INTEGRATING TELEMEDICINE FOR DISASTER RESPONSE: TESTING THE EMERGENCY TELEMEDICINE TECHNOLOGY ACCEPTANCE MODEL

by

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DEDICATION

This is dedicated to my loving husband Ed Davis, my daughters Christie Vela, Loryn Davis & Shannon Davis, my grandsons, Manny Vela and Eddie Vela, my granddaughter Lilliana Marie Vela, my son-in law Juan Vela. My five sisters, Marie Sabadish, Kathy Zionkowski, Eileen Dewitt, Madeleine Barna, and Bernadette Nace; four brothers, Bob Nace, Joe Nace, Arthur Nace and Mike Nace; my dear mother, Delia and in fond memory of my Dad, Bob Nace, who was forever my cheerleader in both life and death during this incredible journey.

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LIST OF ABBREVIATIONS

- ETTAM: Emergency Telemedicine Technology Acceptance Model
- MCI: Mass Casualty Incident
- STAT: Simulated Telemedicine Acceptance Test
- TAM: Technology Acceptance Model
- TTAS: Total Technology Acceptance Score
- TeleICU: Critical & Emergency care Telemedicine
- TPB: Theory of Planned Behavior
- TTAM: Telemedicine Technology Acceptance Model

ABSTRACT

INTEGRATING TELEMEDICINE FOR DISASTER RESPONSE: TESTING THE EMERGENCY TELEMEDICNE TECHNOLOGY ACCEPTANCE MODEL

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George Mason University, 2013

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Background: There is little evidence that technology acceptance is well understood in healthcare. The hospital environment is complex and dynamic creating a challenge when new technology is introduced because it impacts current processes and workflows which can significantly affect patient care delivery and outcomes. This study tested the effect of the Emergency Telemedicine Technology Acceptance Model (ETTAM) to predict technology acceptance scores. Managing surge capacity, a sudden increase of severely injured patients during a disaster, is a critical global issue. Mobile telemedicine was introduced into emergency departments in multiple hospital systems for activation during a simulated mass casualty incident (MCI) to leverage clinical expertise and to manage surge capacity. The success of this program was dependent on the user's acceptance of the technology. The Simulation Telemedicine Acceptance Tool (STAT) was adapted to measure technology acceptance scores.

Purpose: The purpose of this study was to test the Emergency Telemedicine Technology Acceptance Model (ETTAM) using telemedicine during a simulated mass casualty incident. The theoretical foundation of the study used components of the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM) to explore multiple constructs and their influence on technology acceptance.

Research Questions:

R1. What are the differences between the total three key determinant scores of those who received telemedicine training compared with those who did not?

R2. How much of the variability of attitude is explained by the three key determinants?

R3. How much of the variability of attitude is explained by intention to use telemedicine?

R4. How much of the variability in total technology acceptance scores is explained by telemedicine training methods?

R5. What is the relationship between total technology scores and the external variables for the trained and untrained observations?

R6. How much of the variability of total technology acceptance scores is explained by an onsite champion?

R7. Will the ETTAM reflect positive relationships between the constructs that make up the Simulated Technology Acceptance Tool?

Three key determinants were defined as: perceived usefulness, perceived ease of use, and understanding of process. Telemedicine training methods included lecture, simulated practice scenarios, and a full scale drill. External variables included highest level of education, clinical role, primary hospital affiliation, primary work setting, years of clinical experience, years of teleICU technology use, gender and age.

Methodology

Design

A quasi-experimental retrospective comparative design was used to explore the impact of a telemedicine training program on technology acceptance scores while using mobile telemedicine during a mass casualty incident. Approval was granted by the Inova Health System IRB for an exempt study to conduct a multi-site distribution of a questionnaire to evaluate technology acceptance in 2009 and the HRSB at George Mason University in 2011. Subjects were given the questionnaire prior to training and the questionnaire process was repeated after the subjects received training. The trained and untrained observations were compared. This study was a within-subjects design. Most of the individuals in the trained and untrained observations were the same individuals studied at different points in time with different levels of training.

Sample

Subjects consisted of a purposive sample of managers, registered nurses, physicians, paramedics and data assistants who work in the clinical environment both at the remote site, which is a site located outside of the hospital and in the hospitals. Managers gathered individuals based on their roles in disaster preparedness for training sessions. The subjects were chosen because they will be the potential users of the telemedicine system in a crisis situation. They were recruited on site in the emergency department to be trained in one or all of the three methods of training. The survey was built into the telemedicine training curriculum. Participation in the survey was voluntary. The informed consent was placed on the front of the questionnaire. The informed consent explained the purpose of the study, risks and benefits and how anonymity would be protected. Individuals who did not receive training were also recruited through emergency department rounds and staff meetings. The subjects worked night or day shifts. The questionnaires were collected at different times of the day, different months of the year in thirteen different hospitals sites. The thirteen hospitals comprised of one level one and one level two trauma centers and eleven community hospitals that were not designated trauma centers. The surveys were anonymous. Exclusion criteria included individuals less than 18 years of age.

Measurement

The Simulation Telemedicine Acceptance Tool (STAT) was adapted from a tool used to measure technology acceptance in a business arena to analyze technology acceptance scores. The tool was adapted to match the healthcare environment and the telemedicine model used for disaster response. The measurement tool used elements of both the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB). The STAT consisted of 39 questions using a 5-point Likert scale. The tool was distributed to the subjects by the researcher or designee prior to the training and after training was completed. A brief explanation was given addressing the study as a measurement of perceptions regarding the use of mobile technology during a disaster. The consent was included on the front of the tool. The training program used three methods including:

- A thirty minute power point presentation consisting of program description, activation, communication, and sustainment processes.
- Two simulation practice scenarios including case scenarios of victims of a mass casualty incident with severe burn and trauma injuries. The first scenario practice was presented during the original training, it involved contacting the teleICU through the telemedicine technology and acting out a simulated disaster scenario; the second scenario practice was done among the remote site and the clinical site one week later. The researcher maintained a virtual presence using the technology during the second scenario practice. The similated scenarios provided hands on experience using the eCareMobile® and an opportunity to learn how to communicate with the virtual team in the teleICU.
- The third method of training was a disaster drill; all thirteen hospitals participated in full scale drills. A full scale drill consists of participation on a local, state and federal level for disaster preparedness. Scenarios were created based on man made or natural disasters. Simulated critical moulaged patients were sent to each hospital and the mobile technology was used to leverage the remote clinical team to assist the teams in the emergency departments.
- Phase one of the study used one-way video, phase two used two-way video. The presence of an onsite champion was also noted.

Procedure

Phase one of the project was conducted in three hospitals over a six month period to test the viability of the telemedicine concept for use during a mass casualty incident. Based on the phase one STAT scores, the project was expanded to place an eCareMobile® in ten additional hospitals. Phase two of the project included a total of thirteen hospitals with implementation spanning an additional two year period.

Summary of Findings

Nonparametric statistics were used to test the relationship between the study constructs. The trained and untrained observations were analyzed separately because of the within-study design. The subjects were matched by hospitals but not matched individually. The surveys were anonymous. The results showed signicant relationships between attitude and perceived ease of use, usefulness, process and intention to use the teleICU during a disaster in both the untrained and trained observations.

The Simulated Technology Acceptance Tool (STAT) was reliable according to the results of the Chronbach's Alpha which showed all items to be greater than .70. Descriptive statistics showed mean scores of the trained respondents were higher than the untrained respondents in each category. This reflected a higher level of technology acceptance after the individuals received training.

A multi-linear stepwise regression for the 3KD and the TTAS for untrained and trained observations showed mean score increases with each additional year of teleICU experience, various hospitals fell into the regression models because their means scores fell significantly above or below the overall mean scores.

The ETTAM model was a good predictor of technology acceptance: however, the researcher recommends a combined theory approach to reflect the complexities of the healthcare environment.

CHAPTER I

Introduction to Study

Disaster response continues to challenge health care organizations around the world. A large scale natural or manmade disaster creates an unpredictable, often chaotic situation that challenges communication, resources and patient care. A sudden surge of patients can inundate a health system almost immediately (Powers 2008; Rubinson et al., 2008).

