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The Use of Video-Teleconferencing to Deliver Voice Therapy At-A-Distance

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Abstract

Telehealth or telemedicine is the use of telecommunications technology to deliver health care services at-a-distance. One of the most commonly recognized benefits of telehealth is improved access to services which includes the opportunity for patients to receive care that otherwise would not be available due to lack of specialists in a geographic area, distance from health care facilities, or lack of transportation. By eliminating geographic considerations, global delivery of health care is possible. One of the barriers to the deployment and widespread use of telehealth is the lack of evaluative data or evidence to prove that this innovative model of service delivery is as effective as the traditional in-person model of delivering health care.

This study investigated the telehealth model of delivering speech-language pathology services at-a-distance. Pre-existing de-identified data were analyzed to describe the feasibility of, patient satisfaction with, and effectiveness of delivering voice therapy remotely using video-teleconferencing. The de-identified data were collected during the operationalization phase of a stepwise process to develop a telehealth vocal rehabilitation protocol. There were 31 participants in this study. Twelve participants in the control group received voice therapy in person at an urban medical center and 19 participants in the experimental telehealth group received voice therapy delivered via video-teleconferencing between the urban medical center and two remote sites: a rural satellite clinic and an overseas clinic.

Comparisons of pre- and post-treatment data on: 1) patient self-rating on the Voice Handicap Index, 2) auditory-perceptual ratings of voice samples, 3) visual-perceptual ratings of video endoscopic laryngeal exams, and 4) noise-to-harmonic ratios indicated no significant

differences between participants who received voice therapy in-person and participants who received therapy remotely via video-teleconferencing. Quantitative analyses of four treatment outcome measures support the effectiveness of delivering voice therapy at-a-distance using video-teleconferencing technology.

Qualitative methods of evaluation were used to explore participants' opinions and capture rich descriptions of their experiences with telehealth. Questionnaires and interviews focused on eliciting overall impressions including satisfaction with and comfort in receiving therapy remotely. Triangulation involved gathering accounts from participants in different roles and comparing results with different sources including existing literature and expert opinion. The following themes emerged from the data: benefits of telehealth (improved access to services, convenience, time savings, cost savings); clinical interactions via video-teleconferencing (initial approach and comfort level, therapy process, patient privacy and confidentiality, innovation); and response to telehealth services (comparing modes of receiving services, patient satisfaction, treatment outcomes). Based upon qualitative analysis of data, the telehealth vocal rehabilitation protocol appears to be: 1) feasible in terms of overcoming barriers to care, and 2) effective in terms of yielding desirable clinical outcomes. However, overcoming administrative, personnel, equipment, technical, workflow, and service delivery issues required time and effort to facilitate successful deployment.

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CHAPTER 1: INTRODUCTION

Introduction

Speech and language disorders affect one's ability to talk, understand, read, and write, and may range from a few speech sound errors to a total loss of the ability to use speech to communicate effectively. It is estimated that more than 46 million people in the United States have some form of disordered communication (National Institute on Deafness and Other Communication Disorders, 2008). Without proper diagnosis and treatment, learning abilities, employment opportunities, and ultimately an individual's standard of living could be severely impacted. Speech-language pathologists (SLPs) evaluate, diagnose, and treat communication disorders in individuals of all ages, from infants to the elderly. The American Speech-Language-Hearing Association (ASHA) is the professional, scientific, and credentialing association for more than 140,000 members and affiliates who are SLPs, audiologists, and speech, language, and hearing scientists in the United States (U.S.) and internationally (American Speech-Language-Hearing Association [ASHA], 2010a). One of its missions is to advocate on behalf of persons with communication and related disorders to ensure their access to quality services.

A significant problem in many geographical areas is a shortage of SLPs. According to the U.S. Bureau of Labor Statistics, employment of SLPs is expected to grow 19 percent from 2008 to 2018, faster than the average for all occupations (Bureau of Labor Statistics, U.S. Department of Labor, 2010). Greater awareness of the importance of early identification and diagnosis of speech and language disorders in young children will increase employment in school settings, particularly with the 2004 Individuals with Disabilities Education Act, a Federal law that guarantees special education and related services to all eligible children with disabilities. A

survey of schools conducted by ASHA in 2006 identified school districts with significant personnel shortages; 68% of respondents reported that job openings were more numerous than job seekers (ASHA, 2006).

In health care facilities, the need for SLPs will increase along with the demand for services for individuals with disabilities or limited function. As the baby-boom generation ages, the possibility of neurological disorders and associated speech, language, and swallowing impairments increases. Medical advances are also improving the survival rate of premature infants, and trauma and stroke victims who often require speech-language pathology (SLP) services (Bureau of Labor Statistics, U.S. Department of Labor, 2010). A health care survey conducted by ASHA in 2009 indicated that 25% of respondents had unfilled positions in their health care facility. The highest percentage of vacancies (36%) was in home health (ASHA, 2009). Although the rate of reported vacancies of SLPs in health care has decreased from its high of 40% in 2005 (ASHA, 2005a), these shortages are still most likely to be felt in rural and underserved areas.

In 1985, ASHA sponsored a National Colloquium on Underserved Populations to identify barriers to service delivery and establish an action plan. One aim of the action plan was to review alternate methods of SLP service delivery that could overcome the personnel and geographic barriers inherent in remote or rural areas (ASHA, 1991). A focused initiative for ASHA from 2001 to 2003 was promoting the use of Web-based and advanced technology to enhance the provision of clinical services and personnel preparation.

Telemedicine is defined as the use of telecommunications technologies to provide medical information and services (Perednia & Allen, 1995). Telemedicine evolved into telehealth with the passing of the 1997 Comprehensive Telehealth Act, which expanded the

focus from physician-only services to services provided by other health professionals including SLPs (ASHA, 1998). One of the most commonly recognized benefits of telehealth is the opportunity for patients to have improved access to services which includes the capability to receive care that previously was not available due to distance from health care facilities, lack of specialists in a geographic area, or lack of transportation (Agency for Health Care Policy and Research, 2001). In fact, by eliminating distance considerations, global delivery of health care services is possible. The term "telepractice" was adopted by ASHA in 2001 to encompass a range of services provided through telecommunications technology that is not exclusively health related, including communication enhancement, education, and supervision in school and health care settings (ASHA, 2001). ASHA's position is that telepractice is an appropriate model of service delivery for the profession of SLP, and may be used to overcome barriers of access to services caused by distance, unavailability of specialists and/or subspecialists, or impaired mobility (ASHA, 2005b).

The potential benefit of telehealth in SLP is significant in light of decreasing costs of telecommunications technologies and devices, more widespread connectivity, personnel shortages, and increasing demand for home health care. In addition to improving accessibility to and increasing availability of services, telehealth enables the delivery of care in the least restrictive environment, increases participation of family members in the clinical process, and increases efficiency in delivering services, particularly for itinerant clinicians.

To fulfill the possibilities of telehealth in enhancing the practice of SLP, research is needed to determine appropriate applications. Telehealth clinical protocols need to be developed and validated, and clinical outcomes including patient reception need to be evaluated. Ethnographic techniques can provide valuable insights into factors underlying patient satisfaction

and dissatisfaction with telehealth (May et al., 2003). Examining patient perceptions would help to address reasons why patients liked or disliked telehealth services and enable health care providers to better understand patients' subjective definitions of the acceptability and utility of telehealth (Mair & Whitten, 2000).

Statement of Purpose

Despite a substantial body of literature advocating the use of telehealth for an increasing array of disciplines and applications in a variety of environments, questions persist about the quality of telehealth. This is attributed in part to its inconsistent nature which ranges from anecdotal accounts of telehealth applications to well-controlled randomized clinical trials (Krupinski et al., 2006). The existing literature on telehealth applications in SLP consists primarily of preliminary investigations and demonstration projects with few empirical studies. Research is needed to support the integration of telehealth into the health care continuum and promote its long-term acceptance. To fulfill the potential that technology offers in delivering SLP services remotely, clinical protocols must be developed and matched with technical requirements. Data from controlled studies are needed to guide evidence-based practice and ensure accurate diagnoses and efficacious treatment of communication disorders via telehealth.

In addition to personnel shortages that limit the accessibility to or availability of SLP services, underserved areas are also less likely to have SLP subspecialists including clinicians with expertise in evaluating and treating voice disorders. It is estimated that voice disorders affect as much as 10% of the U.S. population, with higher frequency for those who depend on their voice for work, such as teachers (ASHA, 2008). Vocal problems can impact careers (e.g., receptionists, broadcasters), reduce profits for a company (e.g., salespeople, telemarketers), and

jeopardize public safety if there is miscommunication of key facts and directives (e.g., emergency vehicle dispatchers, law enforcement officers, armed forces service members) (Titze, Lemke, & Montequin, 1997). For individuals with voice disorders, vocal rehabilitation can restore and preserve quality of life and possibly improve one's economic situation. SLPs play an essential role in treating voice disorders (Ramig & Verdolini, 1998). The use of technology offers the potential to overcome geographic and personnel barriers for individuals in need of vocal rehabilitation.

This study analyzed de-identified data to describe the feasibility of, patient satisfaction with, and effectiveness of delivering voice therapy remotely using video-teleconferencing. The data were collected during the operationalization phrase of a telehealth research protocol. The development of the vocal rehabilitation protocol is described in Chapter 3 (pages 34 to 48).

Research Questions

Quantitative Research Question: Is the use of video-teleconferencing for remote delivery as effective as in-person delivery of treatment for voice disorders?

Qualitative Research Question: How is the telehealth model of treating voice disorders perceived by patients and health care providers?

CHAPTER 2: REVIEW OF THE LITERATURE

Chapter 2 provides a historical perspective of telemedicine or the use of telecommunications technology for medical, diagnostic, monitoring, or therapeutic purposes, which expanded into telehealth to encompass applications across the full spectrum of health sciences, and evolved into telepractice to include a range of services provided by SLPs and audiologists that are not exclusively health related. Because telepractice represents an innovative model of service delivery rather than a new clinical service or procedure, the review of literature includes applications of the telehealth or telepractice model to assess and treat a range of disorders across subspecialties in SLP. The chapter concludes with a summary of issues related to delivering SLP services at a distance.

History of Telemedicine

While the vast majority of telemedicine applications have occurred in the last 20 to 30 years with concomitant advances in information technology, its history is much older. The prefix "tele-" is derived from Greek meaning "at a distance, far off, far away, or far from." Thus, the terms "telemedicine" and "telehealth" refer to medicine or health at-a-distance. In fact, if telehealth is considered as any medical service performed remotely regardless of how information is transmitted, the first public health surveillance network originated in the Middle Ages when information about the bubonic plague was communicated across Europe by methods such as bonfires (Craig & Patterson, 2006).

Developments in national postal services and telegraphy in the mid-19th century facilitated the delivery of personal health care from afar. For example, during the American Civil War, the telegraph was used to order medical supplies and transmit casualty lists. Since its invention in the late 19th century, the telephone has been used for delivering health services. As early as 1910, amplified sounds from a stethoscope were transmitted through the telephone network. Similar devices are still used today in addition to other applications that have evolved,

including transmission of electrocardiograms and electroencephalograms (Craig & Patterson, 2006).

When communication by radio became possible at the end of the 19th century, its utility in providing medical advice for seafarers was quickly recognized. In 1920, the Seaman's Church Institute of New York was one of the first organizations to provide medical care using the radio. By 1938, more than five maritime nations established radio medical services including the International Radio Medical Centre headquartered in Rome, Italy which assisted over 42,000 patients from 1935 to 1995. At present, radio medical advice is provided for in-flight medical incidents by on-call health care workers on the ground (Craig & Patterson, 2006).

Foundation of Modern Telemedicine

Recent advances in telemedicine are based upon innovations in electronic methods of communication including digital techniques, and the pioneering efforts of a few organizations and individuals including the manned space-flight program of the National Aeronautics and Space Administration (NASA). By the late 1950s, closed-circuit television and video communications were used by medical personnel in clinical situations. In 1964, a two-way closed-circuit television system permitted interactive consultations at-a-distance between specialists and general practitioners in a psychiatric institute and a state mental hospital in Nebraska. In 1967, a two-way audiovisual microwave circuit was established to link Massachusetts General Hospital and the Logan International Airport Medical Station for the provision of medical care to passengers and airport employees 24 hours a day. From 1971 to 1975, a program in Alaska assessed the viability of using satellite-mediated video consultation to improve village health care (Craig & Patterson, 2006).

Bashshur (2002) defines three eras in the evolution of telemedicine that are closely linked to advances in information technology, telecommunications, and computers. The telecommunications era of the 1970s and early 1980s depended on broadcast and television technologies that proved to be costly, complex, cumbersome, and often unreliable. Digitization in telecommunications and advances in computer processing marked the emergence of the digital era in the late 1980s. The Integrated Service Digital Network (ISDN) technology which enables simultaneous transmission of voice, video, and biometrics data at relatively high speeds within a "universal" network is a hallmark of this era. The present era in telemedicine is dominated by the powerful, less expensive, ubiquitous Internet which allows open access to a global communication environment.

The use of telecommunications technology has been explored in numerous medical specialties including radiology, dermatology, pulmonology, otolaryngology, ophthalmology, cardiology, oncology, surgery, psychiatry, psychology, rehabilitation, and home health care. Teleradiology is probably the most widespread and successful application of telemedicine. Digital radiology allows access regardless of geographical distance and significantly increases efficiency. Web-based software allows access to films through personal computers from any location with sufficient quality for most consultative needs (Burgess et al., 1999). However, despite innovations in applying technology to health care, traditional problems of access, availability, quality of service, and security persist (Bashshur, 2002).

A survey of telemedicine activity in the U.S. in 2002 indicated that over 85,000 teleconsultations excluding teleradiology were performed by more than 200 programs in over 30 specialties. Mental health, pediatrics, dermatology, cardiology, and orthopedics accounted for almost 60% of these teleconsultations. Although most operational telemedicine services are

located in industrialized countries including the U.S., Canada, Australia, and the United Kingdom (U.K.), there is evidence to suggest that global adoption is imminent in the future (Craig & Patterson, 2006).

Future Initiatives for Telemedicine

While technology may be available to establish connectivity for telemedicine virtually anywhere, other elements of infrastructure need to be addressed and resolved. In 2011, the American Telemedicine Association issued its policy priorities to allow patients, providers, and payers to realize the benefits of telemedicine. Changes needed in public policy include (American Telemedicine Association, 2011):

1. increasing federal coordination and impact on telemedicine by:
    a. mandating telehealth as a covered service under federal health benefit plans;
    b. integrating telemedicine into federal health care programs;
    c. focusing on opportunities to utilize telemedicine in the implementation of the national health insurance reform;
    d. extending Medicare coverage for telehealth services;
    e. resolving conflicts governing medical staff credentialing and privileging for telehealth networks;
    f. expanding the existing rural health care program to provide broadband services to all physicians and health care offices;
    g. providing financial and technical support for development of telemedicine networks through a variety of research, grant, and support programs;
2. increasing state support of telemedicine by:

a. expanding state Medicaid plans to cover telehealth services;
b. supporting state-funded initiatives including telehealth networks focused on specific medical conditions such as stroke, at-risk pregnancies, and traumatic brain injury, and in specific settings such as school-based clinics and correctional facilities;
c. supporting telehealth benefit coverage for state-regulated health benefit plans;
d. adopting collaborative agreements among states that facilitate physician and other health providers' licensure portability;
e. supporting the ability of patients to receive prescriptions for medication that are not designated as federally controlled substances over the Internet from a health care provider who is licensed and legally able to issue such a prescription at the location of the patient;
f. requiring insurance carriers to provide malpractice coverage for telehealth services;

3. insuring the coordination and usability of resources for emergency preparedness and response efforts (e.g., identify capacity of existing public health and health care networks to provide emergency services and determine how resources of such networks can best be used and incorporated into emergency response efforts); and

4. working with international organizations to maintain policy priorities to address the globalization of telemedicine.

Historical Perspective of Telehealth in Speech-Language Pathology

Early application of telecommunications technology in SLP focused on diagnosis and treatment of neurogenic communication disorders. In 1976, a "Tel-communicology" health care delivery system for veterans was developed to meet expanding demands, upgrade services, and overcome logistic problems. This system was designed to enhance rather than replace traditional programs to treat patients with communication disorders including aphasia and dysarthria (Vaughn, 1976). Beginning in 1987, investigators in Mayo Clinic facilities provided SLP telemedicine consultations for patients with communication disorders including dysarthria, apraxia, and cognitive-communication impairment. They concluded that telemedicine provides an appropriate medium for speech-language consultations that is reliably accurate in identifying various acquired neurogenic and psychogenic speech disorders (Duffy, Werven, & Aronson, 1997). In 1992, clinicians at the Veterans Affairs Medical Center in Martinez, California conducted a simulation study to compare in-person with "remote conditions" in the appraisal and diagnosis of aphasia, apraxia, dysarthria, and dementia. The agreement in diagnosis among appraisal conditions was 93% to 94%. Results suggested that either television or computer-controlled video laserdisc by telephone could be substituted for face-to-face (in-person) sessions (Wertz et al., 1992). More recently, clinicians in Australia, Canada, Greece, Ireland, Japan, the U.K., the U.S., and Sweden have been exploring the possibility of using telehealth to diagnose, assess, and provide treatment to individuals with communication disorders who otherwise may not have access to these services.

Review of Telehealth Activities in Speech-Language Pathology

A literature search on telehealth applications in SLP was conducted of current available resources including peer-reviewed journal articles, professional and lay articles, and policy statements by associations. The following terms were queried: telehealth, telemedicine, telepractice, telerehabilitation, speech pathology, speech-language pathology, communication disorders, speech therapy, and language therapy. The search resulted in 48 articles that are tabulated in Appendix A.

The existing literature consists primarily of pilot studies and anecdotal accounts of telehealth applications, and a limited number of empirical studies. A variety of venues are involved in the delivery of telehealth SLP services, including schools, medical centers, rehabilitation hospitals, specialty cancer care centers, outpatient clinics, residential health care facilities, rural community health centers, Veterans Administration Medical Centers, military medical facilities, universities, patient's homes, child care centers, and corporate settings (ASHA, 2010b). The majority of applications are aimed at reaching out to underserved populations in remote or rural areas within a district, county, state, province, or country to evaluate and/or treat speech, language, cognitive-communication, and swallowing disorders. The studies are summarized below according to disorder categories and telehealth issues.

Summary of Speech-Language Pathology Telehealth Applications

Neurogenic Communication Disorders

Many telehealth applications for neurogenic communication disorders have been reported since the pioneering studies of the 1970s and 1980s. Investigators at the Rehabilitation Engineering Research Center on Telerehabilitation at the National Rehabilitation Hospital

(NRH) in Washington, D.C. have been at the forefront in technology innovations to deliver SLP services to patients with history of cerebral vascular accident (CVA) or traumatic brain injury (TBI). They report that telehealth offers the potential to extend the continuum of care and improve clinical outcomes for these patients, particularly in light of insurance reimbursement challenges and shortened lengths of hospital stays (Baron, Hatfield, & Georgeadis, 2005; Brennan, Georgeadis, & Baron, 2002; Brennan, Georgeadis, Baron, & Barker, 2004; Georgeadis & Brennan, 2003).

More recently, significant research has been conducted in Australia, where distances and limited access to SLPs make telehealth a desirable alternative to in-person services. Clinicians conducted studies to explore the validity and reliability of assessing acquired dysarthria in adults using formal standardized and informal assessments administered via their custom-built telerehabilitation system over a 128 kilobits per second (kbps) Internet connection. In their pilot study with 19 participants and a follow-up study with 24 participants, they concluded that valid and reliable assessment of dysarthria is possible via telerehabilitation methods. Furthermore, participants reported high overall satisfaction in the telerehabilitation environment (Hill et al., 2006; Hill, Theodoros, Russell, & Ward, 2009). Clinicians also administered standardized language assessments to determine the validity and reliability of assessing aphasia via their Internet-based video-teleconferencing (VTC) system using a bandwidth of 128 kbps. Thirty-two participants with aphasia due to stroke or TBI were assessed simultaneously in either an in-person or online-led environment by two SLPs. No significant differences were reported between test scores obtained in the online versus in-person test environments (Theodoros et al., 2008).

An investigator at the Center for Health and Disabilities Research at the NRH in Washington, D.C. conducted a pilot study to examine the equivalence of functional

communication assessment by SLPs using videoconferencing at a transmission speed of 384 kbps. A randomized, double-crossover agreement design was used in which 24 post-stroke patients were administered a subset of the Boston Diagnostic Aphasia Examination and a set of functional communication measures (speech comprehension, speech expression, and motor speech) from ASHA's National Outcomes Measurement System. Each patient was simultaneously scored by both the face-to-face (in-person) SLP and the remote SLP. Percentage agreement within the 95% limits of agreement ranged from 92% to 100% for each communication measure (Palsbo, 2007).

In the Netherlands, a Web-based application for speech training was developed for patients with dysarthria that enables them to independently maintain the quality of their speech after discharge from in-person sessions with the SLP. The telerehabilitation application allows SLPs to remotely formulate individualized therapy programs and monitor and evaluate changes in patients' speech, and is intended to support and intensify regular speech exercises rather than replace in-person therapy sessions (Beijer et al., 2010).

In anecdotal reports, the Speech Therapy Department at St. Alexius Medical Center in Bismarck, North Dakota provided care through their Tele-Care Network to patients in rural communities who suffered a stroke and lacked access to local SLP services because of staffing, reimbursement, and travel constraints. In addition to overcoming barriers to accessing services, high patient satisfaction, positive treatment outcomes, and cost savings to patients and their families were reported (Houn & Trottier, 2003). A speech pathologist in the Department of Veterans Affairs in Lexington, Kentucky used videophones to treat anomia. For the two patients who completed treatment, post-therapy identification of 30 picture cards ranged from 80% to 100% accuracy compared with pre-therapy measures of 10% to 70% accuracy. Benefits of

delivering therapy via videophones included reduced travel costs for patients and the clinician, increased patient compliance with scheduled therapy sessions, more frequent therapy sessions, and cost-savings (Tindall & Wright, 2006). Clinicians in Vasterbotten, Sweden reported improved access to speech-language rehabilitation for adults with aphasia (County Council of Vasterbotten, n.d.).

Telehealth is being used to address the problem of unfilled SLP positions in home health care agencies (Brady, 2007; Carpenedo, 2006; Clark, Dawson, Scheideman-Miller, & Post, 2002). One of the many important responsibilities of SLPs in this setting is to evaluate and treat patients recovering from speech, language, cognitive, and swallowing disorders associated with CVA. Timely and regular rehabilitation services are critical to maximize the potential for recovery of function or use of compensatory strategies to enable the patient to be as independent as possible including the possibility of returning to the workforce.

Childhood Speech and Language Disorders

There has been greater awareness of and increased emphasis on the importance of early identification and diagnosis of speech and language disorders. When the Individuals with Disabilities Education Act (IDEA) was implemented in 1990 mandating special education and related services to all eligible children with disabilities, rural schools were faced with personnel shortages and problems with recruitment and retention. In Oklahoma, a metropolitan rehabilitation hospital, a rural hospital, and a rural school formed a partnership to test the outcomes and acceptance of teletherapy in a public school (Forducey, 2006). In North Dakota, the Center for Persons with Disabilities located at Minot State University developed a program to provide speech-language therapy through interactive videoconferencing in remote areas of North Dakota where services were otherwise limited or nonexistent because of SLP personnel

shortages (Madsen & Rollings, 2005). In Ohio, four small rural school districts participated in a pilot trial of telehealth speech-language therapy. Thirty-eight students with articulation, language and/or fluency disorders were treated in two groups to compare progress in therapy provided through videoconferencing and in-person. Investigators concluded that videoconferencing was a reliable and effective method of service delivery. Students made similar progress during the study and satisfaction surveys indicated that students and parents overwhelmingly supported the telehealth service delivery model (Grogan-Johnson, Alvares, Rowan, & Creaghead, 2010).

Intense early intervention is considered best practice for treating children with autism spectrum disorder (ASD) and parents can serve as effective agents of intervention in the home environment. In a pilot study, remote technology was used to coach parents of two children with ASD. Two clinical models of intervention were compared: a traditional model of twice-weekly speech and language therapy sessions, and a telehealth model of once-a-week clinical session followed by a home-based session administered by the parents and remotely supervised and coached by the clinician. Results suggested that gains yielded in traditional therapy can be maintained and exceeded in a treatment model that incorporates telehealth. Parents perceived telehealth sessions to be as valuable as services delivered directly by the clinician, were comfortable using the technology, and were willing to continue intervention with their children at home (Baharav & Reiser, 2010).

A secure telemonitoring system was developed at the Rehabilitation Engineering Research Center on Telerehabilitation at the University of Pittsburgh that provides a means for telerehabilitation of communication skills by linking a SLP and child/parents at home or school settings. The system transforms a therapy software program into a telerehabilitation system with a motivating, computer-based play character designed to enhance children's communication

skills and stimulate verbal interaction. The developers evaluated the system with four families with children with disabilities. Responses from the SLP and families were positive in terms of ease of use and the capability of viewing and providing feedback on children's performance, and assessing their progress remotely (Parmanto et al., 2008).

Early intervention can reduce the negative effects of childhood speech-language disorders such as academic difficulties. Children with speech and language disorders in rural and remote areas may be at a disadvantage because of poor access to SLP services. Results of a pilot study in Australia suggest that an Internet-based assessment protocol delivered via video teleconferencing (VTC) through a 128 kbps link has potential to provide a clinically reliable method for assessing pediatric speech disorders (Waite et al., 2006). In the United Kingdom, clinicians are using videoconferencing technologies to deliver speech-language therapy remotely to support services to children with communication difficulties in mainstream schools (Rose et al., 2000). In Belfast, SLP services were provided to preschool children in a nursery and in their homes with an interactive audio-visual interface, computers, and ISDN lines (256 kbps). "Televisits" allowed parents to participate more fully in their child's therapy program and gain a greater understanding of their child's communication development by observing them in the nursery setting. Clinicians were able to observe the child's communication environment in an unobtrusive manner and provide guidance to parents (McCullough, 2001). These projects demonstrate that telehealth is a viable treatment option for children with special needs and can be used to support the delivery of speech-language therapy services in the schools.

