STAFF PERCEPTIONS OF A TELEROBOT IN THE ASSESSMENT OF DYSPHAGIA IN STROKE PATIENTS

by
Tammi Hanson

A thesis
submitted in partial fulfillment
of the requirements for the degree of
Master of Science in the Department of Communication and Sciences Disorders
Idaho State University

Fall 2017

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of TAMMI HANSON find it satisfactory and recommended that it be accepted.

_____

J. Anthony Seikel, Ph.D., Major Advisor

_____

Shauna Smith, M.S., Committee Member

_____

Curt Anderson, Ph.D., Graduate Faculty Representative

TABLE OF CONTENTS

List of Tables:

Abstract

Purpose: The purpose of this study was to compare perceptions of staff who worked directly or indirectly with a telerobot for the treatment of dysphagia in stroke patients. **Methods**: A sample size of 45 clinical staff from Providence Portland Medical Center in Portland, Oregon, and Providence Willamette Falls in Oregon City, Oregon, who either had or had not experienced working with a telerobot for the use of dysphagia assessment provided information through a survey sent to their work email addresses. The survey consisted of 18 questions, including demographic information and opinions regarding past or potential use of a telerobot for the assessment of dysphagia. **Results**: Data from the survey questions were statistically analyzed using Pearson's Correlation Coefficient, resulting in several inferences in regards to staff perceptions, potential use, and training of staff for future use of a telerobot in the health care setting. The primary findings were that staff perceptions of a telerobot and training support further development of the telerobot for dysphagia assessment.

Keywords: Telehealth, telerobot, telepractice, teleswallow, speech language pathology, dysphagia, speech therapy.

Chapter One: Introduction and Review of the Literature

Introduction

Changes in health care delivery reflect an effort nationally to reduce cost while improving effectiveness (Catlin & Cowan, 2015; Reinke, 2015). The Affordable Care Act (Affordable Care Act, 2010) has mandated, for instance, that care be delivered in a patient-centered manner, and that provisions for electronic medical records transfer be developed as a means of increasing communication among health care team members. This poses a particular challenge for rural areas that are underserved by health care professionals. Recent advances in telemedicine have made health care more accessible to patients in rural communities, but there remain questions concerning the effectiveness of remote medicine, as well as the impact on local health care providers. This study examines the perceptions of a group of individuals charged with mediating delivery of an assessment protocol delivered by telerobot and initiated at a remote site.

Telepractice consists of many elements, all of them rooted in technology. Older technologies (e.g., paper records) are being transitioned to electronic records, and communication between patient and healthcare provider has moved from traditional models (e.g., paper; telephone) to newer technologies (e.g., email, text, online accounts). Intrinsic to the evolution of technology is the understanding that the participation of the clinician and patient is critical to communication and successful treatment.

The effectiveness of telepractice is influenced by research, security, and attitudes of the individuals involved. First, the quality and quantity of research in the particular fields discussed has paved the path for efficacious treatment which can be performed remotely. Second, cyber security must be maintained to ensure legal accountability to patients and their health information, particularly as technology in healthcare evolves. Third, attitudes of users impact

telepractice. Views on the integration of technology and health care in the literature are discussed at length.

This review defines and delineates aspects of remotely performed health care. It begins with a discussion of telepractice in the broader context of medicine, followed by its use in speech-language pathology. Examples of the growth of telepractice, as it relates to the evolution of technology in medicine will be discussed, particularly as it extends into the fields of speech-language pathology. The review then shifts to disorders of swallowing (dysphagia), including a definition, statistical data, and ties to telepractice. Current studies regarding dysphagia and telepractice will be reviewed. A study using a telerobot to remotely conduct dysphagia evaluations will then be examined.

Telepractice

The ability for individuals to obtain access to healthcare providers in order to receive basic treatment can be compromised due to circumstances related to distance, mobility, and time constraints, among others. The use of technology for performing remote rehabilitation services in healthcare, known as telerehabilitation, has therefore become increasingly popular (Theodoros & Russell, 2008). The roots of remote rehabilitation stem from telemedicine, which dates back to the early 20th century when Willem Einthoven recorded the electrical cardiac signals of patients with a string galvanometer and telephone wires. Telemedicine is defined as " . . . rapid access to shared and remote medical expertise by means of telecommunication and information technologies, no matter where the patient or relevant information is located" (Strehl & Shabde, 2006, p. 957).

The notion of treating patients remotely, or telepractice, has a historical use in medicine secondary to technology. Since the early 1900s, telepractice evolved from physicians giving advice to ill crew members out at sea via radio (Strehl & Shabde, 2006) to physicians giving advice to patients hundreds of miles away via videoconferencing over the internet (Butcher, 2015). Nurse advice lines have been available for decades offering information and triage support via telephone, and more recently individual patients have had ready access to self-diagnosis materials via the internet from websites such as WebMD and the National Institute of Health (NIH). Vital sign monitoring, such as cardiac telemetry, was transmitted via radio signal when patients were being rushed to the hospital in the 1970s and 1980s (Woodwark & Gillespie, 1970). This information can now be sent rapidly and with greater quality over a wireless network (Takeuchi et al., 2008). Physicians can more readily tend to patients via telepractice sites, such as the University of Washington's Telehealth Services. On the Telehealth Services website, patients can visit a virtual clinic via webcam and microphone any time, 24 hours a day, and see a physician generally within 30 minutes for a flat fee. Patients can be treated, referred, or receive prescriptions by a licensed practitioner (University of Washington, 2016). The university's virtual services are part of a 120 hospital network managed by Carena, Inc. Carena's mission is to be a pioneer of change in healthcare delivery in the 21st century, incorporating new delivery methods of care with technology (Carena, Inc., 2016).

Telepractice in Speech-Language Pathology

Studies assessing the efficacy and validity of the use of telecommunication for speech-language pathology emerged in the 1970s when Vaughn (1976) tested the effectiveness of aphasia treatment via telephone. With the expansion of technology since the 1970s,

telerehabilitation has become more prolific. Edwards and colleagues (2012) conducted a search of published, peer-reviewed studies which overall validated remote diagnosis and/or treatment of aphasia, apraxia, dysarthria, voice disorders, dysphagia, fluency disorders, articulation, and language disorders. Since the turn of the 21st century, telepractice studies in speech-language pathology have grown and continue to incorporate rapidly developing technology, such as faster internet connectivity and custom videoconferencing software (Keck & Doarn, 2014). The American Speech and Hearing Association (ASHA) has incorporated telepractice into a standard delivery of care, providing resources regarding state requirements, roles and responsibilities, technology, and laws and regulations (ASHA, n.d.). With technology becoming more sophisticated and interactive, telerobotics has emerged as a means of operation in therapy. Studies pertaining to the validity of their use in speech-language pathology have been emerging in the literature, including the treatment of aphasia (Choe et al., 2013), intellectual disability (Robles-Bykbaev et al., 2015), literacy (Patel et al., 2012), and autism (Cabibihan et al., 2013; François et al., 2009; Goodrich et al., 2012; Robles-Bykbaev et al., 2015; Villano et al., 2011).

Traditionally, treatment in speech-language pathology has been performed in-person. This hands-on approach includes physical palpation of the oral mechanism, modeling of sound production, gesturing to a point of reference, and so forth. Alternatives to the traditional method have been developed to shorten the physical and temporal gaps between patient and clinician. For instance, Kully (2000) reported the use of videoconferencing by the University of Alberta for providing follow-up treatments to adult clients who stutter. Similarly, treatment for vocal fold paralysis, vocal nodules, and vocal edema has also been conducted remotely with positive results (Mashima et al., 2003). Mashima conducted a study using two speech-language pathologists; one

assessed clients with voice disorders in-person, while a second assessed the clients remotely via videoconferencing. The authors concluded that remote assessment for voice disorders results in the same effectiveness as in-person treatment.

