NR
Clark et al., 2002	3	Videophone
Cole et al., 1986	3	Telephone
Duffy et al., 1997 - Part A	2-	Satellite
Duffy et al., 1997 - Part B	3	Satellite
Fitch & Cross, 1983	3	Telephone/Computer
Georgeadis et al., 2004	2+	Videoconferencing
Georges et al., 2004	3	Videoconferencing
Halpern et al., 2004	3	Personal Digital Assistant
Harrison et al., 1999	3	Videotape/Audiotape Mail-Ins; Telephone
Helm-Estabrooks & Ramsberger, 1986	3	Telephone
Hill et al., 2006	3	Videoconferencing
Hill et al., 2006	2+	Videoconferencing
Jessiman, 2003	3	Satellite
Kully, 2000	3	Videoconferencing
Lalor et al., 2000	3	Videoconferencing
Mashima et al., 2003	2+	Real Time Audio-Video Monitoring
McCullough, 2001	3	Interactive Audio-Visual Interface
Palsbo, 2007	1+	Videoconferencing
Sicotte et al., 2003	3	Videoconferencing
Theodoros et al., 2006	3	Videoconferencing
Tindall & Wright, 2006	3	Videophone

Table 6: continued.

Author	QA	Type of Technology Used
Vaughn et al., 1987	3	Computer-Assisted Delivery
Waite et al., 2006	3	Videoconferencing
Wertz et al., 1987	3	Closed-Circuit Television; Computer-Controlled Videolaserdisc over Telephone
Wertz et al., 1992	3	Closed-Circuit Television; Computer-Controlled Videolaserdisc over Telephone
Wilson et al., 2004	3	Videotape/Audiotape Mail-Ins; Telephone

Note. NR = Not Reported; QA = Quality Assessment.

Table 7: Diagnosis and Outcome Measures Table.

Author	QA	Primary Diagnosis	Child/ Adult	Dx/Tx	Outcome Measures Used
Brennan et al., 2004	2+	TBI; CVA	A	Dx	Percent Information Unit (used to rate SRP); Satisfaction Survey; Technology Experience Survey
Burns et al., 1998	3	Cerebral Palsy	A	Tx	N/A
Carpendo, 2006	3	Parkinson's Disease	A	Tx	Intelligibility Ratings; SPL levels; Satisfaction Survey
Clark et al., 2002	3	LCVA	A	Tx	FIM Scores
Cole et al., 1986	3	Articulation and Language Delay	C	Dx	Fisher Logemann Test of Articulation Competence; Renfrew Action Picture Test
Duffy et al., 1997 - Part A	2-	CP; CVA; TBI; MS; Hx of Basilar Artery Aneurysm Repair	A	Dx	Oral Motor Examination, Motor Speech Examination, Language Examination
Duffy et al., 1997 - Part B	3	Otolaryngologic, Neurogenic, Speech-Language, Psychiatric, Internal Medicine Disorders	A	Dx	Oral Motor Examination, Motor Speech Examination, Language Examination
Fitch & Cross, 1983	3	CVA	A	Tx	N/A
Georgeadis et al., 2004	2+	TBI; CVA	A	Dx	Percent Information Unit (used to rate SRP); Satisfaction Survey
Georges et al., 2004	3	CVA; Pneumonia; GERD; CP; PD; Mental Status Changes; Glioblastoma; Closed Head Injury	A	Dx	Videofluoroscopy
Halpern et al., 2004	3	Parkinson's Disease	A	Tx	Average dB SPL
Harrison et al., 1999	3	Stuttering	C	Tx	% Syllables Stuttered; Syllables Per Minute
Helm-Estabrooks & Ramsberger, 1986	3	CVA	A	Tx	NSST; BDAE Cookie Theft Description
Hill et al., 2006	3	TBI; CVA; PD; HypoxicBI; Neurosurgery for Tumor	A	Dx	Modified Frenchay Dysarthria Assessment; Assessment of Intelligibility of Dysarthric Speech; Perceptual Voice Analysis; Severity Rating Scale

Table 7: continued.