Fluency Disorders

Telehealth is particularly advantageous in the treatment of fluency disorders because there are few specialized centers for treating stuttering, and long-term follow-up is frequently

required for maintenance. Early stuttering should be treated efficaciously in the preschool years to prevent progression to a chronic form. Although the Lidcombe Program of Early Stuttering Intervention has been shown to be an effective treatment, many children in Australia who live in rural and remote areas do not have access to this program. Because it is implemented by parents under guidance of a SLP, it is easily adaptable to telehealth delivery. A series of research trials provided evidence that use of low-tech telehealth technology yielded satisfactory clinical outcomes; however, in one study, the results were obtained with lengthier treatment times and at higher cost compared to traditional clinic-based delivery (Lewis, 2006; Wilson, Onslow, & Lincoln, 2004).

Researchers at the Australian Stuttering Research Centre at the University of Sydney conducted a Phase 1 trial to investigate the viability of telehealth delivery of the Camperdown Program with adults who stutter. This behavioral treatment was conducted remotely via telephone and e-mail contact between clinician and patient. Preliminary data from 10 adults suggested that the Camperdown telehealth program has potential to provide efficacious treatment for patients who do not have access to traditional face-to-face (in-person) treatment. The group showed 82% reduction in stuttering frequency immediately after treatment and a 74% reduction 6 months after treatment (O'Brian, Packman, & Onslow, 2008).

A study was conducted with children and adolescents who stutter to assess the feasibility and outcome of delivering services at-a-distance between a Montreal pediatric tertiary care center and a primary care center in a remote area in Northern Quebec, Canada. Results demonstrated that interactive videoconferencing is a feasible and effective service delivery model and resulted in improved fluency in all participants. Stuttering ranged from 13% to 36%

before treatment, 2% to 26% after treatment, and 4% to 32% during the six-month follow-up (Sicotte, Lehoux, Fortier-Blanc, & Leblanc, 2003).

Clinicians at the Institute for Stuttering Treatment and Research at the University of Alberta in Canada used videoconferencing to provide services to adults in geographically remote areas following their discharge from intensive treatment at the Institute. Clinical measures of communicative performance, verbal reports from patients, and clinician judgments indicated that treatment goals were met and patients were satisfied with their telehealth treatment (Kully, 2000; Kully, 2002).

Voice Disorders

SLPs in Australia used an Internet-based telerehabilitation application to deliver the Lee Silverman Voice Treatment (LSVT) to 10 participants with Parkinson's disease (PD). Patient access to this treatment is limited because of distance, the limited availability of certified LSVT clinicians in rural/remote areas of Australia, and patient mobility challenges that preclude or impede their travel to a health care facility in both urban and rural environments. Treatment outcomes data demonstrated that the online treatment was feasible and effective (Theodoros et al., 2006).

A study was conducted to compare outcomes of the LSVT delivered to 24 individuals with idiopathic PD via videophones to published data of the treatment delivered in-person. Results indicated a significant change in pre-treatment to post-treatment measures of vocal loudness and favorable comparison to published outcomes. Responses on a patient satisfaction questionnaire indicated that participants were highly satisfied with videophones as a means of receiving health care services. Estimated savings in time and cost associated with travel to and

from therapy sessions were included in the analysis (Tindall, Huebner, Stemple, & Kleinert, 2008).

Investigators in Australia validated an Internet-based telerehabilitation system designed to assess patients following surgical removal of the larynx because of cancer. Greater than 80% agreement was reported between online and face-to-face (in-person) assessments of oromotor, swallowing, and communication outcomes of 20 patients post-laryngectomy; however, visualization of the stoma was reported to be poor. Assessments were conducted at a bandwidth of 128 kbps (Ward et al., 2007).

Swallowing Disorders

In addition to communication disorders, SLPs evaluate, diagnose and treat swallowing disorders or dysphagia. Patients who are at risk for dysphagia should be thoroughly evaluated because impaired swallowing can result in significant morbidity and mortality. However, SLP subspecialists in dysphagia may not be available in small rural communities or in remote areas. In addition to a clinical evaluation, instrumental examination (e.g., videofluoroscopic, fiberoptic endoscopic) is routinely used to identify underlying variables and determine appropriate management strategies for the swallowing problem. Investigators at the University of Illinois developed a program using video transmission over a T1 line that permitted real-time, remote, interactive evaluation of oral/pharyngeal swallowing function. A custom interface enabled an expert SLP at the controlling site to direct a modified barium swallow (MBS) study remotely and view and interpret in real-time the videofluoroscopic images captured in a hospital radiology suite (Perlman & Witthawaskul, 2002).

In anecdotal reports, a SLP at the University of Kansas Hospital mentored a colleague at a rural site in Kansas in performing MBS studies utilizing a videofluoroscope that attached

directly to a Polycom F/X system. In addition to providing an invaluable diagnostic service to patients in an underserved area, the cooperative venture eventually enabled the clinician at the rural site to complete the swallow studies independently (Georges, Potter, & Belz, 2006).

A SLP with the Visiting Nurse Association Health Services in Port Huron, Michigan monitored her patient through their tele-homecare program after discharging him from in-home dysphagia therapy. The services, which were considered adjunct to the therapy already provided, resulted in significant improvement in the patient's swallowing function. Without tele-homecare, the follow-up services would not have been possible since monitoring or maintenance is not considered a skilled service that warrants in-home visits (Brady, 2007).

Technology in Speech-Language Pathology Telehealth Applications

Telehealth Models of Service Delivery

Telehealth delivery models include clinician interactive (synchronous), store-and-forward (asynchronous), and self-monitoring/testing. The clinician interactive model is typically conducted in "real-time" synchronous communication. This model is used for procedures that traditionally require in-person encounters between patient and clinician. The store-and-forward model involves the electronic transmission of clinical data from one location to another and does not require the patient and clinician to be available at the same time. This model is routinely used by radiologists and dermatologists. In the self-monitoring or testing model, the patient provides data to the clinician without any on-site facilitator. This model is primarily used for patients with chronic illnesses who require close monitoring of vital signs including measurements of blood sugar levels or cardiac function.

The dynamic nature of communication, problem-solving, and behavior modification often necessitates synchronous transmission for "real-time" interactive evaluation and treatment of communication disorders. Studies have demonstrated that VTC is a viable and effective method for providing SLP services at-a-distance (Brennan et al., 2004; Duffy et al., 1997; Forducey, 2006; Georgeadis & Brennan, 2003; Hill et al., 2006; Kully, 2000; Madsen & Rollings, 2005; Mashima & Holtel, 2005; McCullough, 2001; Myers, 2005; Perlman & Witthawaskul, 2002; Rose et al., 2000; Sicotte et al., 2003; Theodoros et al., 2006). Auditory/ verbal and visual interaction are essential for most procedures or at least preferred over audio only connections to enhance a sense of clinician "presence" and to facilitate rapport with patients. Although the majority of SLP applications utilize VTC technology, store-and-forward components have also been employed as an adjunctive mode to supplement services delivered in person or to review and validate information observed and recorded during synchronous telehealth encounters (ASHA, 2010b; County Council of Vasterbotten, n.d.; Hill et al., 2006; Lewis, 2006; O'Brian et al., 2008; Perlman & Witthawaskul, 2002; Pierrakeas, Georgopoulos, & Malandraki, 2005; Theodoros et al., 2006; Vaughn, 1976; Waite et al., 2006; Ward et al., 2007).

Equipment and Transmission Mediums

Equipment used in SLP telehealth applications have included telephones, videophones, fax machines, VTC units, computers for e-mail and VTC software and webcams, closed circuit televisions, and image scanners (ASHA, 2005c). An important consideration in equipment selection is the existence of the infrastructure or network across which they connect. Intervention tools such as custom software are being developed to interface with VTC equipment to provide a "virtual desktop" for clinicians to administer therapy materials (Brennan et al., 2002; Glykas & Chytas, 2004; Pierrakeas et al., 2005). Videoconferencing hardware, software, and peripheral

devices will continue to change and incorporate advances in telehealth technologies (ASHA, 2010b).

Selection of VTC equipment should include consideration of camera capabilities, display monitor capabilities, microphone and speaker quality, and multi-site capability (ASHA, 2010b). Technology used for telehealth SLP sessions should not distort or interfere with communication, or must do so only in a minimal and well-characterized way, since the quality of signals must support assessment and treatment of communication disorders (Brennan et al., 2004). Equipment, connectivity mediums, and bandwidth specifications vary according to the telehealth application and desired outcomes. Image and sound quality must be adequate to support the clinical procedure. While this may paradoxically present access issues related to the need to travel to telehealth sites with appropriate equipment and infrastructure, it is important to maintain clinical standards.

Network connection speed impacts overall quality of video and audio clarity. In a review of 225 articles on the use of VTC in clinical contexts including SLP, a minimum bandwidth of 384 kbps was required in most applications to establish adequate audio and visual clarity (Jarvis-Selinger et al., 2008). At any point in time, available bandwidth may be reduced by the number of users on the communication network (ASHA, 2010b). The following findings were reported in studies of SLP telehealth applications: “while the quality of sound and visual images permitted accurate judgments about most aspects of patient’s speech performance, subtle features like speech breathing were more difficult to assess;” “at times, competing Internet traffic compromised audio and video quality;” “although a majority of participants receiving treatment remotely indicated that online delivery was acceptable, some respondents indicated that the audio and visual quality was less than adequate;” “occasional problems associated with

connectivity were resolved by preparing patients and having a back-up available such as a telephone in the room;" "unlike other video-streaming applications that can tolerate loss of video quality, the analysis of swallowing function requires high-fidelity video with no loss in quality." These impressions provide valuable information for future telehealth applications.

Patient Candidacy for Telehealth Applications in Speech-Language Pathology

The telehealth model of delivering SLP services may not be appropriate in all circumstances or for all patients because clinical services are based on the unique needs of each individual patient (ASHA, 2010b). Patient candidacy for telehealth is determined on a case-by-case basis utilizing careful selection criteria. While not exclusionary, the following factors are typically considered: 1) ability to sit in front of a monitor and attend to the clinician, 2) ability to see material on a computer monitor, 3) ability to follow directions to operate the equipment, 4) ability to sit in front of a camera and minimize extraneous movements to avoid compromising the image resolution, 5) manual dexterity to operate a keyboard if needed, 6) hearing acuity, 7) cognitive ability, 8) speech intelligibility, 9) comfort level with technology, 10) willingness of patient or family/caregiver to participate, 11) cultural/linguistic considerations such as the availability of an interpreter if needed, and 12) access to and availability of technical resources if needed (ASHA, 2005c).

Investigators at the Mayo Clinic reported the following challenges for SLP consults in their early experience with telemedicine: 1) the inability to assess muscle strength and musculoskeletal tension and to physically manipulate speech structures may result in omission of important information in patients with motor speech disorders, 2) eliciting sensitive case history information at-a-distance may be difficult when assessing patients with psychogenic speech

disorders, and 3) patients with significant language or cognitive impairment may have difficulty grasping the interactive process over television monitors (Duffy et al., 1997).

Clinicians at the Rehabilitation Engineering Research Center on Telerehabilitation at the NRH reported that age, education, technology experience, and gender did not significantly affect the difference between performance of brain-injured patients on a standardized speech-language evaluation conducted face-to-face (in person) versus via videoconference (Brennan et al., 2004). Stroke-related symptoms such as poor attention, severely impaired comprehension, poor vision, and motor impairment may adversely affect a patient's ability to participate in a telehealth session. However, "in-home" delivery of speech-language services may be most appropriate for this population if family members, caregivers or paraprofessionals are available and willing to provide assistance (Brady, 2007; Brennan et al., 2002; Mashima, Birkmire-Peters, Holtel, & Syms, 1999).

Response to Telehealth Applications in Speech-Language Pathology

Patient Satisfaction

In addition to positive clinical outcomes, telehealth applications in SLP have yielded favorable patient feedback. With technological advancements and the ubiquitous use of computers in our daily lives, telehealth is assuming a desirable role in the delivery of health care, particularly for patients with an interest in technology. In Brennan et al.'s study (2002), 4 out of 10 patients with left and right CVA reported that their comfort level was better in the telerehabilitation condition because they felt "less self-conscious" when the clinician was out of the room or was "less distracted because the computer made it interesting." In a subsequent study

with 40 participants with recent CVA or TBI, 34 out of 40 participants expressed an interest in future use of VTC (Georgeadis, Brennan, Barker, & Baron, 2004).

In a case report by Kully (2000), a patient who stuttered perceived the VTC format as challenging but manageable, and less demanding on fluency control than the telephone format which was the traditional medium for their long-distance maintenance program. In a study that compared in-person with remote delivery of a vocal rehabilitation protocol, both quantitative data on clinical outcomes and qualitative feedback were positive from patients who received therapy via the telehealth model [e.g., "The video sessions were just as good (as in-person). It made it more interesting to see technology playing a part in medical sessions."]. In fact, 16 out of 16 qualitative patient comments on the telehealth model were positive (Mashima et al., 2003).

Clinician Satisfaction

Clinician satisfaction with the telehealth model is critical to its widespread acceptance and use. With positive patient responses, most SLPs engaged in telehealth have embraced the use of technology in their practice, despite admitting to initial skepticism. Although the lack of tactile feedback and cues may require creative problem-solving or even preclude the use of techniques that require "hands on" delivery, investigators have reported that the absence of a clinician's physical presence does not compromise the "human element" or reduce the effectiveness of services provided via telehealth (Brennan, 2006; Mashima et al., 2003). Suboptimal clinician satisfaction has generally been reported with telehealth systems that utilized low bandwidth transmission or low-tech options for auditory-perceptual ratings of speech characteristics that are inherently challenging to judge such as nasality or resonance, or visual-perceptual ratings of oromotor movements or anatomical structures (Hill et al., 2006; Ward et al., 2007).

Benefits of Telehealth in Speech-Language Pathology

Anecdotal reports have espoused the benefits of telehealth in SLP. Remote delivery of services meets the care needs of home-bound post-stroke patients with impaired mobility. Sub-acute patients with restorative potential can benefit from daily intervention with the use of adjunct telehealth treatment to supplement in-home visits and enhance clinical outcomes (Brady, 2007; Brennan et al., 2002; Carpenedo, 2006). Follow-up services, particularly after discharge from intensive or inpatient treatment can have a significant positive impact on functional outcomes. Telehealth also allows for closer monitoring to determine when additional services are needed (Brady, 2007; Carpenedo, 2006; Georgeadis & Brennan, 2003). Individualized home exercise programs can be developed to facilitate carryover of learned skills to the functional home environment (Brown & Carpenedo, 2006). In-home telehealth sessions also afford the opportunity to include family members and caregivers in the rehabilitation program.

Telehealth not only increases the capacity to provide service in a "no service" area but reduces the potential delay of service (Brown & Carpenedo, 2006). For example, the development of a telehealth program in rural Kansas eliminated wait time in scheduling modified barium swallow studies, decreased travel time, reduced patient fatigue, and improved accuracy of results. Patient follow-up was enhanced through timely discussion of results and recommendations (Georges et al., 2006).

In spite of SLP shortages in rural areas, telehealth enables clinicians in home health agencies to cover a larger geographic area while providing more therapeutic services to patients (Brady, 2007). Telehealth or telepractice is also being used to meet the communication needs of students in underserved school districts across the country such as in remote areas of West Virginia. In Ohio, the telehealth model was initiated as part of a multi-pronged effort to increase

availability of SLP services in public schools statewide (Polovoy, 2008). The cost benefits associated with reducing staff time and minimizing travel expenses are significant for itinerant school services as well as home health care. Notably, personnel shortages are most critical in these settings.

In several reports, telehealth provided access to a university medical center. As a result, both patient and clinician benefited from the knowledge and expertise of a host of medical specialists. This was particularly advantageous for clinicians practicing in rural environments with few opportunities to interact with colleagues for professional growth and skill development (Georges et al., 2006; Jin, Ishikawa, Sengoku, & Ohyanagi, 2000; Perlman & Witthawaskul, 2002).

Challenges and Barriers to Telehealth Applications in Speech-Language Pathology

In 2002, ASHA conducted a survey of 1,600 members to sample their activities and attitudes with respect to telepractice (telehealth). Respondents were positive about the potential of telehealth. However, the barriers they perceived included cost, lack of professional standards, and lack of data on efficacy and cost-effectiveness (ASHA, 2002). Challenges and barriers to widespread adoption of telehealth services in SLP are summarized in Table 1.

Start-up costs including equipment purchase and installation as well as maintenance costs and connectivity charges can be prohibitive. However, with technological advances, these costs are decreasing. In addition, with the expansion of telehealth applications and demonstrated positive cost-benefits ratio, telehealth systems are becoming more widespread in hospitals, clinics, home health care agencies, and schools.

Table 1. Barriers to Telehealth Applications in Speech-Language Pathology

- Lack of funds for purchasing start-up equipment
- Lack of infrastructure to support telehealth services
- Lack of administrative, personnel, and/or technical support
- Lack of reimbursement for telehealth services
- Lack of professional and technical standards and guidelines to ensure appropriate application that does not compromise the standard of care expected for in-person clinical encounters
- Lack of data on efficacy and cost-effectiveness of telehealth services
- Licensure restrictions including the need to obtain multiple state licenses to practice across state lines
- Ethical issues including protecting and preserving patients' privacy and confidentiality and complying with HIPAA regulations
- Legal issues including risk management (e.g., ensuring clinical and technical competency; obtaining informed consent; using assistants and caregivers in providing services)

Many telehealth applications in SLP have been demonstration projects or funded research protocols. The lack of reimbursement presents a challenge to sustainment of programs beyond the initial stages of research and development (Brennan, 2006). The majority of clinicians (71%) surveyed in 2002 reported that they were not being reimbursed for telehealth services; 15% reported reimbursement by private pay, 10% by private insurance, and 5% by Medicaid (ASHA, 2002). Fortunately, federal funds are being offered to support telehealth programs, particularly in rural health networks (e.g., grants from the Office for the Advancement of Telehealth). In 2009, a request was submitted to add speech-language pathology services to the list of approved Medicare telehealth services for 2011.

Legal and ethical issues associated with telepractice in SLP include state licensure, privacy and confidentiality, malpractice, competence, informed consent, and use of assistants (Denton, 2003). Current licensure requirements present a barrier to telehealth; obtaining multiple

state licenses is required to practice across state lines. Licensure typically includes initial application and subsequent renewal fees as well as fulfilling examination and continuing education requirements which differ across states. If telehealth is to be a feasible means of providing services, the restrictive nature of interstate licensure requirements must be resolved. Potential solutions include the establishment of national regulations, Congressional action to regulate telemedicine licensure, reciprocity for the purposes of telehealth, or cooperation among states for multi-state licensure in telemedicine (Brown, 2003; Denton, 2003; Savard et al., 2003).

A significant barrier to the deployment and widespread use of telehealth is the lack of evaluative data or evidence to prove that this innovative model of service delivery is as effective as the traditional in-person model of delivering health care. A critical need that can be addressed through research is the establishment of technical standards and guidelines to ensure appropriate application that does not compromise the quality of care expected in face-to-face or in-person clinical encounters (e.g., different bandwidths required for different tasks).

While concept studies may demonstrate the potential usefulness of telehealth applications, determining clinical efficacy is an important next step. One of the first research questions that must be answered is whether or not a telehealth diagnosis is as accurate as an in-person evaluation and whether or not a telehealth rehabilitation program is as effective as in-person treatment. Standards, data, and publications of clinical efficacy are critical for the acceptance and reimbursement of telehealth services (Holtel & Burgess, 2002).

Clearly, in developing a telehealth service it is important to balance technical issues (e.g., available infrastructure), financial issues (e.g., support for equipment and transmission costs), clinical issues of integrity (e.g., not compromising standard of care), practical issues (e.g., least disruption of clinical workflow, available support personnel, provider workload), legal and

ethical issues (e.g., licensure, patient privacy, risk management), and acceptance issues (e.g., patient and provider satisfaction).

Qualitative Research in Telehealth

Quantitative measures are typically used to analyze clinical outcomes or measure the effectiveness of services delivered at-a-distance. Comparisons are often made between "in-person" and "remote" groups to determine if telehealth methods, procedures, and techniques yield outcomes that are consistent with standards of best practices for traditional, in-person delivery. In fact, the majority of telehealth research has had a technological focus yielding information about bandwidths and resolution, while our knowledge about the human dimension remains sparse (Mair & Whitten, 2000).

In their 2006 published research agenda, the American Telemedicine Association recognized grounded theory as an acceptable research design that can be used to provide a better understanding of telehealth (Krupinski et al., 2006). For example, valuable insights into factors underlying positive and negative experiences with telehealth can be gained by analyzing qualitative data such as interview responses.

Although quantitative studies on the development and implementation of telehealth systems demonstrate clinical efficacy and cost-effectiveness, qualitative methods may add a more focused view of how these outcomes are achieved by critically exploring the professional and organizational processes that lead to specific outcomes. For example, ethnographic techniques may reveal the complexity of integrating and stabilizing telehealth as a new mode of service delivery (May et al., 2003). These processes are often overlooked by proponents of

telehealth who rely on demonstrations that technology supports the clinical application as the primary criterion of success.

According to MacFarlane, Harrison, and Wallace (2002), qualitative research can complement quantitative studies of telehealth to enhance understanding of organizational issues and interactive processes. “Seeing through the eyes” of their participants was instructive in their investigation of teleconsultations. Semi-structured interviews and focus groups with hospital specialists, general practitioners, and patients revealed different perceptions of the same teleconsultations.

Aas (2000) examined the organizational effects of telehealth using qualitative interviews to obtain empirical data. Participant responses provided valuable insights regarding the organizational consequences of telehealth including changed mechanisms for internal coordination, restructuring, different flows of patients through the health care system, improved coordination of care, new job descriptions, and relocation of the place of work.

In a systematic review of research into patient satisfaction with teleconsultations, 32 studies were identified that examined interactive video consultations between health care providers and patients in diverse contexts ranging from specialist consultations to home nursing. The investigators conducted a qualitative overview of the data and concluded that issues relating to patient satisfaction require further exploration from the perspective of both patients and providers. Methodological deficiencies such as small sample sizes, non-randomized patient selection criteria, study settings, and flaws in study designs limited the generalizability of research findings (Mair & Whitten, 2000).

Wallace et al. (2002) conducted a randomized controlled trial of over 2000 joint teleconferenced consultations (JTC). Although concerns about sample size and random selection

of participants were addressed in their research design, they concluded that their quantitative findings left many important questions unanswered and did not provide insight on how patient satisfaction could be maximized and dissatisfaction minimized in new telehealth initiatives. In a follow-up qualitative study, the investigators used semi-structured interviews to explore patient perceptions of JTC with particular reference to reasons underlying, and factors contributing to patient satisfaction and dissatisfaction with telehealth. While patients appreciated convenience, reduced costs, and increased punctuality with JTC, they perceived clinical care as more important than "customer care." There were divergent views about doctor-patient interactions with some patients reporting that technology interfered with doctor-patient communication and some preferring that their physical exam be conducted directly by the specialist rather than by the general practitioner under the tutelage of the specialist (Harrison, MacFarlane, Murray, & Wallace, 2006).

In addition to studying patient satisfaction with the telehealth model, it is important to collect data on health care providers' satisfaction since the distance mode of delivering services often necessitates modification of clinical approaches, methods, and techniques. Clinicians are often apprehensive that it may be difficult to establish "rapport" with patients at-a-distance with lack of the "human factor" that is present in person-to-person encounters. Hopp et al. (2006) conducted qualitative interviews to examine the perceptions of direct providers of telehealth services, primary care providers, and hospital administrators in a network of Veterans Health Administration hospitals. In addition to themes related to both opportunities and barriers to the implementation of telehealth services, results of the study suggest strategies to improve future development and increase provider acceptance of telehealth services.

CHAPTER 3: ISSUES RELATED TO VOICE THERAPY

Chapter 3 highlights issues related to treatment efficacy for voice disorders including outcome measures and patient compliance. Evidence from several studies suggests that patient compliance and adherence to treatment play a greater role in vocal rehabilitation than any specific therapy approach. A stepwise process for developing a telehealth vocal rehabilitation program is described to address the problem of the "ultimate non-adherence" or patient "dropout" from voice therapy.

Treatment Efficacy

Voice disorders range from mild hoarseness to complete voice loss, and are typically characterized by abnormalities in pitch, loudness, and/or vocal quality that may limit the intelligibility or effectiveness of oral communication. Voice disorders may result from disordered laryngeal, respiratory, and/or vocal tract functioning. For example, improper use of the larynx with excessive throat clearing, yelling, prolonged talking over loud background noise, or muscular imbalances may produce physical changes in the vocal folds that negatively affect the voice. Voice disorders may be due to other medical/physical conditions (e.g., trauma, neurological disorders, allergies) or psychological factors (e.g., stress, conversion reactions, personality disorders), or a combination of factors (Ramig & Verdolini, 1998).

There is evidence that individuals with voice disorders benefit from services from SLPs (Ramig & Verdolini, 1998). However, the amount of efficacy studies on voice therapy is sparse and many have methodological problems. Although a variety of voice treatments has been described, there is limited guidance about the value of these treatments which include specific techniques, loosely organized principles, and eclectic approaches using a combination of strategies. The type of voice treatment generally depends on diagnostic category, patient characteristics, and the SLP's preference. Further research is needed to guide evidence-based voice therapy (Pannbacker, 1998; Speyer, 2008).

The effectiveness of voice treatment is often based on judgments by parents/patients, clinicians, and otolaryngologists (Pannbacker, 1998). Effects of therapy can be determined by applying the same measurements before and after treatment. Different aspects of voice production are used to assess the success or lack of success of voice therapy. An important indicator is vocal quality. However, unstable internal standards for comparing speech stimuli and the lack of consensus in defining perceptual concepts pose significant problems in classifying characteristics of vocal quality. A more objective evaluation of voice is acoustic analyses in which algorithms describe variability in pitch period (jitter) and peak-to-peak amplitude (shimmer), or the ratio of energy of in-harmonic to harmonic components (noise). However, imperfections in this method include the possibility of errors in pitch tracking, the inadequacy of acoustic analysis in aperiodic vocal vibrations which are common in dysphonic voices, and the use of unnatural speech samples (i.e., sustained vowels). Laryngostroboscopy or video recordings of laryngeal structures and vocal fold vibration have been used to evaluate outcomes associated with the source of voice production through visual-perceptual evaluation of vocal fold morphology and function. When measuring the effects of therapy, it is also important to assess the beneficial or negative changes experienced by the patient, as in self-evaluation of a patient's perceived handicap resulting from the voice disorder (Speyer, 2008).