Elements of Telepractice

There are two required elements to make telepractice work: a shared, common technology and the human element. First among these is having a common, shared telecommunication system. Information technologies that have facilitated medical technology include the use of fax, mobile phone, radio, and internet; common internet technologies include email, messaging, and live video conferencing. As these technologies have been more widely adopted, they have shortened the perceived distance between people, so that individuals with medical concerns can gain access to healthcare and health care professionals can provide services more efficiently.

Fax machines are used to send information, generally on paper, over a telephone line that prints onto paper at the destination. Medically-related items such as a patient's chart, prescriptions, or instructions can be sent quickly. As healthcare has become more integrated with technology, these medically-related items are transferring from paper to electronic files (Cusack et al., 2013), and this information can be sent through a specific network (intranet) or to another network over the internet. As charting systems begin to link to one another, patient information can be shared, whether that patient goes to a rural doctor's appointment or is taken to the emergency department of a large urban hospital.

Live, interactive video can be a powerful tool when incorporated into telepractice. This can be accomplished simply using devices with an internet connection and a camera, such as a

desktop computer, laptop, tablet, mobile phone, and even robotics. Telerobots have an important role in telepractice, as they are a means of visual interaction that can provide physical assistance as well (Seelye et al., 2012).

Another important component of telepractice is the human element, including both the clinician and the patient. The clinician is required to control the communicative means of reaching the patient as well as the course of therapy. The patient must adapt to remote instruction, as well as the technology through which it is routed. Training may be required on multiple fronts depending on the role of clinician and ancillary staff assisting in treatment. This training involves the integration of clinical knowledge in accordance with the patient's needs, as well as technical knowledge to operate the equipment being used to reach the patient.

Effectiveness of Telepractice

Several factors are involved in determining the effectiveness of telepractice, including accumulating scientifically valid evidence on effectiveness, ensuring security safeguards, the effects of evolving technology, and human interaction. Before elements of telepractice can be ethically used in society, research must be conducted to prove that its efficacy is greater than or equal to the approach it is designed to simulate. Standards for evidence based practice articulate the criteria for effective and efficient delivery of services, and these can provide guidance for evaluating new technologies as well. These standards hold that research must adhere to a systematic approach that is procedural, reproducible, and rigorously governed by principles of the scientific method (Kelly et al., 2001). This research can include clinical outcomes, cost effectiveness, or perceptions of those involved (Roine et al., 2001).

Another factor in the effectiveness of telepractice is the strength of technological safeguards. Human error and information technology security, or cyber security, can trigger a host of problems in healthcare. The wrong number can be dialed when sending sensitive information over a fax machine, or the wrong email address can be typed in. Laptops containing patient's medical information can be stolen, or a physician's private practice computer network can be hacked. These are examples of possible breaches of protected health information under the Health Insurance Portability and Accountability Act (HIPAA) and its revisions. The most recent revision, the HIPAA Omnibus Rule, passed in 2013 and contains updates to keep up with the changing world of technology in healthcare (Department of Health and Human Services, 2013). These changes included the patient's right to request an electronic copy of health information, prohibiting the sale of private health information without consent, and establishing responsibility to business associates to comply with HIPAA (Strauss, 2013).

The beneficial aspects of a changing world of technology in healthcare include reduced waiting time for appointments, manual effort, and cost savings (Chernichovsky & Leibowitz, 2010; Crilly et al., 2011), but there are also negative aspects. The evolving HIPAA rules influence a need for healthcare providers and entities to update protections. Information technology staff has a crucial role in maintaining HIPAA compliance, yet are not always aware of practices and standards (Sterling, 2015). Profit margins and research also can have a negative impact, as the preventative market shift in healthcare may not be profitable in the long run (Kellermann & Nihar, 2015).

Both clinician and patient need to have a degree of comfort with the process of telepractice in order for it to be successful (Seelye et al., 2012). Historically, patients who have

been surveyed in regards to receiving healthcare services via telepractice have expressed satisfaction with reduced travel time, shorter waiting time, and greater accessibility to a specialist. Dissatisfaction has been expressed in the form of anxiety regarding the ability of the patient to communicate over an unconventional medium with a healthcare professional (Mair & Whitten, 2000). Both patients and clinicians have reported a shift in roles, as the clinician must rely on the patient to be their assistant. This in turn stimulated the patient to take an active, instrumental role in their care (Sorknæs et al., 2015). Studies seeking the perception of healthcare professionals have unveiled concerns with the lack of human presence in telehealth, possibly leading to social isolation and imprecise assessment (Sharma & Clarke, 2014), as well as barriers with technical support and organization resources such as staffing (Odeh et al., 2014). Satisfaction regarding the technology can be impacted by other inherent obstacles, such as a patient's hearing or vision impairment, which can confound remote communication efforts.

Dysphagia and Telehealth

Defined as difficulty with swallowing, "dysphagia" presents itself in a number of ways, whether related to mastication and bolus preparation, or poor laryngeal elevation. Diagnosing dysphagia begins with a screening by a nurse or speech-language pathologist (SLP), or a complete clinical evaluation by an SLP. The nurse screening is minimally invasive and meant to quickly determine if any further assessment may be needed by a professional specialized in swallowing. The dysphagia screening generally consists of a water swallow test in which the patient is given a sip of water while the nurse observes for overt signs of dysphagia, such as coughing, drooling, or bolus holding. If signs are present, the patient is referred for a comprehensive assessment (DePippo et al., 1992; Hines et al., 2011; Logemann et al., 1999).

This evaluation requires a physician's order, is more in-depth, and is performed by an SLP (Swigert et al., 2009). After an initial chart review, several areas are assessed for functionality: oral anatomy, respiratory function, labial control, lingual control, palatal function, pharyngeal wall contraction, laryngeal control, reactions to sensation, and cognitive function. Treatment of dysphagia is variable, as there are a multitude of issues with varying degrees of severity. Interventions may include postural techniques, sensory awareness, swallow maneuvers, swallowing exercises, and solid and liquid consistency changes (Logemann, 1998).

Regarding stroke populations, the American Heart Association and the American Stroke Association recommend that all acute stroke patients receive a swallow screening to prevent dehydration, malnutrition, and disease processes that occur secondary to aspiration (Jauch et al., 2013). Untreated, respiratory complications may result, including aspiration pneumonia. One-third of stroke-related deaths are attributed to aspiration pneumonia. An average of 60,000 deaths occur annually in the United States from complications resulting from dysphagia (Veterans Health Administration, 2006). Therefore, it is imperative for individuals with dysphagia to have access to treatment. Developments in telepractice can bridge that gap. This study examines the perceptions by staff members regarding implementation of robot-based assessment, as reported by Morrell, Hyers, Stuchiner, and Yanase (2016). Ward and colleagues (2012) recently affirmed the validity of telerehabilitation for assessment of dysphagia by comparing assessed outcomes from an in-person speech-language pathologist and a remote one. Participants included 40 patients who were exhibiting symptoms of dysphagia ranging from mild to severe. A qualified assistant accompanied the in-person clinician and patient in a room while the other clinician was located in another room in the same building. The telerehabilitation system consisted of two

notebook computers: the first was located in the patient room, positioned appropriately for the remote speech-language pathologist's view of the patient, and the second one was located with the remote speech-language pathologist. The computers contained custom videoconferencing. The remote clinician directed the assessment procedures and made clinical judgments while the in-person clinician made simultaneous independent judgments as the assistant performed the directed assessment procedures. Each of the judgment categories had an overall acceptable outcome in supporting levels of agreement between the two clinicians in >79% of parameters related to food and fluid trials, aspiration risk, and clinical management.

