4-2016

User Acceptance of Neurology Telemedicine Technology in the Emergency Department

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April 2016

Acknowledgements

First, I would like to thank Dr. Sajeesh Kumar for his guidance in completing my thesis.

Most importantly, I would like to thank my husband, Jeff for his unwavering support and understanding through this long process.

I would also like to thank my children Becca, Jimi and Jeffery for their patience and understanding, especially on our summer vacations!

Abstract

There is currently a significant shortage of trained neurologists in the country. In addition to the shortfall of neurologists, there is an increasing need for this specialty due to an aging population, increase in the incident of neurologic diseases and an increasing demand for healthcare (Freeman, 2013). The development of tele neurology technology has been shown to help address these problems. As with any new technology there are multiple barriers to overcome, one of those being user acceptance of the technology. A survey of users of the telemedicine product VGo was conducted at Hunt Regional Medical Center to access the end-user's perceived usefulness and ease of use of this technology. The response rate to the survey was 50% and yielded much information about the user's acceptance of the technology and revealed the difference in perceptions of those with and without experience using the technology. This information will be valuable to the emergency department staff to use in addressing the identified barriers to improve acceptance and use of the product, ultimately improving quality of patient care.

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Chapter 1

Introduction

Background

Early intervention for diagnoses such as acute myocardial infarction (AMI) and acute ischemic stroke can mean life or death. A 2010 literature review titled "Early identification and delay to treatment in myocardial infarction and stroke: differences and similarities" revealed that "half of AMI patients admitted to the ED were given inappropriately low levels of triage" (Herlitz et al., 2010, p.6). In addition, "A prolonged door-to-ECG time at the ED was associated with a poorer outcome" (Herlitz et al., 2010, p.6). "Similar experiences were found in stroke. It was shown that a rapid response system in hospital could reduce the delay in stroke" (Herlitz et al., 2010, p.6). If a rapid response system was in the form of neurology telemedicine, that could potentially improve patient outcomes for these and other neurological diagnoses. A specific form of telemedicine for strokes called tele stroke "may help to overcome some of the shortcomings of regional hospitals by providing the expertise of established stroke center on demand and within minutes" (Audebert, Meyer & Klostermann, 2010, p.1). As well, the use of telemedicine can help neurologist to be more efficient (Freeman, Vatz, Griggs & Pedley, 2013, p. 483). This potentially could result in improved patient outcomes. In a study of neurology departments representing the top 50 hospitals ranked by *U. S. News and World Report*, 63% rated telemedicine as equivalent to in-person care (George et al., 2012, p. 125). This same study states that "Telemedicine is increasingly viewed as a means to improve health care delivery and the telemedicine industry is projected to be an $18 billion global market by 2015" (George et al.,

2012, p. 123). The biggest benefit would be to the patient by having access to the specialty treatment needed in a timely manner to affect the outcome of their condition. In a 2013 study titled "The workforce task force report clinical implications for neurology" it was stated that "management by neurologists of disorders such as Parkinson disease, for example, has been shown to reduce hospitalizations and health care expenditures" (Freeman et al., 2013, p.481). These studies demonstrate the importance of having specialty trained neurologist available to treat patients and show how having them available can potentially improve patient outcomes, safety and reduce costs.

Another reason to demonstrate the benefits of the use of neurology telemedicine is a projected increase in the shortfall of neurologist to 19% by 2025 (Freeman et al., 2013, p.480). It is predicted that there will be an increase in neurology patients in the emergency department and due to the lack of neurological specialists and training "could result in worse outcomes" (Freeman et al., 5, p.482). It makes sense that if there are fewer specialists to treat conditions and more patients with those conditions there is going to be a crisis. Telemedicine is being used to help offset this potential crisis. In a 1997 study of telemedicine used by East Carolina University School of Medicine, where there are serious shortages of health care providers it was noted that "telemedicine is helping to overcome this shortage by making specialty medical consultations available to people in rural communities" (Balch & Tichenor, 1997, p. 2). In the study of the 50 top rated hospitals, it was reported that 85% of neurology departments in those hospitals plan to provide telemedicine (George et al., 2012, p.126). This is good news if hospitals take the steps necessary to tap into telemedicine industry and utilize neurology telemedicine services. It may eventually be a hospitals best option given the predicted shortage of neurologists.

A key component to positive patient outcomes, and often an overlooked one, is user acceptance and use of the technology. Many components can influence user perceptions and acceptance. Among some of the lessons learned during implementation of the East Carolina University School of Medicine telemedicine program, they identified "a clear need for a high level of teamwork among all network participants…..good interpersonal communication is especially important" (Balch, 1997, pg. 4). The study went on to identify that the "socio-cultural component cannot be overlooked" (Balch, 1997, pg. 4). To address this they conducted frequent demonstrations with all stakeholders but still did not expect that all would embrace the technology immediately. They found a phased approach to work best (Balch, 1997). Another lesson learned was one of staffing to ensure the technology was consistently working correctly, as this component could greatly affect user acceptance. In addition to staffing, technical requirements was a consideration, again to ensure the technology was working each time it was required for use. A final lesson learned was one of scheduling, because they had multiple sites with limited resources to utilize the technology (Balch, 1997). For an emergency department, scheduling of resources would be impossible, so dedicated technology would be a requirement. A final recommendation of this study was "we believe that telemedicine must become fully integrated with traditional medical information systems to be more effective" (Balch, 1997, pg. 5).

Purpose of the Study

The purpose of this study is to evaluate the effectiveness of using neurology telemedicine in the emergency department and specifically identify barriers that may exist in the form of user acceptance of neurology telemedicine technology that could affect clinical outcomes. Are there barriers created by user acceptance of the technology? Do the users perceive that the technology

is useful and easy to use? The expected benefit would be addressing any identified barriers to improve usage of the technology and ultimately improve patient outcomes. This information could then be utilized by other organizations working to develop a neurology telemedicine program in their facilities to reference as lessons learned and address these barriers prior to implementation.

Definitions of Key Terms

- Tele neurology: "is the use of modern communication technology to enable neurology to be practiced when the doctor and patient are not present in the same place and possibly not at the same time" (Patterson, 2005, p. 55).
- Improve: to bring into a more desirable or excellent condition.
- Benefit: Something that is advantageous or good; an advantage.
- Practitioner: "a person who works in a professional medical or legal business" (Merriam-Webster, 2015).
- Perceived usefulness (PU): "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320).
- Perceived ease of use (PEOU): "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320).
- [Patient]Outcome: "The health state of a patient (or change in health status) resulting from healthcare, desirable or adverse" (National Quality Forum, 2016, p. 14).

Chapter 2

A Review of the Literature

Currently there is a significant shortage of trained neurologists in this country. "The current neurologist shortfall averaged for the entire United States is 11% in 2012 and is projected to increase nationally to 19% by 2025" (Freeman, Vatz, Griggs, & Pedley, 2013, p. 480). In addition to the shortfall of neurologists, there is an increasing need for this specialty due to an aging population, increase in the incident of neurologic diseases and an increasing demand for healthcare (Freeman, 2013). When neurologic conditions are treated promptly and managed by a neurologist, patients can have better outcomes. Stroke is an example of such a condition since the recommended course of treatment of administration of tissue plasminogen activator (tPA) within 3 hours of onset of symptoms can be provided by a neurologist making that definitive diagnosis (Selvam, 2013). In addition, "management by neurologists of disorders such as Parkinson disease…has been shown to reduce hospitalizations and health care expenditures" (Freeman, 2013, p. 481). Another neurologic condition that requires long-term follow-up is epilepsy, affecting almost 1% of the population (Patterson, 2005). The use of tele neurology has been found to help address these problems. "Tele neurology is the use of modern communication technology to enable neurology to be practiced when the doctor and patient are not present in the same place, and possibly not at the same time" (Patterson, 2005, p. 55). There are many benefits to the use of tele neurology, however there are several considerations that must be kept in mind regarding the clinical use of the technology and why it is or is not effective. Brear, in her review of articles noted that "the technical features and performance of a telemedicine application will also influence the clinical results, for example if an application

does not allow clinicians to follow their normal work routines, it may not be used and thus will not produce clinical benefits" (Brear, 2006, p. 25).

Purpose of this Review

The primary purpose of this review is to identify the benefits of using neurology telemedicine, the potential impact on patient outcomes and to evaluate the impact of user acceptance of the technology on successful use and implementation of neurology telemedicine in the emergency department.

Databases Utilized

Electronic databases were searched to identify relevant articles. Databases used to conduct the searches were PubMed/Medline, CINAHL with Full Text and Scopus. Search terms used were; benefits of neuro telemedicine, neuro telemedicine outcomes, neuro telemedicine in the emergency department, and tele neurology. The searches were limited to the English language and no articles older than 10 years old were included.

The most successful keyword search was tele neurology. First the title of the article was reviewed. If the title seemed to fit the purpose, the abstract was reviewed to determine if the full article should be reviewed to be included. Criteria used to determine for inclusion was; if it pertained to treatment of neurological conditions, if it included the use of tele neurology technology, if it included benefits, outcomes or analysis of the use of tele neurology.

Findings

There were many studies and reviews of studies of tele neurology applications and their benefits and outcomes however, only a few were selected. A flowchart of the screening process

can be found in Figure 1. Detailed in Table 1 is the study design, results and conclusions of each article reviewed. Points pertinent to the purpose of this review will be highlighted here.