The Washington DC metropolitan area has been identified as a high risk area for a terrorist attack which could lead to a regional mass casualty incident. This could result in potentially three times or greater the average volume of critically injured patients requiring personnel proficient in triage, burn care and the care of patients with traumatic injury (Sztajnkrycer, Madsen, & Baez, 2006; Xiong et al., 2010). This potential situation presents a critical care surge capacity issue that is being addressed on both a national and international level (Sztajnkrycer, Madsen, & Baez, 2006). Care received in the first twenty four to forty-eight hours for this population of patients is critical to patient survival of primary injuries (Carr, Edwards, & Martinez, 2010). The United States federal government has notified emergency response organizations that in the event of a terrorist attack or mass casualty incident, these patients may remain in non-trauma centers for at least ninety-two hours following a disaster (Xiong et al., 2010). Yet local area hospitals have limited resources to manage large volumes of critically ill patients

(Rubinson et al., 2008). According to Culley, it is difficult to test the outcomes of performance during a mass casualty incidence due to the urgency and volatility of the environment during a disaster. The emergence of new technology is creating the opportunity for enabling decision support leading to potential future studies (Culley, 2011).

Telemedicine was used back in 1988 for the earthquake in Armenia to treat victims immediately after the earthquake as well as for long term psychological and physiological effects that often follow severe mass casualty events. (Houtchens, B. et al. 1993; Nicogossian, A., Pober, D. & Roy, S., 2001; Doarn, C. et.al., 2003; Nicogossian & Doarn, 2011). The importance of improvement and enhanced communication in disaster preparedness has been escalated due to the spread of H1N1, the events of September 11th, natural disasters such as Katrina, Sandy and the earthquakes in Haiti, Chile and Japan, tornadoes across the country and most recently the Boston marathon bombings. The Boston marathon bombings in April, 2013 remind us of the volatility and anxiety that is distinctive of terrorism which can lead to devastating injuries with physiological and psychological impacts lasting well beyond the actual event. In May, 2011, an F5 tornado directly hit St. Johns Hospital in Joplin, Missouri. It was a stark reminder of how important it is to prepare for the unexpected events that often occur during a disaster (Shin & Jacobs, 2012). There continues to be a repetition of past mistakes despite lessons learned. Most recently, in hurricane Sandy, we saw inconsistency in evacuation procedures that were similar to those experienced in hurricane Katrina, in both instances at risk patients were placed in perilous situations (Powell, 2012). The use of telemedicine lends a whole new facet to disaster response and enables the critical activity of communication and situational awareness to take place during a major incident.

The teleICU model has been in place since 2004 and uses advanced telemedicine technology as a vehicle to provide intensive care services for critical care patients in multiple hospitals from a teleICU center. TeleICU includes real time, interactive software using voice and video technology. This technology allows the hospital-based critical care team to collaborate with the clinical team in the teleICU. Remote intensivists and critical care nurses provide consultation, preventive care assessments, clinical support, and interventions. (Rosenfeld et al 2000; Celi, Hassan, Marquardt, Breslow & Rosenfeld, 2001; Breslow et al., 2004). The teleICU model was expanded to include disaster support in 2009. This study explores the impact of telemedicine training and simulation practice on technology acceptance by members of disaster response teams.

Statement of Problem

User acceptance is the key to a successful implementation of any new system affecting individuals and clinical teams. This researcher planned to study the level of user acceptance of a new teleICU model in the emergency department for team multisite disaster response. There has been a great deal of variability in the level of acceptance of the use of teleICU in critical care by both critical care nurses and physicians. This has led to gaps in the use of the teleICU model in many organizations potentially impacting the value of the teleICU on improving patient outcomes (Lilly &

Thomas, 2009). It is important to understand the factors that contribute to technology acceptance, including user characteristics such as age and gender. These characteristics were studied in the business setting and found to change as exposure to technology increased. Males were early adopters of technology but over time the gender and age difference narrowed (Morris, Venkatesh, Ackerman, 2005). Acceptance of technology is dependent on a variety of characteristics including:

1) Computer experience;
2) amount of clinical experience;
3) clinical roles;
4) complexity of the patient population;
5) availability of essential resources;
6) leadership support and influence and
7) integration of clinical teams

All of these items appear to play an important role in technology acceptance. Technological advancements continue to occur at a very rapid pace in the healthcare field, allowing for increased application and adoption of telemedicine programs (Houtchens et al., 1993; Angood, Doarn, Holaday, Nicogossian, & Merrell, 1998; Garshnek & Burkle, 1999). Since actual use of technology is directly linked to acceptance (Davis & Venkatesh, 2004), it becomes vitally important to understand the influences that impact the successful adoption of new technology. Addressing these challenges may lead to future enhancements in health science curricula related to development of technology skills for all levels of the clinical team, from novice to expert. In order to leverage the available clinical expertise during a crisis, it will be vitally important to assure:

- Clear understanding of how the emergency response process works;
- precise identification of communication processes;
- basic description of equipment functionality;
- a well defined role for telemedicine in disaster response;
- dedicated teams with both clinical and telemedicine expertise;
- establishment of a process for sustaining the model and
- policies and procedures that support the telemedicine model.

Communication continues to be a recurring challenge during large scale disasters. Coalitions of multiple hospital sites participating in disaster planning enhance relationship building and skilled communication. Telemedicine adds the addition of clinical expertise to assist onsite teams with triage, consultation and situational awareness. It is essential to practice and develop the components of virtual communication during an emergency by building an integrated clinical partnership between the virtual and onsite teams (Bernstein, McCreless, & Murry, 2007). Due to the challenges faced by healthcare organizations regarding disaster preparedness, the importance of empirical studies related to the use of technology for decision support during a mass casualty event is essential. There are many lessons learned from past large scale disasters, but there is lack of research outcomes to guide practice during a disaster. There is a need for a standardized approach to disaster response in order to manage a chaotic multifaceted event that impacts caretakers and victims on a psychological, emotional and physical level (Culley, 2011).

Theoretical Framework

The Technology Acceptance Model was introduced by Davis in 1986 in response to the need to understand technology acceptance when new programs are introduced in the field of business. Ineffective implementation can increase costs related to high resource utilization, lost time and productivity, and reduced emotional investment in the outcome (Davis, 1986, Davis & Venkatesh 2004).

The Theory of Planned Behavior (TPB) was an evolution of the early conceptual models studied in the 1970s. Fishbein & Ajzen (1975) explored the works of researchers as early as 1932. Early researchers were interested in the influence of attitude on actual behavior. Originally the model was known as the Expectancy-Value Theory which led to the Theory of Reasoned Action and developed into the Theory of Planned Behavior (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Ajzen, 1991). Davis and Venkatesh combined the Theory of Planned Behavior and the Technology Acceptance Model to test technology acceptance in the business setting.

According to Davis and Venkatesh (2004) the user's perceived ease of use of technology includes hands on experience and interaction with the program. Perceived ease of use relates to the users perception that is does not take a lot of mental effort to use the innovation. Perceived usefulness relates to the value that the innovation adds to current processes used to achieve a task. Venkatesh & Davis (2004) believe perceived ease of use and perceived usefulness greatly influence the intention to use and attitude toward using technology. The authors stated that perceived usefulness may not be influenced by hands on experience but rather factual information about the technology would have a greater impact on the perceived value or usefulness of the technology. The authors cited perceived usefulness as a strong indicator of satisfaction on intention to use new technology. The user's perceived value of the technology application being introduced is very important to their intention to use technology (Davis & Venkatesh, 2004). Acceptance of a new telemedicine model is, therefore, a key to the success of the use of telemedicine as a valuable resource during a mass casualty incident.

In Roger's Diffusion of Innovation, Rogers describes how different individuals come to accept change over time and how they are impacted by various societal cultures or norms. Rogers defines diffusion as "the process by which innovation is communicated through certain channels over time among the members of a social system" (Ryan, 1943). Roger's key determinants are related to communication, rate of adoption and the cultural population affected by an innovation. Knowledge and influence were also central components of his theory. According to Rogers, decisions to adopt a new idea may be made on an individual basis, by the whole group or may be influenced by leadership (Rogers, 1976).

It is important to realize the challenges that technology acceptance presents when implementing a new technological model. A successful leader of the implementation of a new technology concept must be aware of the need to involve the user at every phase of development as well as to anticipate meeting the user where they are in their level of acceptance. Rogers's diffusion of innovation theory describes this process of acceptance as a multifaceted and dynamic phenomenon.

Conceptual Underpinnings for the Study

The Technology Acceptance Model and the Theory of Planned Behavior were the foundational models used to create the Emergency Telemedicine Technology Acceptance Model introduced in this study. Diffusion of Innovation was added to reflect the complexity of the healthcare environment's progression toward technology acceptance.