A larger scale study was completed by Morrell and colleagues (2016) to confirm the validity of teleswallow assessment in two-hundred stroke patients. Certified and qualified speech-language pathologists employed by Providence Health and Services were recruited for this study. They were well versed in the traditional/in-person assessment of dysphagia. They were trained and prepared for their in-person and remotely located roles for watching a patient on screen in mock trials. The assistant role was performed by clinical staff (registered nurses, certified nursing assistants, etc.). Remote assessment was performed via a telerobot, model RP-7 by InTouch Health. This telerobot was known to the clinical staff as the Telestroke robot since it was also used for the assessment of stroke patients by neurologists. The telerobot was remotely controlled by the distant speech-language pathologist and connected to the facility's wireless network. A mounted camera, screen, microphone, and speakers allowed for appropriate audio and visual communication between clinician and patient. Patients with an admitting diagnosis of cerebral vascular accident were initially assessed for candidacy following a physician's order for a swallowing evaluation. An in-person swallowing assessment was performed by one clinician

and then a second assessment was performed with a remote clinician advising a staff member who was with the patient. Patients were presented liquids and solids in accordance with ASHA's standards in presenting oral administration trials by the assistant while the speech-language pathologist assessed swallowing remotely. Scoring of the patient's dysphagia was done in accordance with ASHA's standards, which includes diet level recommendations for solids and liquids, supervision for intake, administration of medications, and aspiration precautions. Assessment results were then compared, resulting in high statistical significance. This study also involved a more independent role for the ancillary staff members who assisted the speech-language pathologist and patient.

The inclusion of ancillary clinical staff in telemedicine as it relates to dysphagia is of utmost importance for the best possible outcomes. Assistance is required to move the machine (telerobot) and follow the instructions of the speech-language pathologist. This begs the question of how ancillary staff members feel about working with the telerobot and how those perceptions may affect the care provided to patients. Ward and colleagues (2013) surveyed 100 clinical staff members who assisted speech-language pathologists in a telerehabilitation setting for the assessment and treatment of dysphagia. The eight-question Likert scale survey inquired about staff perceptions post treatment, ranging from the audio and visual quality of the telerobot to one's ability to care for and build rapport with a patient. The overall ratings were positive in every category.

Research Hypotheses

The purpose of this study is to compare perceptions of staff who worked directly or indirectly with a telerobot for the treatment of dysphagia in stroke patients. It was hoped that

this would give insight into the barriers, both physically and perceptually, which may affect clinical staff perception of telerobot use in patient care. The comparison of experience of those who have and have not worked with a telerobot may also lead to future adjustments in telerobot presentation and education to clinical staff. The overarching question posed by this study is: how do ancillary staff members who either have or have not worked with a telerobot perceive it and its function?

The research question is thus: Do healthcare providers participating in dysphagia assessment with the assistance of a telerobot have different perceptions of the telerobot's benefit from those who could potentially utilize a telerobot for the same assessments?

Chapter Two: Methodology

This study sought to determine the perspective of healthcare providers charged with assisting in telerobot use in dysphagia assessment. To that end, a group of staff members who had been involved in the use of a telerobot for that purpose were surveyed. Staff members who had not been involved were also surveyed for comparison.

Participants

The ancillary staff sample for this study were employees at the Providence Portland Medical Center (PPMC); a medium-sized hospital in the Portland, Oregon, metropolitan area and Providence Willamette Falls Medical Center (PWF); a small hospital just outside of Portland, Oregon. The staff members from PPMC primarily consisted of registered nurses, certified nursing assistants, physicians, and therapists (speech-language pathologists, respiratory therapists, physical therapists, and occupational therapists) who had either observed or taken part in the Morrell et al., 2016 study. These staff members worked with patients who were admitted for cerebral vascular accident and had a resulting diagnosis of dysphagia. The staff members from PWF primarily consisted of registered nurses and certified nursing assistants who had not taken part in the Morrell et al., 2016 study nor had they worked with the telerobot but who were, nonetheless, aware of the function and role of the telerobot in healthcare.

Materials & Instrumentation

Information was obtained concerning perception of telerobot use by means of a survey for participants to anonymously complete. The survey (See Appendix A) was hosted by Qualtrics, and contained 18 questions. The first four questions refer to the participant's job title, department, years of service, and age. The fifth question delineates the respondents based on

their answer of having worked or observed the telerobot. The latter 13 questions inquire the participant's opinion regarding the telerobot or potential use of a telerobot. Participants were asked to rate the quality of the telerobot's function in patient care. Participants had options on a five and seven point scale rating from 'strongly agree' to 'strongly disagree'.

The levels of diagnosed dysphagia in these patients ranged from mild to severe (1-7) in accordance with the National Outcomes Measurement System (NOMS) Swallowing Rating Scale by the American Speech and Hearing Association.

Procedures

Individuals were invited to participate from a mass-sent work email. A click-enabled link was provided in the email to the survey on the Qualtrics website. Participants were informed that their data were confidential and results would be shared as grouped responses without identifiers. Participants then completed the survey and results were saved to a password protected account on the Qualtrics website.

Chapter Three: Results

The objective of this study was to assess if individuals participating in direct delivery of dysphagia assessment perceived benefit from a telerobot differently from those of individuals utilizing a telerobot for the same assessments. A survey of 18 questions was distributed to a pool of healthcare workers who work at two different hospitals and either had or had not experienced working with a telerobot for the assessment of dysphagia.

Likert Scale Conversion

An experimental error resulted in the experienced group receiving the survey using a 5 point scale and the inexperienced group receiving the survey using a 7 point scale. Colman and Norris (1997) state that conversion from a 5 to 7 point Likert scale is a viable option when required, and results in strong data retention at 85%. Thus, a conversion ratio of 7:5 was created for ease of comparison of the five and seven point scales from the survey, as demonstrated in Table 3.1.

Table 3.1

Ratio Conversion Values for Converting 7 Point Likert Scale to a 5 Point Scale

5-Point Scale Rating	7-Point Scale Rating	Converted Value 7:5, converting 7 point scale to 5 point scale
1 (Strongly Agree)	1 (Strongly Agree)	0.7148
2 (Somewhat Agree)	2 (Agree)	1.4296
3 (Neither Agree/Disagree)	3 (Somewhat Agree)	2.1444
4 (Somewhat Disagree)	4 (Neither Agree/Disagree)	2.8592
5 (Strongly Disagree)	5 (Somewhat Disagree)	3.574
	6 (Disagree)	4.2888

	7 (Strongly Disagree)	5.0036

Pearson Product Moment Correlations

Pearson Product Moment correlations coefficients were calculated to determine the relationship among the survey questions for each group of respondents (experienced versus non-experienced). Questions for each group were compared within groups, and then compared as a whole. Interpretations of correlation size were made based on Mukaka (2012).

Participants

From a potential of 350 people between two hospitals, 45 respondents answered the survey, yielding a return rate of 12.9%. Demographic information from the first four questions included healthcare profession, age, years of healthcare experience, and department in which the individual worked (Table 3.2). Demographic variables, such as classification of staff member (e.g., CNA, RN, etc.) were used to identify differences between respondents. Respondents were divided into two groups; those who had experience with the telerobot and those who did not (Table 3.3). Each group contained one respondent who did not finish the survey in its entirety. The group that answered yes to question five (Experienced Group), *'Have you observed or worked directly with the Telestroke Robot?*,' numbered 28 in total, including 17 registered nurses (RN), five from a therapy department (speech, occupational, physical, or respiratory), three physicians, two certified nursing assistants (CNA), and one 'Other Healthcare Professional.' Information regarding the perception of the telerobot and its function was summed and compared. This information was then summarized with inferences on how to proceed with the use of telerobots in the assessment of dysphagia, speech therapy, and health care in general.

Table 3.2

Demographics of the Sample

	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Profession
Number of Respondents	30 (66%)	9 (20%)	3 (7%)	2 (4%)	1 (2%)
Age Range	23-63	30-58	40-48	32-47	35-37
Mean Age	40.25	38.63	43.33	39.5	36
Range of Years in Healthcare	1-38	1-30	12-20	7-10	13-15
Mean of Years Worked in Healthcare	13.83	13.13	15.33	8.5	14
Department Worked in: Critical Care	25	1	3	1	
Department Worked in: Therapy		6			1
Department Worked in: Medical/Surgical	4			1	
Department Worked in: Other	1	1			

Table 3.3

Experienced Group Distribution for Question 5.