One such study of a review of practice models and published literature revealed the following benefits to telemedicine implementation:

- Increased practice outreach, development, and efficiency
- Decreased travel time and expenses for doctors and patients
- Expansion of educational opportunities and continuing medical education for physicians
- Individual and group education for patients about their neurologic disease
- Easy recruitment of patients into clinical trials
- Improvement of access to neurologic expertise for remote or underserviced areas
- Reduction in geographical disparity for neurologic care
- Decreased response time in stroke
- High patient and family satisfaction survey scores with their tele neurology care (Wechsler et al, 2013, p. 671)

This study also identified some of the barriers to telemedicine implementation:

- Disruption of traditional doctor-patient relationship
- Physician reluctance to adopt novel technology in practice
- Limitation to billing and reimbursement for time spent
- Additional costs for technology
- Licensing, credentialing issues for out-of-state physicians
- Concern for malpractice liability

- Performing complete neurologic examination solely via telehealth, particularly evaluating muscle tone and strength, sensation, reflexes and funduscopic examination
- Obtaining neurodiagnostic tests such as EEG, EMG, and neuroimaging in remote settings

(Wechsler et al, 2013, p. 671)

To expand on the barriers to telemedicine technology this study elaborates that the potential to disrupt the doctor-patient relationship may result in a reluctance to implement the technology and "necessitates ongoing evaluation and new approaches to optimize the telemedicine interaction" (Wechsler et al, 2013, p. 673). In addition, there are concerns of inadequate training for those clinicians involved in the telemedicine examination. "For health care providers not specially trained in neurology, performing a complete neurologic examination,… is difficult to achieve" (Wechsler et al, 2013, p.673). Part of the conclusions of this study noted, "an increase in physician awareness and support at the federal and state level is necessary to facilitate expansion of telemedicine into further areas of neurology" (Wechsler et al, 2013, p. 670).

Another study conducted an electronic database search to investigate the use of telemedicine in managing acute stroke and post-stroke rehabilitation. (Roots, Bhalla, & Birns, 2011) "A review of the literature showed that between 2003 and 2010, over 20 studies investigated more than 15000 patients presenting with acute stroke. Early studies demonstrated that tele medical management of acute stroke was safe, feasible and acceptable…" (Roots, 2011). The key findings of the literature review were:

- Telemedicine allows a stroke physician to provide remote specialist assessment of patients with real-time clinical evaluation
- Correct treatment decision, with reduced delay in diagnosis, are made more often with telemedicine than with telephone consultation
- Telemedicine may be used at any point along the stroke patient care pathway
- Telemedicine-delivered stroke care is effective within a "hub and spoke" model in a geographically organized network

  (Roots, 2011, p. 48)

It was also noted in this review that "despite the published benefits of telemedicine for acute stroke, its cost-effectiveness to inform treatment decisions and resource utilization has not been assessed formally" (Roots, 2011, p. 485).

Another study evaluated the effectiveness of a tele stroke system developed at the Medical College of Georgia called REACH (Remote Evaluation of Acute IsCHemic Stroke) (Switzer, 2009). Using review of literature they looked at 50 patients treated between February 2003 and March 2006 with intravenous tPA using the REACH tele stroke system. The findings "demonstrated that i.v. tPA may be administered safely and rapidly to patients initially presenting to EDs in rural counties. Additionally, the bolus of tPA was initiated within 90 min. in 22%, and within 120 min [minutes] in one-half of treated patients, increasing the likelihood of an outcome with minimal or no disability" (Switzer, 2009, p. 9).

In another study of neurology cases a descriptive analysis of a total of 508 neurology cases and 131 traumatic brain injury (TBI) cases was conducted (Yurkiewicz, 2012). The results showed that "response times decreased, with a mean response time of 8 hours, 14 minutes for

neurology consults and 2 hours, 44 minutes for TBI consults" (Yurkiewicz, 2012, p. 1237). The conclusions of this study were "e-mail-based neurology and TBI subspecialty teleconsultation is a viable method for overseas providers in remote locations to receive expert recommendations for a range of neurologic conditions" (Yurkiewicz, 2012, p. 1237).

In a randomized, blinded, prospective study of 234 patients the authors of this study set out to measure "whether telemedicine or telephone was superior for decision-making in acute telemedicine consultations" (Meyer, 2008, p. 2). The findings revealed the following:

> .. stroke telemedicine consultations result in more accurate decision making compared to telephone, and can serve as a model for the effective use of telemedicine in other medical fields. The more appropriate decisions, high rt-PA userates, improved data collection, low ICH rates, low technical complications, and favorable time requirements all support telemedicine's efficacy, most specifically for decision-making, and may enable more practitioners to use telemedicine in daily stroke care (Meyer, 2008, p. 20).

All of the previous studies focused on the outcomes of the use of telemedicine for neurologic conditions. Another study that was reviewed was focused on neurology specialists. This study surveyed 47 neurology departments representing the top 50 hospitals as ranked by *U.S. News and World Report.* The reason this study was included is because it shows that there is a willingness by neurologists to provide telemedicine services. Specifically the study showed that "over 85% of leading US neurology departments currently use or plan to implement telemedicine within the next year" (George, 2012, p. 123). The study also evaluated quality measures and indicated that "twenty respondents (63%) rated telemedicine as equivalent to in-person care, 10 (31%) rated telemedicine as inferior, and 1 (3%) as superior" (George, 2012, p.

125). Some of the challenges listed by those rating telemedicine as inferior were "due to a loss of personal touch, inability to perform a complete physical examination, dependency on another person's examination, or difficulty with hearing and visually impaired patients" (George, 2012, p. 126).

The final study reviewed was one of a systematic review of the literature and stakeholder interviews to identify implementation challenges of a tele stroke network. Some of the potential barriers to a tele stroke system use in practice include:

- Reluctance because of unfamiliarity; low rates of system use; perceptions of treatment delay; overconfidence in decisions; conflict with cultural norms
- Technical problems are fairly rare, but can include problems with sound or image quality; or difficulties/delays getting access to equipment or network
- Lack of staff confidence or capability in neurological assessment or CT scan reading, fear of clinical complications (e.g. haemorrhage)
- Lack of local IT staff to support the technical system
- Cultural differences and poor communication routes between disciplines, and centres (French, 2013, pgs. 5-6).

Analysis of the Results

The findings of these studies clearly show that the use of tele neurology improves patient treatment and outcomes. While there is a shortage of neurologists, a high percentage of neurology departments are providing tele neurology services and more plan to do so. However, there are some identified barriers to the acceptance of the tele medicine technology. Further

study into the end users perceptions of the usefulness and ease of use of the technology would be beneficial in establishing best practices for implementation of telemedicine technology.

Table 1: Study Characteristics

Study	**Subjects and study design**	**Results**	**Conclusions**
French, B. et.al. 2013	Systematic search of healthcare databases and the Internet to identify descriptions of the implementation of tele stroke projects; interviews with key stakeholders during the development of one UK tele stroke network. Supporting documentation from existing projects was analyzed to construct a framework of implementation stages and tasks, and a toolkit of documents. Interviews and literature were analyzed with other data sources using Normalisation Process Theory as described in the e-Health Implementation Toolkit.	61 tele stroke projects were identified and contacted. Twenty projects provided documents, 13 with published research detailing four stages of tele stroke system development, implementation, use and evaluation. Interviewees identified four main challenges: engaging and maintaining the commitment of a wide range of stakeholders across multiple organisations; addressing clinicians perceptions of evidence, workload and payback; managing clinical and technical workability across diverse settings; and monitoring how the system is used and reconfigured by users.	Information to guide tele stroke implementation is sparse, but available. By using multiple sources of data, sufficient information was collated to construct a web-based toolkit detailing implementation tasks, resources and challenges in the development of a tele stroke system for assessment and thrombolysis deliver in acute care. The toolkit is freely available online.
Wechsler, L.R. et.al. 2013	Review of practice models and published literature on primary studies of the efficacy of neurology telemedicine	Tele neurology is of greatest benefit to populations with restricted access to general and subspecialty neurologic care in rural areas, those with limited mobility, and those deployed by the military. Through the use	Tele neurology is an effective tool for the rapid evaluation of patients in remote locations requiring neurologic care. These underserved locations include geographically isolated rural areas as well as urban cores with

		of real-time audio-visual interaction, imaging and store-and-forward systems, a greater proportion of neurologists are able to meet the demand for specialty care in underserved communities, decrease the response time for acute stroke assessment, and expand the collaboration between primary care physicians, neurologists, and other disciplines. The American Stroke Association has developed a defined policy on tele neurology, and the American Academy of Neurology and federal health care policy are beginning to follow suit.	insufficient available neurology specialists. With this technology, neurologists will be better able to meet the burgeoning demand for access to neurologic care in an era of declining availability. An increase in physician awareness and support at the federal and state level in necessary to facilitate expansion of telemedicine into further areas of neurology.
Meyer, B. C., et al 2008	Acute stroke patients were randomized to telemedicine or telephone consultations. Primary outcome measure was whether the thrombolytic treatment decision was correct, as determined by central adjudication. Secondary outcomes included rt-PA use-rate, 90 day functional outcomes, hemorrhages, and technical observations.	Two hundred thirty-four patients were prospectively evaluated. Mean NIHSS score was 9.5 (11.4+-8.7 telemedicine, 7.7+-7.0 telephone; p=0.0020). One telemedicine consult (0.9%) was aborted for technical reasons, though was included in intention-to-treat analyses. Correct treatment decision was made more often in telemedicine (98.2% telemedicine, 82% telephone; OR 10.9; 95% CI 2.7-44.6; p=0.0009). IV rt-PA use-rate was 25% (28% telemedicine, 23% telephone; OR 1.3; 95% CI 0.7-2.5; p=0.4248). Ninety day functional outcomes were not different for BI (95-100) (OR 0.6; 95% CI 0.4-1.1; p=0.1268) or for	This trial reports that stroke telemedicine consultations result in more accurate decision making, compared to telephone, and can serve as a model for the effective use of telemedicine in other medical fields. The more appropriate decisions, high rt-PA use rates, improved data collection, low ICH rates, low technical complications, and favorable time requirements all support tele medicine's efficacy, most specifically for decision-making, and may enable more practitioners to use telemedicine in daily stroke care.