In one study, the effects of voice therapy in chronically dysphonic patients with diverse diagnoses were reported to be clearly significant in group comparisons between pre-treatment and post-treatment data on perceptual rating, acoustic analysis, and assessment of laryngo-stroboscopic recordings. Improvement was reported in 40% to 50% of patients for each of the three outcome measures; however, relations among the three evaluation tools to measure pre- and post-treatment changes were weak. Furthermore, the effects of therapy for individual

patients were divergent and could not be explained by pre-treatment status, age, gender, or diagnostic group. No restrictions were placed on the type of voice therapy administered since the investigators' aim reportedly was to evaluate the efficacy of voice therapy in "actual practice." The low correlation among the three methods of evaluation suggests that a multidimensional evaluation of voice is needed to provide a comprehensive assessment of treatment outcome (Speyer, Wieneke, & Dejonckere, 2004).

Voice therapy typically includes modification of voice and speech production in addition to management of internal, environmental, and voice use factors that may be contributing to the voice disorder. Therefore, patient adherence to behavioral change is critical to the effectiveness of voice therapy. In fact, evidence from several studies suggests that patient compliance and adherence to treatment play a greater role in voice rehabilitation than the specific therapy approach. Therapy "dropout" is a common clinical problem and may be considered as the ultimate non-adherence. The dropout rate of participants prior to completion of prescribed voice therapy trials in four separate studies ranged from 16% to 25% (Behrman, 2006; Behrman, Rutledge, Hembree, & Sheridan, 2008).

In a retrospective study designed to document voice therapy completion and dropout rates in two large voice centers, only 35.4% of 147 participants completed the course of therapy; 64.6% or 95 participants discontinued before completion. The variables analyzed in the study were not predictive of dropout and included demographics (gender, age, race/ethnicity), otolaryngology diagnosis, severity of quality-of-life handicap, and severity of dysphonia. The investigators suggested that future research should focus on examining methods to effect a reduction in dropout including transportation barriers and alternative service delivery models such as telehealth (Hapner, Portone-Maira, & Johns, 2009).

Delivering Voice Therapy At-A-Distance

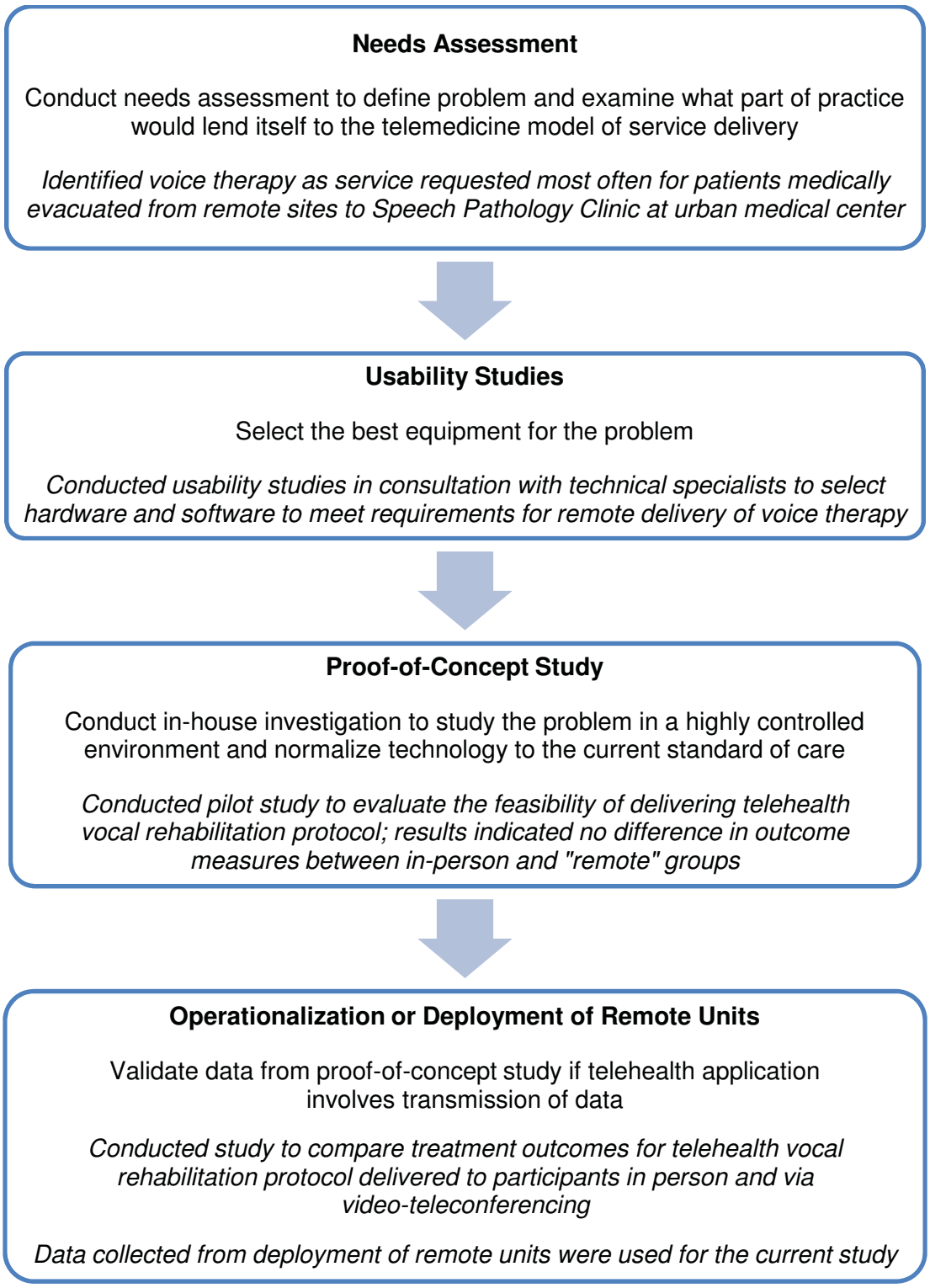
Burgess et al. (1999) described a stepwise process for developing a comprehensive telemedicine Otolaryngology-Head and Neck Surgery service including audiology and SLP. This approach includes: (a) needs assessment or problem definition to examine what part of the practice would lend itself to telemedicine deployment; (b) usability studies to select the best equipment for the problem; (c) proof-of-concept in-house investigation to study the problem in a highly controlled environment and normalize technology to the current standard of care; and (d) operationalization or deployment of remote units to validate in-house data if the advance being studied involves transmission of data.

Figure 1 displays this stepwise process that was used in the current study to develop a speech pathology vocal rehabilitation protocol to complement a comprehensive otolaryngology telemedicine service in an urban medical center. De-identified data collected from the operationalization phase of the protocol were used for the present study.

Needs Assessment

A speech pathology clinic in an urban medical center received referrals for 26 patients with voice disorders over an 18-month period from otolaryngologists in a widely dispersed geographic area. On average, these patients were air evacuated from distances of as much as 4,000 miles to the urban medical center for an abbreviated course of voice therapy. This incurred direct costs for travel expenses and indirect costs including time away from work and family. This type of vocal rehabilitation was identified as a service that could be delivered with the use of telecommunications technology to enable patients to complete the standard course of voice therapy at-a-distance without the need to travel to the urban medical center (Mashima & Holtel, 2005).

Figure 1. Stepwise Process (Burgess et al., 1999) Used to Develop the Telehealth Vocal Rehabilitation Protocol in This Study



Usability Studies

Usability studies were conducted in consultation with technical specialists to select hardware and software to best meet the needs of the telehealth vocal rehabilitation protocol. The requirements were initially determined for the in-house investigation phase (Whitaker, 1997) and subsequently for the transmission of data with the deployment of remote units to validate the in-house data (N. Sakauye, personal communication, 2004). Off-the-shelf software programs for voice analysis and real-time feedback were evaluated for their functionality, usability, and cost. The following features were assessed and compared: 1) real time acoustic analysis of voice signal; 2) display of voice as a visual signal on video monitor; 3) compatibility with PC computers; 4) reasonable cost; and 5) technical support from manufacturer. Kay Elemetrics Multi-Speech, Model 3700 was selected for the pilot study and Sona-Speech II, Model 3600 was selected for the deployment study.

Pilot Study: Proof-of-Concept

A pilot study was completed to evaluate the feasibility of delivering the telehealth vocal rehabilitation protocol in a highly controlled environment within the urban medical center prior to deploying remote units (Mashima et al., 2003). The study protocol was approved by the medical center's Institutional Review Board and investigators adhered to the policies for protection of human subjects. Seventy-two patients with voice disorders served as participants. A total of 34 males and 38 females with a mean age of 45 years enrolled in the study. Participants were matched according to diagnostic category and were randomly assigned to either the in-person group or the remote VTC group as they enrolled in the study. Participants in the in-person group received therapy conducted with the clinician in the same room while participants in the

VTC group received therapy conducted with the clinician in an adjacent room interacting via a real-time audio–video monitoring system.

Fifty-one participants (71%) completed the vocal rehabilitation protocol. Treatment outcome measures included: 1) patient satisfaction ratings, 2) auditory-perceptual ratings of voice quality, 3) visual-perceptual ratings of laryngeal endoscopic examinations, and 4) acoustic measures of jitter and shimmer on sustained phonation. Data collected pre- and post-treatment were compared. No differences in the four treatment outcome measures were found between the two modes of delivery. Participants in both the in-person group and the VTC group showed positive changes on all measures after completing the vocal rehabilitation protocol. A summary of the outcomes for the pilot study is displayed in Appendix B.

Operationalization with Deployment of Remote Units

Following the proof-of-concept study, the voice therapy protocol was delivered locally and at two remote sites via VTC. This experiment and its outcomes provided the de-identified data for the present study described in the next chapter.

VTC hardware and software were installed to establish connectivity between the urban medical center and the two remote sites via ISDN lines at 384 kbps bandwidth. The study protocol was approved by the Institutional Review Boards at each site and investigators adhered to the policies for protection of human subjects.

Participants

Forty-two male and female patients with voice disorders ranging in age from 18 to 80 years who were referred to the Speech Pathology Clinic at the urban medical center served as participants. Etiologic correlates included vocal nodules, laryngopharyngeal reflux with muscle tension dysphonia, vocal hyperfunction with no laryngeal pathology, unilateral vocal fold

paralysis, and functional aphonia. Patients with reported vision, hearing, and/or cognitive impairment were excluded from the study. Patients enrolled at the urban medical center were randomly assigned to the in-person (control) or telehealth (experimental) group. Participants in the control group received voice therapy in person while participants in the experimental group received voice therapy remotely via VTC. Patients enrolled at the overseas remote site were assigned to the telehealth group and received voice therapy via VTC.

Equipment for Connectivity

The following VTC hardware was used:

1. Tandberg Set-Top 880 Videoconferencing System;
2. Panasonic PV-C2542, 25-inch Combination TV/VCR;
3. MPC ClientPro 325D PC Desktop, Pentium 4 Processor, 2.4 GHZ, 40 GB Hard Disk Drive, 0.5 GB RAM;
4. M-Audio MobilePre USB - USB Bus-Powered Preamp and Audio Interface;
5. Adtran Quad NT1 ACE 4 Stand-alone Quad ISDN BRI Termination Device;
6. Shure SM57 Unidirectional Dynamic Microphone;
7. Sennheiser HD-497 Over-Ear Headphones.

A diagram illustrating VTC connectivity for the remote delivery of voice therapy is presented in Figure 2.

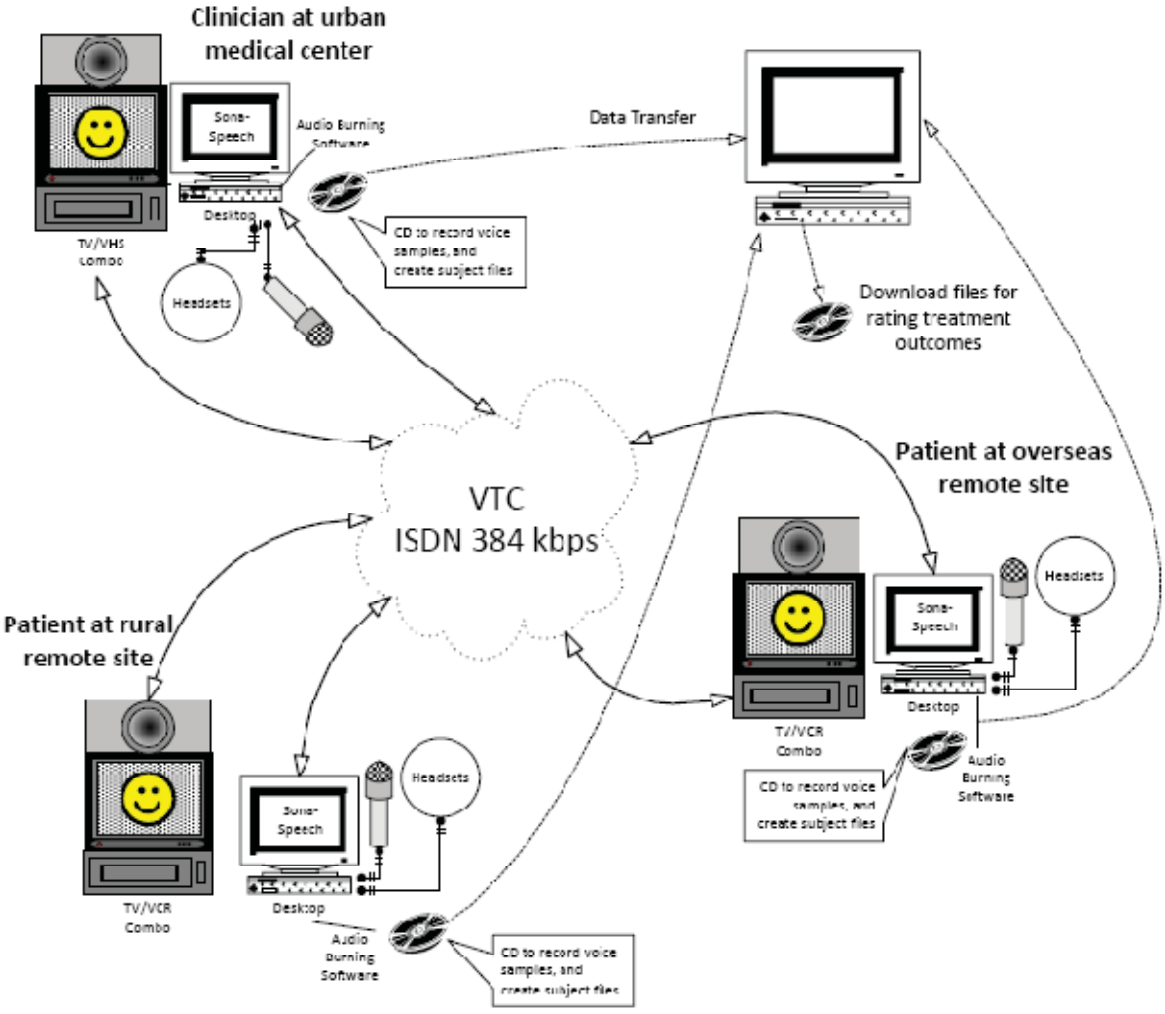
Evaluation and Therapy

Pre-treatment evaluation.

Each participant was seen in person for an evaluation by an otolaryngologist and SLP prior to enrollment in treatment. The evaluation protocol included a history of the problem,

description of symptoms, patient self-evaluation of voice, perceptual assessment of voice samples, laryngeal videoendoscopic examination, and acoustic measures of sustained phonation.

Figure 2. Video-Teleconferencing Set-Up for Telehealth Delivery of Voice Therapy



History of the problem and description of symptoms.

Information on symptoms, vocal behaviors, onset, course over time, variability, general and vocal health, medications, voice use, and phonotraumatic behaviors was obtained to define the problem, describe symptoms, diagnose, and determine etiology or contributing factors to guide the formulation and implementation of an individualized treatment program for each

participant. Information was gathered through interview, clinical observations, and a case history form presented in Appendix C.

Patient self-evaluation of voice.

Participants were asked to judge the relative impact of his or her voice disorder upon daily activities by completing the Voice Handicap Index (VHI). The VHI, presented in Appendix D, is a psychometrically validated instrument that was developed to measure the psycho-social handicapping effects of voice disorders (Jacobson et al., 1997). The paper-and-pencil assessment tool was completed by each participant using a 5-point ordinal rating scale which ranges from zero (never) to 4 (always). It is routinely used to: 1) assess an individual's judgment about the impact of his or her voice disorder upon daily activities; 2) evaluate the effectiveness of voice treatment techniques; and 3) measure functional outcomes in behavioral, medical, and surgical treatments of voice disorders.

Instructions were presented as prescribed: "The following are statements that many people have used to describe their voices and the effect of their voices on their lives. Check the response that indicates how frequently you have the same experience." The self-rating form consists of 30 statements divided into three domains representing functional, physical, and emotional aspects of voice disorders. The functional subscale encompasses statements that describe the impact of a person's voice disorder on daily activities. The physical subscale probes self-perceptions of laryngeal discomfort and voice output characteristics. The emotional subscale consists of statements representing a person's affective responses to a voice disorder (Jacobson et al., 1997).

Perceptual assessment of voice samples.

Digital recordings of voice in running speech and sustained vowels were recorded in a quiet test room with ambient noise < 50 dB (Titze, 1994). A noise survey in the test room at the urban medical center was conducted by an industrial hygiene technician and the sound level was reported at 45 dBA (H. M. Miyamoto, personal communication, November 28, 2008). An analysis extracted from voice samples recorded in the test room at the remote site clinic yielded comparable results (P. M. Scheifele, personal communication, May 20, 2009).

The voice samples were captured and analyzed with the Sona-Speech II, Model 3600 software (Kay Elemetrics, Lincoln Park, NJ) on a MPC ClientPro 325D Desktop PC with a Pentium 4 Processor, 2.4 GHZ clock speed, 40 GB Hard Disk Drive, and 0.5 GB RAM. A professional grade Shure SM57 Unidirectional Dynamic Microphone was used with a mouth-to-microphone distance held constant at 10 cm (Titze, 1994). The Real-Time Pitch module was used to record participants reading the first paragraph of *The Rainbow Passage* (Fairbanks, 1960). The text for the passage is presented in Appendix E.

Laryngeal video endoscopic examination.

Flexible fiberoptic endoscopic laryngeal examinations were performed and recorded with the following equipment: Kay Elemetrics Rhino-Laryngeal Stroboscope, Model 9100B (Kay Elemetrics Corporation, 1996); PentaxVNL-1170K Diagnostic Naso-Pharyngo Laryngoscope, Pentax PSV 4000 Medical Video Camera for Endoscopy, Pentax EPK-1000 Digital Color Video Processor, and Sony RDR-GX315 DVD Recorder.

Participants were seated in an SMR Maxi ENT examination chair. Each nostril was sprayed with a solution of 50% Afrin (0.05%) and 50% Lidocaine (4%) prior to insertion of a

flexible fiberoptic naso-pharyngo-laryngoscope. The phonoscopic assessment protocol (adapted from Rosen & Murry, 2000) is presented in Appendix F.

Acoustic measures of sustained phonation.

The Multi-Dimensional Voice Program (MDVP) module of the Sona-Speech II was used to obtain acoustic measures of sustained phonation. Vocalizations were captured and analyzed according to procedures described in the Instruction Manual (Kay Elemetrics Corporation, 2002). Participants were asked to sustain /a/ at a comfortable pitch and loudness level. Signals were captured after voice was initiated and before voice was terminated to eliminate voice onset and offset. The MDVP was used to extract computerized measurements of noise-to-harmonic ratio (NHR) on three 4-second samples of sustained /a/ that were digitally recorded at a sampling rate of 44100 Hz with 16-bit resolution.

NHR is an average ratio of energy of the inharmonic components in the range of 1500 to 4500 Hz to the harmonic component energy in the 70 to 4500 Hz range. It is a general evaluation of the noise presence in the analyzed signal such as amplitude and frequency variations, turbulence noise, sub-harmonic components, and/or voice breaks (Deliyski, 1993). The normative threshold for NHR in the MDVP is 0.19 dB (Kay Elemetrics, 2002).

Vocal rehabilitation protocol.

Participants received a course of individualized therapy with behavioral techniques to rehabilitate their voice by increasing vocal efficiency and improving vocal function and quality. Therapeutic regimens were based upon evaluation results of each participant and tailored to address vocal tissue health, participant vocal complaints and physiologic correlates, baseline phonatory behaviors, and vocal demands. Rehabilitation strategies and techniques were the same for both the in-person and VTC groups, and incorporated: 1) a formal hydration program; and 2)

vocal hygiene counseling or a formal program to reduce or eliminate phonotraumatic behaviors; in addition to 3) explanation of the problem; 4) facilitating voice therapy techniques (Boone, 1982; Boone & McFarlane, 2000) including focus, establishing a new pitch, yawn-sigh, glottal attack changes, open-mouth approach, pitch inflections, and chant talk; 5) "confidential voice" (Colton, Casper, & Leonard, 2006); and 6) Vocal Function Exercises (Stemple, Glaze, & Klaben, 2000). Participants who presented with signs and symptoms of LPR were instructed on behavioral, lifestyle, and diet management strategies for reflux and monitored for compliance with omeprazole therapy as prescribed by the otolaryngologist. None of the participants with vocal fold paralysis or vocal nodules received surgical intervention during the course of therapy.

According to Boone's (1974) criteria, participants were discharged from therapy if (a) their self-reported voice quality improved in most settings, (b) they reported less discomfort associated with prolonged voice use, (c) laryngeal lesion (if any) was reduced in size or was no longer present, (d) laryngeal edema was reduced or resolved, or (e) there was no noticeable improvement. None of the participants was involuntarily terminated from the study.

Post-treatment voice evaluation.

Data were collected from participants in person upon discharge from therapy to compare pre- and post-treatment measures between the in-person and VTC groups. The post-treatment voice evaluation protocol consisted of assessment tools used in the pre-treatment evaluation: 1) patient self-evaluation of voice with the VHI (Jacobson et al., 1997), 2) audio recordings of voice samples, 3) video recording of laryngeal endoscopy, and 4) NHR (acoustic measures). In light of the multidimensional aspects of voice, the clinical evaluation aimed at using complementary measures to assess treatment outcomes.

Patient satisfaction survey.

In addition to the post-treatment voice evaluation protocol, participants who received therapy via VTC were asked to complete a written survey at the time of discharge from treatment. The survey consisted of six questions that were formulated to elicit overall impressions of their telehealth experience. The questions focused on issues relevant to the telehealth model of service delivery including access to care, and comfort and satisfaction with the care received. Participants rated their responses on a 5-point scale ranging from 1 (strongly agree) to 5 (strongly disagree). A section for "additional comments" was included to provide an opportunity for participants to write their personal annotations or free responses in their own words without the limitations of the pre-set categories of the survey. The survey is presented in Appendix G.

Research Hypotheses

De-identified data from the operationalization study was used in the present research protocol to test the following quantitative research hypotheses and address the following qualitative questions:

Quantitative research objective: To compare the effectiveness of voice therapy delivered in person and at-a-distance via interactive video-teleconferencing (VTC) links.

Hypothesis 1. There will be no difference between treatment outcome scores on the Voice Handicap Index (VHI) for patients who receive voice therapy in person and patients who receive voice therapy via interactive VTC.

Hypothesis 2. There will be no difference between treatment outcome ratings of voice samples for patients who receive voice therapy in person and patients who receive voice therapy via interactive VTC.

Hypothesis 3. There will be no difference between treatment outcome ratings of laryngeal videoendoscopy samples for patients who receive voice therapy in person and patients who receive voice therapy via interactive VTC.

Hypothesis 4. There will be no difference between treatment outcome measures of noise-to-harmonics ratio for patients who receive voice therapy in person and patients who receive voice therapy via interactive VTC.

Qualitative research objective: To explore participants' attitude toward and satisfaction with remote voice therapy. Participants include patients, on-site referring physician, on-site and remote SLPs.

Qualitative research question 1. How do patients respond to voice therapy delivered remotely?

Qualitative research question 2. How is the telehealth model of service delivery perceived by health care providers, including the clinician providing care, the referring physician, and the on-site SLP coordinator?

CHAPTER 4: METHODS

Research Approach

Pre- and post-treatment de-identified data from participants who completed the deployment phase of the vocal rehabilitation protocol described in Chapter 3 on pages 37 to 47 were used to address the research hypotheses and questions for the current study. The research protocol was approved by the University of Cincinnati Medical Institutional Review Board.

Participants

De-identified data collected from male and female participants in the operationalization study were analyzed in the present study. The age range of participants was narrowed from 18 to 80 years, to 25 to 70 years in the present study to eliminate the potential influence of age-related voice change (e.g., presbylarynges). There were 31 participants: 12 received treatment in person and 19 received treatment via VTC. Diagnostic categories included nodules, laryngopharyngeal reflux with muscle tension dysphonia, hyperfunction without pathology, unilateral vocal fold paralysis, and functional aphonia.

Materials and Procedures

Voice Handicap Index (VHI)

Pre- and post-treatment VHI scores were compared and used as one indicator of the effectiveness of the vocal rehabilitation protocol. The VHI is a psychometrically validated tool that is used to assess patients' perceptions of the impact of their voice disorder upon daily activities (Jacobson et al., 1997). Participants' self-ratings of the relative impact of his or her voice disorder upon daily activities were tabulated and scored to obtain pre- and post-treatment subscale (functional, physical, emotional) and total scale scores.

Auditory-Perceptual Assessment of Voice Samples

Pre- and post-treatment digital audio recordings of each participant reading *The Rainbow Passage* and sustaining the vowel /a/ were randomly ordered in the first or second position of a pair. The pairs of voice samples for the 31 participants were randomly ordered in a data file for SLP judges to rate. The two ASHA-certified SLPs who rated the samples in the pilot study served as judges for the present study. Both judges have extensive experience (over 25 years) in diagnosing and treating voice disorders. Neither of the SLP judges evaluated or treated the participants.