Davis used the Theory of Reasoned Action (TRA) to adapt his measurement tool to create the Technology Acceptance Model (TAM). Davis used this model to study technology acceptance in the business setting. The model assumes that perceived usefulness and perceived ease of use influence the intention to use leading to actual use of technology. Perceived usefulness is also assumed to be impacted by perceived ease of use (Davis, 1986). See Figure 1.1

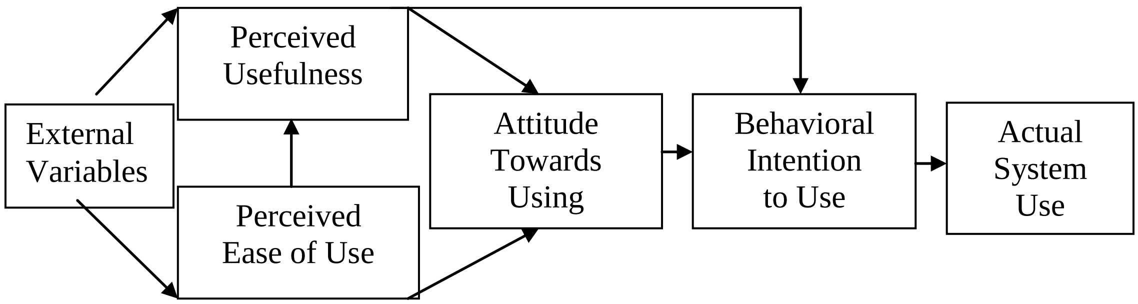


Figure 1.1 Technology Acceptance Model (TAM) Davis 1986

The Emergency Telemedicine Technology Acceptance Model was also adapted from the Telemedicine Technology Acceptance Model (Kowitlawakul, 2008). Kowitlawakul explored the technology acceptance of subjects in the healthcare setting who had little or no exposure to the teleICU technology. Kowitlawakul studied predictors that had an impact on a nurse's intention to use teleICU technology. Davis's technology acceptance model was the basis for her theoretical framework. Kowitlawakul found that perceived usefulness had the greatest influence on intention to use the teleICU (Davis, 1986; Kowitlawakul, 2011). See Figure 1.2

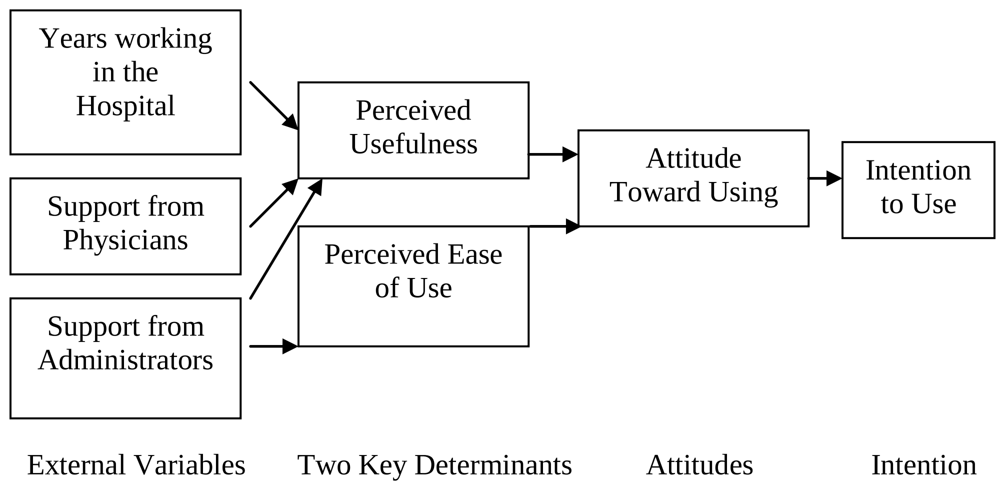
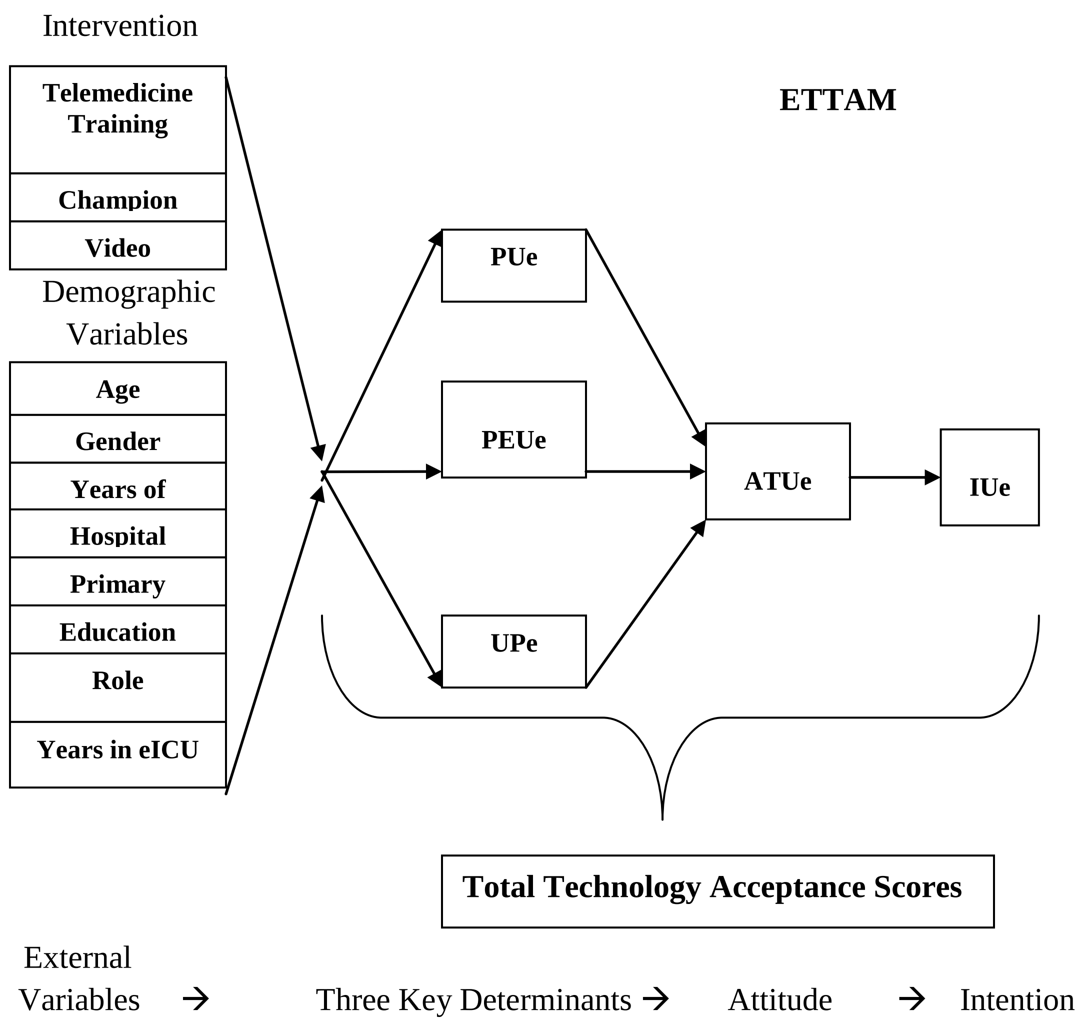


Figure 1.2 Telemedicine Technology Acceptance Model Kowitlawakul 2008

This study expands on Kowitlawakul's research by including subjects who are exposed to the use of the teleICU. The technology acceptance scores of the experienced users are compared with the scores of the users with no exposure to the teleICU program. This study also adds a training program and includes an analysis of the impact of the training on technology acceptance scores. The goals of this study are to explore the impact of the telemedicine training on the perceived ease of use, usefulness, understanding of process, attitude and intention to use the teleICU model during a mass casualty incident and to test the relationship between the five variables as well as the influence of the external demographic variables on technology acceptance scores. See figure 1.3 Proposed conceptual model of the research study.



ETTAM= Emergency Telemedicine Technology Acceptance Model; PUe=Perceived Usefulness of eCareMobile; PEUe=Perceived Ease of Use of eCareMobile; UPe= Understanding of Process of eCareMobile; ATUe= Attitude toward Use of eCareMobile; IUe=Intention to Use eCareMobile; TTAS=Total Technology Acceptance Scores; STAT=Simulated Technology Acceptance Tool

Figure 1.3 Emergency Telemedicine Technology Acceptance Model (ETTAM) Proposed Research Model

Purpose of the Study

The purpose of this study is to test the Emergency Telemedicine Technology Acceptance Model (ETTAM) while using telemedicine during a simulated mass casualty incident. The analysis of results will focus on the technology acceptance scores of those who received training and those who did not through statistical analysis of perceived usefulness, perceived ease of use, and the understanding of the process scores (three key determinant scores). The study will further explore the relationship of the three key determinants on attitude toward use and the relationship of attitude on the intention to use telemedicine. The variability of the telemedicine training methods and demographic variables on the total technology scores will be determined.