	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Q5 - Have you observed or worked directly with the Telestroke Robot?	17 (61%)	5 (18%)	3 (11%)	2 (7%)	1 (3%)	28

Data Analysis

Information regarding the perception of the telerobot and its function was summed and compared. Subsequently, Pearson Product Moment Correlation Coefficients were calculated to determine the strength of relationship among the questions for individual participant classification, as well as for participants as a whole.

Experienced Group Results

Question 6: I understand what the Telestroke Robot is and why it is used.

Table 3.4 exhibits the totaled results of question six as follows: 20 *strongly agree*, six *somewhat agree*, zero *neither agree/disagree*, zero *somewhat disagree*, zero *strongly disagree*. All of the experienced group agreed that they understood what the telerobot is and why it is used, as all respondents chose either *strongly agree* or *somewhat agree* for this question. Physicians and CNAs expressed the strongest understanding of the telerobot use, with 100% strongly agreeing that they had that knowledge. Both 75% of the nurses and 75% of the therapists strongly agreed as well.

Table 3.4

Experienced Group distribution for Question 6

Q6 - I understand what the Telestroke Robot is and why its used.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	12 (46%)	3 (11%)	3 (11%)	2 (8%)		20 (77%)
Somewhat Agree	4 (16%)	1 (4%)			1 (4%)	6 (23%)
Neither Agree/Disagree						0

Somewhat Disagree	0
Strongly Disagree	0

Question 7: The Telestroke Robot is a useful tool in the assessment of dysphagia (difficulty swallowing).

Table 3.5 exhibits the totaled results of question seven as follows: five *strongly agree*, 10 *somewhat agree*, 10 *neither agree/disagree*, zero *somewhat disagree*, one *strongly disagree*. The majority of the experienced group (57.5%) agreed that the telerobot was a useful tool for assessing dysphagia, including 100% of the therapists and CNAs. Only one participant, an RN, responded with disagreement.

Table 3.5

Experienced Group Distribution for Question 7

Q7 - The Telestroke Robot is a useful tool in the assessment of dysphagia (difficulty swallowing).	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	3 (11%)	1 (4%)		1 (4%)		5 (19%)
Somewhat Agree	4 (16%)	3 (11%)	1 (4%)	1 (4%)	1 (4%)	10 (38.5%)
Neither Agree/Disagree	8 (30%)		2 (8%)			10 (38.5%)
Somewhat Disagree						0
Strongly Disagree	1 (4%)					1 (4%)

Question 8: I feel comfortable working with the Telestroke Robot.

Table 3.6 reveals the totaled results of question eight as follows: seven *strongly agree*, eight *somewhat agree*, five *neither agree/disagree*, three *somewhat disagree*, three *strongly disagree*. As can be seen in Table 3.6, there was a mix of comfort when working with the telerobot. Fifty percent of the therapists felt less comfortable working with the telerobot than the nurses (25%), physicians (0%), or CNAs (0%). The physicians and CNAs all agreed with feeling a level of comfort with the robot.

Table 3.6

Experienced Group Distribution for Question 8

Q8 - I feel comfortable working with the Telestroke Robot.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	4 (16%)		2 (8%)	1 (4%)		7 (28%)
Somewhat Agree	6 (23%)		1 (4%)	1 (4%)		8 (31%)
Neither Agree/Disagree	2 (8%)	2 (8%)			1 (4%)	5 (19%)
Somewhat Disagree	3 (11%)					3 (11%)
Strongly Disagree	1 (4%)	2 (8%)				3 (11%)

Question 9: I received appropriate training for working with the Telestroke Robot.

Table 3.7 exhibits the totaled results of question nine as follows: two *strongly agree*, four *somewhat agree*, two *neither agree/disagree*, seven *somewhat disagree*, seven *strongly disagree*, four *not applicable*. As seen in Table 3.7, question nine was the only question resulting in an unfavorable majority (59%), in which the majority of the RNs (69%) and all of the CNAs (100%) chose *somewhat disagree* or *strongly disagree*. The only profession who responded strongly in agreement was the physicians (66%).

Table 3.7

Experienced Group Distribution for Question 9

Q9 - I received appropriate training for working with the Telestroke Robot.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	1 (4%)		1 (4%)			2 (8%)
Somewhat Agree	3 (11%)		1 (4%)			4 (16%)
Neither Agree/Disagree	1 (4%)	1 (4%)				2 (8%)
Somewhat Disagree	6 (23%)		1 (4%)			7 (26%)
Strongly Disagree	5 (19%)			2 (8%)		7 (26%)
Not Applicable		3 (11%)			1 (4%)	4 (16%)

Question 10: The Telestroke Robot benefits patients.

Table 3.8 exhibits the totaled results of question 10 as follows: 15 *strongly agree*, 10 *somewhat agree*, one *neither agree*/*disagree*, zero *somewhat disagree*, zero *strongly disagree*. All of the experienced group participants agreed that the telerobot benefits patients except for one, an RN, who neither agreed/disagreed with the statement. The majority, 57%, strongly agreed.

Table 3.8

Experienced Group Distribution for Question 10

Q10 - The Telestroke Robot benefits patients.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	8 (30%)	2 (8%)	3 (11%)	2 (8%)		15 (57%)
Somewhat Agree	7 (26%)	2 (8%)			1 (4%)	10 (39%)
Neither Agree/Disagree	1 (4%)					1 (4%)
Somewhat Disagree						0
Strongly Disagree						0

Question 11: The Telestroke Robot benefits clinical staff.

Table 3.9 exhibits the totaled results of question 11 as follows: 10 *strongly agree*, 14 *somewhat agree*, one *neither agree/disagree*, one *somewhat disagree*, zero *strongly disagree*. Similar to question ten, the vast majority (92%) of the experienced group agreed that the telerobot benefits clinical staff. One CNA was neutral and one RN somewhat disagreed, while all of the physicians strongly agreed.

Table 3.9

Experienced Group Distribution for Question 11

Q11 - The Telestroke Robot benefits clinical staff.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	5 (19%)	1 (4%)	3 (11%)	1 (4%)		10 (38%)
Somewhat Agree	10 (38%)	3 (12%)			1 (4%)	14 (54%)
Neither Agree/Disagree				1 (4%)		1 (4%)
Somewhat Disagree	1 (4%)					1 (4%)
Strongly Disagree						0

Question 12: Instructions given by the Speech Therapist through the robot were easy to understand.

Table 3.10 exhibits the totaled results of question 12 as follows: five *strongly agree*, five *somewhat agree*, three *neither agree/disagree*, zero *somewhat disagree*, zero *strongly disagree*, 13 *not applicable*. Thirteen of the respondents (50%) marked *not applicable* for question 12, indicating that these individuals may have only observed, rather than directly worked with, the telerobot. Of the other 13 respondents, 10 (77%) agreed that the instructions were understandable and three (23%) were neutral.

Table 3.10

Experienced Group Distribution for Question 12

Q12 - Instructions given by the Speech Therapist through the robot were easy to understand.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	2 (8%)	1 (4%)		2 (8%)		5 (19.5%)
Somewhat Agree	2 (8%)	1 (4%)	1 (4%)		1 (4%)	5 (19.5%)
Neither Agree/Disagree	2 (8%)	1 (4%)				3 (11%)
Somewhat Disagree						0
Strongly Disagree						0
Not Applicable	10 (38%)	1 (4%)	2 (8%)			13 (50%)

Question 13: The diagnostic outcomes from using the Telestroke Robot are accurate.