Author	QA	Primary Diagnosis	Child/ Adult	Dx/Tx	Outcome Measures Used
Hill et al., 2006	2+	CVA/TBI	A	Dx	Scores from BDAE-3 Short Form; Satisfaction Survey
Jessiman, 2003	3	Articulation and Language Delay	C	Dx/Tx	SPAT-D; Informal Probes; Parent Questionnaire
Kully, 2000	3	Developmental Stuttering	A	Tx	Perceptual Judgments
Lalor et al., 2000	3	CVA	A	Dx	Language and Dysphagia Evaluation
Mashima et al., 2003	2+	Voice Disorder	A	Tx	Perceptual Judgments; Acoustic Analysis; Satisfaction Ratings; Fiber-optic Laryngoscopy
McCullough, 2001	3	Down Syndrome; Cornelia de Lange Syndrome	C	Tx	Spontaneous Signing; Picture Selection, Picture Naming, Vocal Imitation
Palsbo, 2007	1+	CVA	A	Dx	NOMS; Subset of BDAE; Open-Ended Questions
Sicotte et al., 2003	3	Stuttering	C/A	Dx/Tx	%SS; Satisfaction Questionnaire; Attendance Log; Structured Interview
Theodoros et al., 2006	3	Parkinson's Disease	A	Tx	SPL Ratings; Pitch Range; Perceptual Ratings
Tindall & Wright, 2006	3	CVA	A	Tx	WAB-AQ Scores; Word Lists
Vaughn et al., 1987	3	CVA	NR	Tx	Language Battery (including PICA)
Waite et al., 2006	3	Articulation Disorder	C	Dx	Single-word Articulation Test; Perceptual Speech Sample Ratings; Oromotor Assessment
Wertz et al., 1987	3	Neurogenic Communication Disorder	NR	Dx	Motor Speech Evaluation; PICA; WAB; Mayo Clinic Language Evaluation; RCBA; Token Test
Wertz et al., 1992	3	Neurogenic Communication Disorder	NR	Dx	Motor Speech Evaluation; PICA; WAB; Mayo Clinic Procedures for Language Evaluation
Wilson et al., 2004	3	Stuttering	C	Tx	Speech Measures (%SS, SPM); Treatment Efficacy Measures (# weeks from start to end Stage I, # consultations to reach Stage II, mean duration of consultations, clinician time for each consultation, frequency of consultations); Parent Questionnaire

Table 7: continued.

Note. A = Adult; BDAE = Boston Diagnostic Aphasia Examination; C = Child; CP = Cerebral Palsy; CVA = Cerebrovascular Accident; dB SPL = Decibel Sound Pressure Level; Dx = Assessment; FIM = Functional Independence Measure; GERD = Gastroesophageal Reflux Disease; Hx = History; LCVA = Left Cerebrovascular Accident; MS = Multiple Sclerosis; N/A = Not Applicable; NOMS = National Outcomes Measurement Scale; NR = Not Reported; NSST = Northwest Syntax Screening Test; PICA = Porch Index of Communicative Ability; QA = Quality Assessment; RCBA = Reading Comprehension Battery for Aphasia; SPAT-D = Structured Photographic Articulation Test featuring Dudsberry; SPL = Sound Pressure Level; SPM = Syllables per Minute; SRP = Story Retell Procedure; TBI = Traumatic Brain Injury; Tx = Treatment; WAB-AQ = Western Aphasia Battery - Aphasia Quotient; %SS = Percentage of Syllables Stuttered.

Table 8: Statistics Table (for studies using statistical analysis).

Author	QA	Summary of Statistics
Brennan et al., 2004	2+	Two-tailed paired samples *t*-test: no significant scores across settings (p=.49), high correlation (r=.93) between T and FTF scores; One-way ANOVA using difference scores (change T-FTF) among descriptive variables: no significant differences (p=.12 - age; p = .79 - education; p = .74 - technology experience; p = .53 - gender)
Georgeadis et al., 2004	2+	Two-tailed paired samples *t*-test: no significant scores across settings (p=.495); One-way ANOVA using difference scores (change T-FTF) - p=.069 for all 3 groups --- post hoc testing no significant difference
Halpern et al., 2004	3	*t*-Test: significant change for all participants pre to post treatment and pre to 6 months post tx (p<.0001); *t*-Test: no significant differences in delayed treatment group during no treatment month (p >.01)
Hill et al., 2006	3	Severity rating scale: +/- .9 scale point for LOA, 100% close agreement; Perceptual voice analysis: 15/26 variables met criteria for % LOA analysis; ASSIDS: % LOA - 83.33% & 100%; FDA: % LOA within clinical criteria for 15/19 subtests
Hill et al., 2006	2+	Wilcoxon Signed Ranks test: no significant difference between OL & FTF score (p<.05) for 24 subtests, significant difference between OL & FTF scores on BNT (p=.046); Spearman's rho correlation: significant correlation between OL & FTF (rho - .51-1.0) - 75% above .9
Mashima et al., 2003	2+	Participant satisfaction: no difference between groups (p<.354); Fiber-optic laryngoscopy: no difference between groups (p<.331); Acoustic analysis (Anova 2): jitter - no difference between groups (p<.390) - small effect size (.29), shimmer - no difference between groups (p<.260) - small effect size (.12); Perceptual judgments: no difference between groups (p<.394)
Palsbo, 2007	1+	% Within 95% Limit of Agreement (92% FTF/92%-100% T); % Exact Agreement (50%-67% FTF/8%-25% T); % Within One Point Agreement (92% FTF/92%-100% T)