		mRS (OR 0.6; 95%CI 0.3-1.1; p=0.0898). There was no morality difference (OR 1.6; 95%CI 0.8-3.4; p=0.2690. Post-rt-PA ICH rates were not different (7% telemedicine, 8% telephone; OR 0.8; 95%CI 0.1-6.3; p=1.0). There was a difference noted for amount of non-completed data (3.1% telemedicine, 12.0% telephone; OR 0.2; 95%CI 0.1-0.3; p<0.001).	
Yurkiewicz, H.R., et al 2012	This was a retrospective analysis that searched electronic databases for neurology consults from October 2006 to December 2010 and TBI [traumatic brain injury] consults from March 2008 to December 2010.	A total of 508 consults were received for neurology, and 131 consults involved TBI. For the most part, quantity of consults increased over the years. Meanwhile, response times decreased, with a mean response time of 8 hours, 14 minutes for neurology consults and 2 hours, 44 minutes for TBI consults. Most neurology consults originated in Iraq (67.59%) followed by Afghanistan (16.84%), whereas TBI consults mainly originated from Afghanistan (40.87%) followed by Iraq (33.91%). The most common consultant diagnoses were headaches, including migraines (52.1%), for neurology cases and mile TBI/concussion (52.3%) for TBI cases. In the majority of cases, consultants recommended in-theater management. After receipt of consultant's recommendation, 84 known neurology	E-mail-based neurology and TBI subspecialty tele consultation is a viable method for overseas providers in remote locations to receive expert recommendations for a range of neurologic conditions. These recommendations can facilitate medically necessary patient evacuation or prevent evacuations for which on-site care is preferable.

		evacuations were facilitated, and 3 known neurology evacuation were prevented.	
Switzer, J. A., et al 2009	We aimed to detail the safety, feasibility, and treatment times of thrombolytic therapy with a web-based tele stroke system. At the Medical College of Georgia, we have developed a tele stroke system (Remove Evaluation of Acute IsCHemic Stroke; REACH) in which emergency physicians in surrounding counties may consult stroke specialists at our institution. The web-based system allows the stroke consultant to obtain history, examine the patient with live video, and review computed tomography. A recommendation is made regarding the administration of tissue plasminogen activator (tPA) before patient transport to the tertiary medical center.	A systematic review of the literature was conducted regarding the use of tPA in academic and community hospitals. Symptomatic hemorrhagic transformation and stroke onset-to-treatment times were compared between the REACH network and other stroke care delivery systems. Between February 2003 and March 2006, 50 patients were treated with intravenous tPA using the REACH tele stroke system. There was one (2%) symptomatic hemorrhage. The mean onset-to-treatment time was 127.6 min (95% confident interval 117.1-138.0) using REACH compared with 145.9 min (95% confidence interval 126.9-164.9) in our Emergency Department [without use of REACH] and 147.8 min in other published systems.	REACH, a web-based tele stroke system, facilitates the safe administration of thrombolytic therapy to patients within rural communities suffering an acute ischemic stroke.
George, B.P. et al 2012	An electronic survey was sent to department chairs, administrator, or faculty involved in telemedicine at 47 neurology department representing the top 50 hospitals as ranked by *U.S. News and World Report.* Main outcome measures: Current use, size, scope,	A total of 32 individuals from 30 departments responded (64% response rate). The primary respondents were neurology faculty (66%) and department chairs (22%). Of the responding departments, 60% (18 of 30) currently provide telemedicine and most (n=120 had initiated	Over 85% of leading US neurology departments currently use or plan to implement telemedicine within the next year. Addressing reimbursement may allow for its broader application.

	reimbursement, and perceived quality of telemedicine services.	services within the last 2 years. Two thirds of those not providing telemedicine plan to do so within a year. Departments provide services to patients in state, out of state, and internationally, but only 6 departments had more than 50 consultations in the last year. The principal applications were stroke (n=14), movement disorders (n=4), and neurocritical care (n=3). Most departments (n=12) received external funding for telemedicine services, but few departments (n=3) received payment for insurers (e.g., Medicare, Medicaid). Reimbursement (n=21) was the most frequently identified barrier to implementing telemedicine services. The majority of respondents (n=20) find telemedicine to be equivalent to in-person care.	
Roots, A., et al 2011	An electronic database search was performed of MEDLINE, EMBSE and the Cochrane Library and extensive manual searching of articles was conducted to identify studies investigating the use of telemedicine in managing acute stroke and post-stroke rehabilitation.	There were 20 observational and 2 randomized, controlled acute studies involving 15872 patients and 2 observational and 4 randomized controlled rehabilitation studies involving 112 patients that met the inclusion criteria.	Telemedicine for stroke, in both acute and rehabilitation settings, was demonstrated to be safe, effective, feasible and acceptable and was shown to reduce geographical differences and increase diagnostic accuracy and update of thrombolytic treatment.

Chapter 3

Methodology

This study is modeled after Davis's Technology Acceptance Model (TAM), which "provides a valid and reliable measure that predicts the acceptance or adoption of new technologies by end-users" (National Institutes of Health, NIH, n.d.). I utilized Davis's 1989 original TAM, which "predicts acceptance based on the end-user's perceived usefulness (PU) and perceived ease of use (PEOU) of the technology for a specific purpose" (NIH, n.d.). The participants of this study are practitioners from Hunt Regional Medical Center and the survey specifically focused on their perceptions of a neurology telemedicine product recently launched in the emergency department called VGo.

VGo is a slender 4-foot tall robot on wheels that works via remote control using a laptop or iPad to control. The VGo technology works with a two-way video and audio communication, allowing physicians to consult with other practitioners and examine patients. Physicians can control the movement of the VGo with their computer mouse or keyboard, tilting and zooming the camera that sits atop its spherical head as they examine a patient, or move from one location to another. An image of the VGo is located in Figure 2.

Research Questions

The specific questions to answer through this research study are:

1. Do users perceive that using VGo will enable them to accomplish tasks more quickly?
2. Do users perceive that using VGo will improve their job performance?
3. Do users perceive that using VGo will increase their productivity?

4. Do users perceive that using VGo will enhance their effectiveness on the job?
5. Do users perceive that using VGo will make it easier to do their job?
6. Do users perceive that using VGo will be useful in their job?
7. Do users perceive that learning to operate VGo would be easy for them?
8. Do users perceive that they would find it easy to get VGo to do what they want it to do?
9. Do users perceive that their interaction with VGo would be clear and understandable?
10. Do users perceive that they would find VGo to be flexible to interact with?
11. Do users perceive that it would be easy for them to become skillful at using VGo?
12. Do users perceive that they would find VGo easy to use?
13. Are there similarities or differences in user perception attributed to the length of experience in hours with the VGo technology?

Research Design

A descriptive research design was used to identify user acceptance of neurology telemedicine technology, VGo, used in the emergency department at Hunt Regional Medical Center. The paper survey was designed and reviewed by a multidisciplinary team at the facility. The tool was approved by the facilities Compliance Committee and the Internal Review Board at the University of Tennessee Health Science Center.

Population and Sample Design

The population surveyed was all practitioners working in the two emergency departments of Hunt Regional Medical Center where the neurology telemedicine product VGo is used.

Data Collection Procedures

The department directors of each emergency department were contacted via telephone to explain the study and obtain permission to distribute the survey. The medical director of the emergency department practitioners was contacted face to face, the study was explained, and permission obtained to distribute to the practitioners. Paper surveys were delivered by hand to each emergency department and distributed by the department director and/or medical director to each staff member.

Data Collection Instrument

The survey instrument was adapted from Davis's Final Measurement Scales for Perceived Usefulness and Perceived Ease of Use. (Davis, 1989, p. 340) The instrument consists of 12 questions, each question has a 7 point Likert scale with 1 = strongly agree, 4 = neutral and 7= strongly disagree. The survey instrument can be found in Figure 3.

Data Analysis

After receipt of the completed surveys the data from each survey was entered into the REDCap database. The data was then exported to Microsoft Excel 2010 for use in this data analysis.

Chapter 4

Results

Response rate of population

A total of 40 surveys were distributed, 27 to emergency department (ED) 1 and 13 to emergency department (ED) 2. Of the 27 distributed to ED 1, 11 were returned resulting in a 40.7% response rate. Of the 13 distributed to ED 2, 9 were returned resulting in a 69.2% response rate. Of the 9 responses from ED 2, one was incomplete. The total responses from both emergency departments were 20 for an overall response rate of 50%.

Profile of Population

The following graphs and table provide the basic information about the respondents to the survey.