Prior to rating the study samples, a 20-minute training session was conducted with both judges using non-study voice samples to discuss the listening and scoring procedure. The training included two practice trials to familiarize the judges with the forced-choice rating task. Following the training session, the pairs of recordings for the 31 participants were presented in free-field over a pair of Altec Lansing computer speakers interfaced with the MPC ClientPro 325D Desktop PC with a Pentium 4 Processor that was used to capture the voice samples. The judges listened to the pairs of recordings in the quiet test room in which the samples were recorded and independently selected the voice sample perceived as exhibiting better voice quality for each participant. The judges were allowed to listen to each sample as often as necessary to complete the ratings. Each judge independently marked selections on the forced-choice Auditory-Perceptual Rating form presented in Appendix H. The rating form listed only the participants' study numbers. The judges had no knowledge of the participants' diagnosis or group assignment. Two weeks after the 31 pairs of samples were rated, 10 pairs were randomly selected and presented to each judge to assess intra-rater reliability.

Visual-Perceptual Assessment of Laryngeal Videoendoscopic Examinations

Pre- and post-treatment video recordings of endoscopic laryngeal examinations of participants were randomly ordered in the first or second position of a pair. The post-treatment recording for one participant was not available because of equipment malfunction during the recording procedure. Pairs of recordings for 30 of the 31 participants were randomly ordered for otolaryngology judges to rate on the forced-choice Visual-Perceptual Rating form presented in Appendix I. The rating form listed each participant's study number and the diagnosis that was made by the examining otolaryngologist at the time of the pre-treatment laryngeal examination.

Two Board-certified otolaryngologists independently reviewed the video exams. Prior to rating the study exams, training was provided to each judge in a 10-minute session for orientation to the task and scoring procedure using non-study laryngeal exams. After the training, the rating sessions were conducted in a quiet room with each judge. The randomly-ordered paired exams were displayed side-by-side on two 17" SamSung Sync Master 710M LCD color video monitors interfaced with a Dell Optiplex 960 desktop PC. The sessions were 45 minutes in duration. Pairs were presented for no less than 30 seconds and no more than 75 seconds. Each judge selected the fiberoptic laryngeal exam perceived as exhibiting better physical findings from the randomized pairs of 30 participants with respect to edema, nodularity, hypo-/hyper-function, and/or immobility. Neither of the otolaryngology judges evaluated or treated the participants. After the 30 pairs of exams were rated, 10 pairs were randomly selected and presented to assess intra-rater reliability.

Acoustic Measures of Sustained Phonation

Pre- and post-treatment noise-to-harmonics ratios (NHR) on sustained phonation for each participant were compared. The MDVP module of Kay Elemetrics' Sona-Speech II was used to

extract computerized measurements of NHR on three samples of sustained /a/ for each participant. Measures for the three replicates were averaged for analysis.

Patient Satisfaction Survey

Responses on the telehealth patient satisfaction survey were used to assess participants' perception of the telehealth model of service delivery for the vocal rehabilitation protocol.

Qualitative Methods of Inquiry

In addition to responses elicited from the Patient Satisfaction survey, interviews were conducted with participants to elicit "stories" about their telehealth experience.

Data Analyses

Statistical Measures

Statistical analyses were performed using JMP version 8 (SAS Institute Inc., 1989-2009). The Wilcoxon rank sum test was used to compare pre- and post-treatment VHI patient self-rating scores and NHR acoustic data for the in-person and VTC groups. Fisher's exact test was performed to compare voice samples (pre- and post-treatment) and laryngeal examination samples (pre-and post-treatment) for the in-person and VTC groups. Probability levels for significance were set at 5 percent. Agreement between raters for the voice samples and laryngeal endoscopic samples was calculated using Cohen's kappa.

Qualitative Analysis

Interviews from participants were transcribed, coded, summarized, and interpreted. Qualitative and quantitative methods were used to analyze responses on the Patient Satisfaction survey to blend opinion with measurement (Cohen, Manion, & Morrison, 2000). Responses to survey questions on the 5-point scale were tabulated and summarized. Written annotations were

compiled with interview transcripts for analysis. Investigator triangulation was used to gather multiple perspectives on telehealth services from patients, the coordinator and referring physician at the overseas remote site, and the investigator.

CHAPTER 5: QUANTITATIVE RESULTS

Statistical Analysis Summary

Of the 31 participants in the study, 12 received treatment in person and 19 received treatment via VTC. Distribution of participant characteristics according to diagnostic category, age, and, gender is displayed in Table 2. The total sample size is 31. One participant in the VTC group had missing data for the laryngeal exam samples, so the sample size for that data set is 30. There was one outlier, discussed below, for analysis of noise-to-harmonic ratio data.

Research Questions and Hypotheses

Quantitative Research Question: Is the use of VTC for remote delivery as effective as in-person delivery of treatment for voice disorders?

Hypothesis 1.

There will be no difference between treatment outcome scores on the Voice Handicap Index (VHI) for patients who receive voice therapy in person and patients who receive voice therapy via interactive VTC.

Results.

The VHI assesses patients' perception of the severity of their voice disorder across three domains or scales: functional (F), physical (P), and emotional (E), each with 10 items rated on a 5-point ordinal scale that ranges from zero (never) to 4 (always). Higher scores represent higher severity of patients' perception of disability due to their voice disorder.

Table 2. Distribution of Participants' Diagnostic Category, Age, and Gender by Group

	In-Person[a]	Rural VTC[b]	Overseas VTC[c]	Total
Diagnostic Category				
Nodules	2	4	0	6
Laryngopharyngeal Reflux with MTD	6	7	1	14
Hyperfunction without Pathology	2	2	4	8
Paralysis	1	0	0	1
Functional Aphonia	1	1	0	2
Age Range (in years)				
25-40	6	7	1	14
41-55	1	4	4	9
56-70	5	3	0	8
Gender				
Female	7	11	5	23
Male	5	3	0	8

Note: VTC = video-teleconferencing. MTD = muscle tension dysphonia.

[a]$n = 12$. [b]$n = 14$. [c]$n = 5$.

The majority of participants responded to all questions, but several participants did not fully complete the survey (one participant missed one or two responses for the F and E scales, and eight participants were missing one or two responses for the P scale). For analysis, missing data were assumed to be missing at random and the mean score was calculated for each scale along with a composite summary measure, which was the sum of the three means. For both the in-person and VTC groups, the distribution of post-treatment scores was significantly lower than the distribution of pre-treatment scores (Table 3: $p<0.01$ for each scale based on the Wilcoxon rank sum test).

Table 3. Comparison of Pre-Treatment and Post-Treatment Voice Handicap Index (VHI) Scores, by Group

	In-Person[a]			Video Tele-Conference[b]		
Scale	Pre-Tx mean (stderr)	Post-Tx mean (stderr)	p-value[c,d]	Pre-Tx mean (stderr)	Post-Tx mean (stderr)	p-value[c,d]
F	12.5 (1.95)	5.0 (1.44)	<0.001	16.2 (2.32)	6.7 (1.71)	<0.001
P	18.5 (1.48)	9.8 (2.12)	0.007	22.6 (1.73)	9.4 (1.99)	<0.001
E	10.8 (2.48)	5.1 (1.60)	0.004	15.7 (2.22)	5.8 (1.79)	<0.001
Total	41.8 (5.20)	19.9 (4.21)	0.002	54.6 (5.73)	21.9 (5.24)	<0.001

Note. F = Functional. P = Physical. E = Emotional.

[a] n =12. [b] n = 19. [c] p-value to test for difference between pre- and post-treatment scores. [d] p-value based on Wilcoxon rank sum test.

An analysis of covariance (ANCOVA) was conducted to see if the post-treatment scores differed significantly by group, adjusted for pre-treatment levels. The results of the ANCOVA did not find a significant difference between groups for any of the scales or the composite measure of the Voice Handicap Index (Table 4: $p>0.40$ for each).

Research hypothesis 1 is accepted. There was no sigificant difference between treatment outcome scores on the VHI for patients who received voice therapy in person and patients who received voice therapy via interactive VTC.

Table 4. ANCOVA Results to Test for Group Differences in Post-Treatment Voice Handicap Index (VHI) Scores

Scale	In-Person adjusted Post mean (stderr)	VTC adjusted Post mean (stderr)	Difference (stderr)	p-value[a]
F	5.9 (1.65)	6.1 (1.30)	0.2 (2.12)	0.919
P	10.8 (8.70)	8.7 (1.83)	-2.1 (3.03)	0.491
E	6.5 (1.67)	5.0 (1.32)	-1.5 (2.16)	0.487
Total	23.7 (5.04)	19.5 (3.97)	-4.3 (6.54)	0.520

Note. stderr = standard error. VTC = Video-Teleconferencing. F = Functional. P = Physical. E = Emotional. Pre-treatment score was significantly associated with post-treatment scores for F, E, and total; marginally significant for P.

[a]p value from t-test.

Hypothesis 2. There will be no difference between treatment outcome ratings of voice samples for patients who receive voice therapy in person and patients who receive voice therapy via interactive VTC.

Results.

Inter-rater reliability for the SLP judges.

Table 5 shows the distribution of pre- and post-treatment voice samples that were selected by the two SLP raters as representing better voice quality. Concordance between the two raters was very good, with agreement on 94% (29/31) of the voice samples, and Cohen's kappa, a measure of inter-rater reliability = 0.631. A kappa between 0.61 to 0.80 is considered substantial agreement between raters according to the criteria of Landis and Koch (1977). A kappa between 0.00 to 0.20 is considered slight agreement. Across groups, both raters selected the post-treatment sample as the better sample for 90% of participants (28/31).

Table 5. Inter-Rater Reliability for Speech-Language Pathology Judges

		Rater B		
		Pre-Tx	Post-Tx	Total
Rater A	Pre-Tx	2	1	3
	Post-Tx	1	27	28
	Total	3	28	31

Note. Overall agreement = 94% (29/31). Kappa = 0.631

Distribution of voice samples selected by two SLP raters, by group.

Both raters picked the post-treatment sample for all 12 (100%) of the in-person participants and 16 of 19 (84%) of the VTC participants. Table 6 shows the distribution of pre- versus post-treatment samples selected, by group and rater. For both raters, there was no significant difference between groups in the likelihood of whether a pre- or post-treatment sample was deemed better (Table 6: p=0.43 for both raters based on twice the one-sided Fisher's exact test p-value). For the subset of 10 voice samples that were rated by each SLP a second time, there was 100% agreement between the first rating and the second rating for each rater.

Research hypothesis 2 is accepted. There was no significant difference between treatment outcome ratings of voice samples for patients who received voice therapy in person and patients who received voice therapy via interactive VTC.

Table 6. Distribution of Voice Samples Rated as Exhibiting Better Voice Quality, by Group, Rater, and Pre-and Post-Treatment

	Rater A					Rater B				
	Pre-Tx		Post-Tx		Total	Pre-Tx		Post-Tx		Total
	n	%	n	%	n	n	%	n	%	n
In-Person	0	0.0	12	100.0	12	0	0.0	12	100.0	12
VTC	3	15.8	16	84.2	19	3	15.8	16	84.2	19
Total	3	9.7	28	90.3	31	3	9.7	28	90.3	31
	p=0.43*					p=0.43*				

*twice the one-sided Fisher's exact test

Hypothesis 3. There will be no difference between treatment outcome ratings of laryngeal videoendoscopy samples for patients who receive voice therapy in person and patients who receive voice therapy via interactive VTC.

Results.

Inter-rater reliability for the otolaryngology judges.

Table 7 shows the distribution of pre- and post-treatment laryngeal videoendoscopy samples that were selected as representing better physical findings by the two otolaryngology raters. Concordance between the two raters was not as high as for the SLP raters. The otolaryngology raters agreed on 70% (21/30) of the samples, but Cohen's kappa was low

(0.151). The post-treatment sample was selected as being better for 87% of participants (26/30) by rater B and for 70% of participants (21/30) by rater A.

Table 7. Inter-Rater Reliability for Otolaryngology Judges

		Rater B		
		Pre-Tx	Post-Tx	Total
Rater A	Pre-Tx	2	7	9
	Post-Tx	2	19	21
	Total	4	26	30

Note. Overall agreement = 70% (21/30). Kappa = 0.151

Distribution of laryngeal videoendoscopy samples selected by two raters by group.

Table 8 shows the distribution of pre- versus post-treatment samples selected by group and rater. Rater A selected the post-treatment sample for 67% of VTC participants (12/18) compared to 75% of in-person participants (9/12), and rater B selected the post-treatment sample for 83% of VTC participants (15/18) compared to 92% of in-person participants (11/12). The differences between groups were not significant and could be due to chance (p=0.94 for both raters based on twice the one-sided Fisher's exact test). For the subset of 10 samples that were rated by each otolaryngologist a second time, there was 70% agreement between the first rating and second rating for rater A, and 90% agreement for rater B. Post-treatment samples were rated as better the second time for two of the three inconsistent ratings for rater A, and for the one inconsistent rating for rater B.

Research hypothesis 3 accepted. There was no significant difference between treatment outcome ratings of laryngeal videoendoscopy samples for patients who received voice therapy in person and patients who received voice therapy via interactive VTC.

Table 8. Distribution of Laryngeal Videoendoscopy Samples Rated as Exhibiting Better Physical Findings, by Group, Rater, and Pre-and Post-Treatment

	Rater A					Rater B				
	Pre-Tx		Post-Tx		Total	Pre-Tx		Post-Tx		Total
	n	%	n	%	n	n	%	n	%	n
In-Person	3	25.0	9	75.0	12	1	8.3	11	91.7	12
VTC	6	33.3	12	66.7	18	3	16.7	15	83.3	18
Total	9	30.0	21	70.0	30	4	13.3	26	86.7	30
	p=0.94*					p=0.94*				

*twice the one-sided Fisher's exact test

Hypothesis 4. There will be no difference between treatment outcome measures of noise-to-harmonics ratios (NHR) for patients who receive voice therapy in person and patients who receive voice therapy via interactive VTC.

Results.

Table 9 shows the mean NHR for the pre- and post-treatment samples by group. The post-treatment ratios were in the normative range (<0.19) for all participants except for one participant in the VTC group, who had a mean value of 0.539 (pre-test score was 0.613). Analyses were run with and without this participant because this value was highly influential in some of the statistical tests.

Table 9. Means, Standard Deviations, and Sample Size for Noise-to-Harmonic Ratio (dB), by Group and Pre- and Post-Treatment

		Lower ratio for Post-Tx		Mean NHR (dB) (sd)		
	n	n	%	Pre-Tx	Post-Tx	p-value[a,b]
In-person	12	11	91.7	0.304 (0.261)	0.134 (0.021)	0.003
VTC, all data	19	16	84.2	0.199 (0.172)	0.150 (0.096)	0.003
VTC, outlier excluded	18	15	83.3	0.176 (0.144)	0.128 (0.017)	0.001

[a]p-value to test for difference between pre- and post-treatment ratios. [b]p-value based on Wilcoxon rank sum test.

Among all participants, 87% (27/31) showed some improvement after treatment (post-treatment NHRs were lower than pre-treatment for 92% of in-person participants and 84% of 19 VTC participants). In both groups the distribution of post-treatment NHRs was significantly lower than the distribution of pre-treatment ratios ($p = 0.003$ for both groups based on Wilcoxon rank sum test).

A one-way analysis of covariance (ANCOVA) was conducted to see if the post-treatment ratios differed significantly between groups, adjusting for the pre-treatment levels. Results are presented in Table 10. The ANCOVA assumes that the association between the independent variable (i.e., pre-treatment ratio) and the dependent variable (i.e., post-treatment ratio) is the same for both groups. This assumption is met when the outlier is removed, but the slopes differ significantly ($p = 0.018$ for test of interaction) when the outlier is included in the analysis. Because of the differing slopes the ANCOVA was only analyzed with the outlier excluded.

Based on the ANCOVA, post-treatment ratios did not differ significantly between the in-person and VTC groups (adjusted mean = 0.129 for VTC versus 0.132 for in-person, p = 0.762). The pre-treatment data were not significantly associated with post-treatment ratios (slope = 0.024, p = 0.184).

Table 10. ANCOVA Results for Noise-to-Harmonic Ratio (dB)

		Adjusted post-treatment mean (stderr)			
	n	In-Person	VTC	Difference (stderr)	p-value[a,b]
Outlier excluded	30	0.132 (0.005)	0.129 (0.004)	-0.002 (0.007)	0.762

[a]p-value to test whether difference equals 0. [b]p-value based on t-statistic.

Research hypothesis 4 is accepted. There was no significant difference between treatment outcome measures of noise-to-harmonics ratio for patients who received voice therapy in person and patients who received voice therapy via interactive VTC.

Patient satisfaction.

The 19 VTC participants completed a survey on patient satisfaction at the time of discharge from treatment. The survey has six questions scaled from 1 to 5, with 1 indicating strongly agree and 5 indicating strongly disagree. All participants answered all the questions, so there was no missing data. Responses are summarized in Table 11.

The responses show that the participants had a very positive experience. More than 90% of participants strongly agreed with questions 1, 2, 3, and 6, and more than 80% of respondents strongly agreed with questions 4 and 5. All participants except one scored all questions as 1 or 2.

Table 11. Patient Satisfaction Among VTC Participants

Question	% Strongly Agree	% Strongly Agree or Agree
1	94.7	100.0
2	100.0	100.0
3	94.7	100.0
4	84.2	94.7
5	89.5	100.0
6	94.7	100.0

CHAPTER 6: QUALITATIVE RESULTS

Introduction

While it is important to determine technological specifications and evaluate clinical effectiveness for telehealth applications, human factors research is also needed to assess the impact of telehealth technologies from the perspectives of users (Krupinski et al., 2006). Qualitative methods of evaluation were used to explore participants' opinions and capture rich descriptions of their experiences with telehealth. Questionnaires and interviews in this study focused on eliciting overall impressions of participants' telehealth experiences including their satisfaction with and comfort in receiving services remotely via VTC. Accounts of patients and the coordinator and referring physician at the remote site were gathered and interpreted to deconstruct the telehealth voice study from participants in different roles to address the qualitative research questions:

- How do patients respond to voice therapy delivered remotely? Patients reported ease in adjusting to the telehealth model and satisfaction with clinical interactions and treatment outcomes via VTC. Their responses will be elaborated below.
- How is the telehealth model of service delivery perceived by health care providers, including the clinician providing care, the referring physician, and the SLP coordinator at the remote site? Telehealth services were perceived positively by all participants involved in the study; no negative comments or insurmountable challenges were reported.

Triangulation involved gathering accounts from participants in different roles and comparing results with different sources including existing literature and expert opinion.

Predominant Themes

Patient satisfaction questionnaires and interviews were used to gather attitudinal data on the telehealth service delivery model. Multiple perspectives were recorded through interviews with the referring physician and coordinator at the overseas remote site. Results are summarized in Appendix J. The following themes emerged from the data:

- Benefits of telehealth
    - Improved access to services
    - Convenience
    - Time savings
    - Cost savings
- Clinical interactions via video teleconferencing
    - Initial approach and comfort level
    - Therapy process
    - Patient privacy and confidentiality
    - Innovation
- Response to telehealth services
    - Comparing modes of receiving therapy
    - Patient satisfaction
    - Treatment outcomes

Benefits of Telehealth

A general theme that emerged from participant accounts focuses on the benefits of the telehealth service delivery model. Participants cited improved access to services, convenience, time savings, and cost savings.

Patients reported:

> Telehealth is an excellent way to get medical care to remote locations. *(source: subject t20 as reported on written survey)*

> Telehealth also saved me time on the road due to traffic here... The flexible appointment time was also great. It allowed me not to miss any time out from work. *(source: subject u21 as reported on written survey)*

Several patients at the overseas remote site cited the logistical convenience because they worked on the military base on which the hospital with our VTC link was located. Other patients traveled from other military bases which involved as much as a two-hour shuttle ride each way.

> Advantage is that no travel is involved. *(source: subject mm39y as reported by remote site coordinator)*

> She wishes there was such a set up (where she lives). *(source: subject pp42y as reported by remote site coordinator)*

The referring physician reported:

> "The answer is obvious" when asked about being a provider in a remote location. There "is a disadvantage when one (SLP) is needed" but the "VTC serves the purpose." *(source: referring physician at remote site as reported by site coordinator)*

The remote site coordinator reported:

> Patients not qualifying for Medevac would not have been able to receive services had it not been for this project. *(source: remote site coordinator)*

Participants at the overseas remote site acknowledged the cost savings associated with receiving services at-a-distance.

> She feels that telehealth saves $$ in medical expenses. *(source: subject ll38y as reported by remote site coordinator)*
>
> It's (a) very good program and it's cost effective (for) both patients and hospital. *(source: subject mm39y as reported by remote site coordinator)*
>
> Definitely cost benefits and time efficiency to stay in-country. *(source: remote site coordinator)*

Clinical Interactions via Video Teleconferencing

In reflecting on their telehealth experience, participants commented on their comfort with receiving treatment at-a-distance, the therapy process via technology, privacy and confidentiality, and innovation.

Comfort with Receiving Therapy Remotely

A patient at the overseas remote site who was apprehensive at the outset described factors that provided reassurance over time:

> First session uncomfortable (analogy to going to see a new doctor and not knowing what to expect). Felt at ease with her therapist and by second session process "became very natural." No negative thoughts re: VTC model of therapy. *(source: subject qq43y as reported by remote site coordinator)*
>
> She said at first she was uncomfortable not knowing what to expect, but felt that my (remote site coordinator) explanation of the equipment and her comfort with you as her therapist helped put her at ease. It "became very natural" after the second session. *(source: subject qq43y as reported by remote site coordinator)*
>
> She felt that it was very important that the SLP understood her problem and was concerned how you would respond, and was relieved at how very supportive you were; she pointed out that the emails between you and her made it feel like she was connected to you. *(source: subject qq43y as reported by remote site coordinator)*

Comfort with remote interaction and technology resonated with other patients:

> She became very comfortable with the long distance mode after a short while, stating that "she didn't think anything of it." *(source: subject nn40y as reported by remote site coordinator)*

> This technology when I was asked to do this research was something that I was excited about doing. *(source: subject u21 as reported during interview)*
>
> The only thing that was ever a problem was set-up, and that was minor. *(source: subject t20 as reported on written survey)*

The remote site coordinator provided additional insight gained through in-person contact with patients.

> Patient's personality appeared to connect on a more emotional level and she readily became comfortable with the VTC arrangement and her interactions with (clinician/researcher) to discuss/expand on both medical concerns and personal issues as if (clinician/researcher) was right in the room with her. *(source: subject mm39y as reported by remote site coordinator)*
>
> Adapted easiest to the VTC arrangement and separated (clinician/researcher)'s and my roles well. However, patient appeared to be cautiously private by nature and some sensitive personal issues that underlied this patient's case may have been difficult to discuss with one person, but probably more difficult to discuss in the presence of two people. *(source: subject qq43y as reported by remote site coordinator)*

Therapy Process

A patient who was a teacher of students with special needs elaborated on the therapy process via telehealth in terms of ease of learning:

> Something that I have to learn to do as far as controlling my own voice and listening to my health care provider, (clinician/researcher) over the media; understanding her principles and what she was trying to teach me as far as therapy, as far as taking care of myself, my throat, it was simplistic enough and easy enough for me to understand because it was done in a way where it was slow, easy for me to understand. *(source: subject u21 as reported during interview)*
>
> It was shown to me through visual like holding my nose or my throat and it's something that I could grasp and generalize on how to use it in other forms of using my voice as far as playing with my grandchildren, making monster noises I was doing that one day with them and I realized that making monster noises put a stress on my voice so as I came in for my therapy I described that to (clinician/researcher) and she says that that is true and there is a different way and ways and techniques of playing by using my voice so all these things I learned by

> coming in and doing it over the media. *(source: subject u21 as reported during interview)*

Patients and the remote site coordinator perceived a delay in transmission of signals during VTC interactions but did not consider the effect as a significant interference in the therapy process.

> Only negative aspect was getting used to the delay in relay time, but she got used to it. *(source: subject ll38y as reported by remote site coordinator)*

> Real-time interaction was slightly compromised due to the slight delay in transmission after a person speaks. Patients quickly adjusted to the delay. *(source: remote site coordinator)*

The coordinator at the overseas remote site served an important role in the clinical process.

> Felt my presence in room aided in clarifying something she did not understand when she neglected to sometimes ask (clinician/researcher) directly during the session. *(source: subject mm39y as reported by remote site coordinator)*

> A pat on the arm, a squeeze of the hand, or a hug were extensions of (clinician/researcher) through me at the end of techniques. *(source: remote site coordinator)*

> (Remote site coordinator) has been supportive, encouraging and an excellent resource towards my improved vocal condition. *(source: subject oo41y as reported on written survey)*

> My presence in the room – felt it was a positive because I could provide the hands-on cues; felt the presence of another person could have been a negative experience if I "wasn't actively involved." *(source: subject qq43y as reported by remote site coordinator)*

> Because the patients were on my side of the VTC monitor, even though I was not the person doing therapy, there was a greater sense of hands on, responsibility, and ownership in taking care of the patients. *(source: remote site coordinator)*

Protecting Privacy and Confidentiality

Although assurance of patient privacy has been cited in the literature as an important issue when delivering health care remotely, participants in this study did not express apprehension over the potential risk of compromising their security and confidentiality. In fact, the only comment on the issue was articulated from a positive perspective:

> I was asked about my privacy and the security of doing health care over a media like this and I didn't have any problems with security or privacy act because as a teacher in Special Ed there are certain things that we have to do as far as confidentiality over the computers, using the computers that I'm sure that in this kind of profession, health care profession, they also set up securities and codes that wouldn't violate my privacy or security as far as my health care so my confidence in the profession of doctors or teachers or anybody in this kind of health care I had no problems with because professionally we all know how to secure things that need to be secured. *(source: subject u21 as reported during interview)*

Innovation

Patients conveyed enthusiasm and support for technological advances in delivering health care:

> To me this research was vital as far as receiving health care in another form. I'm very, very thrilled that we are progressing as far as our health care. *(source: subject u21 as reported during interview)*

> She feels that there needs to be a change in "the paradigm of thinking" in treating patients with the use of this type of technology, for example, she said you can take college courses online. *(source: subject ll38y as reported by remote site coordinator)*

Response to Telehealth Services

A blending of qualitative and quantitative methods was used to enhance understanding of telehealth with reference to patient satisfaction and treatment outcomes. Quantitative data analysis is reported in Chapter 5, while qualitative data are summarized below.