Table 8: continued.

Author	QA	Summary of Statistics
Theodoros et al., 2006	3	Paired *t*-tests: significant increases for sustained phonation, reading, and conversational speech (p = .0001), significant increases in pitch range (p = .032); Wilcoxon Signed Ranks test: significant improvements in breathiness (p = .011), loudness level (p = .008), pitch variability (p = .005), and loudness variability (p = .008), non-significant improvements in hoarseness, intelligibility, and articulatory precision
Wertz et al., 1987	3	Kappa Analysis comparing diagnosis in 3 conditions (FTF-Television; FTF-Videolaserdisc; Television-Videolaserdisc): 20/21 comparisons for specific disorders in combinations of conditions showed significant agreement (p<.05 or better); ANOVA: no significant difference in patient performance on any measure among conditions
Wertz et al., 1992	3	Kappa Analysis comparing diagnosis in 3 conditions (FTF-Television; FTF-Videolaserdisc; Television-Videolaserdisc): 20/24 comparisons for specific disorders in combinations of conditions showed significant agreement (p<.05 or better); Correlations of performance between combinations of conditions (.89-.98) all significant (p<.001); Paired *t*-tests: significant difference (p<.05) for PICA Overall score between FTF and videolaserdisc and between television and videolaserdisc, no significant differences (p<.05) among conditions for WAB-AQ or WAB-CQ

Note. ASSIDS = Assessment of Intelligibility of Dysarthric Speech; BNT = Boston Naming Test; FDA = Frenchay Dysarthria Assessment; FTF = Face-to-Face; Level of Agreement; OL = online; PICA = Porch Index of Communicative Ability; QA = Quality Assessment; T = Telehealth; WAB-AQ = Western Aphasia Battery – Aphasia Quotient; WAB-CQ = Western Aphasia Battery – Cortical Quotient.

Table 9: Study Procedure and Overall Outcomes Table.

Author	QA	Comparisons Being Made	Dx/Tx	Conclusions Regarding Telehealth
Brennan et al., 2004	2+	FTF and T Results	Dx	Positive
Burns et al., 1998	3	N/A	Tx	Positive
Carpendo, 2006	3	Pre and Post Tx Results	Tx	Positive
Clark et al., 2002	3	Pre and Post Tx Results	Tx	Positive
Cole et al., 1986	3	FTF and T Results	Dx	Positive
Duffy et al., 1997 - Part A	2-	FTF and T Results	Dx	Positive
Duffy et al., 1997 - Part B	3	N/A	Dx	Positive
Fitch & Cross, 1983	3	Pre and Post Tx Results	Tx	Positive
Georgeadis et al., 2004	2+	FTF and T Results	Dx	Positive
Georges et al., 2004	3	N/A	Dx	Positive
Halpern et al., 2004	3	FTF and T Results	Tx	Positive
Harrison et al., 1999	3	Pre and Post Tx Results	Tx	Positive
Helm-Estabrooks & Ramsberger, 1986	3	Pre and Post Tx Results	Tx	Positive
Hill et al., 2006	3	FTF and T Results	Dx	Positive
Hill et al., 2006	2+	FTF and T Results	Dx	Positive
Jessiman, 2003	3	FTF and T Results; Pre and Post Tx Results	Dx/Tx	Positive
Kully, 2000	3	Pre and Post Tx Results	Tx	Positive
Lalor et al., 2000	3	N/A	Dx	Mixed
Mashima et al., 2003	2+	FTF and T Results	Tx	Positive
McCullough, 2001	3	Pre and Post Tx Results	Tx	Positive
Palsbo, 2007	1+	FTF and T Results	Dx	Positive
Sicotte et al., 2003	3	Pre and Post Tx Results	Dx/Tx	Positive
Theodoros et al., 2006	3	Pre and Post Tx Results	Tx	Positive

Table 9: continued.