Table 3.11 exhibits the totaled results of question 13 as follows: one *strongly agree*, 10 *somewhat agree*, 15 *neither agree/disagree*, zero *somewhat disagree*, zero *strongly disagree*. As seen in Table 3.11, the experienced group as a whole was a neutral majority regarding diagnostic outcomes. Ten respondents (38%), including all three physicians, somewhat agreed that the diagnostic outcomes are accurate, and only one individual, an RN, strongly agreed.

Table 3.11

Experienced Group Distribution for Question 13

Q13 - The diagnostic outcomes from using the Telestroke Robot are accurate.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	1 (4%)					1 (4%)
Somewhat Agree	6 (23%)	1 (4%)	3 (11%)			10 (38%)
Neither Agree/Disagree	9 (34%)	3 (12%)		2 (8%)	1 (4%)	15 (58%)
Somewhat Disagree						0
Strongly Disagree						0

Experienced Group Summary

The majority of respondents chose either *strongly agree* or *somewhat agree* for the questions concerning understanding what the telerobot is and how it is used (Tables 3.4 : 100%),

the usefulness of the telerobot (Table 3.5 : 57.5%), comfort-level with the robot (Table 3.6 : 59%). patient benefit (Table 3.8 : 96%), and staff benefit (Table 3.9 : 92%). Both the physician and CNA groups tended to respond favorably, as evidenced by questions stating that they understand how the telerobot works, usefulness of the telerobot, comfort-level with the robot, patient benefit, staff benefit, instructions from the speech therapist, and diagnostic outcomes (Tables 3.4 - 3.6 and 3.8 - 3.11). The only question resulting in an unfavorable majority (59%) was number nine in Table 3.7, '*I received appropriate training for working with the Telestroke Robot,*' in which the majority of the RNs (69%) and all of the CNAs (100%) chose *somewhat disagree* or *strongly disagree*.

Inexperienced Group

The group that answered 'no' to question five (inexperienced group), '*Have you observed or worked directly with the Telestroke Robot?*,' numbered 17 in total, including 13 registered nurses, 4 from a therapy department (speech, occupational, physical, or respiratory), zero physicians, zero certified nursing assistants, and zero "Other Healthcare Professional."

Table 3.12

Inexperienced Group Distribution for Question 5

	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Q5 - Have you observed or worked directly with the Telestroke Robot? (no)	13 (76%)	4 (24%)	0	0	0	17

Question 14: I understand what a telerobot is and why it is used.

Table 3.13 exhibits the totaled results of question 14 as follows: 10 *definitely yes*, five *probably yes*, one *might or might not*, zero *probably not*, zero *definitely not*. As seen in Table 3.13, the majority of respondents (94%) in the inexperienced group affirmed understanding of what a telerobot is and why it is used. Only one individual, an RN, marked otherwise with *might or might not*. All of the therapists marked *definitely yes*.

Table 3.13

Inexperienced Group Distribution for Question 14

Q14 - I understand what a telerobot is and why it is used.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Definitely Yes	6 (38%)	4 (25%)				10 (63%)
Probably Yes	5 (31%)					5 (31%)
Might or Might Not	1 (6%)					1 (6%)
Probably Not						0
Definitely Not						0

Question 15: A telerobot would be a useful tool in the assessment of dysphagia (difficulty swallowing).

Table 3.14 exhibits the totaled results of question 15 as follows: one *strongly agree*, nine *agree*, three *somewhat agree*, two *neither agree/disagree*, one *somewhat disagree*, zero *disagree*, zero *strongly disagree*. The majority of respondents (82%), including all of the therapists, agreed that the telerobot would be a useful tool for dysphagia assessment. Two respondents were neutral and only one individual, also an RN, somewhat disagreed.

Table 3.14

Inexperienced Group Distribution for Question 15

Q15 - A telerobot would be a useful tool in the assessment of dysphagia (difficulty swallowing).	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree		1 (6%)				1 (6%)
Agree	6 (38%)	3 (19%)				9 (57%)
Somewhat Agree	3 (19%)					3 (19%)
Neither Agree/Disagree	2 (12%)					2 (12%)
Somewhat Disagree	1 (6%)					1 (6%)
Disagree						0
Strongly Disagree						0

Question 16: I would feel comfortable working with a telerobot.

Table 3.15 exhibits the totaled results of question 16 as follows: three *strongly agree*, six *agree*, six *somewhat agree*, one *neither agree/disagree*, zero *somewhat disagree*, zero *disagree*, zero *strongly disagree*. The majority of respondents (94%), including all of the therapists, agreed that they would feel comfortable potentially working with a telerobot. One individual, an RN, felt neutral.

Table 3.15

Inexperienced Group Distribution for Question 16

Q16 - I would feel comfortable working with a telerobot.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	2 (12%)	1 (6%)				3 (18%)
Agree	5 (32%)	1 (6%)				6 (38%)
Somewhat Agree	4 (25%)	2 (13%)				6 (38%)
Neither Agree/Disagree	1 (6%)					1 (6%)
Somewhat Disagree						0
Disagree						0
Strongly Disagree						0

Question 17: Access to a telerobot would benefit patients.

Table 3.16 exhibits the totaled results of question 17 as follows: four *strongly agree*, eight *agree*, three *somewhat agree*, one *neither agree/disagree*, zero *somewhat disagree*, zero *disagree*, zero *strongly disagree*. The majority of respondents (94%), including all of the therapists, agreed that accessing a telerobot would benefit patients. One individual, an RN, was neutral.

Table 3.16

Inexperienced Group Distribution for Question 17

Q17 - Access to a telerobot would benefit patients.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree	2 (12%)	2 (12%)				4 (25%)
Agree	6 (38%)	2 (12%)				8 (50%)
Somewhat Agree	3 (19%)					3 (19%)
Neither Agree/Disagree	1 (6%)					1 (6%)
Somewhat Disagree						0
Disagree						0
Strongly Disagree						0

Question 18: Access to a telerobot would benefit clinical staff.

Table 3.17 exhibits the totaled results of question 18 as follows: one *strongly agree*, nine *agree*, five *somewhat agree*, one *neither agree/disagree*, zero *somewhat disagree*, zero *disagree*, zero *strongly disagree*. The majority of respondents (94%), including all of the therapists, agreed that they would benefit from accessing a telerobot. One individual, an RN, was neutral.

Table 3.17

Inexperienced Group Distribution for Question 18

Q18 - Access to a telerobot would benefit clinical staff.	Registered Nurse	Therapist	Physician	Certified Nursing Assistant	Other Healthcare Professional	Total
Strongly Agree		1 (6%)				1 (6%)
Agree	6 (37%)	3 (19%)				9 (56%)
Somewhat Agree	5 (32%)					5 (32%)
Neither Agree/Disagree	1 (6%)					1 (6%)
Somewhat Disagree						0
Disagree						0
Strongly Disagree						0

Inexperienced Group Summary

The majority of respondents in the inexperienced group had favorable opinions of telerobot use and access. The therapists group marked *definitely yes, probably yes, strongly agree, agree*, or *somewhat agree* for all questions (100%), as compared to the nurses who

marked those categories as a majority regarding understanding what a telerobot is and why it is used (Table 3.13 : 92%), the usefulness of a telerobot for assessing dysphagia (Table 3.14 : 75%), potential level of comfort working with a telerobot (Table 3.15 : 92%), patient benefit (Table 3.16 : 92%), and staff benefit (Table 3.17 : 92%). Question 15, *A telerobot would be a useful tool in the assessment of dysphagia (difficulty swallowing),* had the only instance of *somewhat disagree* (one respondent, an RN) of either group. There were no instances of *disagree, strongly disagree, definitely not*, nor *probably not* in the inexperienced group.

Correlation Analysis

To determine the strength of relationships among the participant classes and groups as a whole a series of Pearson Product Moment Correlations were calculated. Results are as follows.