Comparing Modes of Receiving Therapy

Comparisons of receiving therapy remotely versus in-person suggest that telehealth delivery was perceived positively although not necessarily equivalent:

> The long distance mode was easy to get used to. *(source: subject ll38y as reported on written survey)*

> Not like face-to-face, but quickly became comfortable with the set up. Felt comfortable that it was 1:1 with (clinician/researcher). *(source: subject mm39y as reported by remote site coordinator)*
>
> Patient adapted easily to the telehealth mode. She felt the sessions were the same as if she was face-to-face. *(source: subject pp42y as reported by remote site coordinator)*
>
> She had no negatives with the long distance mode of treatment. *(source: subject qq43y as reported by remote site coordinator)*
>
> (Clinician/researcher) is an excellent therapist!! I do not think the outcomes would have been significantly different for patients had she been face-to-face. The only other concern was the inability to use hands on techniques that may have aided some patients. *(source: remote site coordinator)*

Treatment Outcomes

Participants including patients, the referring physician, and coordinator at the remote site reported positive treatment outcomes:

> Pre and post test outcome measures…were positive. Patient improvement for the majority of patients. *(source: remote site coordinator)*
>
> He felt that the project "was effective in meeting patient care"…some patients stated that they benefitted from receiving voice therapy via VTC. *(source: referring physician at remote site as reported by remote site coordinator)*
>
> She reported that her singing voice is back to her normal ability!!! *(source: subject pp42y as reported by remote site coordinator)*
>
> Therapy appeared to have impacted this patient in a very significant way—she made a major decision to quit a full-time job that would serve to decrease situations for potentially vocally abusive behaviors (therapy may have been a "boost" to help her validate reasons for a decision that she may have already been contemplating? *(source: subject pp42y as reported by remote site coordinator at time of discharge from therapy)*
>
> (Clinician/researcher) was extremely informative and (gave) excellent advice contributing to an overall improvement in my voice awareness and vocal health. *(source: subject oo41y as reported on written survey)*
>
> I feel so far it has (worked) and I'm very glad that I took this way, this road (voice therapy via VTC) instead of the other road (surgical intervention for vocal nodules). *(source: subject u21 as reported during interview)*

> (Clinician/researcher) and (remote site coordinator) are really helpful and very patient in helping me to get my voice back. *(source: subject pp42y as reported on written survey)*
>
> Learning how to talk without straining my voice through speech lessons. *(source: subject r18 as reported on written survey)*

The coordinator at the overseas remote site called patients 4.5 months after completion of the research protocol and their discharge from therapy. She reported that patients maintained levels of improvement in their vocal function as well as compliance with their treatment regimen including facilitating exercises and improved vocal hygiene.

> Voice sounded strong and clear; when asked about good vocal hygiene practices she said she continues to drink lots of water. *(source: subject ll38y as reported by remote site coordinator 4.5 months following discharge from therapy)*
>
> She was getting over another bout with allergies, but her voice actually sounded strong and only mildly hoarse. *(source: subject mm38y as reported by remote site coordinator 4.5 months following discharge from therapy)*
>
> Called at work during her break time from classroom. Normal vocal quality; sounded strong. She indicated that she is learning not to yell to help her maintain good vocal quality. *(source: subject oo41y as reported by remote site coordinator 4.5 months following discharge from therapy)*
>
> Normal voice quality has been maintained and she is pleased about that; she spontaneously informed me that she still remembers to use her "whooop" technique if she needs assistance with her singing. *(source: subject pp42y as reported by remote site coordinator 4.5 months following discharge from therapy)*

Patient Satisfaction

As participants reflected on their general appraisal of the project, a common thread was positive experiences with telehealth.

> I cannot say anything bad about it because I've had only positive experiences, there has been no negatives. *(source: subject u21 as reported during interview)*
>
> I really enjoyed it. Thought it was cool. *(source: subject ll38y as reported on written survey)*

> Said there were no negative. *(source: subject mm39y as reported by remote site coordinator)*
>
> She commented that the voice project was "very interesting" and "wished (she) could have been involved with it longer." *(source: subject oo41y as reported by remote site coordinator)*
>
> "Everything is great!" (when I asked her about any negative aspects). *(source: subject pp42y as reported by remote site coordinator)*
>
> There is no constructive criticism to report. This was an extremely helpful and valued experience. *(source: subject l12 as reported on written survey)*
>
> Glad to be your test subject. *(source: subject e5 as reported on written survey)*
>
> (Clinician/researcher) and ENT staff are a God-send!. *(source: subject k11 as reported on written survey)*
>
> Excellent care and very professional staff!!! *(source: subject y25 as reported on written survey)*
>
> Felt there were no negative issues with the actual patient care side of the project. He received no negative feedback from the patients in the voice study. *(source: referring physician at remote site as reported by remote site coordinator)*
>
> Results appeared to have been positive…with reported patient satisfaction in the service delivery. *(source: remote site coordinator)*
>
> Consistent patient satisfaction. *(source: remote site coordinator)*

One patient expressed enthusiastic support of telehealth with positive treatment outcomes:

> I'm all for media therapy…the techniques work. *(source: subject u21 as reported during interview)*

Several patients offered suggestions and recommendations:

> Telehealth will be more effective if participant (patient) is provided with a CD of voice practice lessons. Patient will be able to practice even after sessions are completed and more often than during each session…2x a month. *(source: subject h8 as reported on written survey)*
> *Note: voice exercises were recorded and copied on CDs to provide a model for home practice between sessions and throughout the generalization and maintenance phases of therapy; patients were given these CDs*

> I think it would be a good thing in the future for voice therapy to be done this way. *(source: subject u21 as reported during interview)*
>
> She felt the project was "very beneficial" and "would recommend it to everyone." *(source: subject ll38y as reported by remote site coordinator)*
>
> It's a good program to keep in the hospital since we don't have a voice therapist, being away from the family and work. *(source: subject mm39y as reported on written survey)*
>
> She felt that…the project was "very beneficial" and would "recommend it to everyone." *(source: subject pp42y as reported by remote site coordinator)*

Serendipitous Result: Professional Collaborations

An unanticipated but important outcome of our project was professional development and distance collaboration. When we recruited the SLP who served as our remote site coordinator, she was hesitant because she did not feel comfortable or confident in treating voice disorders. She agreed to participate when her role as coordinator (rather than as voice clinician) was defined. In the course of observing and assisting with telehealth therapy sessions, she quickly acquired knowledge, skills, and clinical competence in assessing and treating voice disorders.

> During my participation in the study, an unexpected positive outcome emerged with the use of VTC as a tool for mentoring. Under (clinician/researcher)'s guidance, my skill base in voice evaluation and therapy increased significantly. Not only did I learn from observation of (clinician/researcher)'s therapy sessions, I had the opportunity for long distance learning in other aspects. Use of telehealth was a great mentoring experience for me. *(source: remote site coordinator)*
>
> The technological capabilities of VTC with the ability to transmit visual and auditory information from a computer monitor were invaluable in the mentoring and learning process. As the on-site coordinator I served as the second pair of eyes for (clinician/researcher) for inter-judge reliability of our clinical observations. There was an urgent need to quickly absorb, filter, and find relevance in patient behaviors with the therapy objectives being addressed to learn as much as I could to sharpen my voice therapy skills. *(source: remote site coordinator)*

As a result, she effectively treated a patient with dysphonia who could not travel the distance from his duty station to the military medical facility at the overseas remote site where we conducted our study.

> Utilizing the voice therapy techniques I learned by observing (clinician/researcher), the patient was able to effect a significant and healthy change in the quality of his voice in the one and only session that time allotted before he had to fly back home. To say the least, it was a thrilling experience to have confidently and successfully "soloed." *(source: remote site coordinator)*

Reciprocally, she consulted with a SLP in our urban medical center on augmentative and alternative communication devices which is her subspecialty. Professional development to address needs of patients at both sites was a mutual benefit achieved by utilizing the VTC system.

Deconstructing Vocal Rehabilitation via Telehealth

Accounts of patients and the coordinator and referring physician at the overseas remote site were coded and interpreted to deconstruct the telehealth voice study from multiple perspectives and address the qualitative research questions:

- How do patients respond to voice therapy delivered remotely?
- How is the telehealth model of service delivery perceived by health care providers, including the clinician providing care, the referring physician, and the SLP coordinator at the remote site?

In addition to summarizing results and interpreting findings, responses were used to formulate recommendations based upon "lessons learned."

Fulfilling a Need to Improve Access to Services

In order to maximize success of a telehealth application, its purpose should be based upon an identified need to improve a health care service (Brebner, Brebner, & Ruddick-Bracken, 2005; Burgess et al., 1999). The theme that telehealth expands treatment options when there is a lack of physical presence of specialists was reinforced in participants' comments. Patients referred for voice therapy did not have equal access to services. Their comments highlight the benefits of the telehealth model in meeting the needs of individuals in rural areas with logistic as well as geographic challenges. The advantages cited include time savings and convenience of access for patients with demanding schedules.

For a participant in the study, telehealth voice therapy was perceived as a low-risk option and desirable alternative to surgical intervention for hoarseness and vocal nodules:

> I didn't wanna…do a surgery because I know with any kind of cutting anywhere on your body, it's gonna leave scar tissue; I felt that if I had a scar on my vocal cords that it would alter my voice; I decided to learn instead a better way of taking care of myself rather than doing surgery…one I'm a coward. I didn't want to be cut on so this was a easy way for me to see if it works…

Her personal commitments and schedule demands conflicted with taking time to attend therapy:

> I can't make it at certain times…because of my personal time and my work time; I teach a special population which is kind of hard for me as a teacher to leave the classroom; there's all kinds of schedules that I would have to meet as a grandmother, a mother, a wife and a teacher.

She volunteered to participate in the research protocol which enabled her to receive therapy remotely via VTC at a satellite clinic, which was closer to her workplace and home. In addition to time constraints, she cited barriers to accessing care at the urban medical center including geographic distance from the facility, frustration of driving in traffic, limited availability of parking, and inclement weather:

> Traffic of getting to (urban medical center); parking is a pain up at (urban medical center); if the weather is rainy or cold then I have to try to run…

She commented on the convenience, both in access and time, of receiving therapy at the nearby rural satellite clinic:

> It's very convenient; it's 10 minutes versus 40, 50 minutes from (urban medical center); finding parking and going up and sitting in the waiting room is a lot of time and therefore I would have to take time away from class and ask my principal for time off to go to (urban medical center); this has saved me absolute time; it's scheduled according to my time].

Qualitative Research Question 1: How do patients respond to voice therapy delivered remotely?

Patients' Response to Remote Delivery of Voice Therapy

Sensitivity to individual patient's preferences and perceptions is vital to success when incorporating the use of technology into clinical practice. While at the outset several participants embraced telehealth as an innovation in health care, other patients recalled feeling apprehensive when approaching their initial telehealth session because of the novelty of the experience. However, patients quickly overcame their apprehension to the extent of embracing the telehealth mode of receiving care.

One of the patients who received therapy at the overseas remote site via VTC was reassigned to a new duty station and received follow-up services in the Otolaryngology and Speech Pathology Clinics at the urban medical center where the research study was conducted. This patient was interviewed and asked to compare her perceptions of remote versus in-person voice therapy (refer to transcript in Appendix K). Of interest to note from the remote site coordinator's account, this patient presented as the most apprehensive in approaching her initial session and subsequently adapted the easiest to the telehealth model.

> The VTC was more effective for me because I was, I say, I remember being more focused I was your only audience, and you were my instructor. There were no distractions, there were no other… I just remember being more prepared and more, there was a sense of more clarity, I was ready to go… *(source: subject qq43y who received therapy via VTC at the overseas remote site and in-person at the urban medical center)*

She referred to her therapy sessions as "experiences" and described her VTC sessions as a "snapshot" or "close picture" which promoted engagement. In contrast, she described her in-person therapy as a "panoramic picture" with more distractions. She perceived the remote sessions as more effective because VTC prompted her to be "more focused" and "involved" as in "tunnel vision" rather than the in-person "panoramic" view with distractions.

> I remember watching the screen and I had no problem following you, the breathing, the patterns, the techniques…and I just seemed to be more in tune. I had what was called, and sometimes people talk about how tunnel vision is a negative thing but I think in this case it was very positive. Because I could see nothing else but my experience when I was on VTC, and now I'm…I see you, I see the experience but I see everything else, it's like a panoramic picture. Then I had more of a snapshot close picture so I was more engaged, just seemed that way. *(source: subject qq43y who received therapy via VTC at the overseas remote site and in-person at the urban medical center)*

Since VTC sessions were scheduled in advance and involved coordination and connection between the two sites, the patient felt committed to keeping her appointments in spite of conflicting work assignments. When she relocated to her new duty station, work-related demands interfered with scheduling regular appointments at the urban medical center.

> I was committed to the time, it was on my schedule, it never changed unless you changed it but…it was a blueprint, it was set in stone, pretty much. So I knew when I was going to study, I knew when I was going to prepare, and there it was. *(source: subject qq43y who received therapy via VTC at the overseas remote site and in-person at the urban medical center)*

> It was more structured and it seemed more formal, you had to prepare because we were doing it at-a-distance. *(source: subject qq43y who received therapy via VTC at the overseas remote site and in-person at the urban medical center)*

> And I found myself even less stressful, whereas now I'm looking at okay, when I can see you, when can I not see you, how do I change that. So if my schedule changes, then my study time changes and my preparation changes as well, even though it, may be it shouldn't… but it does. *(source: subject qq43y who received therapy via VTC at the overseas remote site and in-person at the urban medical center)*

The time-saving and convenience of receiving therapy via VTC were also mentioned in this patient's account.

> You have to make more of an effort to come right, which is why it takes more time out of your schedule because it's the travel time, the parking time. It's all those things, and in addition to the fact that it's not a set schedule also means that my study and preparation, and practice is not set. *(source: subject qq43y who received therapy via VTC at the overseas remote site and in-person at the urban medical center)*

The following statement provides a dimension that the construct of "distance" does not always refer to geographic location:

> Even though you were further I found you were closer, and now here you're closer but I find you farther…you were further on VTC but you were closer, the experience was closer, and now here, you're closer but I feel further from the experience. *(source: subject qq43y who received therapy via VTC at the overseas remote site and in-person at the urban medical center)*

Protecting patient confidentiality has been cited as a fundamental charge when providing health care services via VTC (ASHA, 2005c, 2010b; Jarvis-Selinger et al., 2008) and was addressed in configuring our equipment with built-in security encryption. However, privacy, patient confidentiality, and data security were not perceived as concerns by participants in the study. In fact, the one patient who referred to these issues expressed confidence that policies and procedures were in place to ensure protection of her privacy.

Treatment Outcomes

ASHA's position (2005b) is that "…the quality of services delivered via telepractice must be consistent with the quality of services delivered face-to-face" (in-person). Telehealth applications require assessment of relevant outcome data to promote and support sustainability. Scientific peer-reviewed publications such as the *Journal of Telemedicine and eHealth* include empiric studies conducted by SLPs that conclude that there is no difference in diagnostic accuracy and the ability to treat and produce evidenced-based outcomes when services are delivered via telehealth versus in person. With support of empiric outcome data, telehealth applications can be integrated into the normal provision of services to enhance existing services and improve access.

Across participant categories, positive treatment outcomes were reported in this study. Patient accounts included comments about improvement in vocal function, the referring physician acknowledged that the "project was effective in meeting patient care," and the coordinator at the remote site noted that "pre and post test outcome measures were positive" with "improvement for the majority of patients."

Qualitative Research Question 2: How is the telehealth model of service delivery perceived by health care providers, including the clinician providing care, the referring physician, and the SLP coordinator at the remote site?

Perceptions of Health Care Providers

Lessons Learned: Insights from the Coordinator at the Remote Site

The coordinator at the overseas remote site was invited to share her observations of therapy provided via VTC as well as her perception of patients' response to receiving services remotely. Her reflections of her telehealth experience provide valuable insights from an ethnographer's perspective. Her comments are incorporated in broad themes within this chapter and focus on: rapport between the clinicians and patients; communicative interactions; inter-judge reliability of clinical observations (remote versus on-site); in-person versus remote contact between clinicians and patients; response to and comfort with technology; and personality characteristics that impact on rapport, ease, and comfort in remote clinical interactions. Her descriptions of telehealth sessions and views of patient behaviors and responses were very informative and provided valuable data for deconstructing our telehealth application and formulating recommendations based upon "lessons learned." Confirmation with existing literature is cited when applicable.

> Clinician could not view patient when voice samples were being recorded on the computer at the remote site. Going back and forth from computer to the telecommunications video monitor aided the clinician in getting video feedback of patient behaviors. *(source: remote site coordinator)*
>
> Maintain patient-therapist connection through emails, as deemed appropriate. With computer availability becoming commonplace, emailing in this model of service delivery aids in personalizing the patient-clinician relationship. Possibly greater patient-clinician contact may occur with this format since both parties have the legitimate reason of distance between them to feel comfortable in more freely using emails to ask questions/share information. Also, written information can be given more clearly and with more detail if needed, for the patient to decipher at his/her pace. *(source: remote site coordinator)*
>
> A skilled clinician is able to more accurately assess a patient's auditory and visual cues even if equipment distortions are present and can more successfully predict what the patient may be doing when only audio is available. This was validated by the coordinator (who was also an SLP) at the remote site when comparing the clinician's and coordinator's judgments of patient behaviors during therapy. *(source: remote site coordinator)*

> When using VTC in a telehealth service delivery model for the purpose of teaching or mentoring, the patient's physical presence with the "student" is definitely an advantage. *(source: remote site coordinator)*

The phenomenon of professional collaboration and mentoring that evolved serendipitously from the remote site coordinator's (SLP's) participation in telehealth sessions has been described in the literature. Remote providers reported gaining knowledge and experience and increasing their diagnostic confidence through participation in videoconferences that enabled them to manage more complex situations and become less reliant on expert consultation, including disciplines involved in providing immediate care such as emergency medicine and stroke neurology, and in rural centers where physicians in nonspecialized facilities were required to provide specialized services for which they were not trained (Jarvis-Selinger et al., 2008). In SLP, a clinician in an underserved rural area of Kansas developed competence in performing swallow studies through mentoring from a colleague at the University of Kansas Hospital in telehealth sessions with patients (Georges et al., 2006). In the present study, the SLP at the remote site gained clinical expertise in treating voice disorders through facilitating telehealth sessions.

Integrating Telehealth in Clinic Workflow

To ensure successful deployment and sustainment, telehealth services should be integrated into existing organizational processes, personnel networks, and training programs (ASHA, 2010b).

Personnel at remote sites can fulfill important functions for telehealth projects. The coordinator for our project at the overseas remote site served multiple roles including SLP to evaluate patients referred for voice therapy, facilitator during telehealth therapy sessions, scheduler, and foremost as a liaison and on-site "champion" in promoting the project. Her

participation was critical to our success and her comments were used to deconstruct the operational features of the project to integrate telehealth into routine clinic workflow.

Scheduling Issues

Scheduling telehealth services requires planning and organization. Factors that must be considered include identifying participants and accommodating their personal schedules and routines and coordinating with room/equipment availability (clinician, patients, family members, caregivers, interpreters, multidisciplinary team members, teachers, aides, facilitators), multiple locations and time zones, availability of required resources and technical support personnel if needed, and network "traffic" at specific times that may impact on quality of transmission.

> Coordinating therapy appointments when there is a significant time difference between the two sites; which site to coordinate securing bridge time. *(source: remote site coordinator)*
>
> The responsibility of arranging VTC connection should be that of the remote site receiving the services. *(source: remote site coordinator)*
>
> Even if (remote site coordinator) had…arranged the patient appointments and telephone follow-ups, (referring physician) felt confident that the ENT Clinic could have handled those tasks. *(source: referring physician at remote site as reported by remote site coordinator)*
>
> Can standing reservations be guaranteed to ensure that patients are seen, or is the VTC scheduling system too complex? *(source: remote site coordinator)*
>
> Site person was not informed that there was a designated hospital technical support person setting up requested reservations by hospital staff for the VTC room and the technical support person was not aware of the voice project's scheduling of patients. As a result, some scheduling conflicts occurred. *(source: remote site coordinator)*
>
> If the VTC equipment and room are shared with other disciplines, naturally it is crucial to coordinate scheduling of the room (at the remote site, the hospital technician was designated the scheduling coordinator for hospital staff not involved in the voice project—after I made my schedule he worked around it since the voice project took priority at the time). *(source: remote site coordinator)*

> At least one designated individual is needed to establish and coordinate a support system at the remote site, e.g., to learn and/or teach use of the telecommunication equipment in conjunction with the computer software, coordinate scheduling of patients with availability of room (when VTC room is shared with other disciplines), distribute patient handouts, etc.. If regular patient use of the VTC room for a particular discipline is needed, specific day(s) of the week with time slots should be established between the two sites and coordinated with the remote site's patient appointment processing system (for example, the appointments desk is aware that Radiology schedules swallow studies only on Monday and Wednesday at specific time slots). *(source: remote site coordinator)*

Technical Issues

Technical support on a routine basis and clinician flexibility in accomplishing objectives are critical to ensure successful deployment and sustainment of telehealth services.

> Technical difficulties (were) not a significant issue, but can be worrisome to the clinician and the on-site coordinator. An established back-up system with a dependable person(s) at the remote site is crucial, e.g., person with knowledge of the equipment to troubleshoot (this may be the responsibility of the hospital technician—however, the technician may not always be readily available with other responsibilities elsewhere in the hospital), telephone contacts at both sites, flexibility of the clinician to change therapy session format to audio only, e.g., telephone conference (so a speaker phone feature in the room is important), etc.; lots of trial and error in the beginning! *(source: remote site coordinator)*

> The hospital technician handled the equipment set up and dial in numbers for the other hospital personnel which is ideal. *(source: remote site coordinator)*

> Integrating technology in telehealth service delivery becomes standard practice by default thereby providing opportunities to improve the quality of patient care. *(source: remote site coordinator)*

> Do military hospitals (versus civilian hospitals) share VTC connection time with nonmedical facilities? Can you get "bumped" from use if another situation takes priority when VTC schedules are full (e.g., working in a military system, some matters may take precedence based on rank of requester; some medical matters also may be of higher priority in a hospital setting). *(source: remote site coordinator)*

Workload/Billing

Workload and reimbursement issues should be addressed prior to initiating telehealth services including verifying coverage for telehealth patient encounters and fulfilling documentation and coding requirements to bill payers for specific procedures delivered via telehealth. Furthermore, providers should seek guidance on regulatory issues to ensure compliance with licensure and credentialing requirements.

> Crediting patient intervention time to one's caseload; patient billing issues if two SLPs are involved at different sites in the same session; which site to pay for the calls, if costs are incurred. *(source: remote site coordinator)*

Technology Recommendations for Conducting Telehealth Voice Therapy

When developing telehealth applications, usability studies should be conducted to select appropriate equipment and establish minimal requirements for connectivity in order to facilitate successful implementation and optimize treatment outcomes. Standard operating procedures should include alternatives for establishing or re-establishing connectivity in the event that the primary option should fail (e.g., telephone or e-mail as back-up if VTC system malfunctions). In addition to having available technical support when needed, basic provider training on use of equipment and establishing connectivity should be conducted on an ongoing basis to increase confidence and skill in troubleshooting as problems arise. Multi-use of a VTC system (e.g., by multiple disciplines for multiple functions) should be considered in building a business case for telehealth (e.g., cost-benefit analysis for initial investment and sustainment of telehealth services).

Based upon her experiences at the remote site, the coordinator was asked to formulate recommendations on the technological aspects of the project.

> Use maximum bandwidth whenever possible. *(source: remote site coordinator)*
>
> Despite occasional technical concerns, e.g., use of slowest bandwidth resulting in increased delay in audio and video feedback as well as distortions in the video, and inability to always view patient directly, the high level of experience of the clinician in providing voice therapy is of significant advantage. *(source: remote site coordinator)*
>
> Unable to see computer transmitted text clearly on the monitor. This did not impact negatively on the study. However, information via computer—such as downloaded information for patients—may have increased possibilities in integrating technology in remote service delivery. *(source: remote site coordinator)*

In their review of experience-based guidelines for the implementation of telemedicine services, Brebner et al. (2005) report that most technical problems arise from the network rather than the equipment. This was consistent with our experience:

> Weekly time slots to connect to VTC and with fastest bandwidth transmission were not guaranteed. Although this was not a major problem during the study, it can be a significant issue. *(source: remote site coordinator)*

Prior to deploying our vocal rehabilitation protocol we consulted with technical experts to ensure that the VTC system and peripheral devices were user friendly, robust, reliable, and suitable to support our clinical application and that the bandwidth and transmission speed of the network were appropriate. In rare events when dedicated bandwidth was not available, we scheduled times to minimize network congestion and planned for alternative connectivity via telephone and email to ensure means of reliable communication.

> Have telephone back-up numbers for telephone conferencing if equipment fails. *(source: remote site coordinator)*

Multi-use of telemedicine system is recommended (Brebner et al., 2005). In fact, after the VTC equipment was acquired and installed at the overseas remote site through our telehealth voice project, the hospital staff implemented other clinical applications.

> (He) reported that the project was very well received by the Command and that he still hears good comments about it. *(source: referring physician at remote site as reported by remote site coordinator)*
>
> (regarding positive comments from hospital Command about the project) My impression is that the voice project provided the hospital with its Telemedicine Room equipment with which they are pleased to have established a beneficial health care service delivery mode. *(source: remote site coordinator)*
>
> He reported that the Telemedicine Room is being well utilized with the hospital branch clinics. Services that have been provided are psychiatric evaluations, nutritional counseling and other counseling (unspecified) services. *(source: technology consultant at remote site as reported by remote site coordinator)*

However, this created a problem with equipment malfunction due to differing equipment settings among users. When our remote site coordinator encountered this predicament, she maintained a key of our required configurations for quick reference.