Author	QA	Comparisons Being Made	Dx/Tx	Conclusions Regarding Telehealth
Tindall & Wright, 2006	3	Pre and Post Tx Results	Tx	Positive
Vaughn et al., 1987	3	FTF and T Results	Tx	Positive
Waite et al., 2006	3	FTF and T Results	Dx	Positive
Wertz et al., 1987	3	FTF and T Results	Dx	Positive
Wertz et al., 1992	3	FTF and T Results	Dx	Positive
Wilson et al., 2004	3	Pre and Post Tx Results	Tx	Mixed

Note. Dx = Assessment; FTF = Face-to-Face; N/A = Not Applicable; QA = Quality Assessment; T = Telehealth; Tx = Treatment

The documents that were not accepted for quality assessment checklist review were review articles that summarized telehealth practice within the field of speech-language pathology, articles featuring telehealth practice without mention of specific participant/study information, opinion pieces, documents published prior to 1982, and professional association documents. Biographical references for these non-checklist reviewed articles can be found in Appendices D – F.

As indicated by the previously presented information, telehealth has been investigated in a variety of contexts within the field of speech-language pathology. Researchers in the field of communication disorders have taken steps to establish the validity and reliability of telehealth in speech-language pathology practice. However, in spite of the various communication disorders investigated with telehealth research, the array of individuals that have been assessed and/or treated via telehealth technology, and the generally positive results of speech-language pathology telehealth research, there remain obvious gaps in the literature base and more research needs to be done.

CHAPTER VI

DISCUSSION

Patterns Noted from Research Findings

As evidenced by the above findings, telehealth has been researched from a wide variety of angles within the field of speech-language pathology. Of the twenty-eight checklist reviewable studies, seventeen were conducted in the United States and eight were conducted in Australia. Researchers in these two countries have led the drive for research involving telehealth practice in speech-language pathology. The telehealth practice researchers, whose documents are presented for review in this study, obtained information for their studies in one of two primary scenarios. In some cases, both the SLPs and participants were located in the same building and the purpose of the study was to investigate the potential uses of telehealth in speech-language pathology in a controlled research environment. In other cases the SLPs were located within a larger medical/office setting and assessment and/or treatment sessions were conducted with a participant(s) who had limited access to speech-language pathology services in a rural location. Regardless of the scenario, valuable information regarding telehealth practice has been obtained and reported on in the research since its use in the field of speech-language pathology was first documented.

The documents included for review in this study represent a variety of research styles and are of varying quality. Of the twenty-eight checklist reviewed documents, one

article received a ranking of '1' and five articles received a ranking of '2' for study type. The rankings of '1' and '2' were the highest assigned ratings based on the SIGN information used in this review (Chapter 2). According to the SIGN recommendations, the articles that received rankings of '1' and '2' also received an additional plus/minus rating based on the overall quality of the study (Chapter 2). The study receiving a '1' received a '+' and four of the studies receiving a '2' received a '+'. The studies that received the rankings of '1+' and '2+' are considered to be studies with a high level of evidence and represent the best available speech-language pathology telehealth research. The authors of these studies used larger sample sizes (18-72 participants), assessed research outcomes with measures that had established validity and reliability, performed statistical analysis of their study results, measured reliability of study results, and ensured the internal and external validity of study results through appropriate study design. The study receiving a ranking of '1' included randomization which also increased the evidence of the study design. These five high level of evidence studies all involved telehealth research with adult populations who had neurological disorders or voice disorders. Four of the five studies were diagnostic in nature and all of the studies involved a comparison of face-to-face service delivery with telehealth service delivery. All five high level of evidence studies used videoconferencing technology as the means for telehealth service delivery. Based on the results of each of these studies, the authors concluded that telehealth delivery results and face-to-face delivery results were equivalent. However, the authors of these studies noted that telehealth service delivery was not a complete replacement for face-to-face service delivery but left the impression that given the positive findings, telehealth practice may be appropriate when combined

with strategically planned face-to-face therapy sessions. All of these studies recommended that further research be conducted on the practice.