Significance of the study

Many healthcare organizations have not kept pace with the public sector's rate of adoption of new technology for patient documentation tools and decision support (Bartholomew, 2004). Health care reform calls for unprecedented change in the use of technology to enhance patient care by improving safety, quality, and creating a more efficient care delivery model with a focus on preventive care and decreased cost.

Technology will play a major role in healthcare redesign. Clinicians will change the way they deliver care and patients will drive technology advancement and availability. These changes will give patients more access to their personal information empowering them to be involved in their health management. The adoption of technology by the end user becomes a crucial element to success. Understanding the critical training components required to promote the value of the use of technology in high acuity patient care environments can lead to successful adoption and actual use of the clinical and technical resources available (Ketikidis et. al. 2013).

The use of telemedicine to leverage clinical expertise and close the distance gap toward much needed medical support in times of emergencies can have a significant impact on patient survival. It is vitally important to eliminate the physical elements that prevent clinical assistance from arriving during a disaster event. Leveraging clinical expertise using technology can enhance critically needed treatments during a crisis situation by providing specialty care that may not be available on site. Although there is new emerging technology to enhance virtual patient care delivery, there is limited research on the use of technology for decision support during a mass casualty incident (Culley, 2011).

This aim of this study is to test the application of the Emergency Telemedicine Technology Acceptance Model when implementing teleICU to assist clinicians with management of a sudden surge of casualties in ten emergency departments during a mass casualty incident. The study focuses on groups of individuals who have been exposed to the teleICU model as well as those who have not been exposed to the model. A training session was provided and methods of training were identified. Individuals will be scored depending on the presence of training, the method of training, technology acceptance scores, perceived ease of use, perceived usefulness, understanding of process, attitude and intention to use teleICU, six study variables and eight external variables will be measured and analyzed.

Mobile voice and video technology is available in each emergency room as well as in a remote non hospital site spanning a sixty mile radius across Virginia. The technology leverages critical care nurses, intensivists, trauma and emergency medicine physicians to the thirteen emergency department sites with a push of a button. The teleICU is able to provide decision support and triage of critical patients. This capability closes the distance gap between community hospitals and trauma centers to provide essential emergency care to critically injured patients.

Acceptance of this technology is a key to the success of the use of the teleICU during a mass casualty incident. According to Venkatesh and Davis, perceived ease of use and perceived usefulness greatly influence the intention to use and attitude toward using technology (Venkatesh and Davis, 2000). Information technology is predicted to improve care, and reduce costs; slow adoption can impact potential benefits and delay effective use of the technology (Lilly, 2009).

The impact of introducing technology as a decision making tool for clinicians may lead to concerns around quality and safety. Although there is much debate about how technology adds components to safeguard patients. There may be ethical concerns if the technology is used to replace individuals attending to the patient. Quality concerns could arise if the clinician using the software for decision making lacks the critical thinking skills to provide evidence based care (Simpson 2005).

Background of the study

The Technology Acceptance Model and the Theory of Planned Behavior have been well documented in the business world. There have been many adaptations of the models to validate technology acceptance (Wu, 2005). Kowitlawakul, (2008) adapted the Technology Acceptance Model and created the Telemedicine Technology Acceptance Model (TTAM) for the clinical environment to explore technology acceptance in the hospital settings. There are limited applications of the TAM in the clinical arena.

The importance of this study addresses the gap between the ability to provide resources for a sudden surge of critically ill patients and our current stressed emergency departments who experience patient volumes that fill them beyond capacity on a daily basis. The study also addresses ways to leverage the limited number of skilled nursing and physician teams to manage a sudden increase in critically injured patient requiring expertise in critical care, trauma, and burn. The use of voice and video technology in critical care has become more common in the past ten years. Patients are treated from a remote site by intensivist physicians who specialize in critical care. The varied level of acceptance of this technology has been a challenge that can influence the effectiveness of a remote program by limiting utililization, potentially leading to delays in patient treatments, ultimately influencing patient outcomes.

Inova Health System is a member of the Northern Virginia Hospital Alliance (NVHA) where the vision was created to use the teleICU program in order to utilize voice and video broadband technology to connect highly skilled trauma, critical care and emergency clinical teams from a remote site to sites in need of advanced support. The clinical team uses mobile broadband voice and video technology to communicate with multiple area hospitals across Northern Virginia to assist emergency response teams to provide care for a surge of victims from a mass casualty incident (MCI). The Crisis Critical Care Capacity and Trauma (C4T) project is a government funded project which addresses the management of surge capacity during a MCI. The National Urban Area Security Initiative (UASI) provided funding for metropolitan areas which are at high risk for terrorist attacks. This funding is provided through the Department of Health and Human Services and Homeland Security. During a MCI, critically injured patients will potentially be sent to hospitals which are unprepared to manage the high acuity and volume of the injuries presented such as burn and trauma patients (Hick, 2004).

Area hospitals have been advised to plan to keep a number of patients over their current capacity for at least ninety-two hours after a MCI. The use of mobile teleICU will leverage the expertise of the remote team to assist with secondary decision support, triage and treatment of severely injured patients. This collaboration will enhance situational awareness during a disaster leading to rapid, informed triage decisions regarding prioritization of the most critically injured patients. The telemedicine model closes the distance gap between a level one trauma center or burn center and a community hospital until the patient can be transported to a higher acuity facility.

Research Statement

The training will positively affect the perceived ease of use, the perceived usefulness, the understanding of the process of utilization of teleICU impacting the attitude toward using and the intention to use teleICU during a mass casualty incident.

Research Questions

R1. What are the differences between the total three key determinant scores of those who received telemedicine training compared with those who did not?

R2. How much of the variability of attitude is explained by the three key determinants?

R3. How much of the variability of attitude is explained by intention to use telemedicine?

R4. How much of the variability in total technology acceptance scores is explained by telemedicine training methods?

R5. What is the relationship between total technology scores and the external variables for the trained and untrained observations?

R6. How much of the variability of total technology acceptance scores is explained by an onsite champion?

R7. Will the ETTAM reflect positive relationships between the constructs that make up the Simulated Technology Acceptance Tool?

Table 1.1 Study Variables

External Variables	**Independent Variable**	**Dependent Variable**
Age	Training Yes	Perceived Usefulness of eCM (PUe)
Gender	No	Perceived Ease of Use of eCM (PEUe)
Yrs clinical	a) Lecture	Understanding of Process (UPe)
Hospital	b) Scenario	Attitude Toward Use of eCM (ATUe)
Primary setting	c) Drill	Intention To Use eCM (IUe)
Education	e) One-way video	
Clinical role	f) Two-way video	
Yrs in eICU	g) Champion	

Definition of Terms

External Variables

Age in years, gender, years of clinical experience, hospital (1-14), primary setting (ED, ICU), education, clinical role, years of teleICU experience of the subjects in the study.

Independent Variables

eCareMobile® training: Subjects were surveyed prior to training and after receiving training. Training consisted of lecture, scenario practice and drills. Subjects who received training may have received 1, 2 or all 3 of these methods.

Lecture: Consisted of a forty-five minute power point presentation and a fifteen minute question and answer period.

Scenario practice: Consisted of hands on practice with the technology using a case study of a critically injured trauma/burn patient. The virtual interaction occurred between the teleICU team and the clinical team in the hospital.

Drill: There were two full scale regional drills in which a simulation of mass casualty incidents were acted out among first responders, the RHCC and the regional hospitals.

One-way video: Video capability of the eCareMobile® cart that allows the teleICU to view the clinical team and the patient in the hospital, the hospital team cannot view the remote team.

Two-way video: Video capability of the eCareMobile® cart that allows the eICU to view the clinical team and the patient in the hospital and simultaneously allows the clinical team in the hospital to view the teleICU remote team.

Champion: Individual located in the ED who takes the lead for training implementation and sustainment of the teleICU program in their organization.

Dependent Variables

Perceived Usefulness: The perceived value of the use of the technology regarding productivity, effectiveness and usefulness during an emergency.

Perceived Ease of Use: The perceptions of the user in regards to the amount of effort both mental and physical required to use the technology.

Perceived Understanding of Process: The understanding of the process of activation, operation, storage and sustainment of the technology.

Attitude: Feelings a user may have toward the technology. Considerations are innovation, ease of use, value proposition.

Intention: The individuals intention to use the technology, do they predict they would use the technology?

Operational Definitions

eCareMobile®: Mobile version of the eCareManager System® that enables voice and video telemedicine capabilities at clinical locations.

TeleICU: A secured telemedicine center where a team of critical care intensivists and nurses, provide clinical support and interventions for the patients in the adult intensive care units 24/7 and multiple emergency departments during a disaster. During an actual disaster there will also be a regional triage officer in the teleICU.

eICU RN: Expert Critical care nurses working in the eICU. eICU RNs are present 24/7 at the remote site.

eLert Button – Notification button located on the cart or on a patient wall in external sites to connect emergently with the teleICU.