> VTC equipment settings had been changed to accommodate other users without the site person's knowledge who then perceived it as equipment malfunction when the equipment did not work (due to ignorance of using different setting adjustments - trial and error learning of equipment!). Be aware of different equipment settings of different users when trouble-shooting technical difficulties. I posted my settings for quick reference. *(source: remote site coordinator)*

Overcoming Organizational and Administrative Barriers: Challenges in Project Implementation from the Perspective of the Coordinator at the Remote Site

It is essential to gain the support of stakeholders (e.g., clinicians, administrators, patients, sponsors/payers, technical and support staff) prior to initiating a telehealth program. Ideally, the telehealth initiative should be included in the institution's strategic plan to affirm administrative approval and commitment, including allocation of resources to support implementation and sustainment (ASHA, 2010b).

May et al. (2003) identified four mandatory conditions for a telemedicine system to stabilize and normalize as a means of service delivery. Operational context was highlighted as a

crucial variable including the complexity of integrating and stabilizing the new mode of service delivery into routine organizational processes and normal modes of professional practice. In our experience, organizational and administrative tasks (i.e., executing a personnel contract, establishing cohesive networks at the remote site to support the project) were undoubtedly the most daunting obstacle, and surpassed the challenges of overcoming geographic distances (i.e., transporting equipment and establishing connectivity) and time differences (i.e., crossing the International dateline).

> *Years* of administrative preparations to approve the telehealth project; therefore, some individuals initially committed to the project had transferred or no longer could provide the designated time to complete the study; this is a problem in a military setting with job transfers inevitable. *(source: remote site coordinator)*
>
> Conflicts in contract for the site person caused further delays in initiating the project. *(source: remote site coordinator)*
>
> Poor hospital-wide communication regarding use of the new VTC room; (apparently the existence of a new VTC room in the hospital was announced but there did not appear to be communication that a voice telehealth project had been implemented). Several staff wanting to use the VTC room did not understand that the equipment came from the voice project and that the voice project took priority. The SLP (telehealth site person) was perceived as monopolizing the use of the room. *(source: remote site coordinator)*

Overcoming Psychological Barriers: Perspective of the Clinician/Researcher

Telehealth may not be appropriate for all patients, in all circumstances, and for all procedures. Exclusion criteria include patients with attention, hearing, vision, or cognitive deficits that interfere with their ability to participate in a telehealth session, and patients who or procedures that require hands-on guidance (e.g., laryngeal manipulation techniques in voice therapy). Clinical procedures and materials may need to be modified to accommodate for the lack of direct physical contact with the patient (e.g., unable to assess muscle tone or strength remotely).

In addition to overcoming geographic barriers to care, proponents of telehealth have often cited the need to overcome psychological barriers to telehealth which include reluctance on the part of health care providers to venture away from in-person encounters with patients. Health care providers' satisfaction with telehealth is a key component of successful deployment of clinical applications since the distance mode of delivering services often necessitates modification of approaches, methods, and techniques (Hopp et al., 2006). Clinicians are often concerned that it may be difficult to establish rapport with patients at-a-distance with lack of the "human factor" that is present with in-person encounters.

Indeed, it was challenging to depart from the comfort and ease of conducting "business as usual." Voice therapy techniques needed to be modified and adapted to accommodate for the lack of physical contact with the patient. While this task was not overwhelming, a source of initial uncertainty was the anticipation of establishing a therapeutic alliance with patients at-a-distance via VTC rather than in-person. Reassuringly, patients reported that their therapeutic relationship with the clinician was not compromised by the use of technology.

> (Receiving therapy remotely) I felt did not inhibit my care at all. *(source: subject u21 as reported during interview)*
>
> I felt very comfortable with the telehealth sessions and was able to communicate easily with my speech pathologist. *(source: subject a1 as reported on written survey)*
>
> During the evaluation, she often looked at the monitor (as did I) looking for your face! That's how natural she felt the set up was. *(source: subject qq43y as reported by remote site coordinator)*

Furthermore, experiences shared by participants suggest that the critical element of optimizing treatment effectiveness by adapting techniques to the telehealth model and relying on signals transmitted via VTC networks was not compromised significantly in providing services

remotely. The coordinator at the remote site identified disadvantages of the clinician not being able to provide "instantaneous" feedback and hands-on guidance or utilize tactile techniques like palpation, but felt she was able to compensate on behalf of the clinician.

> Only problem is the clinician cannot cue the patient instantaneously, if needed. *(source: remote site coordinator)*

> Unable to provide hands-on cues if needed. This did not significantly impact on the study. Use of the remote site coordinator served as an alternative. *(source: remote site coordinator)*

Summary

Qualitative data captured through questionnaires and interviews with participants provide an understanding of our telehealth vocal rehabilitation protocol from multiple frames of reference. Meaning constructed from reports of participants' experiences highlight perceptions of care provided remotely, patient and provider satisfaction, clinical outcomes, and relevant operational and technological issues. Based upon qualitative analysis of data, the telehealth service delivery model appears to be: 1) feasible in terms of overcoming barriers to care, and 2) effective in terms of yielding desirable clinical outcomes. However, administrative, personnel, equipment, technical, workflow, and service delivery issues required time and effort to facilitate successful deployment. Recommendations based upon "lessons learned" are provided to help professionals who may be interested in initiating SLP telehealth applications.

CHAPTER 7: DISCUSSION

The purpose of this study was to investigate the telehealth model of delivering SLP services at-a-distance using video-teleconferencing technology. Pre-existing de-identified data were analyzed to describe the feasibility of, patient satisfaction with, and effectiveness of delivering voice therapy remotely. Quantitative comparisons of pre- and post-treatment data on 1) patient self-rating on the Voice Handicap Index, 2) auditory-perceptual ratings of voice samples, 3) visual-perceptual ratings of video endoscopic laryngeal exams, and 4) noise-to-harmonic ratios indicated no significant differences between participants who received voice therapy in-person and participants who received therapy remotely. Based upon qualitative analysis of data, the telehealth vocal rehabilitation protocol appears to be 1) feasible in terms of overcoming barriers to care, and 2) effective in terms of yielding desirable clinical outcomes.

In the early stages of developing the telehealth vocal rehabilitation protocol, multiple measures of treatment outcomes were selected because of the novelty of the service delivery model and the lack of existing evidence to support its deployment. Critical questions that needed to be addressed in the absence of data in the literature included whether the integrity of audio and video signals captured at remote sites and transmitted at a distance would allow for accurate and reliable assessment of voice. Therefore, multiple data sets were used to measure and triangulate treatment outcomes.

Patient Self-Ratings with the Voice Handicap Index (VHI)

The VHI was developed to quantify patients' perception of disability associated with voice disorders. It is often used to monitor treatment effectiveness because it typically takes less than five minutes to administer and has been shown to have test-retest reliability and construct

validity, as well as sensitivity for a wide variety of voice disorders (Jacobson et al., 1997). For example Schindler et al. (2007) used the VHI to evaluate treatment outcomes in the pediatric population, while Wingate et al. (2007) used it with professional voice users to demonstrate improvement following therapy.

Cheng and Woo (2010) conducted a nonrandomized, prospective study to investigate subjective and objective outcome measures in 21 patients who underwent phonosurgery for treatment of non-neoplastic vocal fold lesions. Results indicated statistically significant differences between pre- and post-operative VHI scores, but not in objective measurements which included acoustic and aerodynamic measures. In a study by Rosen et al. (2000) with 37 participants, the VHI showed a significant change following treatment for different voice disorders including unilateral vocal fold paralysis (UVFP), vocal cyst/polyp, and muscle tension dysphonia (MTD). All three groups showed a reduction in their average VHI after receiving treatment which included surgical, medical, and behavioral voice therapy.

In the present study, the distribution of post-treatment VHI scores was significantly lower than the distribution of pre-treatment scores for both the in-person and VTC groups. These findings are consistent with studies cited in the literature indicating patients' perception of improvement in voice following therapy, as measured by the VHI. Furthermore, there was no significant difference between VHI scores for patients who received voice therapy in person and patients who received voice therapy via interactive VTC, representing decreased patient perception of disability following voice therapy regardless of the service delivery mode.

Auditory-Perceptual Ratings

In his systematic review on the effects of voice therapy, Speyer (2008) reported that the perceptual evaluation of voice quality is usually considered the gold standard for voice assessment. However, because voice is a multidimensional phenomenon, it can be expected that patients will not show an abnormality in all aspects of voice, nor an improvement in all aspects. Furthermore, unstable internal standards for comparing speech stimuli and the lack of consensus in judging perceptual parameters pose significant difficulties in judging characteristics of vocal quality. In light of these challenges, a forced-choice method was used in this study and a 20-minute training session was conducted with non-study voice samples to familiarize the judges to the task.

Results indicate that both raters selected the post-treatment voice sample as better for 90% of participants, with no significant differences between the in-person and VTC groups. Inter-judge (94%) and intra-judge (100%) reliability scores were high. This outcome measure provided convincing evidence to support the research hypothesis.

Laryngeal Videoendoscopy Ratings

Although there was no significant difference between outcome ratings of laryngeal videoendoscopy samples for patients who received voice therapy in person and patients who received voice therapy via interactive VTC, inter-judge reliability as measured by Cohen's kappa was low (0.151). Furthermore, the post-treatment sample was selected as being better for 87% of participants (26/30) by rater B, but only for 70% of participants (21/30) by rater A.

Laryngopharyngeal reflux (LPR) represented the largest diagnostic category (47% or 14 of 30) for the pairs of exams that were rated. Difficulties inherent in subjective ratings and low

inter-judge agreement in rating physical signs of LPR even under ideal practice conditions have been reported in the literature (Beaver et al., 2003; Branski, Bhattacharyya & Shapiro, 2002; Kelchner et al., 2007; Milstein et al., 2005).

Beaver et al. (2003) conducted a prospective analysis using digital laryngeal videostroboscopy (LVS) to assess objective improvement of the larynx after six weeks of proton pump inhibitor (PPI) therapy. While they concluded that 3 independent blinded examiners were able to detect signs of improvement in LPR disease after PPI therapy using digital LVS, inter-rater reliability was "only fair" on the Laryngopharyngeal Reflux Disease Index, with a range of kappa values from -0.097 to 0.766.

In a prospective randomized blinded study to determine the reliability of assessing laryngoscopic findings potentially associated with LPR disease, Branski et al. (2002) reported poor inter-rater reliabilities with five otolaryngologists, and extremely variable intra-rater reliability. They concluded that laryngeal physical findings of LPR disease cannot be reliably determined from clinician to clinician which makes precise laryngoscopic diagnosis of LPR highly subjective.

Kelchner et al. (2007) reported the need for greater consensus among professionals with regard to discreet features of physical findings associated with LPR, a fuller understanding of normal variants, and greater emphasis on inter-rater reliability. In their prospective study to determine inter- and intra-judge agreement in rating signs of LPR, two SLPS and two otolaryngologists used the Reflux Finding Scale to independently rate videotapes of endoscopic examinations for 30 participants asymptomatic of reflux. Level of rater agreement regarding the presence and severity of physical findings attributed to LPR differed within and between otolaryngologists and SLPs.

Milstein et al. (2005) conducted a study to: 1) determine the prevalence of laryngeal irritation signs associated with reflux in normal asymptomatic participants, and 2) compare findings between flexible and rigid laryngoscopes in an attempt to increase specificity of diagnosis of reflux in endoscopic laryngeal examinations. They concluded that flexible laryngoscopy is more sensitive but less specific in identifying potential signs related to LPR. Overall agreement of the three raters was low, as measured by Kappa statistics. The investigators suggested that future studies should consider technical as well as observer variability in identifying specific laryngeal signs for LPR.

Problems with inter- and intra-judge agreement in rating laryngeal stroboscopic examinations have led clinicians and researchers to develop assessment instruments and training tools to improve the reliability of ratings (Peppard & Bless, 1990; Poburka, 1999; Poburka & Bless, 1998; Rosen, 2005; Walker & Messing, 2006). Rosen (2005) formulated a video stroboscopy research tool consisting of 10 parameters selected from a literature review and clinical experience. The tool was validated with results of 18 reviewers including 14 otolaryngologists and 4 SLPs with special interest and training in laryngology or voice disorders. Inter-rater reliability on the 10 parameters ranged from 0.11 to 0.65 with four of the dimensions exhibiting reliability coefficients of less than 0.50. Research to increase reliability and utility of the instrument was proposed including the use of anchors to provide reviewers with an external, common reference point for each parameter.

Perhaps the use of videoendoscopic images to assess voice treatment outcomes in this study may have been enhanced by the correspondence or accompaniment of voice samples for each of the pre- and post-treatment video samples. Although auditory-perceptual and visual-perceptual measures were judged independently to avoid potential bias, pairing the voice

samples with the video samples for both SLP and otolaryngology judges may have provided a more realistic representation of a complementary examination in clinical practice (i.e., phonoscopic assessment).

Noise to Harmonic Ratios (NHR)

Signal-to-noise ratio has been shown to differentiate between sustained vowels produced by normal subjects versus subjects with laryngeal pathologies (Zhang & Jiang, 2008). However, it has also been suggested that although NHR is a useful quantitative index to confirm a perceptual diagnosis of dysphonia and evaluate quantitative changes in a dysphonic voice over time, it should be used as a complement, rather than a substitute for perceptual evaluation because of its low specificity and relatively high false positive and false negative probabilities (Jotz et al., 2002). In one study, NHR was significantly correlated with perceptual ratings of roughness and the overall degree of deviance of voice (Bhuta, Patrick, & Garnett, 2004). In another study, the ratio was suggested to be more clinically useful than jitter as an objective and quantitative index for assessing the degree of hoarseness (Yumoto, Sasaki, & Okamura, 1984). NHR has also been identified as a more sensitive index of vocal function than jitter for discriminating changes in voice associated with normal aging (Ferrand, 2002).

Because of the equivocalness of using acoustic measures to evaluate outcome in clinical trials of intervention aimed at improving voice quality (Carding et al., 2004; Speyer et al., 2004), the NHR was selected to serve as only one of five complementary indicators in the present study. Results indicated that for both the in-person and VTC groups, the distribution of post-treatment NHRs was significantly lower than the distribution of pre-treatment ratios. Lower post-treatment ratios suggest improvement.

Clinical Implications

The goal of SLP services is to maximize functional abilities, life participation, and promote quality of life and independence for individuals with communication disorders. For example, treatment for communication disorders in children can facilitate their ability to learn and may lead to better job opportunities in their future. Rehabilitation services provided by SLPs can help adults improve their function after a stroke and facilitate their transition back to work, or reduce their need for expensive nursing home care. Telehealth supports the mission of making SLP services available and accessible to those in need by resolving inequities in care delivery resulting from personnel and geographic barriers.

Benefits to Patients and Their Family

Potential benefits of telehealth should be measured in qualitative as well as quantitative outcomes. In addition to cost savings across sectors (e.g., health and human services, dependent care, education, business), improved accessibility to services via telehealth can reduce or eliminate travel time and inconveniences associated with travel such as availability of transportation, parking problems, and difficult or risky access during inclement weather. Providing services via telehealth can also eliminate the need for a family member to take time away from their work to transport a patient to therapy.

For home-based telehealth services, in addition to convenience, rehabilitation can incorporate a more functional approach by involving family members and caregivers. Behaviors and skills targeted in therapy can be established in the context of daily activities or existing routines and within natural interactions with communication partners in the patient's home environment. Improving access to services may enable patients to participate in therapy on a more regular basis and increase compliance to treatment, which may improve clinical outcomes.

Telehealth Applications to Care for War Fighters

A challenge in rehabilitative medicine that has evolved in recent years is caring for military service members and veterans with traumatic brain injury (TBI). TBI has been referred to as the signature injury of Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). As a result, rehabilitation specialists are striving to develop military-based research and clinical programs that represent best practice (Belanger, Uomoto, & Vanderploeg, 2009; Helmick, 2010). Telehealth capabilities and advances in technology have transformed the provision of medical care in military settings and within the Veterans Health Administration (VHA). New technologies are being used to enhance the identification of TBI, manage symptoms in deployment settings, and improve care coordination throughout military and VHA systems (Girard, 2007). The Defense and Veterans Brain Injury Center Tele-TBI Clinic and Remote Assessment Center provides TBI screening, assessment, consultation, and care to patients at remote military medical centers and troop intensive sites where demand for specialized care fluctuates with mass mobilizations. The VHA has developed a state-of-the-art Polytrauma Telehealth Network to provide patients with timely and convenient access to specialist rehabilitative care and enable their return to their local communities (Cornis-Pop, 2006; Darkins et al., 2008).

In September 2009, the U.S. Army Medical Research and Materiel Command, the Telemedicine and Advanced Technology Research Center, and the American Telemedicine Association assembled a group of experts from government, military, academia, and industry. The symposium was convened to share knowledge, challenges, and ideas on existing and potential applications of telemedicine and innovative technologies to identify and treat TBI (Doarn, 2009) including: 1) remotely connecting patients with providers and specialists; 2)

identifying concussion and mTBI using electronic cognitive assessment systems; 3) providing real-time video visits with family members; 4) information sharing to enable clinical teams to collaborate on TBI care; 5) managing medication; and 6) providing interactive video programs and Web-based courses to train medics, physician assistants, nurses, and other providers in civilian and military settings.

SLPs are playing a critical role in the recovery and rehabilitation of our nation's wounded warriors. Just as technological advances in weaponry, protective gear, and medical care have changed the nature of warfare and injuries sustained in combat, the armamentarium of telehealth and advanced technologies is being used to enable improved access and quality of rehabilitative care in environments that lack the physical presence of SLP expertise. VTC is being used for consultations with patients, group and individual therapy, patient and family education, care coordination, professional education, and clinician mentoring. Benefits are significant for patients. In addition to improving access to care (e.g., eliminating the frustration and fatigue of driving in heavy traffic with exposure to bright sunlight that can trigger headaches), it is anticipated that the appeal of technological innovation may increase motivation and compliance with treatment for a "tech-savvy" generation of young military service members and veterans (Mashima, 2010).

Limitations of the Study

Participant Demographics

A limitation of this study was the small number of participants. The comparison group consisted of 12 participants who received voice therapy in person, and the experimental group consisted of 19 participants who received voice therapy via VTC. Furthermore, the VTC or

telehealth group (n = 19) represented 14 participants at a rural clinic that was accessible to the clinician's site at an urban medical center by means of personal transportation, and 5 participants at an overseas remote site/hospital that was not readily accessible to the clinician's site (i.e., minimum 2-hour ground transport and 8-hour flight). Although both sampled populations reported positive patient satisfaction, convenience in accessibility and time savings were cited as benefits by participants at the rural clinic, in contrast to availability of services and significant cost savings cited by participants at the overseas remote site. Non-availability of services is the circumstance that typically creates the need for telehealth.

Another limitation is that participant demographics are representative of the population or context within which the study was conducted (i.e., military health care system), but may not be representative of the general population in need of telehealth services. The primary age range was 25 to 40 years (n = 14), with less representation in age categories of 41-55 years (n = 9) and 56-70 years (n = 8). It may be hypothesized that the elderly population would be more likely to require telehealth rehabilitation services because they are at higher risk for conditions that may result in the need for SLP services (e.g., stroke, dementia) with co-morbidities that also restrict mobility (e.g., paralysis, dependence). Interestingly, the study population was predominantly female (n = 23) rather than male (n = 8) which does not reflect statistics of the military population. Closer inspection indicated that most female participants were dependents of military service members, retirees, and veterans.

Furthermore, because participants in the study were beneficiaries of military medical services they represented a fairly homogenous group with reference to cultural considerations. With the use of technology, global delivery of services is possible. Although the construct of distance becomes relative, the significance of cultural and linguistic sensitivity must be

addressed particularly when crossing geographical, political, cultural, and organizational boundaries.

Operational Challenges in Crossing Institutional Boundaries

The primary reason for the small cohort of participants at the overseas remote site was the significant delay in initiating deployment of services because of challenges encountered in executing the personnel contract to hire the project coordinator. As a result of the delay, the coordinator, who was the spouse of an active duty officer, was available for six months rather than the expected 12 months to conduct the study at the remote site because she relocated with her husband to his new duty station. This highlights the fact that administrative barriers may be more formidable than geographic barriers when initiating telehealth services. It also underscores the importance of timely delivery of services when serving the military population because of the transient nature of residence with frequent rotations in duty station assignments.

Future Directions

In 2010, ASHA developed a document on "Professional Issues in Telepractice for Speech-Language Pathologists" to update its position paper, technical report, and knowledge and skills statement that were issued in 2005, and to clarify aspects of delivering services via telehealth (ASHA, 2010b). Quality assurance and collection of outcomes data are cited as integral components of developing telepractice/telehealth services. With increased interest and activity in telehealth and the rapid advancement of technology, additional evidence is needed to support the incorporation of telehealth services into standard clinical protocols and routine business practices. Demonstrations and several small-scale investigations of SLP telehealth applications including the present study have reported favorable outcomes. Data from large

randomized controlled trials are needed to expand the evidence base for informed clinical decision-making and to establish public policies to promote the continued growth and development of telehealth services in SLP.

Conclusions

The specific aim of this study was to explore the potential of telehealth in SLP. Specifically, this study analyzed pre-existing de-identified data to investigate the effectiveness of and satisfaction with a telehealth vocal rehabilitation protocol. The de-identified data were collected during the deployment phase of a stepwise process to develop a comprehensive telemedicine/telehealth otolaryngology protocol (Burgess et al., 1999) that included: 1) needs assessment or problem definition to identify a service that would lend itself to the telehealth model, 2) usability studies to select the best equipment to address the problem, 3) proof-of-concept in-house investigation to study the problem in a highly controlled environment and normalize technology to the current standard of care, and 4) deployment of remote units to validate in-house data.

Analyses of the deployment data confirmed findings of the in-house proof-of-concept investigation and supported the research hypotheses. There were no differences between participants who received voice therapy in person and participants who received therapy at-a-distance via interactive VTC on four treatment outcome measures: 1) patient self-rating on the Voice Handicap Index, 2) auditory-perceptual ratings of voice samples, 3) visual-perceptual ratings of video endoscopic laryngeal exams, and 4) noise-to-harmonic ratios. In addition, patient satisfaction surveys and participant interviews revealed high satisfaction with the telehealth or VTC model of service delivery among patients and health care providers.

Based upon qualitative analysis of data, the telehealth service delivery model appears to be feasible and effective for treating voice disorders. However, overcoming administrative, personnel, equipment, technical, and workflow issues required time and effort to facilitate successful operationalization. Recommendations based upon "lessons learned" are offered in support of expanding the use of technology and promote success in future SLP telehealth applications.

While ASHA supports the use of telehealth to overcome barriers to accessing SLP services, widespread acceptance has been influenced by the reluctance of payers to reimburse this method of service delivery. A fundamental concept underlying advocacy for broadening reimbursement policies is to clarify that telehealth is not a different service, but rather a different method of service delivery. Assuring that the quality of services delivered via telehealth is comparable to services delivered in-person is essential to acceptance by payers, providers, and patients (Brown, Brannon & Romanow, 2010). This study provides additional evidence for telehealth; specifically, voice therapy delivered via video-teleconferencing yielded comparable positive outcomes to voice therapy delivered in-person.