While it was encouraging that the authors of these high level of evidence studies reported equivalent results of telehealth and face-to-face service delivery, caution should taken by readers of these studies. 'Equivalent' should not be used based on non-rejection of the null hypothesis. Additionally, it should not be said that results were 'equivalent' based on non-significant results between the two service delivery scenarios. It is possible that there was not enough statistical power to detect significance within the studies.

The remaining twenty-two checklist-reviewed documents received SIGN rankings of '3' indicating that these studies were preliminary documents including pilot studies, case studies, and conference presentations. Twelve of these studies focused on adult populations, six focused on child populations, one study was a mix of both populations, and three studies did not report age information. Seven of these studies were diagnostic in nature, thirteen studies were treatment in nature, and the remaining were a combination of diagnostic and treatment in nature. In the adult population studies, the participants had diagnoses of neurological disorders or fluency disorders. In the child population studies, the participants had diagnoses articulation and language delay or fluency disorders. Seven of these studies used technology that did not allow for face-to-face visualization (telephones, mail-ins, computers, and personal digital assistants). Fourteen studies used videophones, videoconferencing, or satellite link-up to provide a simulated face-to-face component to telehealth sessions. One study did not report the type of technology used in the study. The outcome measures used to measure progress in these studies were a combination of measures with and without good validity and reliability information. Five

of these studies reported statistical analysis results obtained from the study data. All but two of the studies reported positive results for telehealth service delivery. Two studies reported 'mixed' results for telehealth services delivery. In one of these instances, telehealth services required more clinician time in order for the clinician to organize treatment materials to be mailed to the study participant. In the other instance, the study participant was an Aboriginal man from Australia and technology training proved to be difficult for the participant and his caregiver, likely given their cultural lifestyle (Lalor et al., 2000). While these studies were considered to be of a lower level of research design, the results of the studies were consistent with the results of the higher level of research studies which helped to further validate the appropriateness of telehealth practice in speech-language pathology.

For the twenty-eight checklist reviewed studies, videoconferencing or other technology equipment allowing the participant and clinician to visualize each other was used for research purposes in twenty instances. As previously noted, all five high level of research studies employed such technology. This was likely the most popular form of technology chosen for telehealth sessions as technology such as videoconferencing closely simulates face-to-face sessions. It allows for the use of both the auditory and visual modalities. This is particularly important for some disorders assessed and treated by SLPs. Many articulation errors require that the SLP be able to visualize the error in order to make an accurate diagnosis. When working with patients who have fluency disorders, secondary behaviors are typically only detected when visible. Visualization of the SLP is also beneficial for the patient during telehealth sessions as he/she can often

better follow the instructions of the SLP when he/she can see facial expressions and hand gestures from the clinician.

For the studies with concerns regarding internal validity, the primary problems included limited participant information, use of unidentified outcome measures or outcome measures without established validity and reliability, or limited information regarding study procedure and/or technology selection. In cases where external validity was of concern, it was commonly due to the use of participant samples that limited the generalization of the study results such as the use of participants with specific characteristics mild-moderate aphasia) and small sample sizes. With the exception of one study which included 150 participants, all studies had small sample sizes with seventy-two participants or less.

Evidence-Based Practice Issues

As previously noted, an ASHA position statement from 2005 stated that SLPs should use EBP when making clinical decisions to ensure that the highest quality clinical services are provided to patients (ASHA, 2005). When considering EBP, the goal is for the SLP to provide services that have been determined to be 'sound' as based on clinical research evidence.

Based on the positive results of studies presented in this modified narrative review and recommendations from telehealth researchers, ASHA endorsed telehealth practice for the field of speech-language pathology. Many ASHA telehealth-related documents, including the technical report on telehealth and knowledge and skills report on telehealth, reference a number of telehealth documents supporting the practice. However, the referenced documents largely consist of professional association documents and small

research studies, many of which are reviewed or referenced in this document. Despite the positive results of research studies and subsequent telehealth endorsement, the evidence base for telehealth practice in speech-language pathology remains weak with only five high level of research studies readily available in the literature. At the time of release of ASHA's telehealth position statement, only three of the higher-level research studies noted in this review were available as published documents which may indicate some prematurity in ASHA's decision to put full association support behind the practice. As the recommendations within the reviewed documents suggested, research of telehealth practice should be continued in order to further strengthen the evidence base.