Incident Commander: Individual responsible for all aspects of an emergency response; including quickly developing incident objectives, managing all incident operations, application of resources, and has responsibility for all persons involved.

Mass Casualty Incident: Large scale emergencies with a potential for a large volume of injured victims affecting many divisions of the healthcare industry and emergency responders on local, state and federal levels.

NVHA: Northern Virginia Hospital Alliance - facilitates and coordinates emergency preparedness planning for the Northern Virginia hospitals that are part of the coalition.

RHCC: Regional Hospital Coordinating Center - Operational arm of NVHA activated during a disaster to assist Northern Virginia Hospitals and free standing emergency departments with surge capacity issues, patient triage and hospital coordination.

TeleICU Intensivist: Board certified intensivists who provide remote care for critically ill patients. Located at a site that is remote from the hospital.

Regional Triage Officer (RTO): Emergency medical physician present in teleICU to triage and consult on disaster victims during a mass casualty incident.

CHAPTER II

Review of Literature

A literature review was completed with a focus on three key topics: TeleICU, technology acceptance and disaster preparedness. Peer reviewed research articles based on the three key topics were reviewed and the literature spanned from 1942 to 2013. CINAHL, OVID, Pub Med, Digital Dissertations and Cochrane Libraries were data bases accessed for the literature review. In addition, advanced notice of publications from AMEDEO Critical Care and Intensive Care online (http://www.amedeo.com) were accessed. Search terms used were: Telemedicine, teleICU, surge capacity, mass casualty incident, triage, disaster response, Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), Diffusion of Innovation.

Healthcare Today

The current economic climate calls for significant reform in the existing healthcare system. Technology is considered a fundamental element needed to reform healthcare to enhance quality and efficiency. The public sector is well ahead of healthcare in the use of electronic technology to manage information (Simpson 2005). Healthcare reform escalates the need for an environment of rapid expansion of the integration of information technology into today's organizations (Venkatesh, Morris, Davis, & Davis, 2003; Young, Chan, & Cram, 2011). Today with current economic challenges and the urgent need for healthcare reform, technology growth is expanding at high speed in healthcare organizations. A significant percentage of an organization's capital budget is spent on technological infrastructure (Westland, & Clark, 2000; Morris, Venkatesh, & Ackerman, 2005).

TeleICU

There is a lack of research evidence regarding the effects of the teleICU model of care. There has been a surge in the growth of virtual decision support systems leading to a gap in understanding the effects of these electronic systems on patient outcomes and financial impacts on organizations (Lilly & Thomas, 2009; Young, Chan & Cram, 2011). Young (2011), performed a search of multiple data bases and abstracts from presentations held at national conferences to explore the effects of the use of a virtual model in critical care on stakeholders to include clinicians, administration and patients (Young, Chan & Cram, 2011). The review spanned a 60 year period, of the 3,086 citations reviewed, 23 eligible studies were found, seven of the studies were peer reviewed. More than 82% of the respondents described a positive impact on patient care (Young, Chan & Cram, 2011).

According to Lilly & Thomas (2009), there is a variance between the experiences of many teleICU programs that range from high impact resulting in improved patient outcomes to sites that experienced little or no impact. Lilly discussed the potential that the degree of improved outcomes may have been related to the extent to which program acceptance led to integration of clinical teams and advancements in the processes of care delivery (Lilly & Thomas, 2009; Young, Chan & Cram, 2011). Lilly (2009), stressed the importance of understanding why many programs see benefits and others do not. He discussed the possibility that level of benefit is directly related to the extent to which program acceptance leads to robust change in the processes of care delivery. The use of telemedicine in disaster response dates back to the 1980's yet we continue to have little understanding of its impact in both disaster response and critical care, Garshneck believed that telemedicine was quite effective in times of disaster despite the availability of modern technology in the 1980s but there are limited studies to show the effect of telemedicine during a disaster (Garshneck, 1999; Lilly, 2009).

Technology Acceptance

Many empirical studies explored the acceptance of information technology. These studies led to the creation of multiple theoretical models. The research spans the fields of information technology, sociology, psychology, computer science and cognitive science (Fishbein & Ajzen 1975; Ajzen & Fishbein, 1980; Venkatesh, Morris, Davis, & Davis, 2003; An, Haymen, Panniers, & Carty, 2007; Kowitlawakul, 2008).

Holden and Karsh (2009) discussed the lack of theoretical research on the use of information technology in healthcare. They used an adaptation of current Health Information Technology (HIT) models to add theoretical approaches to the understanding of technology acceptance. Holden & Karsh suggested the use of the theory of planned behavior to understand behaviors in relation to HIT. They suggested behaviors are influenced by beliefs (2009).

Since the early 1930's researchers have been interested in the influence of attitude on a behavior or intention to act. (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Ajzen, 1991). Venkatesh, Morris, Davis & Davis (2003), stated that the role of intention as a predictor of actual use is critical. Research had consistently shown behavioral intention to use was the strongest predictor of actual use.

Kowitlawakul (2008), described how TAM was used extensively in business, education and information technology but rarely in health care. Kowitlawakul found in her study that contrary to the original TAM findings, perceived ease of use had more significant effect on nurses attitudes than perceived usefulness. Nurses attitude was a significant factor toward intention to use, this finding coincides with the findings of previous studies (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Ajzen, 1991, Venkatesh, Morris, Davis, & Davis, 2003; Kowitlawakul, 2008).

Pare, Sicotte, & Jacques (2006), described the importance of early ownership in a program change to enhance acceptance of new technology. Team integration and user involvement early on in program development was paramount to the success of a program. Individuals have a need to perceive the technology change as adding value rather than adding additional work or taking something away. Nurses often voiced concerns about interruption of workflow, duplication of efforts and patient privacy (Lee, 2004, Wakefield et al., 2007). It is vital that the transition to the use of technology be presented as a transformational experience to bring growth rather than a change that becomes a battle. The authors describe new technology adoption as an “evolution rather than a revolution.” (Pare, Sicotte, & Jacques, 2006).

The literature is replete with examples of attempted implementations of high cost complex computer software systems without success (Davis & Venkatesh, 2004). It is fundamentally important to continue to explore and understand the challenges usually inherent in planning, implementation, utilization and long term employee engagement in the daily use of a technology system in the dynamic and unpredictable hospital environment.

Use of an information system by all members of a multidisciplinary team on a consistent basis, is a fundamental building block that leads to the success of any technology implementation project. Pare, Sicotte, and Jacques (2006) described the concept of psychological ownership and its relationship with the intention to use new technology. In psychological ownership, the technology is an extension of the individual. In order to achieve this level of ownership, the individual must be a part of the creation of the design and development of the technology (Lee 2005; Morris, Venkatesh, & Ackerman, 2005; Pare, Sicotte, & Jacques, 2006; Lee, 2007; Wakefield et al., 2007).

Lee (2007) discussed the importance of decreasing the length of time it takes to gain acceptance of the computer information systems in the healthcare environment. The healthcare industry is known for being late adopters of new technology; therefore, it is important to focus on decreasing the transition time so that the benefits of the technology can be realized. Early identification of barriers and benefits can be the building blocks for strategic planning for implementation teams (Lee, 2007; Wakefield et al., 2007).

Martinez-Torres (2008) used the Technology Acceptance Model (TAM) to test acceptance of eLearning and found TAM to be a strong predictor of perceived ease of use but not a strong predictor of intention and attitude towards using. This finding contradicts the findings of Davis and Venkatesh on the subject of intention and attitude (Davis, 1986; Davis, 2004; Venkatesh, 2000; Venkatesh, 2003).

Rogers (1976) uses the science of sociology to understand the phenomenon of an individual's rate of acceptance of new innovations. The Diffusion of Innovation Theory describes the complexity of the variables that play a part in the acceptance of a new idea. The role of knowledge and persuasion in the final decision to buy in to the innovation is a characteristic of the theory. Rogers discusses how some individuals accept change on an individual basis while others are influenced by leadership or their social or cultural group. (Rogers, 1976). It is very important that leaders and innovators understand the dynamic and evolutionary characteristics of change. This will help the innovator to assist the users to be successful when implementing new technology.