Figure 4

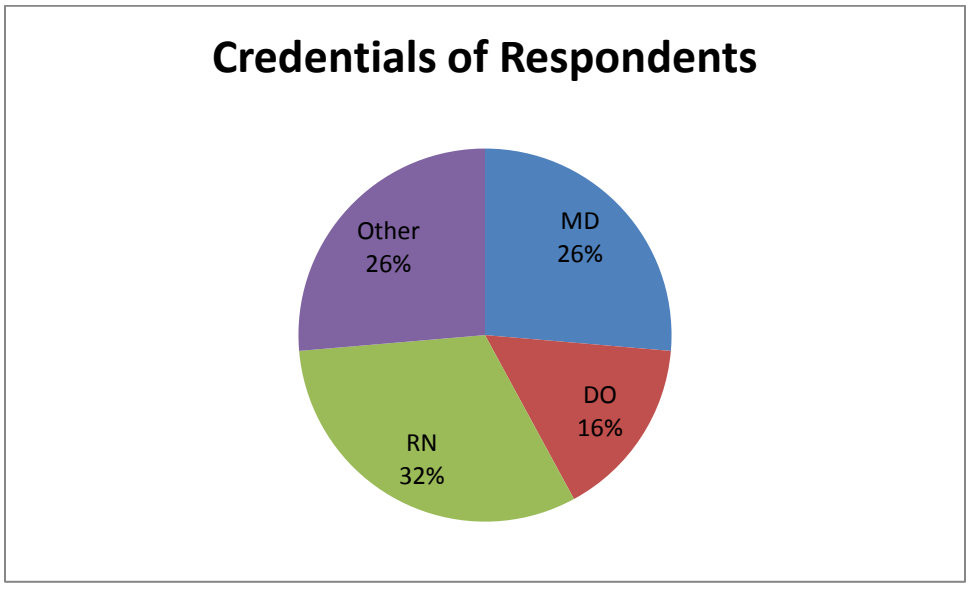


Table 2

Age of Respondents

Age	No. of Respondents	Percent of Total Respondents
20-30 years old	2	10.5%
30-40 years old	6	31.6%
40-50 years old	4	21.1%
50-60 years old	5	26.3%
60 + years old	1	5.3%
Total	18	95%

Figure 5

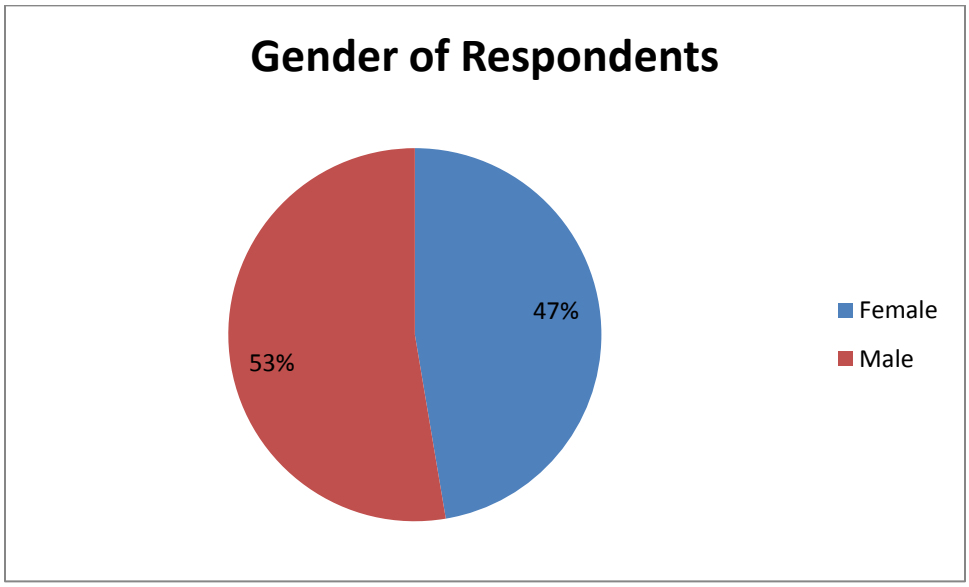
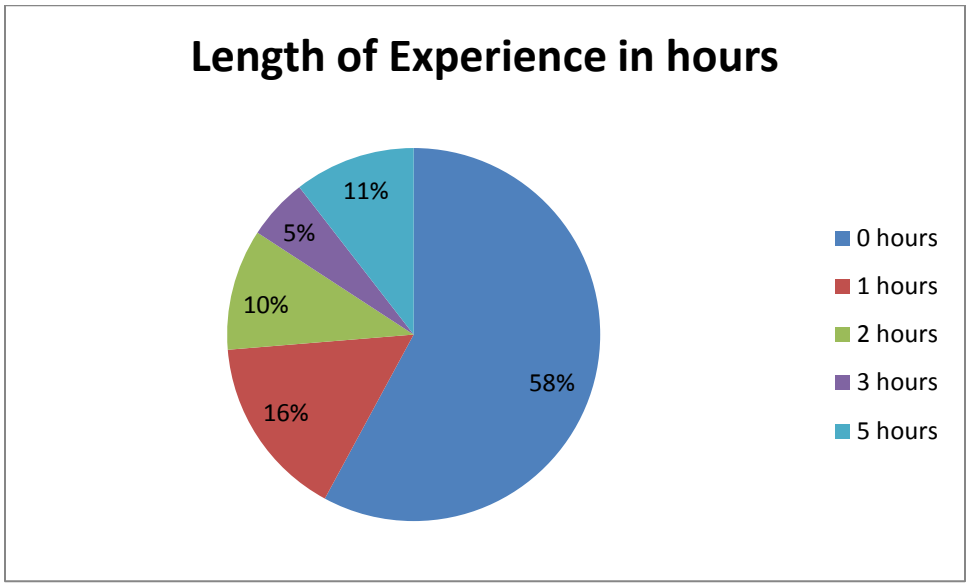


Figure 6



Research Questions

The following figures and tables display the results of each of the survey questions.