Based on the available information from this review and telehealth practice use information obtained from other disciplines, ASHA's foresight in its endorsement of telehealth practice was monumental in recognizing the future of technology within the profession. In spite of positive results documented in early research and ASHA's endorsement of telehealth practice, the association's support appears premature and inconsistent when considering the relatively weak evidence base and the established and widely supported EBP guidelines set forth by ASHA.

Future Considerations

Based on the previously noted findings, researchers have made great strides in attempts to establish telehealth as an accepted practice in the field of speech-language pathology. However, several issues should be addressed as telehealth becomes a more frequently used practice in speech-language pathology.

Telehealth has been investigated in multiple realms within speech-language pathology. However, as previously noted, the only areas of telehealth service delivery

that have been confidently investigated with high-powered research studies involve adult populations with neurological and voice disorders. While telehealth service delivery with children has been researched and appears to have great potential within the field, the high-powered data to support telehealth practice with this population is not yet available in the literature.

As previously noted, both diagnostic and treatment studies have been conducted with child and adult participants. Multiple disorders, including language, articulation, voice, motor speech, dysphagia, and fluency disorders, have been studied. In spite of the available studies, the overall evidence base remains weak and research into telehealth practice should continue. To further establish the evidence base for telehealth practice, more high level research studies should be conducted. Future studies should have larger sample sizes and include more detailed information on participant characteristics and study methodology for study replication purposes.

Future speech-language pathology telehealth studies should consider the effects of the participant's background history on their ability and willingness to use telehealth equipment. Kushniruk (2004) noted the importance of 'usability testing' to determine problems that individuals of various ages and levels of education would be likely to encounter when working with telehealth technology. Factors such as socio-economic status, education history, and technology experience could all affect a participant's ability and willingness to comply with a speech-language pathologist's instructions for using telehealth equipment appropriately. However, as time continues to pass, these issues will likely become less relevant as recent generations have been introduced to technology early in life and are accustomed to using various types of technology in daily activities.

From the earliest recognized speech-language pathology telehealth study in 1976 which employed a telephone for service delivery, technology has become more advanced to the point of more recent studies utilizing satellite-based videoconferencing for telehealth research. Technology will continue to evolve with time and electronics manufacturers are continually releasing faster, smaller, and more affordable products to consumers. Research studies should continue in order to ensure the profession remains competitive among other allied health professions in providing the best available services to patients as new technology is made available.

An additional factor that should be considered within the telehealth domain involves the determination of the most appropriate telehealth equipment for individuals receiving speech-language therapy services. As previously noted, videoconferencing has recently been the most widely used technology when conducting telehealth research studies. This technology method allows users to take advantage of both the auditory and visual modalities for therapy activities. However, videoconferencing may not always be the most appropriate technology for all disorders and populations. Additionally, information specific to each piece of telehealth equipment must be determined and standards set to ensure that selected equipment is set up with minimum established standards for operation and use. The Speech-Language Pathologists Providing Clinical Services via Telepractice: Technical Report (2005) noted that minimal technical specifications such as resolution and transmission rate should be set to ensure that optimal telehealth services are provided to patients.

In the process of this review, a number of 'in progress' studies were located. These studies are investigating telehealth assessment and treatment for a variety of

disorders including TBI, Parkinson's disease, and dysphagia. It is hoped that the researchers of these studies will take into account the findings and recommendations of this review and incorporate them into their research to further strengthen the evidence base for telehealth practice in speech-language pathology.

As research continues, telehealth service delivery will likely continue to increase, particularly as a supplement to face-to-face service delivery. Based on the current available research, telehealth promises to be an exciting option for providing services to patients who are remotely located or unable to attend regularly scheduled therapy services at an on-site location. Other perceived benefits of telehealth practice for patients include an increased amount of contact between patients and clinicians, reduced time for patients spent in facility waiting rooms, and a reduction in parking challenges and traveling expenses for patients coming to facilities for outpatient services. Perceived benefits of telehealth practice for clinicians include increased patient contact hours, a reduction in traveling expenses for home health clinicians, and a reduction in non-productive time spent in the event of patient 'no-shows' in clinical practice. Positive results for telehealth practice have been reported in the majority of studies that have been conducted thus far and as noted, the benefits of telehealth extend to both professionals in the field and patients receiving therapy services. However, as previously stated, research should continue to be conducted on the practice prior to widespread use of telehealth in the clinical environment.