Disaster Preparedness

The key to success in disaster response is an awareness of potential risks of events, an organized response plan, practice simulations for disaster response, and a plan for recovery in the event a disaster occurs. (Brevard et al., 2008; Goston, Hanfling, Hodge, Courtey, Hick, & Peterson, 2009; Carr, Edwards, Martinez, 2010). According to Garshneck and Burkle, there were few published reports discussing telemedicine's relationship to outcomes in disaster support. They believed that telemedicine applications can improve disaster medicine outcomes and that emergency care providers must plan effectively to use telemedicine to improve disaster outcomes (Garshneck & Burkle, 1999). There is little empirical evidence of the effectiveness of the use of information technology for decision support during a mass casualty incident. The use of telemedicine in disaster response is predicted to be highly effective, there is a need to provide evidence to validate improved outcomes. Much of disaster preparedness experience is created through practice drills and actual emergency events (Culley, 2011).

The ethical issues that arise during a disaster contribute to the many challenges presented with a sudden surge of patients with limited resources. Decisions about life and death, treatments versus comfort measures are vital to a change in focus from individual to population (Sztajnkrycer, Madsen, & Baez, 2006; Brevard et al., 2008; Goston &, Hanfling, 2009).

According to Rubinson et al. (2008), surge capacity planning in hospital organizations should be focused on three main priorities; space, personnel and equipment. A potential for a lack of support for 10 days with triple the number of patients can very quickly deplete resources. Identifying alternate areas in the hospital for managing the surge of patients as well as preparing non critical care clinical staff to care for critically injured patients is essential (Rubinson et al., 2008).

Summary

The healthcare environment is multifaceted and complex. This adds to the challenge of introducing new technology. The involvement of multiple disciplines required for technological interventions and standardization of care enables clear communication between many specialists to provide the best care possible for each patient (Pare, Sicotte, & Jacques, 2006; Wakefield et al. 2007).

The economic impact and the quality and safety of care delivery stress the need for successful implementations when introducing new technology. The level of effectiveness of a new program is impacted by the level of acceptance therefore, a successful implementation, well developed curriculum and plans for sustainment are fundamentals when introducing new innovations.

Understanding the needs of the individuals using the technology is a primary step, assisting them with creating new workflows are essentials that cannot be overlooked. Realizing that individuals approach change in a variety of ways will lead to a successful and sustainable program

Wakefield states that some key barriers to information systems are a risk to service, quality and disruptions in workflow (Wakefield et al., 2007). The key to success is to have the implementation team well integrated with the clinical team. The greater the involvement of the clinical team in the project design, the greater the incidence of enhanced quality, acceptance and adoption of the technology (Morris, Venkatesh, & Ackerman, 2005; Pare, Sicotte, & Jacques, 2006; Lee, 2007; Wakefield et al., 2007).

There is a need to conduct more empirical studies on the effects of the use of teleICU on patient outcomes and the financial implications for organizations. The literature is replete on the topic of technology acceptance, however, there is limited theoretical application to healthcare. There is a gap between the concept of telemedicine use in disaster response and actual empirical data on outcomes (Culley, 2011). This study will address the use of telemedicine as a source of decision support during a mass casualty incident and the impact of training techniques on technology acceptance.

The population chosen may not have experience or previous knowledge of the telemedicine concept. The study will reveal the differences in the technology acceptance scores of those who have experience and those who do not.

CHAPTER III

Methodology

Design

This study was a retrospective quasi–experimental comparative design using secondary data from evaluation scores measuring intention to use teleICU, attitude toward using teleICU, perceived usefulness of teleICU, perception of ease of use of teleICU and understanding of the process of using teleICU during a MCI. Individuals answered an evaluation survey and identified if they had received teleICU training or if they had no prior training. The trained and untrained observations were compared. This study was a within-subjects design. Most of the individuals in the trained and untrained observations were the same individuals studied at different points in time with different levels of training.

Sample

Subjects consisted of a purposive sample of managers, registered nurses, physicians, paramedics and data assistants who work in the clinical environment both at the remote site and in the hospitals. The surveys were anonymous. Exclusion criteria: individuals less than 18 years of age, actual patients and moulaged patients were not included in the study.

Power & Sample Size

A power analysis was done to estimate the sample size needed to obtain significant results for the difference in the mean TTAS scores between untrained and trained observations:

Output = sample size
Design = Independent
Input:

alpha = 0.05
power = 0.8
delta = 6
m = 0.817
sigma = 19

Results:

"The researcher planned a study of a continuous response variable from independent control and experimental subjects with 0.817 control(s) per experimental subject. In a previous study the response within each subject group was normally distributed with standard deviation of 19. If the true difference in the experimental and control means is six, we will need to study 176 trained observations and 144 untrained observations to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05" (Dupont, 1998).

A power analysis was done to estimate the sample size needed to obtain significant results for the difference in the mean 3KD scores between untrained and trained observations:

Output = sample size

Design = Independent

Input:

alpha = 0.05

power = 0.9

delta = 4

m = 0.817

sigma = 11

Results:

"The researcher planned a study of a continuous response variable from independent control and experimental subjects with 0.817 control(s) per experimental subject. In a previous study the response within each subject observation was normally distributed with standard deviation 11. If the true difference in the experimental and control means is four, we will need to study 178 trained observations and 145 untrained observations to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0.9. The Type I error probability associated with this test of this null hypothesis is 0.05" (Dupont, 1998).

Procedure

In the pilot group, the intervention was an education program consisting of a lecture, practice scenarios of simulated burn and trauma victims. The scenarios of care delivery were acted out by a clinical RN onsite and a virtual eRN role simulating the physician role in the event of a mass casualty incident. An eCareMobile© cart consisting of one-way video was the vehicle for communication and collaboration. The scenario based training was repeated one week later at each hospital between the eICU and the hospital site using the technology. Data collection began in August, 2009; the scenarios were acted out for a third time with a trauma surgeon in a full scale disaster drill simulating a terrorist attack. A purposive sample of physicians and nurses who work in the emergency department, the intensive care unit and the teleICU were surveyed. Table 3.1

Data were collected on external variables such as primary hospital affiliation, primary setting, highest level of education, clinical role, years of experience, teleICU experience, type and amount of telemedicine education, age and gender. The type of video used one-way vs. two-way as well as the presence of a champion was recorded. Data were entered into PASW SPSS 18 for Statistical Analysis.