Figure 7

Using VGo in my job would enable me to accomplish tasks more quickly

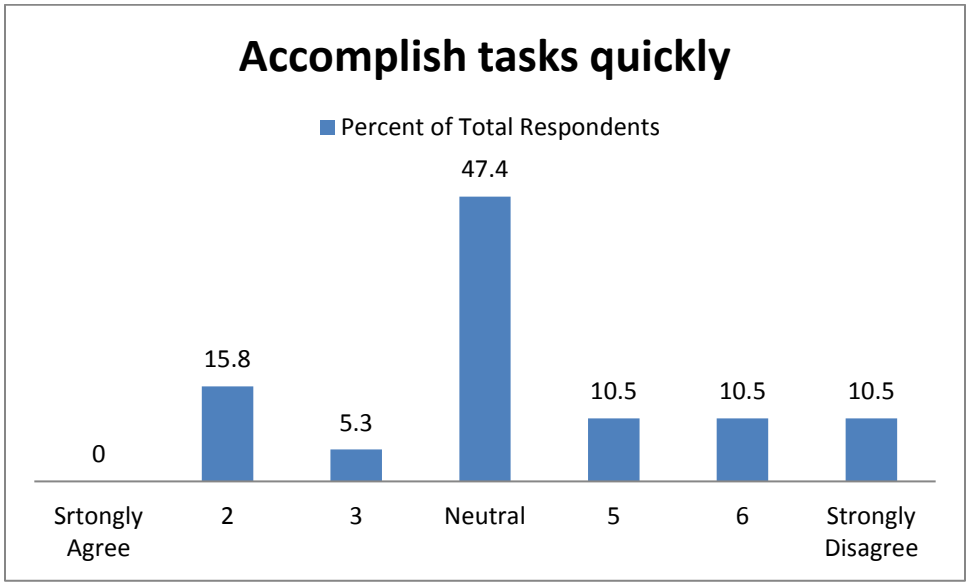


Figure 8

Using VGo would improve my job performance

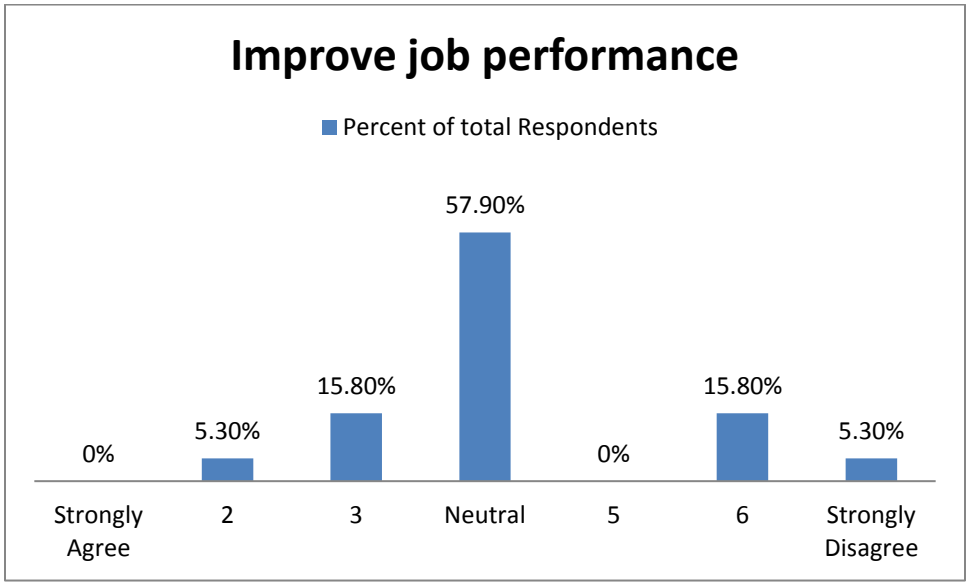


Figure 9

Using VGo in my job would increase my productivity

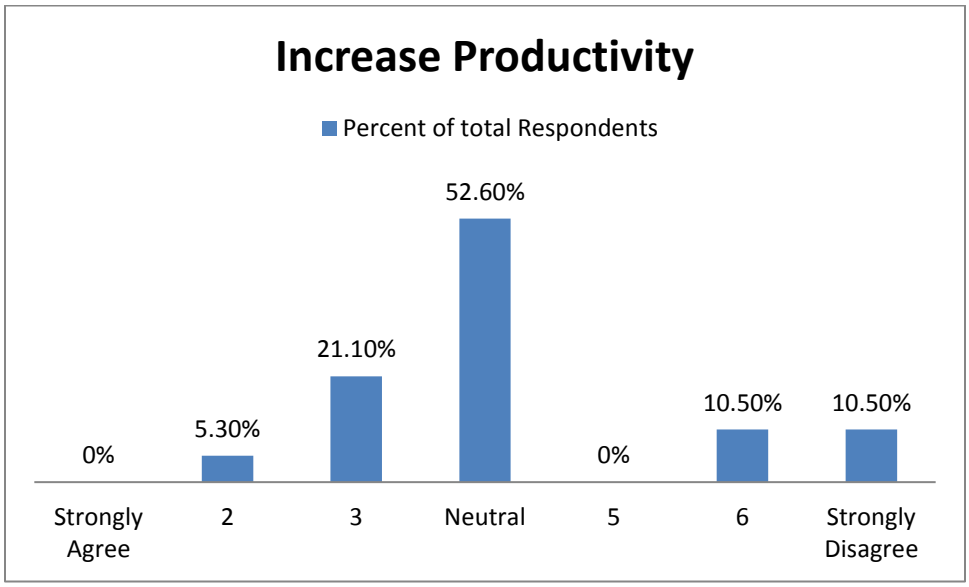


Figure 10

Using VGo would enhance my effectiveness on the job

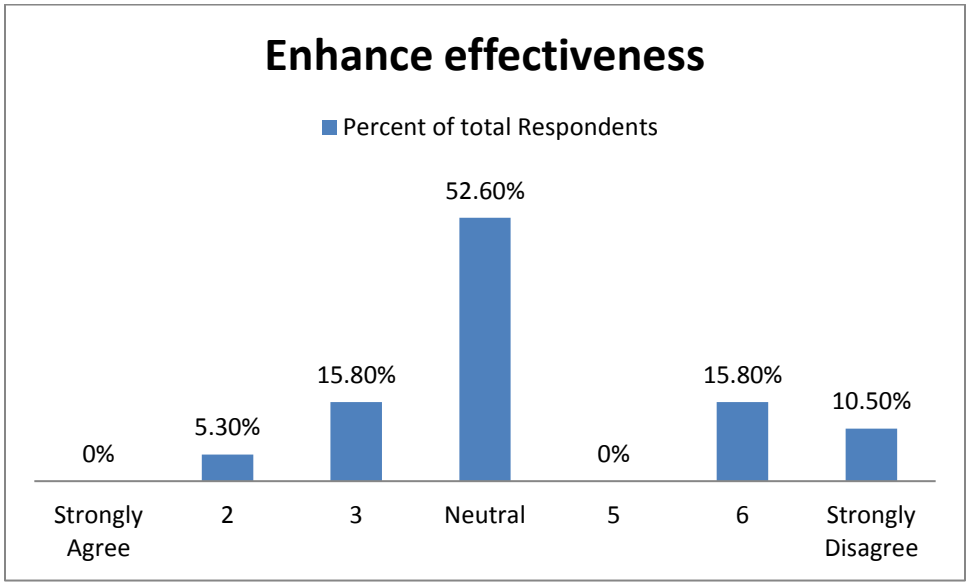


Figure 11

Using VGo would make it easier to do my job

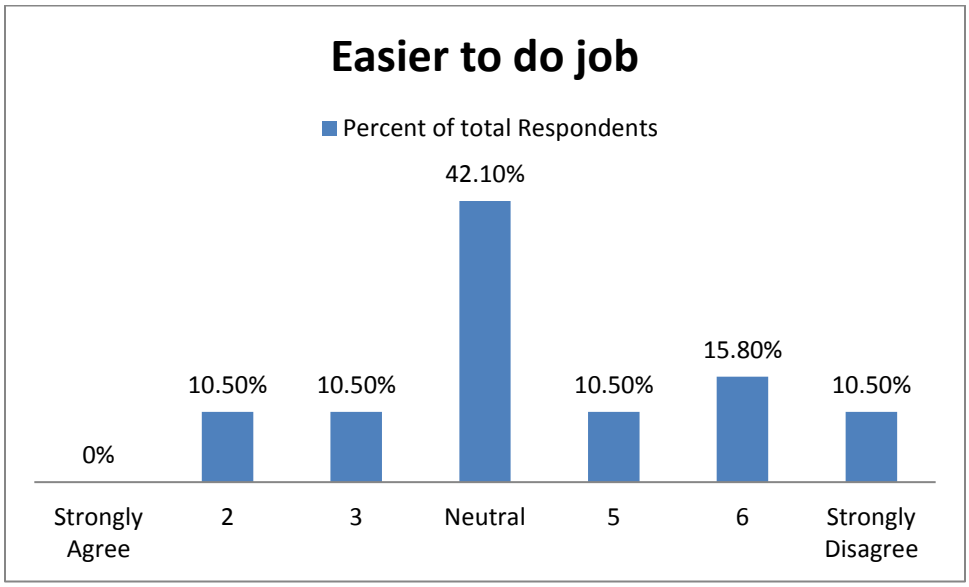


Figure 12

I would find VGo useful in my job

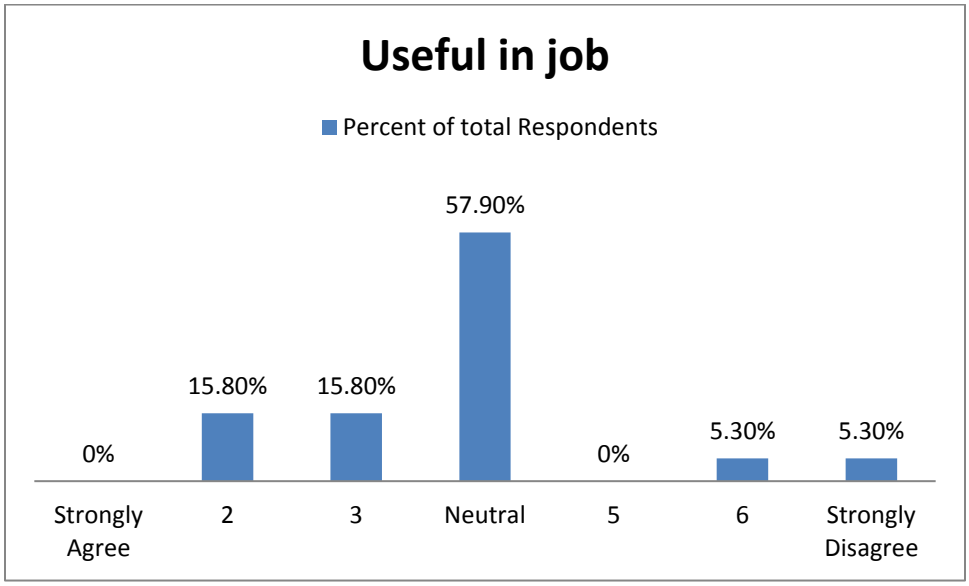


Figure 13

Learning to operate VGo would be easy for me

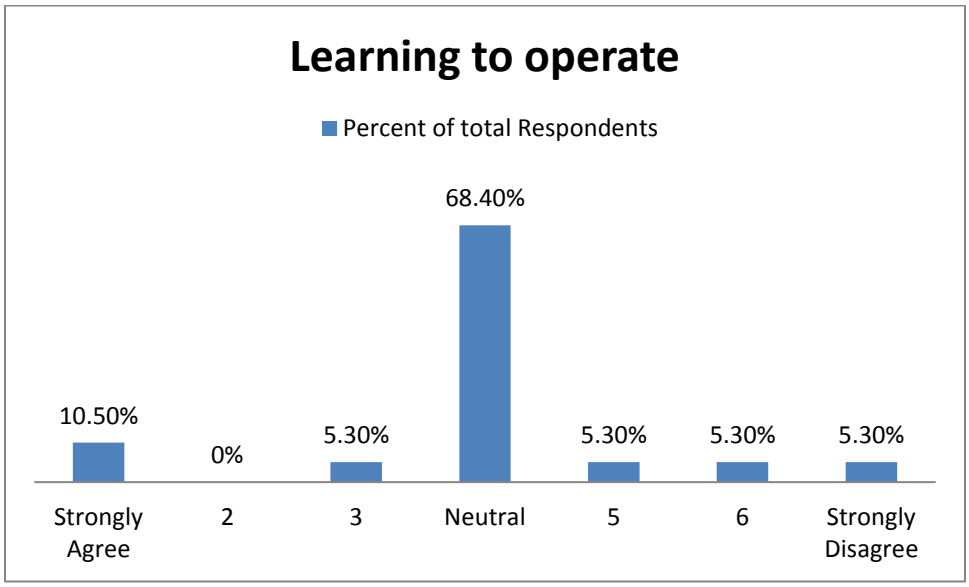


Figure 14

I would find it easy to get VGo to do what I want it to do

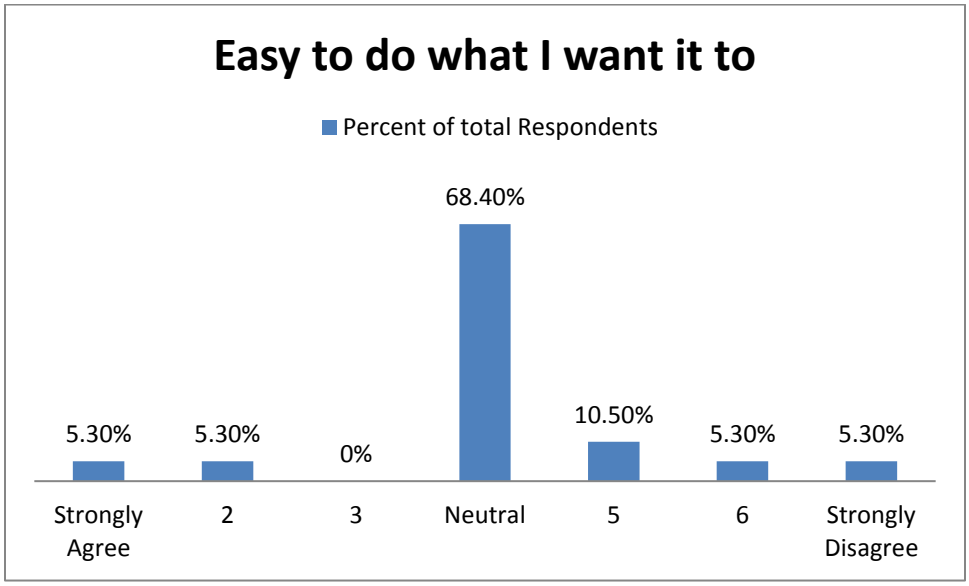


Figure 15

My interaction with VGo would be clear and understandable

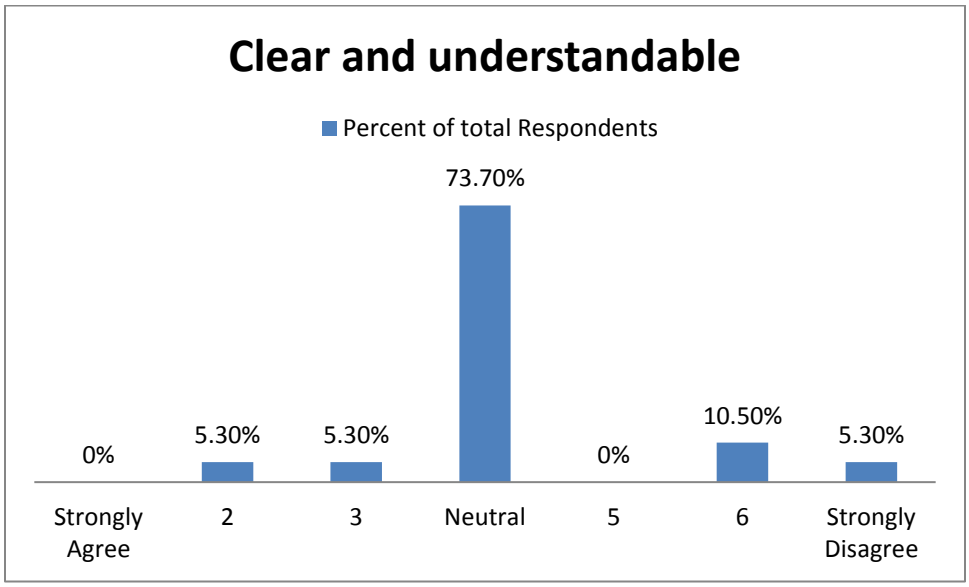


Figure 16

I would find VGo to be flexible to interact with