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Appendix A. Summary of Telehealth Applications in Speech-Language Pathology

Study or Application	Participants	Site(s)	Type of Service	Diagnosis/Disorder	Technology Used	Evaluation & Conclusion*
Baharav & Reiser (2010)	2 children (4 yrs, 6 mos; 5 yrs, 2 mos) with autism spectrum disorder (ASD) and their parents	clinic in university setting (Western Washington University) and participants' home	Speech-language intervention for ASD including traditional clinic-based therapy and home-based therapy via telepractice administered by parents and remotely supervised and coached by clinician	autism spectrum disorder (ASD)	Dell Latitude 2100 Netbook computer with Web cam and wireless BlueTooth headsets; broadband Internet connection, Skype version 4.0.0.226	Results of this pilot study indicated that gains obtained in traditional therapy were maintained in treatment model that combined clinic and home-based intervention by parents using telepractice
Beijer, Rietveld, van Beers, Slangen, van den Heuvel, de Swart, & Geurts (2010)	web-based speech training application for patients with dysarthria	The Netherlands	"support and intensify" and not substitute regular speech therapy to enable patients to independently maintain speech quality after completing traditional therapy; database of dysarthric speech	chronic dysarthria following acquired neurological impairments	desktop or laptop computer with Internet connection of at least 256 kbps to access central server that hosts two types of recorded speech audio files (MP3 or WAV format) that can be uploaded by patients	Technical feasibility of this E-learning-based speech therapy has been verified empirically; efficacy, cost-effectiveness, and user satisfaction are being evaluated

Brady (2007)	experience of a home health agency	Visiting Nurse Association Health Services in Port Huron, Michigan	telehomecare speech therapy	case report of patient with dysphagia	video and non-video units for videoconference (VC) sessions or to monitor patients	speech therapy services have proven to be the most conducive to tele-homecare; allows close monitoring and helps to determine when additional or follow-up services are needed
Brennan, Georgeadis, & Baron (2002); Brennan, Georgeadis, Baron, & Barker (2004); Georgeadis, Brennan, Barker & Baron (2004)	number: 40 23 males 17 females age: 18-70**	Rehabilitation Engineering Research Center on Telerehabilitation at the National Rehabilitation Hospital	administered Story Retelling Procedure (SRP) to measure language production and comprehension of spoken narratives	14 patients with right cerebrovascular accident (CVA), 14 with left CVA; 12 with traumatic brain injury (TBI)	computer-based video tele-conferencing (VTC) with full duplex audio and video over a high bandwidth of 10 megabits per second (Mbps) Local Area Network connection	no statistically significant difference was found on SRP performance between face-to-face (FTF) and VTC settings; 34/40 were interested in future VTC use; 6/40 "no" or "maybe"(all participants with TBI)
Carpenedo (2006); Brown & Carpenedo (2006)	more than 200 patients received treatment in the speech telepractice program	Visiting Nurse Service of New York Home Care (Manhattan, Brooklyn, Queens, the Bronx)	combines service delivery via telepractice as an adjunct to in-home speech treatment visits; oral-motor, language, voice (LSVT), dysarthria, dysphagia and cognitive-communication intervention	speech disorders secondary to Parkinson's disease, communication disorders following stroke, transient ischemic attack (TIA), neurogenic dysfunction, neuromuscular dysfunction; aphasia, dysarthria	videophones	patient feedback was positive (4.2 to 4.8 on 5 point Likkert scale) rating ease of use, training received, improved overall plan of care, staff knowledge and professionalism
Clark, Dawson, Scheideman-Miller, & Post (2002)	teletherapy case study of 52-yr old female with left CVA	rural Oklahoma and INTEGRIS Jim Thorpe Rehab Center	interactive telerehab (Physical Therapy, Speech-Language	moderate to severe nonfluent receptive and expressive aphasia and moderate	desktop videophone using plain old telephone system (POTS) at clinician	after 62 SLP teletherapy sessions patient expressed basic needs independently;

			Pathology, Psychology, Vocational Rehab)	apraxia of speech secondary to left CVA	site; set-top communication device using existing telephone for audio and television for video in patient's home; 18 frames per second; maximum data rate of 33.69 kilobits per second (kbps)	FIM scores on cognitive & communication items improved; cost savings for travel; productivity savings for caregiver
County Council of Vasterbotten (n.d.)	application in delivering speech therapy in Vasterbotten, Sweden	Lycksele Hospital to cottage hospitals with video technology located throughout Vasterbotten County; plan to expand to schools in rural areas	interactive speech-language rehabilitation; plan to expand to pediatric and adolescent rehabilitation	aphasia; plan to extend services to vocal problems and speech-language problems or dyslexia and "stammering"	"video technology;" described interactive and store-and-forward applications	positive results; high patient satisfaction
Duffy, Werven, & Aronson (1997)	number: 150 consultations 46 males 104 females age: 20-90 number: 8 age: 35-87	Mayo Clinic facilities in Minnesota, Arizona, Florida project comparing FTF	speech-language pathology consultations speech-language evaluation	dysarthria, apraxia, aphasia, dysphonia, cognitive-communication impairment, laryngectomy, stuttering cerebral palsy, stroke, basilar artery	non-compressed satellite transmissions, broadcast quality, analogue, visual equivalent of 108 Mbps digitized low-data rate satellite	telemedicine provides medium for speech-language consultations that is reliably accurate in identifying various acquired neurogenic and psychogenic speech disorders

		with remote delivery of services from Mayo Clinic in Rochester to rural community hospital in Wabasha, Minnesota	including examination of oral mechanism, motor speech and language	aneurysm repair, TBI, multiple sclerosis	transmission; 1.5 Mbps	
Forducey (2006)	number: completed approximately 11,000 speech teletherapy sessions age: school-aged	Speech Teletherapy program, Oklahoma	speech-language screenings; group and individual therapy; standardized testing; IEP meetings via TC	speech-language delay/impairment, autism, fluency disorder, hearing loss	real-time, two-way interactive TC-point-to-point Internet Protocol (IP); VC endpoints with T1 or greater connections to the state technology network infrastructure	provided much-needed clinical services to students who otherwise would have minimal or no access to speech services
Georgeadis & Brennan (2003); Brennan (2006) [Baron, Hatfield, & Georgeadis (2005)]	adults [case study]	Rehabilitation Engineering Research Center on Telerehabilitation at the National Rehabilitation Hospital in Washington, DC	adult speech-language rehabilitation [treatment of neurogenic communication impairment]	speech-language and cognitive communication disorders secondary to neurologic impairment [moderate nonfluent aphasia and moderate-severe apraxia of speech]	custom software package REmote SPEech-language Cognitive-communication Treatment (RESPECT) combines live VTC features with "Virtual Desktop" via customized graphical user interface to enable clinician to administer therapy materials	[patient exhibited marked improvement with reading comprehension scores and spontaneous verbal output; patient's family noted a significant difference in communication skills]

Georges, Potter, & Belz (2006)		University of Kansas Hospital and a rural site in Kansas	remote, interactive modified barium swallow studies; telementoring	dysphagia	video fluoroscope attached to a Polycom F/X system at the remote site	clinicians at both sites were comfortable with the technology and studies indicated good acceptance by patients; allowed mentoring clinicians at rural site which resulted in professional growth and skill development
Glykas & Chytas (2004)	20 speech-language therapists delivering services to children and adults	system set up and implemented in a clinical center in Athens, Greece and accessed by users from Greece and the United Kingdom	usability study evaluating user acceptance including usefulness in therapy sessions, user friendliness, accuracy of feedback, range of uses, portability of the system, affordability	hearing impairment, voice disorders, disfluency, learning disabilities, cleft palate, physical disabilities, speech-language delay and disorder, neurological disorder, others	web-based system of technology-assisted speech-language therapy tools and visual speech aids including information, tests, report templates, database for storing patient records and information, e-learning applications; active server pages (ASP) technology	"Telelogos" provides potential to supplement traditional delivery of speech therapy services; enhances access to information and resources, empowers patients to make informed health care decisions, streamlines organizational processes and transactions, and improves quality, value, and patient satisfaction
Grogan-Johnson, Alvares, Rowan & Creaghead (2010)	number: 38 age: 4 to 12	4 rural school districts in Ohio	speech-language therapy	articulation, language and/or fluency disorders either as primary handicapping condition or related to a learning disability	personal computer (PC)-based VC via educational network at minimum bandwidth of 10 Mbps; peripheral devices included headphones, document camera	VC was a reliable and effective method of delivering speech-language therapy services; students made similar progress using telepractice as they did with on-site therapy

Hill, Theodoros, Russell, Cahill, Ward, & Clark (2006)	number: 19 age: 18 to 78	university and hospital laboratory in Australia	counterbalanced, repeated measures design comparing perceptual assessments of motor speech disorders administered FTF and in an online environment	dysarthria associated with an acquired neurological impairment	real-time VTC Internet 128 kbps IP connection; store-and-forward video and audio data	online assessment of motor speech disorders using Internet-based system is feasible; more reliable assessment is possible with additional refinement of technology and assessment protocols; measurements of severity of dysarthria, % intelligibility in sentences, and most perceptual ratings fell within clinically acceptable criteria; several online ratings on the Frenchay Dysarthria Assessment were not comparable to FTF
Hill, Theodoros, Russell, & Ward (2009)	number: 24 age: 16 to 78	telerehabilitation environment and FTF environment in Australia	assessment of dysarthria using formal standardized and informal assessments via a custom-built telerehabilitation system	dysarthria associated with acquired neurological impairment	VC link over 128 kbps Internet connection, custom-built software including store-and-forward function that enabled high-resolution video and high-quality audio files, data-sharing capabilities,	results from this study confirm results of a previous study that valid and reliable assessment of dysarthria over the Internet is possible

Houn & Trottier (2003)	number: 20	Speech Therapy Department at St. Alexius Medical Center in Bismarck, North Dakota and 7 medical centers and 1 school	speech-language pathology services	stroke reported as example	full-motion video consultation with spontaneous audio and video interaction; written material faxed or mailed in advance; Elmo overhead projector stand	clinicians reported "a very positive experience and appears to be beneficial for everyone involved"; provided opportunity to reach patients who would otherwise not receive services
Kully (2000); [Kully (2002)]	case report of 38 year-old male [n = 80 sessions age = 3 to 38] (aim was to gather preliminary experience to determine feasibility and clinical practice issues)	Telehealth Centre at the University of Alberta's Faculty of Rehabilitation Medicine and rural telehealth center in Two Hills, Alberta, Canada	follow-up sessions after completing intensive 3-week treatment program at the Institute for Stuttering Treatment and Research in Edmonton; involved practice of specific speech skills/strategies and discussion aimed at facilitating self-management and problem-solving skills [combination of in-clinic and telehealth visits]	stuttering	(VC system employed a digital line with a data rate of 770 kbps; document camera relayed graphic images) [primarily through ISDN lines with bandwidth from 128 to 384 kbps]	verbal reports of both patient and clinician were positive; patient reported satisfaction with structure of session and effectiveness of feedback; clinician evaluated session outcomes as satisfactory; high quality of sound and visual images permitted accurate judgments about most aspects of patient's speech performance
Lewis (2006)	15 children	Australia	Lidcombe Program of Early Stuttering Intervention	stuttering	"low-tech telehealth adaptation" including training videos, recorded speech samples,	although telehealth delivery required more lengthy treatment times and higher cost than clinic-based delivery, it

					telephone consultations, e-mail	is a viable, effective option to improve access to services
McCullough (2001)	4 preschool children with Down syndrome and 1 preschool child with Cornelia de Lange syndrome	nursery/clinic and home in Belfast	27 teletherapy sessions focused on parent training (20 to 35 minutes per session)	communication disorders in children with special needs	in home: TV/video recorder, motion media Setop box/pan-tilt-zoom (PTZ) camera in clinic: PC, PTZ camera, VCON system connected via ISDN2 line (128 kbps)	user friendly and reliable for both parents and therapists; telemedicine judged to be a viable and effective treatment option for children with special needs; "children related to the system in a natural and spontaneous manner"
Madsen & Rollings (2005)	50 students in 9 schools	North Dakota Center for Persons with Disabilities at Minot State University and rural schools in North Dakota	speech and language therapy		interactive VC: Windows XP with Pentium III processors and 256 MB of memory; T1 Internet access connections	analysis of data collected during online speech-language therapy indicated telehealth as effective model for providing articulation and language therapy
Mashima, Birkmire-Peters, Holtel, & Syms (1999); Mashima, Birkmire-Peters, Syms, Holtel, Burgess, & Peters (2003); [Mashima & Holtel (2005)]	number: 51 age: 18 to 85 [preliminary data]	hard-wired video camera and monitor in adjacent rooms compared with FTF [military medical facilities in Hawaii and Japan]	treatment of voice disorders [deployment of remote units to treat voice disorders]	vocal nodules, vocal fold edema, vocal fold paralysis, vocal hyperfunction without pathology	real-time interaction via video camera and monitor sharing voice analysis software via NetMeeting [VTC with Tandberg 880 via ISDN lines at 384 kbps bandwidth]	no difference in treatment outcomes between telehealth and FTF conditions

Myers (2005)	number: 3 case presentations age: 55, 45, 76	specialty cancer care center and local health care facilities in Canada	alaryngeal speech and swallowing therapy, management of tracheoesophageal voice prosthesis, psychosocial support, education of patient/family/ health care providers	aphonia, dysphonia, dysphagia secondary to head and neck cancer	VC; technology requirements for patients with head & neck cancer include availability of close-up; high resolution video and still images; adequate lighting for accurate assessment of stomas, prosthesis status, and skin and mucosal properties; room with acceptable acoustics to assess speech intelligibility	utility of telehealth in management of individuals with head and neck cancer appears promising; recommend research to evaluate clinical effectiveness of speech-language pathology services for this patient population as well as other clinical populations
O'Brian, Packman, & Onslow (2008)	number: 10 8 males 2 females age: 22-48	Australian Stuttering Research Centre and participants' naturalistic settings (e.g., home, work, university)	Phase I trial to investigate the viability of telehealth delivery of the Camperdown Program for adults who stutter	stuttering	telephone and e-mail	participants showed an 82% reduction in stuttering frequency immediately after treatment and a 74% reduction 6 months after treatment; preliminary data suggest that telehealth Camperdown has potential to provide efficacious treatment for clients who do not have access to traditional FTF treatment

Palsbo (2007)	24 adults; 18 males 6 females age: 25-81	National Rehabilitation Hospital in Washington, DC; INTEGRIS/Jim Thorpe Rehabilitation Hospital in Oklahoma City	randomized, double-crossover agreement design using pairs of FTF and remote SLP evaluators	post-stroke (time since stroke ranged from 2 months to 15 years; median = 1 year)	VTC at 384 kbps	results suggested that assessment of a patient's functional communication using VTC is equivalent to a FTF encounter
Parmanto, Saptono, Murthi, Safos, & Lathan (2008)	development of secure telerehabilitation system for children; piloted with 4 families	Rehabilitation Engineering Research Center on Telerehabilitation at the University of Pittsburgh	telerehabilitation of communication skills for children in home settings; SLP monitors children's activities in home settings while providing feedback and therapy materials remotely	speech-language disorders in children with disabilities	speech-language therapy software with desktop computer that sends data to remote server with application that allows SLP to access data remotely; portal provides facilities for sharing online resources, documents, and video and audio files	current system architecture provides asynchronous store-and-forward monitoring; future application will include live monitoring using Internet-based secure VC system
Perlman & Witthawaskul (2002)	project to design a program to conduct modified barium swallow studies remotely	University of Illinois at Urbana-Champaign and a fluoroscopy suite in a hospital	real-time, remote, interactive evaluation of oral/pharyngeal swallowing function via an Internet system; video recording with back-up store-and-forward	swallowing disorder	PCs at remote and controlling sites connected via broadband Internet (IP); T1 with maximum throughput at 1.5 Mbps (hospital); 10 Mbps Ethernet LAN (university lab)	preliminary work has proceeded well; system will eventually permit creation of a dysphagia portal and databank for secured, worldwide access for research and education, and serve as a virtual workspace for experts to collaborate

Pierrakeas, Georgopoulos, & Malandraki (2005)	application of online collaborative environments for speech therapy	Greece	group therapy; mentoring; continuing education; clinical consulting in multidisciplinary teams	articulation disorders, aphasia, stuttering	real-time interactive and store-and-forward components; real-time multi-point VC with connections as low as 28.8 kbps; PC with video and audio capabilities and dial-up connection; on-line collaboration environments	telemedicine provides patients in rural and remote areas with access to quality rehabilitation services that are sufficient, accessible, and user-friendly leading to new possibilities in comprehensive and long-term, cost-effective diagnosis and therapy
Polovoy (2008)	school-aged children	public school districts in remote and underserved areas of Minnesota, West Virginia, and Ohio	speech-language therapy	articulation, fluency, language disorders	computers, Web cameras, VC software	positive feedback from students and parents; required commitment from stakeholders including teachers and administrators
Rose, Furner, Hall, Montgomery, Katsavras, & Clarke (2000)	18 school-aged children	nursery in Salisbury, 4 primary schools in Wiltshire, UK	therapy support services for children entering mainstream schooling	"communication difficulties"	real-time interactive VTC via 3 x ISDN2 lines	VC technology can be used to support the delivery of speech and language therapy services into schools
Savard, Borstad, Tkachuck, Lauderdale, & Conroy (2003)	number: 75 age: 9 months to 86 years (not all received SLP services); 1 case study of pediatric neurologic	Sister Kenny Rehabilitation Institute in Minneapolis, MN; National Rehabilitation Hospital in Washington,	telerehabilitation consultations included physiatrists, physical therapists, occupational therapists, speech-language	neurologic diagnoses including CVA, Parkinson's disease, spinal cord injury, cerebral palsy, traumatic brain injury, amyotrophic lateral sclerosis,	Polycom ViewStation; ISDN (128-384 kbps), IP (128-768 kbps); satellite	"SLP rated the clinical effectiveness of the encounter as good; limitations identified were lack of evaluation and follow-up tools validated for care delivery via VTC"

	consult including speech-language assessment	D.C.; LBJ Tropical Medical Center in American Samoa	pathologists, recreation specialists, equipment specialists, orthotists	multiple sclerosis, muscular dystrophy		
Sicotte, Lehoux, Fortier-Blanc, & Leblanc (2003)	number: 6 age: 3- 19	Montreal pediatric tertiary care center and a local primary care centre in a remote area in northern Quebec, Canada	assessment and treatment for persons who stuttered and were unable to receive services within their community	stuttering	VC unit, reception frequencies varied between 50 Hz and 7.0 kHz; transmission took place at a maximum of 768 kbps via an intranet	patient and clinician satisfaction were high, participants considered the intervention to be effective; patients' perceptions regarding a decrease in stuttering were favorable
Theodoros, Constantinescu, Russell, Ward, Wilson, & Wootton (2006)	number: 10 8 males 2 females age: mean = 73, SD = 10	clinician in one room and participant in another room connected via VC link	Lee Silverman Voice Treatment (LSVT) for speech disorder associated with Parkinson's disease (PD)	mild to moderate-severe hypokinetic dysarthria secondary to idiopathic PD	VC via a 128 kbps Internet link; store-and-forward, text transfer	results demonstrated the feasibility of an Internet-based application to deliver the LSVT; further research needed involving larger numbers of participants
Theodoros, Hill, Russell, Ward, & Wootton (2008)	number: 32 age: 21 to 80	University of Queensland and laboratory at local metropolitan hospital in Australia	assessment of aphasia	mild to severe aphasia secondary to cerebral vascular accident or TBI	PC-based VC system using 128 kbps Internet link; store-and-forward system with capture of high resolution video clips and high quality audio recordings	results indicated that valid and reliable assessment of aphasia using standardized assessment tools can be achieved via an Internet-based VC system
Tindall, Huebner, Stemple, & /Kleinert (2008)	number: 24 age: 52 to 84	clinic and patients' home	LSVT	idiopathic PD with hypokinetic dysarthria	Televyou TV 500SP videophone connected via	significant change in pretreatment to posttreatment measures

					standard telephone service line	of vocal loudness, favorable comparison to published outcomes, and patient satisfaction with the technology provide support for videophones as an alternative method of service delivery
Tindall & Wright (2006)	number: 1 age: 57	Veterans Affairs Medical Center in Lexington, Kentucky and patient's home	treatment for anomia	Broca's aphasia; left CVA	videophones	patient responded well to therapy delivered via videophones; no assistance needed to operate the videophone; positive feedback from spouse
Vaughn (1976)	adults	Veterans Affairs Hospital in Birmingham, Alabama	supplementary and reinforcement services on an outreach basis for veterans with communication disorders	voice disorders, alaryngeal speech, articulation disorders, stuttering, aphasia, dysarthria, auditory disturbances	Tel-Communicology system utilized telephonic systems, programmed materials and educational media	eliminated travel time, reduced travel costs, and increased frequency of therapy contacts
Waite, Cahill, Theodoros, Busuttin, & Russell (2006)	number: 6 age: 4:3 to 6:8 (mean = 5.3)	University of Queensland; pilot study comparing FTF assessment vs. "online" clinician in another room within the same building	assessment of single-word articulation, speech intelligibility in conversation, and oromotor structure and function	mild to moderately severe speech disorder	VTC through a 128 kbps Internet link; transfer of pre-recorded video and audio data to the online clinician	high level of agreement between on-line and FTF assessment; results provided preliminary evidence for the feasibility of an Internet-based assessment of childhood speech disorders

Ward, White, Russell, Theodoros, Kuhl, Nelson, & Peters (2007)	number: 20 17 males 3 females age: 41-70; mean = 61	separate rooms within same hospital in Australia	comparison of simultaneous on-line and FTF assessments of oromotor, swallowing, and communication in patients post laryngectomy to validate Internet-based telerehabilitation option	surgical removal of larynx due to cancer	assessments conducted at bandwidth of 128 kbps; specialized VC software allowed real-time objective evaluation, captured high quality video and audio recordings independent of VC tools, data sharing, and Web camera control	patients were 100% satisfied with usability of system and quality of services they received; there was greater than 80% agreement between online and FTF clinician for all variables relating to oromotor function, swallowing status and communication ability; however, visualization of the stoma was poor; clinician satisfaction with the functionality of the system was low, although their ratings were high for ease of use and potential for telerehab as service delivery method
Wertz, Dronkers, Bernstein-Ellis, Sterling, Shubitowski, Elman, Shenaut, Knight, & Deal (1992)	number: 72 age: adults	simulation study comparing FTF vs. remote conditions; Veterans Affairs Medical Center in Martinez, California	appraisal and diagnosis of neurogenic communication disorders	aphasia, apraxia, dysarthria, dementia, TBI, confusion, right hemisphere	closed circuit television; computer-controlled video laserdisc over the telephone	agreement in diagnosis among appraisal conditions (93% to 94%) and close approximation of patient performance on appraisal measures among conditions suggest that either television or computer-controlled video laserdisc by telephone

						could be substituted for FTF appraisal and diagnosis
Wilson, Onslow, & Lincoln (2004)	number: 5 age: 3 yrs, 5 mos to 5 yrs, 7 mos	Australia; low-tech telehealth adaptation of the Lidcombe Program of Early Stuttering Intervention	therapy for childhood stuttering	stuttering	telephone calls; recordings of speech samples mailed to clinician	telehealth adaptation of the Lidcombe Program may be clinically viable and able to produce satisfactory clinical outcomes; delivery via VTC should be investigated

*as reported by investigators
**age reported in years unless otherwise indicated

Appendix B. Summary of Treatment Outcomes for Telehealth Voice Therapy Proof-of-Concept (Pilot) Study

Patient Satisfaction Measures	Participant ratings of perceived voice improvement and process and outcome of therapy voice improved = 5.24 (1 = not at all; 6 = maximally) process and outcome of therapy = 1.00 to 1.68 (1 = positive; 5 = negative)
Perceptual Measures	Ratings of pre- and post-therapy voice samples by two ASHA certified speech pathologists Post-therapy voice samples were rated as better than pre-therapy samples for 90% of participants
Laryngoscopy Measures	Ratings of pre- and post-therapy laryngeal exams by two Board certified otolaryngologists Post-therapy laryngeal images were rated as better than pre-therapy images for 82% of participants
Acoustic Measures	Jitter and shimmer measures of sustained phonation Post-therapy jitter and shimmer measures were lower for both groups

Note. Of the 72 participants enrolled [36 in telehealth (experimental) group, 36 in conventional (control) group], 51 participants (71%) completed the vocal rehabilitation protocol; 23 in experimental group, 28 in control group. There were no differences in outcome measures between the experimental group and the control group. Participants in both groups showed positive changes on all outcome measures after completing the vocal rehabilitation protocol.

Appendix C. Case History

Participant Alpha-Numeric Code:

Date of Evaluation:

Please complete sections A through F:

PATIENT HISTORY

A. Description of Problem

1. When did you first notice your voice change?
2. In what type of speaking situations did you first notice it?
3. Describe your voice:
4. What do you think caused your voice change?
5. Is your voice problem: getting worse ____ getting better ____ staying the same ____
6. Have you ever lost your voice completely? For how long?
7. Have you ever been seen by a speech pathologist or received voice therapy in the past?

B. Variability

1. Is your voice better in the morning or in the evening?
2. Do you think there is a pattern to your voice? For example, does your voice get hoarse after you talk a lot? Is your voice better after "warming it up?"

C. Voice Usage

1. How do you use your voice during a typical day?
2. If you work, what kind of work do you do and how much talking is required?
3. When you are not working, what do you enjoy doing?
4. How much talking do you usually do in a day?

D. Symptoms: Circle any of the following symptoms you experience:

hoarseness	breathy voice	"lump in the throat sensation"
throat tightness	voice strain	chronic throat irritation (scratchy, tickle)
inadequate loudness	frequent laryngitis	voice cuts out in the middle of sentences
pitch is too high or too low	choking	loss of pitch range
persistent cough	tension in back of neck	swallowing difficulties
dry throat	frequent sore throat	heartburn
burping	bitter taste in mouth	excessive throat mucus

E. Medical History

1. Have you ever been seen by an ENT (ear, nose, throat) doctor?
2. Do you know of any physical problems related to your voice change?
3. Have you ever been diagnosed with:
   _____ Vocal polyps/ nodules/ granuloma/ contact ulcers
   _____ Vocal cord paralysis or paresis
   _____ Laryngopharyngeal reflux or gastroesophageal reflux (GERD)
   _____ Laryngeal cancer
4. Sometimes stress and tension may contribute to the development of voice problems. Do you think your voice change is related to tension or stress?
5. How would you describe your general health?
6. Do you have any chronic illnesses or allergies? If yes, please list them.
7. Are you taking any medications? If yes, please list them.
8. Have you had any previous surgery?
9. Did you have a recent hearing test? If yes, when. If no, do you have any hearing problems?

F. Vocal Behaviors: Please check all the following behaviors in which you engage:

clear throat: ___ use tobacco products: ___ how much? _____ drink alcohol: ___ how much?_____

drink coffee/tea/colas: ___ how much? _____ yell: ___ cheer at sporting events: ___

call others from a distance: ___ cough or sneeze loudly: ___ laugh hard: ___ use inhalants: ___

exposed to secondhand smoke, fumes or environmental irritants: ___ talk in nightclubs: ___

grunt during exercise or lifting: ___ teach/present speeches/ perform on stage: ___ sing: ___

talk loudly during upper respiratory infections (colds): ___ talk in noisy environments: ___

talk over the telephone for long periods of time: ___ imitate voices or environmental sounds: ___

call cadence: ___

How much water do you drink in a day? _____

Appendix D. Patient Self-Rating with the Voice Handicap Index (VHI)

Name_____ Date_____Follow-up #_____

Voice Handicap Index (VHI)
(Jacobson, Johnson, Grywalski, *et al.*)

Instructions: These are statements that many people have used to describe their voices and the effects of their voices on their lives. Check the response that indicates how frequently you have the same experience.

(Never = 0 points; Almost Never = 1 point; Sometimes = 2 points; Almost Always = 3 points; Always = 4 points)

	Never	Almost Never	Sometimes	Almost Always	Always
F1. My voice makes it difficult for people to hear me.					
P2. I run out of air when I talk					
F3. People have difficulty understanding me in a noisy room					
P4. The sound of my voice varies throughout the day.					
F5. My family has difficulty hearing me when I call them throughout the house.					
F6. I use the phone less often than I would like.					
E7. I'm tense when talking with others because of my voice.					
F8. I tend to avoid groups of people because of my voice.					
E9. People seem irritated with my voice.					
P10. People ask, "What's wrong with your voice?"					
F11. I speak with friends, neighbors, or relatives less often because of my voice.					
F12. People ask me to repeat myself when speaking face-to-face.					
P13. My voice sounds creaky and dry.					