Registered Nurses

The RN profession group made up the majority of respondents (66%) with 30. Fifty-seven percent of the RNs had experience with the telerobot and 43% did not. Of those RNs who had experience with the telerobot, there were four moderate positive correlations with questions seven and 10, seven and 12, eight and 10, and 10 and 11 (Table 3.18). These coefficients indicate that the RNs who agree the telerobot is a useful tool for dysphagia assessment also agree that it benefits patients and that they were given understandable instructions from an SLP by means of the robot. The correlations also indicate that those who perceive the telerobot as a benefit to staff also see it as a benefit to the patient. These same individuals expressed comfort in working with the robot. There were two high positive correlations with questions 11 and 12 (0.866) and questions seven and 11 (0.7316). RNs who agreed that the telerobot benefitted

clinical staff were those who felt they had been properly instructed in its use. There were no negative correlations with this data.

Table 3.18

Correlation Coefficients: RNs with Telerobot Experience

	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13
Q6		-0.1443	0.0295	0.2576	-0.0592	0.1491	0.433*	0.00
Q7	-0.1443		0.3321	0.0744	0.5643*	0.7316*	0.6823*	0.4082*
Q8	0.0295	0.3321		0.3318	0.5085*	0.4442*	0.2165	0.292
Q9	0.2576	0.0744	0.3318		0.0661	-0.064	0.00	0.2833
Q10	-0.0592	0.5643*	0.5085*	0.0661		0.6623*	0.433*	0.2513
Q11	0.1491	0.7316*	0.4442*	-0.064	0.6623*		0.866*	0.0703
Q12	0.433*	0.6823*	0.2165	0.00	0.433	0.866*		0.00
Q13	0.00	0.4082*	0.292	0.2833	0.2513	0.0703	0.00	

*Significant coefficient.

Correlation coefficients calculated for the inexperienced RN group (n=12) resulted in two moderately positive correlations, as seen in Table 3.19. Questions 14 and 15 indicate that those who understand what a telerobot is see it as useful for assessing dysphagia. Questions 17 and 18 indicate that those who see a benefit to patients also feel it be beneficial to clinical staff.

Table 3.19

Correlation Coefficients: RNs without Telerobot Experience

	Q14	Q15	Q16	Q17	Q18
Q14		0.5501*	-0.0511	0.3331	0.3898
Q15	0.5501*		-0.232	0.05	0.154
Q16	-0.0511	-0.232		0.2553	-0.2043

Q17	0.3331	0.05	0.2553		0.6673*
Q18	0.3898	0.154	-0.2043	0.6673*	

*Significant coefficient

Therapy Group

The therapy group was the second largest group at 20% of respondents, totaling nine (one of whom did not finish the survey in its entirety). Due to the limited number of responses in both the experienced (n=5) and inexperienced groups (n=4), correlation coefficients could not be calculated for the therapy groups. However, information from questions seven and 11 indicate when the experienced group of therapists somewhat agreed that the telerobot is a useful tool for assessing dysphagia, they also somewhat agreed that it benefits clinical staff. It is clear by the overwhelming agreement in questions 14 - 18 that the inexperienced group of therapists would be interested in using a telerobot.

Physicians

The physician group was the third largest group at 7% of respondents, totaling three. Due to the limited number of responses in both the experienced (n=3) and inexperienced groups (n=0), a correlation coefficient could not be calculated for the physicians. However, information from Tables 3.4 - 3.11 indicates trends regarding this group. All of the physicians had experience with the telerobot and marked favorably in regards to understanding what the telerobot is (100% strongly agreed), feeling comfortable working with the telerobot (66% strongly agreed), agreeing that the diagnostic outcomes are accurate when using the telerobot (100% somewhat agreed), and affirming that the telerobot benefits both patients and clinical staff (100% strongly agreed in both instances).

Certified Nursing Assistants

The CNA profession group was the smallest with 4% of respondents, totaling two. Due to the limited amount of responses in both the experienced (n=2) and inexperienced groups (n=0), a correlation coefficient could not be calculated for the CNAs. However, information from Tables 3.4 - 3.11 indicates trends regarding this group. Both of the CNAs had experience with the telerobot and marked favorably in regards to understanding what the telerobot is (100% strongly agreed), the telerobot's usefulness in assessing dysphagia, feeling comfortable working with the telerobot, receiving understandable instructions from the speech therapist (100% strongly agreed), and agreeing that the telerobot benefits patients (100% strongly agreed). Interestingly, the CNAs felt strongly regarding training, as they all marked strongly disagree regarding receiving appropriate training (Table 3.7). Despite the overall degree of disagreement with this question, the CNAs were the only profession group to strongly disagree as a whole. However, Table 3.7 clearly indicates that training all staff involved with the telerobot is an aspect to be examined due to the degree of dissatisfaction expressed.

Experienced Group as a Whole

The experienced group consisted of 28 responses in total. These responses were examined using Pearson's Product Moment Correlation Coefficients to determine the degree of relationship among variables for the group as a whole (Table 3.20). There were six moderately positive correlations with questions six and 12, seven and 11, seven and 12, eight and 10, 10 and 11, and 10 and 12. These correlations indicate that those in the experienced group felt that the telerobot benefited patients and clinical staff. In addition, the experienced group, understood the speech therapist's instructions and felt comfortable working with the telerobot. Respondents

also agreed on the ease of understanding the speech therapist along with understanding the telerobot's usefulness in dysphagia assessment.

Table 3.20

Correlation Coefficients for the Experienced Group: Results as a Whole

	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13
Q6		-0.0577	0.1484	0.2049	0.1184	0.185	0.5667*	0.0853
Q7	-0.0577		0.1331	0.0095	0.4672*	0.5446*	0.6374*	0.1478
Q8	0.1484	0.1331		0.264	0.5851*	0.4296*	0.4049*	0.1692
Q9	0.2049	0.0095	0.264		0.0991	0.14	-0.2212	0.3785
Q10	0.1184	0.4672*	0.5851*	0.0991		0.5915*	0.6172*	0.1179
Q11	0.185	0.5446*	0.4296*	0.14	0.5915*		0.3937	0.1421
Q12	0.5667*	0.6374*	0.4049*	-0.2212	0.6172*	0.3937		-0.1455
Q13	0.0853	0.1478	0.1692	0.3785	0.1179	0.1421	-0.1455	

*Significant coefficient

Inexperienced Group as a Whole.

The inexperienced group consisted of 17 responses in. These responses were examined using Pearson's Product Moment Correlation Coefficients to determine the strength of relationships among the variables for the group as a whole (Table 3.21). There were two moderately positive correlations with questions 14 and 15, and 17 and 18. This indicated that the inexperienced group agreed that the telerobot is a potential useful tool for assessing dysphagia, and it is beneficial to patients and staff.

Table 3.21

Correlation Coefficients for the Inexperienced Group: Results as a Whole

	Q14	Q15	Q16	Q17	Q18
Q14		0.6232*	-0.0228	0.4227	0.4975

Q15	0.6232*		-0.0602	0.1133	0.4162
Q16	-0.0228	-0.0602		0.2346	0.0133
Q17	0.4227	0.1133	0.2346		0.7196*
Q18	0.4975	0.4162	0.0133	0.7196*	

*Significant coefficient

Chapter 4: Discussion & Conclusions

This study highlighted key points for easing technology into the medical setting by means of a telerobot. Access and use of a telerobot in a health care setting, particularly in medium and small-sized hospitals, was favorably viewed by staff as evidenced by data collected and analyzed by this study. Thus, perceptions of benefit by individuals participating in direct delivery of dysphagia assessment differ only slightly from those of individuals utilizing a telerobot for the same assessments.