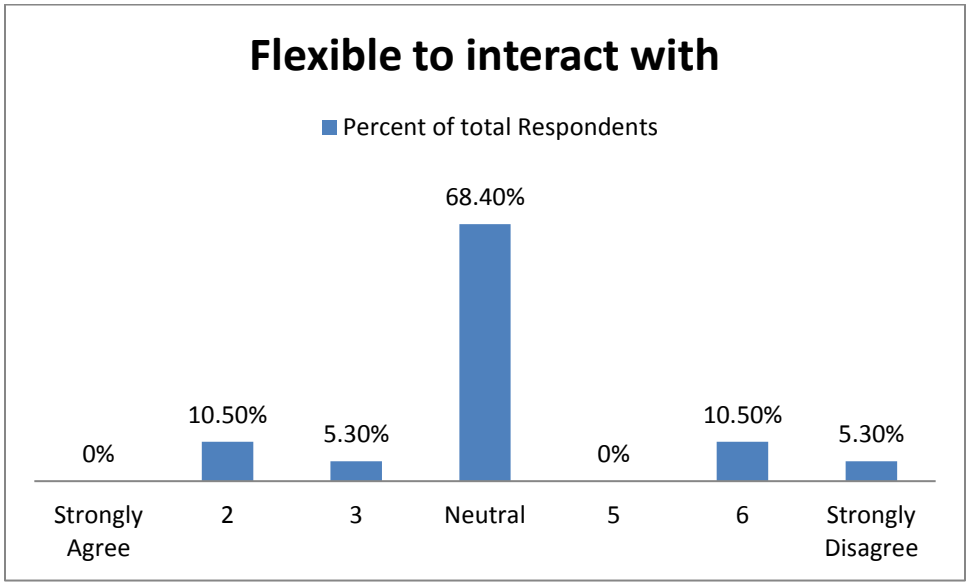


Figure 17

It would be easy for me to become skillful at using VGo

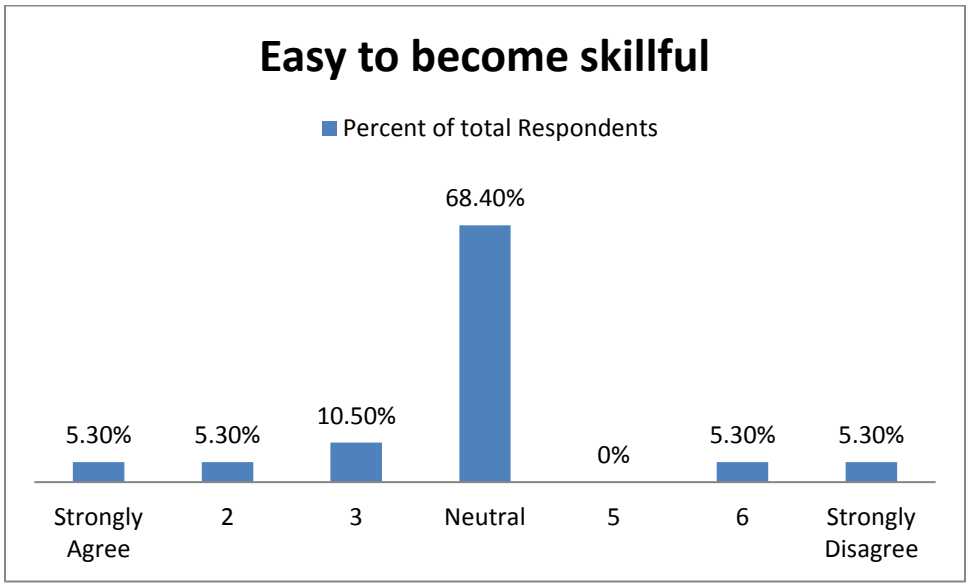


Figure 18

I would find VGo easy to use

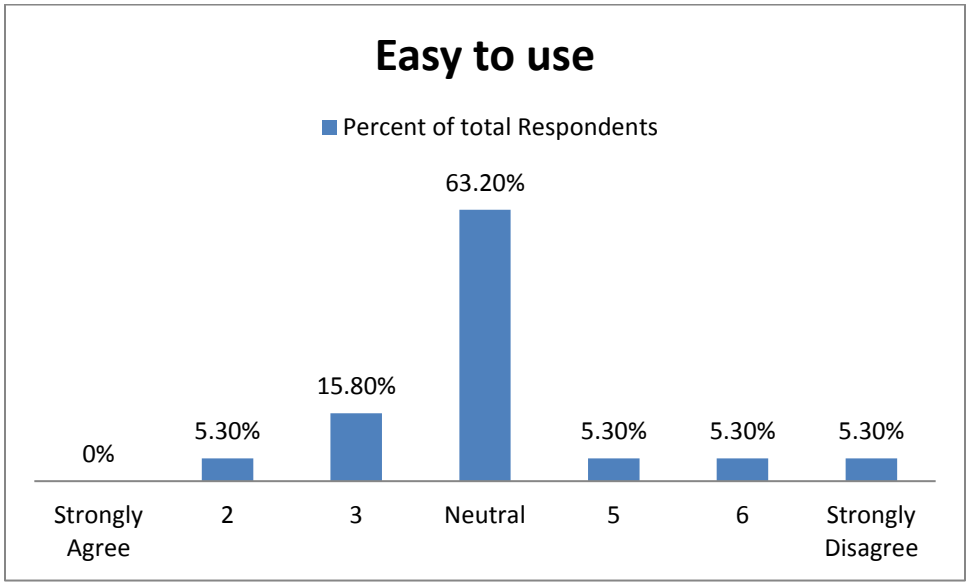


Table 3

Respondents with no experience using VGo

Percent of Total Responses*	1 Strongly agree	2	3	4 Neutral	5	6	7 Strongly disagree
Question							
User Acceptability							
1 Accomplish tasks quickly	0	0	0	54.5%	18%	18%	9%
2 Improve job performance	0	0	9%	63.6%	0	18%	9%
3 Increase productivity	0	0	0	72.7%	0	18%	9%
4 Enhance effectiveness	0	0	9%	72.7%	0	18%	9%
5 Easier to do job	0	9%	0	54.5%	9%	18%	9%
6 Useful in job	0	0	18%	72.7%	0	9%	9%
Ease of Use							
7 Learning to operate	9%	0	0	72.7%	0	9%	9%
8 Easy to do what I want it to	9%	0	0	72.7%	0	9%	9%
9 Clear and understandable	0	0	0	81.8%	0	9%	9%
10 Flexible	0	0	0	81.8%	0	9%	9%
11 Easy to become skillful	0	9%	9%	63.6%	0	9%	9%
12 Easy to use	0	0	9%	72.7%	0	9%	9%