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APPENDIX A

METHODOLOGY CHECKLIST

METHODOLOGY CHECKLIST
(adapted from SIGN Methodology Checklist 1: Systematic Reviews and Meta-analyses; Checklist 2: Randomised Controlled Trials; and Checklist 3: Cohort Studies)

Study identification (include authors, title, year of publication, journal title, volume, inclusive pages):
_____
_____

Guideline topic:_____ **Key question number:**_____

Checklist completed by:_____ **Study Design:** _____ **Level:** ____

SECTION 1: INTERNAL VALIDITY			
In a well conducted study:		***In this study the criterion:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	A description of the methodology used is included.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	The assignment of subjects to treatment groups is randomized.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid, and reliable way.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
SELECTION OF SUBJECTS			
1.7	The two groups being studied are selected from source populations that are comparable in all respects other than the factor under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.8	What percentage of individuals or clusters recruited into each arm of the study dropped out before the study was completed.		

ASSESSMENT			
1.9	The outcomes are clearly defined.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.10	The assessment of outcome is made blind to exposure status.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.11	Where blinding was not possible, there is some recognition that knowledge of exposure status could have influenced the assessment of outcome.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.12	Evidence from other sources is used to demonstrate that the method of outcome assessment is valid and reliable.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
CONFOUNDING			
1.13	The main potential confounders are identified and taken into account in the design and analysis.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
STATISTICAL ANALYSIS			
1.14	Have confidence intervals been provided?		
SECTION 2: OVERALL ASSESSMENT OF THE STUDY			
2.1	How well was the study done to minimize the risk of bias or confounding, and to establish a causal relationship between exposure and effect? *Code ++, +, or -*		
2.2	Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the exposure being investigated?		
2.3	Are the results of this study directly applicable to the patient group targeted in this guideline?		
SECTION 3: DESCRIPTION OF THE STUDY (Note: The following information is required for evidence tables to facilitate cross-study comparisons. Please complete all sections for which information is available). PLEASE PRINT CLEARLY			
3.1	How many patients are included in this study? *List the number in each group separately.*		

3.2	What are the main characteristics of the study population? *Include all relevant characteristics – e.g. age, sex, ethnic origin, comorbidity, disease status/diagnosis, education, technology experience, community/hospital based.*	
3.3	What environmental or prognostic factor is being investigated in this study?	
3.4	What comparisons are made in the study? *Are comparisons made between presence or absence of an environmental / prognostic factor, or different levels of the factor?*	
3.5	For how long are patients followed-up in the study?	
3.6	What outcome measure(s) are used in the study? *List all outcomes that are used to assess the impact of the chosen environmental or prognostic factor.*	

3.7	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. absolute or relative risk. Include p values and any confidence intervals that are provided.* ***Note****: Be sure to include any adjustments made for confounding factors, differences in prevalence, etc.*	
3.8	How was this study funded? *List all sources of funding quoted in the article, whether government, voluntary sector, or industry.*	
3.9	Does this study help to answer your key question? *Summarize the main conclusions of the study and indicate how it relates to the key question.*	
3.10	How were participants selected for this study?	

3.11	What type of telehealth consultation was used? *(e.g. speech-language assessment, speech-language intervention technique/program)*	
3.12	What type of technology was used in this study?	
3.13	What were the conclusions regarding telehealth practice based on the outcomes of the study?	
3.14	What reliability data is included in the study?	
3.15	What validity data is included in the study?	

APPENDIX B

STUDY EVALUATION LIST

The following is a partial list of characteristics/items that will be evaluated in each article or study. This list is currently incomplete because the final list will be dependent on the exact studies accepted for the review.

Method Used (study design)

Level of Evidence Ratings

Internal/External Validity Judgments

Reliability Information

Participants

- -number of participants
- -participant characteristics (age, education, gender, technology experience)
- -method of selection
- -speech-language pathology diagnosis

Type of Telehealth Consultation

- -assessment protocol
- -intervention technique

Type of Technology Used

Outcomes of Research

APPENDIX C

ARTICLE REFERENCES FOR REVIEWABLE ARTICLES

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APPENDIX D

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