The level of agreement in both experienced and inexperienced groups pertaining to dysphagia and telerobot use indicates that staff acceptance of the telerobot for dysphagia therapy may ease implementation of the device for this purpose in the near future. Understandably, the experienced group expressed stronger impressions of telerobot than the inexperienced group, as indicated by the differential strength of the correlation coefficients between the two groups. Notably, those who had experienced the telerobot had stronger positive perceptions, as reflected in the correlation coefficients, than those in the inexperienced group. Thus, it would appear that experience mediates not only stronger but more positive perceptions of the benefits of using a telerobot in assessment and treatment of dysphagia.

Training of staff involved with the telerobot was the strongest indicator of improvement needed for future implementation of telerobot use. The perception of staff was that they had not received adequate training. Further analysis of staff pre- and post-telerobot use would be beneficial for determining the appropriate amount of training and involvement in implementation.

The level of agreement in both groups regarding patient and staff benefit indicates that telerobot use could expand to multiple settings, particularly small and rural areas, to reach

patients for assessment/treatment and staff as a useful tool. It is possible that a telerobot could have use in other areas of speech-language pathology, such as language and cognitive assessment/treatment. Factors including materials, appropriately trained staff, and audio/visual perception may influence the telerobot's potential in working in expanded areas of speech-language pathology.

As indicated by this study, training of staff involved with the telerobot was the strongest indicator of improvement needed for future implementation of telerobot use. The perception of staff was that they had not received adequate training, although that could also have reflected some other aspect of telerobot use not addressed in the survey, such as staff feeling that they had not been adequately consulted in the implementation process. Further analysis of staff pre- and/or post-telerobot use would be beneficial for determining the appropriate amount of training and involvement in implementation.

Conclusions

The results of this study concluded that there are several statistically significant correlations relating to the perceptions between and among healthcare providers who have and have not experienced utilizing a telerobot for the assessment of dysphagia. This included relations among benefit for patients and staff, understanding what a telerobot is, and supporting the tlerobot's use in dysphagia assessment. A number of indicators were identified in support of the telerobot's current and potential use, as well as barriers that could be further analyzed to better equip individuals working with the robot, including easing comfort levels by ensuring education and training as part of implementation. Thus, staff perceptions of a telerobot and training support further development of the telerobot for dysphagia assessment.

References

Affordable Care Act. (2010). *The Affordable Care Act, Section by Section*. Retrieved from http://www.hhs.gov/healthcare/rights/law/index.html

American Speech and Hearing Association. (n.d.) *Telepractice.* (Practice Portal). Retrieved from www.asha.org/Practice-Portal/Professional-Issues/Telepractice.

Butcher, L. (2015). TELEHEALTH AND TELEMEDICINE TODAY. *Physician Leadership Journal*, 2(3), 8-13.

Cabibihan, J., Javed, H., Ang, M., & Aljunied, S. (n.d). Why Robots? A Survey on the Roles and Benefits of Social Robots in the Therapy of Children with Autism. *International Journal Of Social Robotics*, *5*(4), 593-618.

Carena, Inc. (2016). *About Carena.* Retrieved from http://www.carenamd.com/about

Catlin, A. C. & Cowan, C. A., (2015). *History of Health Spending in the United States, 1960-2013.* Retrieved from: https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/HistoricalNHEPaper.pdf

Chernichovsky, D., & Leibowitz, A. A. (2010). Integrating Public Health and Personal Care in a Reformed US Health Care System. *American Journal Of Public Health*, *100*(2), 205-211. doi:10.2105/AJPH. 2008.156588

Choe, Y., Jung, H., Baird, J., & Grupen, R. A. (2013). Multidisciplinary stroke rehabilitation delivered by a humanoid robot: Interaction between speech and physical therapies. *Aphasiology*, *27*(3), 252-270. doi:10.1080/02687038.2012.706798

Colman, A. M., & Norris, C. E. (1997). Comparing rating scales of different lengths: Equivalence of scores from 5-point and 7-point scales. *Psychological Reports*, *80*(2), 355.

Crilly, J. F., Keefe, R. H., & Volpe, F. (2011). Use of Electronic Technologies to Promote Community and Personal Health for Individuals Unconnected to Health Care Systems. *American Journal Of Public Health*, *101*(7), 1163-1167. doi:10.2105/AJPH.2010.300003

Cusack, C. M., Hripcsak, G., Bloomrosen, M., Rosenbloom, S. T., Weaver, C. A., Wright, A., & ... Mamykina, L. (2013). The future state of clinical data capture and documentation: a report from AMIA's 2011 Policy Meeting. *Journal Of The American Medical Informatics Association: JAMIA*, *20*(1), 134-140. doi:10.1136/amiajnl-2012-001093

Department of Health and Human Services. (2013). 45 CFR Parts 160 and 164; Modifications to the HIPAA Privacy, Security, Enforcement, and Breach Notification Rules Under the Health Information Technology for Economic and Clinical Health Act and the Genetic Information Nondiscrimination Act; Other Modifications to the HIPAA Rules; Final Rule. Retrieved from https://www.gpo.gov/fdsys/pkg/FR-2013-01-25/pdf/2013-01073.pdf

DePippo, K. L., Holas, M. A., & Reding, M. J. (1992). Validation of the 3-oz water swallow test for aspiration following stroke. *Archives Of Neurology*, *49*(12), 1259-1261.

Edwards, M., Stredler-Brown, A., & Houston, K. T. (2012). Expanding Use of Telepractice in Speech-Language Pathology and Audiology. *Volta Review*, *112*(3), 227-242.

François, D., Powell, S., & Dautenhahn, K. (2009). A long-term study of children with autism playing with a robotic pet: Taking inspirations from non-directive play therapy to encourage children's proactivity and initiative-taking. *Interaction Studies*, *10*(3), 324-373.

Friehs, G. M., Zerris, V. A., Ojakangas, C. L., Fellows, M. R., & Donoghue, J. P. (2004) Brain-machine and brain-computer interfaces. *Stroke*. 35, 2702-2705.

Goodrich, M., Colton, M., Brinton, B., Fujiki, M., Atherton, J., Robinson, L., & ... Acerson, A. (2012). Incorporating a Robot into an Autism Therapy Team. *Ieee Intelligent Systems*, *27*(2), 52-59.

Hines, S., Wallace, K., Crowe, L., Finlayson, K., Chang, A., & Pattie, M. (2011). Identification and nursing management of dysphagia in individuals with acute neurological impairment (update). *International Journal Of Evidence-Based Healthcare*, *9*(2), 148-150.

Jauch, E. C., Saver, J. L., Adams Jr, H. P., Bruno, A., Connors, J. B., Demaerschalk, B. M., & ... Yonas, H. (2013). Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the american heart association/american stroke association. *Stroke (00392499)*, *44*(3), 870-947. doi:10.1161/STR.0b013e318284056a

Keck, C.S., & Doarn, C.R. (2014). Telehealth Technology Applications in Speech-Language Pathology. *Telemedicine & E-Health, 20*(7), 653-659. doi:10.1089/tmj.2013.0295

Kellermann, A. L., & Desai, N. R. (2015). Obstacles to developing cost-lowering health technology: The inventor's dilemma. *JAMA: Journal Of The American Medical Association*, *314*(14), 1447-1448. doi:10.1001/jama.2015.10114

Kelly, M. P., Heath, I., Howick, J., & Greenhalgh, T. (2015). The importance of values in evidence-based medicine. *BMC Medical Ethics*, *16*(1), 69. doi:10.1186/s12910-015-0063-3

Kully, D. (2000). Telehealth in speech pathology: applications to the treatment of stuttering. *Journal of Telemedicine and Telecare*. 6(2), 39-41.

Logemann, J. A. (1998). *Evaluation and treatment of swallowing disorders*. (2nd ed.). Austin, TX: Pro-Ed

Logemann, J. A., Veis, S., & Colangelo, L. (1999). A screening procedure for oropharyngeal dysphagia. *Dysphagia*, *14*(1), 44-51.

Mair, F., & Whitten, P. (2000). Systematic review of studies of patient satisfaction with telemedicine. *BMJ (Clinical Research Ed.)*, *320*(7248), 1517-1520.