*Represents 11 total respondents

Table 4

Respondents with experience using VGo

Percent of Total Responses*	1 Strongly agree	2	3	4 Neutral	5	6	7 Strongly disagree
Question							
User acceptability							
1 Accomplish tasks quickly	0	37.5%	12.5%	37.5%	0	0	12.5%
2 Improve job performance	0	12.5%	25%	50%	0	12.5%	0
3 Increase productivity	0	12.5%	50%	25%	0	0	12.5%
4 Enhance effectiveness	0	12.5%	25%	37.5%	0	12.5%	12.5%
5 Easier to do job	0	12.5%	25%	25%	12.5%	12.5%	12.5%
6 Useful in job	0	37.5%	12.5%	50%	0	0	0
Ease of Use							
7 Learning to operate	12.5%	0	12.5%	62.5%	12.5%	0	0
8 Easy to do what I want it to	0	12.5%	0	62.5%	12.5%	0	0
9 Clear and understandable	0	12.5%	12.5%	62.5%	0	12.5%	0
10 Flexible	0	25%	12.5%	50%	0	12.5%	0
11 Easy to become skillful	0	0	12.5%	75%	0	0	12.5%
12 Easy to use	0	12.5%	25%	50%	12.5%	0	0

*Represents 8 total respondents

Table 5

	Total responses						
Percent of Total Responses	1 Strongly agree	2	3	4 Neutral	5	6	7 Strongly disagree
Question							
User acceptability							
1 Accomplish tasks quickly	0	15.7%	5.2%	47.3%	10.5%	10.5%	10.5%
2 Improve job performance	0	5.2%	15.7%	57.8%	0	15.7%	5.2%
3 Increase productivity	0	5.2%	21%	52.6%	0	10.5%	10.5%
4 Enhance effectiveness	0	5.2%	15.7%	52.6%	0	15.7%	10.5%
5 Easier to do job	0	10.5%	10.5%	42.1%	10.5%	15.7%	10.5%
6 Useful in job	0	15.7%	15.7%	57.8%	0	5.2%	5.2%
Ease of Use							
7 Learning to operate	10.5%	0	5.2%	68.4%	5.2%	5.2%	5.2%
8 Easy to do what I want it to	5.2%	5.2%	0	68.4%	10.5%	5.2%	5.2%
9 Clear and understandable	0	5.2%	5.2%	73.6%	0	10.5%	5.2%
10 Flexible	0	10.5%	5.2%	68.4%	0	10.5%	5.2%
11 Easy to become skillful	5.2%	5.2%	10.5%	68.4%	0	5.2%	5.2%
12 Easy to use	0	5.2%	15.7%	63.1%	15.2%	5.2%	5.2%

Chapter 5

Analysis and Discussion

Thirty-one percent (31%) of the respondents were RN's while 26% were MD's and another 26% fell into the other category (Figure 4).

Seventy-nine percent (79%) of the respondents were between 30-60 years old. Thirty-two percent (32%) were 30-40, 21% were 40-50 and 26% were 50-60. One respondent did not answer this question. (Table 2).

The gender of the respondents was almost a 50/50 split, with 47% female and 53% male (Figure 5).

Forty-two percent (42%) of respondents indicated having experience in using VGo while 58% reported having no experience in using the product. Of those reporting having experience with using VGo, 15.8% had 1 hour of experience, 10.5% had 2 hours of experience, 5.3% had 3 hours of experience and 10.5% had 5 hours of experience (Figure 6).

The first set of six questions was designed to access the user's acceptability of the VGo product. Forty-seven percent (47%) of the respondents were neutral in their response to the statement "Using VGo in my job would enable me to accomplish tasks more quickly". Twenty-one percent (21%) had a positive response, with 16% rating a 2 and 5% rating a 3. While 32% had a negative response, with a 10.5% rating each for 5, 6 and 7, representing strongly disagree (Figure 7).

When responding to the statement "Using VGo would improve my job performance", 58% of respondents were neutral. Twenty-one percent (21%) had a positive response, with 16%

rating a 3 and 5% rating a 2. While the other 21% had a negative response, with 16% rating a 6 and 5% rating a 7 of strongly disagree (Figure 8).

Responses to "Using VGo in my job would increase my productivity" revealed a 53% neutral response. There was a higher positive response to this statement with 26% positive responses representing 21% at a 3 and 5% at a 2. The negative response was at 21% representing 10.5% at 6 and 10.5% at a 7 of strongly disagree (Figure 9).

Fifty-two percent (52%) of respondents were neutral to the statement "Using VGo would enhance my effectiveness on the job". Twenty-one percent (21%) responded positively with 16% at a 3 and 5% at a 2. Twenty-six percent (26%) responded negatively with 16% at a 6 and 10% at a 7 of strongly disagree (Figure 10).

The statement "Using VGo would make it easier to do my job" resulted in a 42% neutral response. Twenty-one percent (21%) responded positively with 10.5% at a 3 and 10.5% at a 2. While 37% responded negatively with 10.5% at a 5, 16% at a 6 and 10.5% at a 7 of strongly disagree (Figure 11).

The final set of six questions was designed to access the user's perception of the ease of use of the product. Fifty-eight percent (58%) of respondents were neutral to the statement "I would find VGo useful in my job". There was a higher positive response of 32% with 16% at a 3 and 16% at a 2. Eleven percent (11%) responded negatively with 5.3% at a 6 and 5.3% at a 7 of strongly disagree (Figure 12).

The statement "Learning to operate VGo would be easy for me" resulted in a 68% neutral response. Sixteen percent (16%) responded positively with 5.3% at a 3 and 10.5% at a 1 of

strongly agree. While the other 16% responded negatively with 5.3% each at 5, 6 and 7 of strongly disagree (Figure 13).

Sixty-eight percent (68%) responded as neutral to the statement "I would find it easy to get VGo to do what I want it to do". Eleven percent (11%) responded favorably with 5.3% at a 2 and 5.3% at a 1 of strongly agree. Twenty-one percent (21%) responded negatively with 10.5% at a 5, 5.3% at a 6 and 5.3% at a 7 for strongly disagree (Figure 14).

The response to the statement "My interaction with VGo would be clear and understandable" revealed 74% of respondents were neutral. Eleven percent (11%) responded positively with 5.3% at a 3 and 5.3% at a 2. Sixteen percent (16%) responded negatively with 10.5% at a 6 and 5.3% at a 7 for strongly disagree (Figure 15).

The statement "I would find VGo to be flexible to interact with" revealed 68% of respondents to be neutral. An equal number fell in both positive and negative response with 16% positive; 5.33% at a 3 and 10.5% at a 2 and 16% negative; 10.5% at a 6 and 5.3% at a 7 for strongly disagree (Figure 16).

Sixty-eight percent (68%) of respondents were neutral to the statement "It would be easy for me to become skillful at using VGo." A higher percentage responded positively at 21%; 10.5% at a 3, 5.3% at a 2 and 5.3% at a 1 of strongly agree. Eleven percent (11%) responded negatively; 5.3% at a 6 and 5.3% at a 7 of strongly disagree (Figure 17).

The final statement "I would find VGo easy to use" showed a 63% neutral response. There was a higher positive response of 21% with 16% at a 3 and 5.3% at a 2. Sixteen percent (16%) responded negatively with 5.3% each for 5, 6 and 7 for strongly disagree (Figure 18).

Comparison of respondents without and with experience using VGo

Table 3 displays the responses to each of the 12 questions from the eleven respondents with no experience using VGo. The questions are grouped by the user acceptability questions and ease of use questions. For the respondents with no experience over half of responses to all questions were neutral, ranging from 54.5% to 81.8%. Of the remaining responses, the majority are negative. Of the user acceptability questions; 1-5 rated at a 6 by 18% of respondents and question 6 was rated at a 6 by 9%. Nine percent (9%) rated questions 1-6 at a 7 for strongly disagree. There was not much difference with the ease of use questions with 9% of respondents rating questions 7-12 at a 6 and 9% rating at a 7 for strongly disagree.

Table 4 displays the responses to each of the 12 questions from the eight respondents with experience using VGo. The questions are grouped by the user acceptability questions and ease of use questions. For the user acceptability questions the percent of neutral responses range from 50% to 25%. The majority of the remaining responses are positive ratings of 2 or 3. Thirty-seven percent (37%) of respondents report a favorable rating of 2 for the questions 1 and 6; “Using VGo in my job would enable me to accomplish tasks more quickly” and “I would find VGo useful in my job”. Fifty percent (50%) of respondents reported a favorable rating of 3 to the statement “Using VGo in my job would increase my productivity”. In the ease of use section of questions 50-75% of respondents were neutral. The remaining responses are more favorable with 25% responding with a rating of 3 for the statement “I would find VGo easy to use” and 25% responding with a rating of 2 for the statement “I would find VGo to be flexible to interact with”.