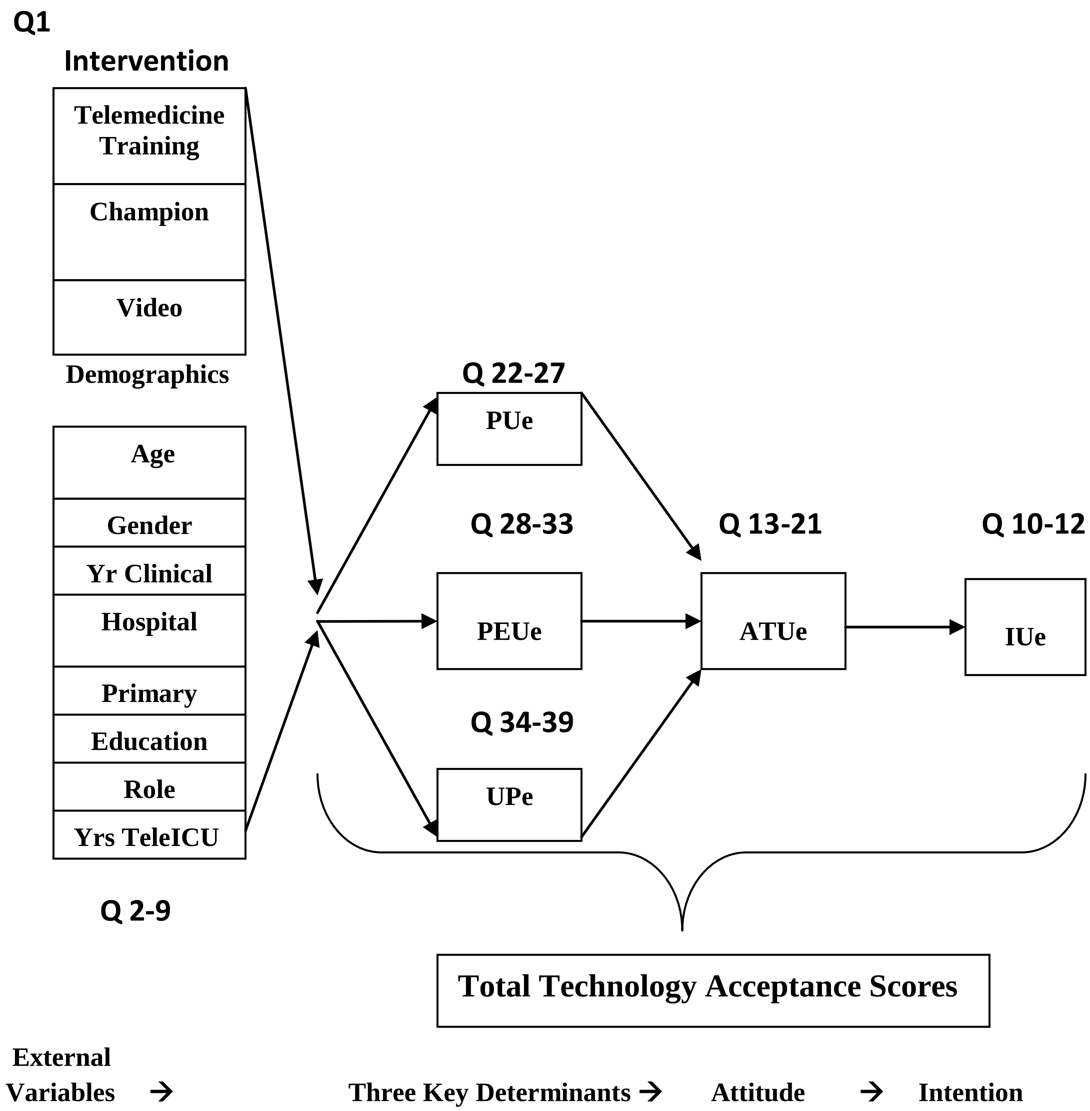
Measurement tool

The measurement tool was a thirty-nine question evaluation tool measuring intention, attitude, perceived usefulness, ease of use of teleICU during a mass casualty incident and understanding of process. The tool was a five point Likert scale ranging from strongly agree to strongly disagree. The first page of the measurement tool was demographic information which consists of the external variables to measure their impact on technology acceptance. They included:

- type of education
- primary hospital affiliation
- primary work setting
- highest level of education
- clinical role
- years of clinical experience

- years of teleICU technology use
- gender
- and age

The tool was adapted with permission granted by Venkatesh and Davis in 2007. Venkatesh and Davis used the tool to measure technology acceptance in the business setting. (Refer to Appendix A)



ETTAM= Emergency Telemedicine Technology Acceptance Model; PUe=Perceived Usefulness of eCareMobile; PEUe=Perceived Ease of Use of eCareMobile; UPe= Understanding of Process of eCareMobile; ATUe= Attitude toward Use of eCareMobile; IUe=Intention to Use eCareMobile; TTAS=Total Technology Acceptance Scores.

Figure 3.1 Model Measurements ETTAM

Table 3.1 Procedure Timeline

Date	Topic	Outcome
5/09	Planning-Steering Committee	Pilot: Proof of concept: three hospital EDs
5/09	Policy and procedures Steering Committee	Establish policies
6/09	Equipment: purchase mobile carts	Ship to three pilot sites
7-8/09	Evaluation, education, practice	Preparation for drill
9/26/09	Chaos 09 Full scale drill: Test eCareMobile®	Evaluate post drill
10/09	Outcomes data presentation to NVHA Board	Expansion of project
2/10	Contract preparation phase 2	Signed & approved 5/25/10
2/10	Expand Steering Committee	Meet 3/10 4/10
5/26/10	Equipment purchase; VPN connection: technology acceptance	Equipment delivery; infrastructure verified
6/15/10	Inova IRB	Approval
7-9/10	Evaluate, education, practice	Practice complete
9/10	Monthly sustainment-practice scenarios	Weekly technology checks
10/10	Capital Shield (Military Drill) 10-14-10	eCareMobile® evaluation
1/2012	The remaining hospitals were implemented over a two year period 2009-2011	One remaining hospital is not implemented

Phase one involves three hospital sites implementing the teleICU model by September 26, 2009. Surveys were distributed and filled out prior to education. Telemedicine training consisted of:

- a power point presentation with lecture;
- two episodes of hands on scenario based training, spaced one week apart;
- and simulated scenarios presented at a regional full scale disaster drill.

The identical evaluation was used to assess technology acceptance of the teleICU model following the drill. The success of the pilot study led to rapid expansion of the program to the remaining hospitals. The Board members of NVHA approved the rollout of eCareMobile® to all hospitals who participate in the NVHA. Ten additional hospitals were added for the second phase of implementation of the teleICU model for disaster response. Changes were made to the measurement tool through lessons learned from the pilot study and expert review of the tool. The training techniques were identical to the phase one training; however, two-way video was introduced and presented many technical challenges which were not present in the pilot. These technical challenges caused some delays in the ability to use eCareMobile® for practice scenarios. The presence of a champion on the unit who was the lead for the project in the hospital assisted the clinical team:

- to learn the process of using the eCareMobile® cart;

- to enhance their acceptance of the teleICU concept
- and to reinforce the value of using the teleICU model for disaster response.

This be came very apparent as we progressed through the various hospitals especially after the project was implemented and we created a sustainment program. The champion was often in an education role in the emergency department.

Ethical Consideration

The surveys were anonymous, there were no identifying factors such as name or date. Risks and potential benefits were clearly identified. Assurances of confidentiality was communicated. Information from the survey was kept in a locked file to maintain confidentiality. The hospitals were numbered to protect the anonymity of the participating hospitals. Participation in the survey was voluntary. The survey was distributed prior to the telemedicine training. The survey was voluntary. The consent form was on the front of each survey. The purpose of the study was defined on the consent form. Completion of the survey was approximately ten minutes. The researcher's contact information was provided. Inova IRB approval was given 6-15-2010. HSRB approval was given by George Mason October 2011.

RQ	DV (Y)	Data Type	IV (X)	Data Type	Statistical Analysis
R1 What is the difference between the total key determinant scores of those who received telemedicine training compared with those who did not?	Key Determinants	Continuous Integer	Training Y/N	Binary 0,1	Multiple Linear Regression
R2 How much of the variability of attitude toward using telemedicine is explained by the three key determinants?	Key Determinants	Continuous Integer	Attitude	Continuous Integer	Spearman Rank Correlation
R3 How much of the variability of attitude is explained by intention to use?	Attitude	Continuous Integer	Intention to use	Continuous Integer	Spearman Rank Correlation
R4 How much of the variability in total technology acceptance scores is explained by telemedicine training methods?	Training Methods	Categorical	TTAS	Continuous Integer	Spearman Rank Correlation
R5 How much of the variability in total technology acceptance scores is explained by the external variables?	External variables	Varies with Variable	TTAS	Continuous Integer	Multiple Linear Regression
R6 How much of the variability in total technology acceptance scores is explained by an onsite champion?	Champion	Binary	TTAS	Continuous Integer	Spearman Rank Correlation
Overall Question: How much of the variability of total technology scores is explained by the ETTAM?					

Table 3.2 Statistical Analysis

Content Validity

The measurement tool was adapted from previous tools used by Venkatesh and Davis who did multiple studies in the business environment on user acceptance of information technology using the Theory of Planned Behavior and the Technology Acceptance Model. Permission to use the tool was granted 10/30/07 via phone communication. The adapted tool was tested by ten teleICU content experts who recommended revisions to the tool leading to the creation of the final measurement tool. Eight PhD students provided feedback for changes to the tool and finally feedback from clinical teams on the pilot sites led to revisions to the final tool. Recommendations from the teleICU experts included the removal of italics on key words so as not to influence the way individuals answered the questions. Wording was changed when the questions did not appear to “make sense”. The Ph.D. students recommended adding some negative questions because all of the original questions were positive. Integrity of the questions were maintained and the answers were reversed during statistical analysis.

Reliability

Chronbach’s alpha was used to measure internal consistency reliability to assure the questions in each of the categories were measuring the construct. A coefficient .70 to.75 may be adequate but coefficients .80 or greater are best. The stronger the reliability the greater the chance the question is measuring the true score. Actual score = hypothetical true score- errors of measurement. Unreliable measures decrease the power of the study and increase the chance of type two errors (Polit, 2010).

CHAPTER IV

Results

This chapter is a presentation of the results from the demographic data, the test means, the Spearman's Rank Correlation and Multi Linear Regression (MLR). A reliability analysis was done to calculate Chronbach's alpha to evaluate internal consistency of the STAT measurement tool. Quantitative data analysis was performed using SPSS PASW 18. The management of missing data is also discussed.