Mashima, P. A., Birkmire-Peters, D.P., Syms, M.J., Holtel, M.R., Burgess, L.P., Peters, L.J. (2003). Telehealth: voice therapy using telecommunication technology. *American Journal of Speech-Language Pathology.* 12(4), 432-439.

Morrell, K., Hyers, M., Stuchiner, T., & Yanase, L. Implementation of a Tele-Swallow Safety Study. In: International Stroke Conference; 2016 Feb 18; Los Angeles (CA).

Mukaka, M. (2012). A guide to appropriate use of Correlation coefficient in medical research. *Malawi Medical Journal : The Journal of Medical Association of Malawi*, *24*(3), 69–71.

Odeh, B., Kayyali, R., Gebara, S. N., & Philip, N. (2014). Implementing a telehealth service: nurses' perceptions and experiences. *British Journal Of Nursing*, *23*(21), 1133-1137. doi:10.12968/bjon.2014.23.21.1133

Patel, S., Malkani, L., Celiz, A., Shah, T., & Pfister, B. (2012). Literary enhancement and physical therapy among children using robotics. 2012 38th Annual Northeast Bioengineering Conference (NEBEC). Philadelphia, Pennsylvania.

Reinke, T. (2015). Transforming health care delivery into a learning health care system. *Physician Leadership Journal*, *2*(6), 12.

Robles-Bykbaev, V., Lopez-Nores, M., Pazos-Arias, J., & Garcia-Duque, J. (2015). RAMSES: a robotic assistant and a mobile support environment for speech and language therapy. 2015 Fifth International Conference on Innovative Computing Technology (INTECH). Galcia, Spain.

Roine, R., Ohinmaa, A., & Hailey, D. (2001). Assessing telemedicine: a systematic review of the literature. *Canadian Medical Association Journal*, *165*(6), 765-771.

Seelye, A. M., Wild, K. V., Larimer, N., Maxwell, S., Kearns, P., & Kaye, J. A. (2012). Reactions to a remote-controlled video-communication robot in seniors' homes: A pilot study of feasibility and acceptance. *Telemedicine & E-Health*, *18*(10), 755-759.

Sharma, U., & Clarke, M. (2014). Nurses' and community support workers' experience of telehealth: a longitudinal case study. *BMC Health Services Research*, *14*(1), 1-14. doi:10.1186/1472-6963-14-164

Sorknæs, A. D., Hounsgaard, L., Olesen, F., Jest, P., Bech, M., & Østergaard, B. (2015). Nurses' and patients' experiences of teleconsultations. *International Journal Of Integrated Care (IJIC)*, *15,*1-2.

Sterling, R. (2015). Defend your practice against HIPAA violations. *Medical Economics*, *92*(5), 52-57.

Strauss, L. J. (2013). Overview of the HIPAA Final Omnibus Rule. *Journal Of Health Care Compliance*, *15*(3), 53-64.

Strehle, E. M., Shabde, N. (2006). One hundred years of telemedicine: does this new technology have a place in paediatrics? *Archives of Disease in Childhood*. 9, 956-959.

Swigert, N., Riquelme, L., & Steele, C. (2009). Swallowing and Swallowing Disorders (Dysphagia). Retrieved from http://www.asha.org/uploadedFiles/FAQs-on-Swallowing-Screening.pdf

Takeuchi, R., Harada, H., Masuda, K., Ota, G., Yokoi, M., Teramura, N., & Saito, T. (2008). Field testing of a remote controlled robotic tele-echo system in an ambulance using broadband mobile communication technology. *Journal Of Medical Systems*, *32*(3), 235-242.

Theodoros D., Russell T. (2008). Telerehabilitation: Current perspectives. *Studies in Health Technology and Informatics*. 131. 191–209.

University of Washington. (2016). *Telehealth Services.* Retrieved from http://www.uwmedicine.org/referrals/telehealth-services

Vaughn, G. (1976). Tel-communicology: health-care delivery system for persons with communicative disorders. *ASHA.* 18(1), 13-17.

Veterans Health Administration. (May, 2006). *Management of patients with swallowing (dysphagia) or feeding disorders*. Retrieved from http://www.va.gov/vhapublications/ViewPublication.asp?pub_ID=1422

Villano, M., Crowell, C., Wier, K., Tang, K., Thomas, B., Shea, N., & ... Diehl, J. (2011). DOMER: A wizard of oz interface for using interactive robots to scaffold social skills for children with autism spectrum disorders. 2011 6th ACM/IEEE International Conference on Human-Robot Interaction (HRI 2011). Lausanne, Switzerland.

Ward, E. C., Sharma, S., Burns, C., Theodoros, D., & Russell, T. (2012). Validity of conducting clinical dysphagia assessments for patients with normal to mild cognitive impairment via telerehabilitation. *Dysphagia*. 27(4), 460-472.

Ward, E. C., Burns, C. L., Theodoros, D. G., & Russell, T. G. (2013). Evaluation of a clinical service model for dysphagia assessment via telerehabilitation. *International Journal Of Telemedicine & Applications*, 1-7. doi:10.1155/2013/918526

Woodwark, G. M., & Gillespie, I. A. (1970). Monitoring of ambulance patients by radio telemetry. *Canadian Medical Association Journal*, *102*(12), 1277-1279.

Appendix A

The following are the 18 questions from the survey.

Q1

I am a:

- ❑ Registered Nurse
- ❑ Certified Nursing Assistant
- ❑ Speech Language Pathologist
- ❑ Other Healthcare Professional:

Q2

Department I work in:

- ❑ Medical/Surgical
- ❑ Critical Care
- ❑ Therapy
- ❑ Other:

Q3

Number of years I have worked in healthcare:

Q4

My age:

Q5

Have you observed or worked directly with the Telestroke Robot?

- ❑ Yes
- ❑ No

Q6

I understand what the Telestroke Robot is and why it is used.

- ❑ Strongly agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Strongly disagree

Q7

The Telestroke Robot is a useful tool in the assessment of dysphagia (difficulty swallowing).

- ❑ Strongly agree
- ❑ Somewhat agree

- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Strongly disagree

Q8

I feel comfortable working with the Telestroke Robot.

- ❑ Strongly agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Strongly disagree

Q9

I received appropriate training for working with the Telestroke Robot.

- ❑ Strongly agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Strongly disagree
- ❑ N/A

Q10

The Telestroke Robot benefits patients.

- ❑ Strongly agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Strongly disagree

Q11

The Telestroke Robot benefits clinical staff.

- ❑ Strongly agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Strongly disagree

Q12

Instructions given by the Speech Therapist through the robot were easy to understand.

- ❑ Strongly agree

- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Strongly disagree
- ❑ N/A

Q13

The diagnostic outcomes from using the Telestroke Robot are accurate.

- ❑ Strongly agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Strongly disagree

Q14

I understand what a telerobot is and why it is used.

- ❑ Definitely yes
- ❑ Probably yes
- ❑ Might or might not
- ❑ Probably not
- ❑ Definitely not

Q15

A telerobot would be a useful tool in the assessment of dysphagia (difficulty swallowing).

- ❑ Strongly agree
- ❑ Agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Disagree
- ❑ Strongly disagree

Q16

I would feel comfortable working with a telerobot.

- ❑ Strongly agree
- ❑ Agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree

- ❑ Somewhat disagree
- ❑ Disagree
- ❑ Strongly disagree

Q17

Access to a telerobot would benefit patients.

- ❑ Strongly agree
- ❑ Agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Disagree
- ❑ Strongly disagree

Q18

Access to a telerobot would benefit clinical staff.

- ❑ Strongly agree
- ❑ Agree
- ❑ Somewhat agree
- ❑ Neither agree nor disagree
- ❑ Somewhat disagree
- ❑ Disagree
- ❑ Strongly disagree