Comparison of positive and negative responses to survey questions

Table 5 combines all the responses to each survey question for ease of comparative analysis. The majority of all of the responses were rates as neutral, ranging from 42.1% to 73.6%. The majority of the questions had an equal distribution of responses on either side representing a bell shaped curve. There were a few instances where there the distribution was more in one area than the other was. The question "Using VGo in my job would enable me to accomplish tasks more quickly" has a total of 31.5% of negative responses compared to 20.9% positive responses. A total of 36.8% of respondents responded negatively to the question "Using VGo would make it easier to do my job", as compared to 21% responding positively. The question "I would find VGo useful in my job" had a total positive response of 31.6% compared to a 10.4% negative response. A total of 20.9% responded negatively to the statement "I would find it easy to get VGo to do what I want it to do", compared to 10.4% with a positive response. The statement "It would be easy for me to become skillful at using VGo" had a total of 20.9% positive responses, compared to 10.4% negative responses.

Limitations and Discussion

There are important limitations of the study to be considered.

- The sample size for the survey was small, so generalizing the data will be difficult.
- The survey conducted for this study was limited to one organization, so generalizing the data will be difficult. However, the concepts behind the study could apply to evaluation of user acceptance to any type of technology.
- The survey was limited to one type of telemedicine technology, VGo. So, the study is not representative of all available telemedicine technology.

- Over half of the respondents had no experience using the technology since it had just recently been implemented. Had the survey been conducted after more exposure to the technology, the results could have been more revealing.
- The literature review revealed no similar studies of user acceptance of telemedicine technology to use as comparison data.

Chapter 6

Conclusion and Recommendations

Summary of Findings

This survey resulted in a very good response rate of 50%, with a total of 20 responses. The respondents were comprised of medical professionals, the majority RN's, but including MD's, DO's and others. The majority of the respondents were between the ages of 30-60 and each gender was represented equally. Of those responding, 42% had experience using the telemedicine technology, VGo while 58% had no experience.

Since there was a distinction between those respondents with experience and without the results were separated and analyzed for each group. There were a total of eleven respondents with no experience. The majority of the group without experience rated each question as neutral. Of the remaining responses, the majority were a negative rating of 5, 6 or 7. There were a total of eight respondents who had anywhere from 1-5 hours experience using the telemedicine technology. This group had a lower number of neutral responses, ranging from 50% to 25%. The majority of their remaining responses were a positive rating of 2 or 3. Given the difference in responses of the two groups, the conclusion can be made that the more experienced users had a more positive view of the product while those with no experience had a more negative view of the product.

Upon analysis of the combined data for each question many of the responses are equally distributed with neutral being the highest rating for each questions, resulting in a bell shaped curve. However, there are a few questions that clearly received a more positive response and those that received a more negative response. The question "I would find VGo useful in my job"

garnered a 31.6% positive response and the question "It would be easy for me to become skillful at using VGo" received a total of 20.9% positive responses. The question "Using VGo in my job would enable me to accomplish tasks more quickly" had a total of 31.5% negative response. "Using VGo would make it easier to do my job" had a negative rating by 36.8% of respondents and "I would find it easy to get VGo to do what I want it to do" was rated negatively by 20.9% of respondents. This data reveals that more of the respondents feel that VGo would not enable them to accomplish tasks more quickly, make their job easier nor would they find it easy to get VGo to do what they want it to do. However, more respondents feel that they would find VGo useful in their job and feel that it would be easy for them to become skillful at using VGo.

Conclusions

As cited previously, there are thirteen specific research questions for this study. The user acceptance survey provided enough data to provide answers to these questions.

The results of this survey clearly indicate that there is a difference in user perceived usefulness and ease of use of the telemedicine technology VGo based on the length of experience with the product (Tables 3 and 4). In addition, the results of the responses to each question represent the user's perceived usefulness and ease of use of the product (Table 5). The overall perceptions of the respondents were neutral, but did reveal that that a percentage of respondents perceive that it would not be easy to get VGo to do what they want, that they would not be able to perform tasks more quickly and it would not make their job easier. However, the results also indicated that user's perceived that it would be easy to become skillful at using VGo and that it would be useful in their job.

Implications of the Study

The results of this study are encouraging as they reveal a more positive perception from staff with experience using the telemedicine product and an overall perception that the product would be useful and easy to become skillful at using. This information demonstrates user acceptance of the product and identifies some of the barriers that the users perceive. Since the more experienced users had more positive response, allowing for more training time for those users with no experience to allow them to become familiar with the product would be beneficial to increasing acceptance. The identified barriers that it would not be easy to get VGo to do what they want, that they would not be able to perform tasks more quickly and it would not make their job easier can be addressed through more rigorous training and hands on experience to alter these perceptions. Improving acceptance and usage of this technology will ultimately improve patient outcomes.

Recommendations

The user acceptance survey gathered data on the end-user's perceived usefulness and perceived ease of use of the telemedicine technology VGo. A more comprehensive study with a larger sample that includes other organizations using a variety of other telemedicine technology could provide more far-reaching results of user acceptance to establish best practice guidelines for implementation of telemedicine technology.

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Appendix

Figure 1

Flow Chart of the Results from the Literature Search

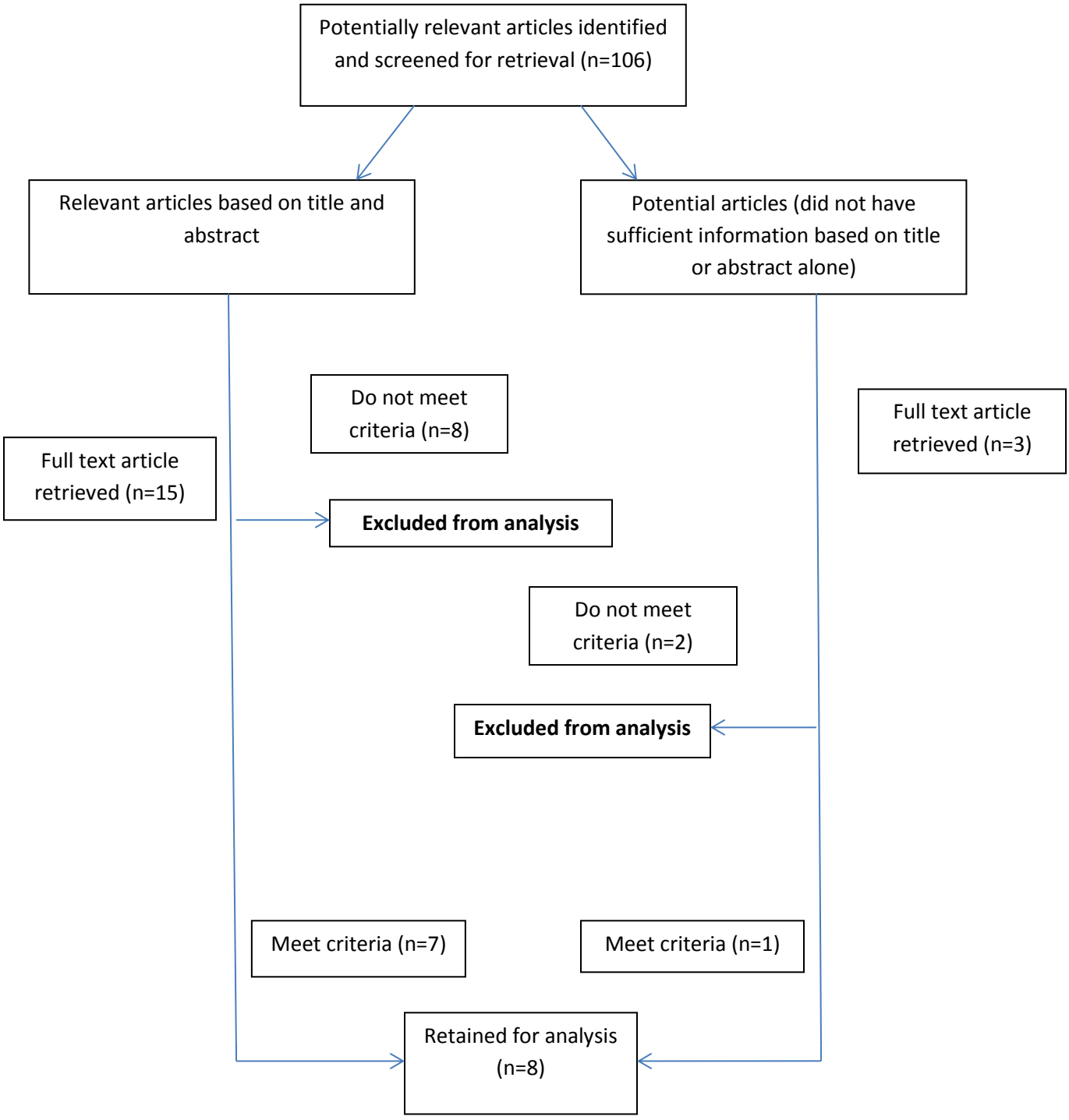

Figure 2

This is an image of VGo, the telemedicine technology utilized by remote specialists to consult with other practitioners and examine patients.

Figure 3 Survey instrument

Please circle the number that best describes your response to each question below:

Using VGo in my job would enable me to accomplish tasks more quickly.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

Using VGo would improve my job performance.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

Using VGo in my job would increase my productivity.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

Using VGo would enhance my effectiveness on the job.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

Using VGo would make it easier to do my job.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

I would find VGo useful in my job.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

Learning to operate VGo would be easy for me.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

I would find it easy to get VGo to do what I want it to do.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

My interaction with VGo would be clear and understandable.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

I would find VGo to be flexible to interact with.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

It would be easy for me to become skillful at using VGo.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7

I would find VGo easy to use.

Strongly Agree Neutral Strongly Disagree
1 2 3 4 5 6 7