	Never	Almost Never	Sometimes	Almost Always	Always
P 14. I feel as though I have to strain to produce voice					
E15. I find other people don't understand my voice problem.					
F16. My voice difficulties restrict my personal and social life.					
P17. The clarity of my voice is unpredictable.					
P18. I try to change my voice to sound different.					
F19. I feel left out of conversations because of my voice.					
P20. I use a great deal of effort to speak.					
P21. My voice is worse in the evening.					
F22. My voice problem causes me to lose income.					
E23. My voice problem upsets me.					
E24. I am less out-going because of my voice problem.					
E25. My voice makes me feel handicapped.					
P26. My voice "gives out" on me in the middle of speaking.					
E27. I feel annoyed when people ask me to repeat.					
E28. I feel embarrassed when people ask me to repeat.					
E29. My voice makes me feel incompetent.					
E30. I'm ashamed of my voice problem.					

Please circle the word that matches your voice today.

Normal Mild Moderate Severe

P_____F_____E_____ Total_____

Appendix E. The Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

Appendix F. Protocol for Flexible Fiberoptic Endoscopic Laryngeal Examination

Tasks:

Quiet respiration

Sustained /i/ at comfortable pitch and loudness

Sustained /i/ at high pitch

Sustained /i/ at low pitch

Sustained /i/ at increased loudness level

Sustained /i/ from low to high pitch

Sustained /i/ from high to low pitch

/i/ --- sniff --- /i/ --- sniff --- /i/ --- sniff

"We see three green trees" (comfortable pitch)

"You should use new blue shoes" (comfortable pitch)

Adapted from: Rosen, C.A., & Murry, T. (2000). Diagnostic laryngeal endoscopy. *Otolaryngologic Clinics of North America, 33*(4), 754.

Appendix G. Telehealth Patient Satisfaction Survey

Read each item and circle one answer:

Overall, the telehealth (video-teleconferencing) sessions were satisfactory.

1	2	3	4	5
Strongly Agree				Strongly Disagree

I was comfortable that the speech pathologist understood my voice problem.

1	2	3	4	5
Strongly Agree				Strongly Disagree

Telehealth made it easier for me to access care for my voice problem.

1	2	3	4	5
Strongly Agree				Strongly Disagree

Telehealth improved my medical care.

1	2	3	4	5
Strongly Agree				Strongly Disagree

My telehealth voice therapy sessions were as good as in-person sessions.

1	2	3	4	5
Strongly Agree				Strongly Disagree

I would use telehealth again.

1	2	3	4	5
Strongly Agree				Strongly Disagree

Additional comments: _____

_____

_____

Thank you for your participation!

Appendix H. Perceptual Rating Sheet for Voice Samples

Listen to voice samples 1 and 2 on each subject. Judge which voice sample is better.
Mark an (x) in the column which represents the better voice sample, 1 or 2.

SUBJECT #	SAMPLE 1	SAMPLE 2
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
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Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		

Rater: _____ Date: _____

Appendix I. Rating Sheet for Video Endoscopic Laryngeal Samples

Review samples 1 and 2 on each subject. Mark an (x) in the column (sample 1 or sample 2) which shows less edema, nodularity, immobility and/or hyperfunction.

SUBJECT #: ETIOLOGIC CORRELATE	SAMPLE 1	SAMPLE 2
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
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Subject #		
Subject #		
Subject #		
Subject #		
Subject #		
Subject #		

Rater: _____ Date: _____

Appendix J. Perspectives from Participant Interviews

Summary of Participant Perspectives

Vocal Symptoms and Treatment Options (reasons for pursuing voice therapy)

Participant at Rural Remote Site (Interview)

I was hoarse and losing my voice and I didn't understand why and it was going on for about a year…they would say, "Are you sick?"; they would notice that my voice over the phone was very raspy or at times I couldn't project…they would always ask me if I had a cold and this was the first clue then that something was wrong so I decided to go to the doctor and find out what was causing my voice to be raspy.

…as I went and got the exam, I was told that I had a little nodule on my vocal cords. I had an option either to take speech therapy or surgery; and as a teacher, I didn't wanna do surgery because I know with any kind of cutting anywhere on your body it's gonna leave scar tissue. I didn't want scar tissues left on my throat so I decided to do voice therapy because I felt that if I had a scar on my vocal cords that it would alter my voice somehow and so I decided to learn instead a better way of taking care of myself rather than doing surgery. I didn't want to be cut on.

Logistic barriers to accessing services (traffic, availability of parking, inclement weather)

Participant at Rural Remote Site (Interview)

I live in (rural community) and so going through the traffic of getting to (urban medical center). Parking is a pain up at (urban medical center). I'm going around several times in the parking lot trying to get parking and if the weather is rainy or cold then I have to try to run into…you know to beat the weather.

References to technological innovation that enabled access to voice therapy

Participant at Rural Remote Site (Interview)

This technology has been wonderful for me as far as coming into (rural satellite clinic).

…this technology when I was asked to do this research was um something that I was excited about doing because as a teacher I'm always into progressive ways of doing things, so to me this research was vital as far as receiving health care in another form. So I jumped to the opportunity of doing this…I'm very, very thrilled that we are progressing as far as our health care.

I think it would be a good thing in the future for voice therapy to be done this way.

Participants at Rural Remote Site (Written Responses on Telehealth Patient Satisfaction Survey)

Telehealth is an excellent way to get medical care to remote locations. (subject t20)

Participants at Overseas Remote Site (in quotes from participants or as reported by remote site coordinator from telephone and in-person interviews)

She feels that there needs to be a change in "the paradigm of thinking" in treating patients with the use of this type of technology. For example, she said you can take college courses online. (subject ll38y)

Remote Site Coordinator

Patients not qualifying for Medevac would not have been able to receive services had it not been for this project.

Privacy, patient confidentiality, data security when receiving services via telehealth

Participant at Rural Remote Site (Interview)

I was asked about my privacy and the security of doing health care over a media like this and I didn't have any problems with security or privacy act because as a teacher in Special Ed there are certain things that we have to do as far as confidentiality over the computers, using the computers that I'm sure that in this kind of profession, health care profession, they also set up securities and codes that wouldn't violate my privacy or security as far as my health care so my confidence in the profession of doctors or teachers or anybody in this kind of health care I had no problems with because professionally we all know how to secure things that need to be secured.

Convenience, time savings, cost benefits resulting from receiving therapy remotely

Participant at Rural Remote Site (Interview)

I can't make it at certain times…because of my personal time and my work time. There's all kinds of schedules that I would have to meet as a grandmother, a mother, a wife and a teacher. I teach a special population which is kind of hard for me as a teacher to leave the classroom because when I do, their behaviors come out and I worry and I stress more because they don't like a substitute teacher coming in.

…it's very convenient because they ask me, "When can you make it" and so I tell them "oh, this time would be convenient, this time" and they scheduled it accordingly.

…finding parking and going up and sitting in the waiting room is a lot of time and therefore I would have to take time away from class and ask my principal for time off to go to (urban medical center). I found coming to going to (rural satellite clinic) which is very close to where I live…it's 10 minutes versus 40, 50 minutes from (urban medical center).

I can walk straight into (rural satellite clinic), straight in the room sit down and on with my therapy whereas if I went to (urban medical center) I'll sit in the waiting room, I'd have to wait, and I've done that before and then when they're ready they call you so this has saved me absolute time and so and then also it's scheduled according to my time…

I found this also doing it this way has taken time and the stress of me going to (urban medical center)…because it's close. This way I can do it on my lunch hour, after school, before I baby-sit. Take me half-an-hour to come here, do my therapy and run home and so I found it very convenient.

Participants at Rural Remote Site (Written Responses on Telehealth Patient Satisfaction Survey)

Telehealth also saved me time on the road due to traffic here. The flexible appointment time was also great. It allowed me not to miss any time out from work. (subject u21)

Participants at Overseas Remote Site (in quotes from participants or as reported by remote site coordinator from telephone and in-person interviews)

She feels that telehealth saves $$ in medical expenses. (subject ll38y)

"It's very good program and it's cost effective both patients and hospital. It's a good program to keep in the hospital since we don't have a voice therapist, being away from the family and work." Medical provider is also monitoring the patient's improvement as well. (subject mm39y)

Advantage is that no travel is involved. (subject mm39y)

Remote Site Coordinator

Definitely cost benefits and time efficiency to stay in-country.

Participants' Appraisal of Project

Participant at Rural Remote Site (Interview)

I cannot say anything bad about it because I've had only positive experiences, there has been no negatives.

Participants at Rural Remote Site (Written Responses on Telehealth Patient Satisfaction Survey)

Glad to be your test subject. (e5)

Telehealth will be more effective if participant (patient) is provided with a CD of voice practice lessons. Patient will be able to practice even after sessions are completed and more often than during each session…2x a month. (h8)

(Clinician/researcher) and ENT staff are a God-send! (k11)

There is no constructive criticism to report. This was an extremely helpful and valued experience. (l12)

Learning how to talk without straining my voice through speech lessons. (r18)

The only thing that was ever a problem was set-up, and that was minor. (t20)

Excellent care and very professional staff!!! (y25)

Participants at Overseas Remote Site (in quotes from participants' written feedback or as reported by remote site coordinator from telephone and in-person interviews)

She felt the project was "very beneficial" and "would recommend it to everyone." "Thank you for all your help. I just wished my schedule was better." (subject ll38y)

Said there were no negative. (subject mm39y)

She commented that the voice project was "very interesting" and "wished (she) could have been involved with it longer." (oo41y)

She wishes there was such a set up at (where she lives). She felt that…the project was "very beneficial" and would "recommend it to everyone." "Everything is great!" (when I asked her about any negative aspects). (pp42y)

Remote Site Coordinator

Results appeared to have been positive with…reported patient satisfaction in the service delivery.

Consistent patient satisfaction.

(regarding positive comments from hospital Command about the project) My impression is that the voice project provided the hospital with its Telemedicine Room equipment with which they are pleased to have established a beneficial health care service delivery mode.

Referring Physician at Overseas Remote Site (as reported by remote site coordinator from in-person interview)

He felt that the project "was effective in meeting patient care" and the fact that I (remote site coordinator) was there to take referrals to evaluate the patients gave him a sense of having his "own personal speech-language pathologist." He received no negative feedback from the patients in the voice study; some patients stated that they benefitted from receiving voice therapy via VTC.

"The answer is obvious" when asked about being a provider in a remote location. There "is a disadvantage when one (SLP) is needed" but the "VTC serves the purpose."

Felt there were no negative issues with the actual patient care side of the project.

Reported that the project was very well received by the Command and that he still hears good comments about it.

Clinical Interactions via Video Teleconferencing

Participant at Rural Remote Site (Interview)

…something that I have to learn to do as far as controlling my own voice and listening to my health care provider, (clinician/researcher) over the media; understanding her principles and what she was trying to teach me as far as therapy, as far as taking care of myself, my throat, it was simplistic enough and easy enough for me to understand because it was done in a way where it was slow, easy for me to understand.

I learned by coming in and doing it over the media…It was shown to me through visual like holding my nose or my throat and it's something that I could grasp and generalize on how to use it in other forms of using my voice as far as playing with my grandchildren making monster noises I was doing that one day with them and I realized that making monster noises put a stress on my voice so as I came in for my therapy I described that to (clinician/researcher) and she says that that is true and there is a different way and ways and techniques of playing by using my voice so all these things I learned by coming in and doing it over the media.

Participants at Rural Remote Site (Written Responses on Telehealth Patient Satisfaction Survey)

I felt very comfortable with the telehealth sessions and was able to communicate easily with my speech pathologist. (a1)

Participants at Overseas Remote Site (in quotes from participants' written feedback or as reported by remote site coordinator from telephone and in-person interviews)

Only negative aspect was getting used to the delay in relay time, but she got used to it. 'The long distance mode was easy to get used to; I really enjoyed it. Thought it was cool." (ll38y)

Felt my presence in room aided in clarifying something she did not understand (when she neglected to sometimes ask clinician/researcher directly during the session). (subject mm39y)

She said that at first she was uncomfortable not knowing what to expect, but felt that my explanation of the equipment and her comfort with you as her therapist helped put her at ease. It "became very natural" after the second session. She felt that it was very important that the SLP understood her problem and was concerned how you would respond, and was relieved at how very supportive you were. My presence in the room – felt it was a positive because I could provide the hands-on cues; felt the presence of another person could have been a negative experience if I "wasn't actively involved." She had no negatives with the long distance mode of treatment. She pointed out that the emails between you and her made it feel like she was connected to you. Note: during the evaluation, she often looked at the monitor (as did I) looking for your face! That's how natural she felt the set up was. (qq43y)

First session uncomfortable (analogy to going to see a new doctor and not knowing what to expect). Felt at ease with her therapist and by second session process "became very natural." Relieved that her therapist understood her voice problem and was supportive to patient. Hands-on cues were helpful. Emails between patient and therapist kept the patient-therapist relationship connected. No negative thoughts re: VTC model of therapy. (qq43y)

Remote Site Coordinator

Real-time interaction was slightly compromised due to the slight delay in transmission after a person speaks. Patients quickly adjusted to the delay. Only problem is the clinician cannot cue the patient instantaneously, if needed.

A skilled clinician is able to more accurately assess a patient's auditory and visual cues even if equipment distortions are present and can more successfully predict what the patient may be doing when only audio is available. This was validated by the coordinator (who was also an SLP) at the remote site when comparing the clinician's and coordinator's judgments of patient behaviors during therapy.

(Clinician/researcher) is an excellent therapist!! I do not think the outcomes would have been significantly different for patients had she been face-to-face. The only other concern was the inability to use hands on techniques that may have aided some patients.

Unable to provide hands-on cues if needed. This did not significantly impact on the study. Use of the remote site coordinator served as an alternative.

Clinician could not view patient when voice samples were being recorded on the computer at the remote site. Going back and forth from computer to the telecommunications video monitor aided the clinician in getting video feedback of patient behaviors.

Maintain patient-therapist connection through emails, as deemed appropriate. With computer availability becoming commonplace, emailing in this model of service delivery aids in personalizing the patient-clinician relationship. Possibly greater patient-clinician contact may occur with this format since both parties have the legitimate reason of distance between them to feel comfortable in more freely using emails to ask questions/share information. Also, written information can be given more clearly and with more detail if needed, for the patient to decipher at his/her pace.

Patient's personality appeared to connect on a more emotional level and she readily became comfortable with the VTC arrangement and her interactions with (clinician/researcher) to discuss/expand on both medical concerns and personal issues as if (clinician/researcher) was right in the room with her. A pat on the arm, a squeeze of the hand, or a hug were extensions of (clinician/researcher) through me at the end of techniques. (impression of subject mm39y)

Adapted easiest to the VTC arrangement and separated (clinician/researcher)'s and my roles well. However, patient appeared to be cautiously private by nature and some sensitive personal issues that underlied this patient's case may have been difficult to discuss with one person, but probably more difficult to discuss in the presence of two people. (impression of subject qq43y)

Comparing In-Person with Remote Therapy

Participant at Rural Remote Site (Interview)

(receiving therapy remotely) I felt did not inhibit my care at all.

I feel that so far it has (worked) and I'm very glad that I took this way this road instead of the other road.

Participants at Overseas Remote Site (in quotes from participants' written feedback or as reported by remote site coordinator from telephone and in-person interviews)

Not like face-to-face, but quickly became comfortable with the set up. Felt comfortable that it was 1:1 with (clinician/researcher). (subject mm39y)

Patient adapted easily to the telehealth mode. She felt that the sessions were the same as if she was face-to-face. (subject pp42y)

Treatment Outcomes

Participant at Rural Remote Site (Interview)

"I'm all for media therapy um, the techniques work…"

Participants at Overseas Remote Site (in quotes from participants' written feedback or as reported by remote site coordinator from telephone and in-person interviews)

(Clinician/researcher) was extremely informative and give excellent advice contributing to an overall improvement in my voice awareness and vocal health. (Remote site coordinator) has been supportive, encouraging and an excellent resource towards my improved vocal condition. I highly recommend both of these individuals for their professionalism and patient support. (subject oo41y)

(Clinician/researcher) and (remote site coordinator) are really helpful and very patient in helping me to get my voice back. (subject pp42y)

She reported that her singing voice is back to her normal ability!!! She concentrates on her breathing and when she hits the high notes, she uses her "whoooop" exercise. (subject pp42y)

Remote Site Coordinator

Pre and post test outcome measures…were positive. Patient improvement for the majority of patients.

(impression of subject pp42y at time of discharge from therapy): Therapy appeared to have impacted this patient in a very significant way—she made a major decision to quit a full-time job that decreased situations for potentially vocally abusive behaviors (therapy may have been a "boost" to help her validate reasons for a decision that she may have already been contemplating?)

(impression of subject ll38y 4.5 months following discharge): Called at work. Voice sounded strong and clear; when asked about good vocal hygiene practices she said she continues to drink lots of water.

(impression of subject mm38y 4.5 months following discharge): Called at work. She was getting over another bout with allergies, but her voice actually sounded strong and only mildly hoarse.

(impression of subject oo41y 4.5 months following discharge): Called at work during her break time from classroom. Normal vocal quality; sounded strong. She indicated that she is learning not to yell to help her maintain good vocal quality.

(impression of subject pp42y 4.5 months following discharge): Called at home. Normal voice quality has been maintained and she is pleased about that; she spontaneously informed me that she still remembers to use her "whooop" technique if she needs assistance with her singing.

Integrating Telehealth in Clinic Workflow

Remote Site Coordinator

Technical difficulties was not a significant issue, but can be worrisome to the clinician and the on-site coordinator. An established backup system with a dependable person(s) at the remote site is crucial, e.g., person with knowledge of the equipment to troubleshoot (this may be the responsibility of the hospital technician—however, the technician may not always be readily available with other responsibilities elsewhere in the hospital), telephone contacts at both sites, flexibility of the clinician to change therapy session format to audio only, e.g., telephone conference (so a speaker phone feature in the room is important), etc.; lots of trial and error in the beginning!

The hospital technician handled the equipment set up and dial in numbers for the other hospital personnel which is ideal.
Site person was not informed that there was a designated hospital technical support person setting up requested reservations by hospital staff for the VTC room and the technical support person was not aware of the voice project's scheduling of patients. As a result, some scheduling conflicts occurred.

If the VTC equipment and room are shared with other disciplines, naturally it is crucial to coordinate scheduling of the room (at the remote site, the hospital technician was designated the scheduling coordinator for hospital staff not involved in the voice project—after I made my schedule he worked around it since the voice project took priority at the time).

At least one designated individual is needed to establish and coordinate a support system at the remote site, e.g., to learn and/or teach use of the telecommunication equipment in conjunction with the computer software, coordinate scheduling of patients with availability of room (when VTC room is shared with other disciplines), distribute patient handouts, etc.. If regular patient use of the VTC room for a particular discipline is needed, specific day(s) of the week with time slots should be established between the two sites and coordinated with the remote site's patient appointment processing system (for example, the appointments desk is aware that Radiology schedules swallow studies only on Monday and Wednesday at specific time slots).

Integrating technology in telehealth service delivery becomes standard practice by default thereby providing opportunities to improve the quality of patient care.

Workload/Billing: Crediting patient intervention time to one's caseload; patient billing issues if two SLPs are involved at different sites in the same session; which site to pay for the calls, if costs are incurred

Scheduling: Coordinating therapy appointments when there is a significant time difference between the two sites; which site to coordinate securing bridge time

The responsibility of arranging VTC connection should be that of the remote site receiving the services.

Can standing reservations be guaranteed to ensure that patients are seen, or is the VTC scheduling system too complex?

Do military hospitals (versus civilian hospitals) share VTC connection time with nonmedical facilities? Can you get "bumped" from use if another situation takes priority when VTC schedules are full (e.g., working in a military system, some matters may take precedence based on rank of requester; some medical matters also may be of higher priority in a hospital setting).

Referring Physician at Overseas Remote Site (as reported by remote site coordinator from in-person interview)

Even if (remote site coordinator) had not arranged the patient appointments and telephone follow-ups, (referring physician) felt confident that the ENT Clinic could have handled those tasks.

Technology Consultant at Overseas Remote Site (as reported by remote site coordinator from in-person interview)

He reported that the Telemedicine Room is being well utilized with the hospital branch clinics. Services that have been provided are psychiatric evaluations, nutritional counseling and other counseling (unspecified) services.

Technology Recommendations

Remote Site Coordinator

Use maximum bandwidth whenever possible.

Despite occasional technical concerns, e.g., use of slowest bandwidth resulting in increased delay in audio and video feedback as well as distortions in the video, and inability to always view patient directly, the high level of experience of the clinician in providing voice therapy is of significant advantage.

Unable to see computer transmitted text clearly on the monitor. This did not impact negatively on the study. However, information via computer—such as downloaded information for patients—may have increased possibilities in integrating technology in remote service delivery.

Weekly time slots to connect to VTC and with fastest bandwidth transmission were not guaranteed. Although this was not a major problem during the study, it can be a significant issue.

Have telephone back up numbers for telephone conferencing if equipment fails.

VTC equipment settings had been changed to accommodate other users without the site person's knowledge who then perceived it as equipment malfunction when the equipment did not work (due to ignorance of using different setting adjustments - trial and error learning of equipment!). Be aware of different equipment settings of different users when trouble-shooting technical difficulties. I posted my settings for quick reference.

Project Challenges

Remote Site Coordinator

Years of administrative preparations to approve the telehealth project; therefore, some individuals initially committed to the project had transferred or no longer could provide the designated time to complete the study; this is a problem in a military setting with job transfers inevitable.

Conflicts in contract for the site person caused further delays in initiating the project.

Poor hospital-wide communication regarding use of the new VTC room; (apparently the existence of a new VTC room in the hospital was announced but there did not appear to be communication that a voice telehealth project had been implemented). Several staff wanting to use the VTC room did not understand that the equipment came from the voice project and that the voice project took priority. The SLP (telehealth site person) was perceived as monopolizing the use of the room.

Professional Mentoring

Remote Site Coordinator

The technological capabilities of video teleconferencing with the ability to transmit visual and auditory information from a computer monitor

were invaluable in the mentoring and learning process. As the on-site coordinator I served as the second pair of eyes for (clinician/researcher) for inter-judge reliability of our clinical observations. There was an urgent need to quickly absorb, filter, and find relevance in patient behaviors with the therapy objectives being addressed to learn as much as I could to sharpen my voice therapy skills.

During my participation in the study, an unexpected positive outcome emerged with the use of VTC as a tool for mentoring. Under (clinician/researcher)'s guidance, my skill base in voice evaluation and therapy increased significantly. Not only did I learn from observation of (clinician/researcher)'s therapy sessions, I had the opportunity for long distance learning in other aspects. Use of telehealth was a great mentoring experience for me.

Because the patients were on my side of the VTC monitor, even though I was not the person doing therapy, there was a greater sense of hands on, responsibility, and ownership in taking care of the patients.

Utilizing the voice therapy techniques I learned by observing (clinician/researcher), the patient was able to effect a significant and healthy change in the quality of his voice in the one and only session that time allotted before he had to fly back home. To say the least, it was a thrilling experience to have confidently and successfully "soloed."

When using VTC in a telehealth service delivery model for the purpose of teaching or mentoring, the patient's physical presence with the 'student' is definitely an advantage.

Appendix K. Transcript of Participant Interview

Participant Interview: Comparing therapy in-person and via video teleconferencing (VTC)

When I think about your questions to what was it like or how comparing the experience…VTC and I guess you could say, "going live" um, I think in terms of um, different levels of…of learning because for me the overall experience what added to the success of the experience I believe was not just the techniques, or not just the techniques, the um, the tools for learning but also the involvement was a very important part of my learning.

The environment, the time of day, the preparation that went into the learning all those elements I think were when I, when I think about how can I compare this
when I think what was the preparation like with VTC, what was my preparation like here, um what was the environment like, what was the setting because all of those things I believe contribute to my learning not only the methods and the tools and ah the instructor as well, um so I think that overall I like to break it up
what was it like for me…does that make sense?

(Yes. So would you say one is better than the other or…)

Yes!

(Which do you prefer…)

I would say that…(pause) I wouldn't say necessarily better but I think for me what was more effective was the VTC.

(non-verbal prompt – look of anticipation – to elaborate)

The VTC was more effective for me because I was, I say, I remember being ah..more focused I was your only audience, um, and you were my instructor. There were no distractions, there were, um, no other, um, I just remember being more prepared and more, there was a sense of more clarity, I was ready to go…I, I just..I think the VTC for me was more effective.

(Do you think because, when you talk about "environment," do you think because it was something that was planned in advance and you knew that it was more difficult to change the schedule because it was via VTC that you had more of a commitment to be there?)

Exactly! I was committed to the time, it was on my schedule, it never changed unless you changed it but it was it was a blueprint, it was set in stone, pretty much. And so I had that agenda and my schedule never changed. So I knew when I was going to study, I knew when I was going to prepare, um and there it was.

And I found myself even less stressful, whereas now I'm um I'm looking at okay, when I can see you, when can I not see you, how do I change that. So if my schedule changes, then my study time changes and my preparation changes as well, even though maybe it shouldn't, but it shouldn't, but it does.

(How about being in the hospital where you worked, was that better access)
so in essence even if I were miles away, really I was just upstairs or where ever your office was, in the same facility, compared with now where you have to, you know walk out of the "tunnel" get in your car come here. So even if I'm much closer physically…)

yes…

(in essence I'm much farther do you think…)

Even though you were further I found you were closer, and now here you're closer but I find you farther.

(Interesting.)

It is. You have to make more of an effort to come right, which is why it takes more time out of your schedule because it's the travel time, the parking time. It's all those things, and in addition to the fact that it's not a set schedule also means that my study and preparation, and practice is not set. Because in (overseas remote site), I remember every other day, before coming to see you, it was a definite study and if I had an extra day, then that was a luxury. But every other day, half-an hour, or 45 minutes practice my breathing in preparation.

But now, I don't have that. So it was more structured and it seemed more formal, you had to prepare because we were doing it at-a-distance.

I remember watching the screen and I had no problem following you, the breathing, the patterns, the techniques…and, and I just seemed to be more in tune. I had what was called, and sometimes people talk about how tunnel vision is a negative thing but I think in this case it was very positive. Because I could see nothing else but my experience when I was on VTC, and now I'm…I see you, I see the experience but I see everything else, it's like a panoramic picture. Then I had more of a snapshot close picture so I was more engaged, just seemed that way.

(Interesting.)

So I think I want to say something else about how, cause you need to report this about how you were further on VTC but you were closer, the experience was closer, and now here, you're closer but I feel further from the experience.