Measurement tool

A reliability analysis was used to calculate Chronbach's alpha to evaluate internal consistency of the STAT measurement tool. Table 4.2 and 4.3

Table 4.1 Study Observations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Phase 1	81	24.8	24.8	24.8
	Phase 2	246	75.2	75.2	100.0
	Total	327	100.0	100.0	

The study had two phases. The first phase was created to test the concept of the teledisaster model on three hospitals. The results of the survey showed an increase in technology acceptance scores leading to the NVHA board members unanimously agreeing to approve the implementation of the teledisaster program to all fourteen hospitals. Table 4.1

Table 4.2 Internal Consistency Reliability of STAT: All Likert Questions

Items 30	n	Observations	Chronbach's Alpha
All survey questions	37	No Training--Phase 1	.984
All survey questions	42	Training------Phase 1	.951
All survey questions	110	No Training--Phase 2	.962
All survey questions	138	Training------Phase 2	.954

Chronbach's Alpha was run to test the reliability of the STAT. All thirty likert scale questions were tested for the phase one and phase two for trained and untrained observations. The reason the phases were tested separately was due changes to the measurement tool made between phase one and phase two based on recommendations from content experts when the tool was tested for content validity. All of the results are desirable >.9 confirming the reliability of the STAT. Table 4.2

Table 4.3 Internal Consistency Reliability of STAT: Constructs

Survey Constructs	n Items	n Subjects	Observations	Chronbach's Alpha
Intention to use	3	37	No Training--Phase 1	.947
Intention to use	3	42	Training------Phase 1	.703
Intention to use	3	110	No Training--Phase 2	.838
Intention to use	3	138	Training------Phase 2	.732
Intention + Attitude	12	37	No Training--Phase 1	.984
Intention + Attitude	12	42	Training------Phase 1	.932
Intention + Attitude	12	110	No Training--Phase 2	.963
Intention + Attitude	12	138	Training------Phase 2	.945
Attitude	9	37	No Training--Phase 1	.979
Attitude	9	42	Training------Phase 1	.926
Attitude	9	110	No Training--Phase 2	.963
Attitude	9	138	Training------Phase 2	.950
Perceived usefulness	6	37	No Training--Phase 1	.978
Perceived usefulness	6	42	Training------Phase 1	.908
Perceived usefulness	6	110	No Training--Phase 2	.931
Perceived usefulness	6	138	Training------Phase 2	.898
Perceived ease of use	6	37	No Training--Phase 1	.944
Perceived ease of use	6	42	Training------Phase 1	.854
Perceived ease of use	6	110	No Training--Phase 2	.761
Perceived ease of use	6	138	Training------Phase 2	.774
Understand Process	6	37	No Training--Phase 1	.957
Understand Process	6	42	Training------Phase 1	.856
Understand Process	6	110	No Training--Phase 2	.812
Understand Process	6	138	Training------Phase 2	.793

To further test the STAT. Chronbach's Alpha was run on each of the test categories in both phase one and phase two and untrained and trained observations. The results showed all coefficients were adequate > than .70. Most coefficients are >.80 which is desired. We can infer that most questions measured the true score and were reliable increasing the power of the study and decreasing the chance of a type two error (Polit, 2010). The surveys for phase two and phase one were measured separately because changes were made to the survey using recommendations from the experts for content validity. The trained and untrained observations were measured separately because the study violated the assumption that each individual was unique. Table 4.3

Missing Data

Management of missing data for age in years, used Mean age =39; imputed 39 for missing data for age observations who received training and those who did not receive training. Clinical years imputed years based on age, if the individual was 34 imputed most common years of experience for age 34: 34(9), 37(11). See table 4.4 and 4.5.

Table 4.4 Descriptive Statistics for Continuous External Variables: Untrained

Variables	M(SD)	Range	Min	Max	Missing (Impute)
Age in years	37.84(10.194)	44yrs	21	65	7 (39)
Yrs of Clinical Exp	11.96(7.906)	40yrs	0	40	2

n = 147

Table 4.5 Descriptive Statistics for Continuous External Variables: Trained

Variables	M (SD)	Range	Min	Max	Missing(Impute)
Age in years	39.62 (10.576)	50yr	20	70	19(39)
Years of Clinical Exp	13.34 (8.210)	40yr	0	40	8

n = 180

The procedure for missing data for likert scale questions was that the researcher imputed the mean of both category mean and column mean when only two missing in a category; if > 2 in a category missing, survey was eliminated. 340 surveys were completed (n=340), 13 were eliminated due to missing data (n=13), a total of 327 surveys were used (n=327); 147 surveys were filled out by those who did not receive training (n=147); 180 surveys were filled out by those who received training (n=180). Statistical analysis was completed separately for trained respondents and untrained respondents because the survey observations contained many of the same individuals. There were individuals who completed surveys in the trained observations who did not complete a survey prior to being trained. This occurred most often during drills because the drills occurred at all 13 hospitals at the same time and the researcher could not be there to give the survey prior to the drill. No procedures were done to match the pretraining survey to the post training survey.

4.6 Imputed Data for Missing Data

Missing Data Category	# Missing	% Missing	#Imputed
Attitude towards use	16	5%	16
Perceived usefulness	13	4%	13
Perceived ease of use	9	3%	10
Perceived understanding of process	5	2%	5
Total	43	14%	43

4.7 Eliminated Surveys Due to Missing Data

Survey	Age (Gender)	Role	Education	# Missing
ID 33	-	-	-	5
ID 42	-	-	-	9
ID 53	59y (M)	Emergency Manager	AD	10
ID 62	- (F)	-	PhD	6
ID 91	44y (M)	PA	MS	6
ID 99	-	RN	AD	7
ID 184	23y (F)	EMT	Diploma	30
ID 185	23y (F)	EMT	AD	30
ID 186	29y (M)	EMT	-	30
ID 192	48y (F)	RN	BS	30
ID 289	-	-	-	9
ID 333	37y (F)	RN	AD	30
ID 339	39y (F)	ED Director	MHA	9

n=13

There were 13 surveys eliminated due to missing data, demographic data is displayed when available on the survey. These surveys were eliminated due to the volume of missing data. Table 4.7

Table 4.8 Nominal and Ordinal variables: No Training n=147

Variables	Number	Percent (%)	Valid Percent (%)
Gender			
Male	24	16.3	16.3
Female	123	83.7	83.7
Primary Setting			
Emergency Department	116	78.9	78.9
Intensive Care Unit	9	6.1	6.1
TeleICU	6	4.1	4.1
Other	16	10.9	10.9
Clinical Role			
Paramedic/EMT	13	8.8	8.8
RN	93	63.3	63.3
Manager	17	11.6	11.6
MD/PA	9	6.1	6.1
Other	15	10.2	10.2
Hospital			
Hospital (1)	16	10.9	10.9
Hospital (2)	9	6.1	6.1
Hospital (3)	13	8.8	8.8
Hospital (4)	12	8.2	8.2
Hospital (5)	6	4.1	4.1
Hospital (6)	0	0	0
Hospital (7)	25	17.0	17.0
Hospital (8)	7	4.8	4.8
Hospital (9)	23	15.6	15.6
Hospital (10)	20	13.6	13.6
Hospital (11)	4	2.7	2.7
Hospital (12)	3	2.0	2.0
Hospital (13)	4	2.7	2.7
Hospital (14)	5	3.4	3.4
Highest level of Education			
Diploma	17	11.6	11.6
Associate Degree	40	27.2	27.2
Bachelor of Science	53	36.1	36.1
Master of Science	24	16.3	16.3
PhD	0	0	0
MD	8	5.4	5.4
DNP	0	0	0
Unknown	5	3.4	3.4
Years of TeleICU Use			
0	126	85.7	85.7
1	1	.7	.7
2	7	4.8	4.8
3	0	0	0
4	1	.7	.7
5	11	7.5	7.5
6	0	0	0
7	1	.7	.7

There were 16.3% (n = 24) men and 83.7 (n = 123) women in the respondents who filled out the survey prior to training. The mean age was 37.84. The majority of the group had no teleICU experience 85.7% (n = 126); The mean years of clinical experience was 11.96. There were 14 hospitals that were planned to be in the study, hospital 6 was a new hospital and has not yet implemented the program. Hospital 7 had the largest group of participants 17% (n=25) and Hospital 12 had the smallest group 2% (n=3). The most frequent primary setting was the emergency department 78.9% (n = 116); those who answered other worked in departments such as Information Technology (IT) or Administration 10.9 % (n = 16). The most common degree was the Bachelors Degree 36.1% (n = 53) and 63.3% (n = 93) were RNs. Those that answered other for the role were a data assistant, EMT, or IT. The mean years of experience were 11.96. Tables 4.4 and 4.8

Table 4.9 Nominal and Ordinal External variables: Trained n = 180

Variables	Number	Percent (%)	Valid Percent (%)
Gender			
Male	18	10.0	10.0
Female	162	90.0	90.0
Primary Setting			
Emergency Department	132	73.3	73.3
Intensive Care Unit	6	3.3	3.3
TeleICU	36	20.0	20.0
Other	6	3.3	3.3
Clinical Role			
Paramedic/EMT	1	.6	.6
RN	137	76.1	76.1
Manager	17	9.4	9.4
MD/PA	6	3.3	3.3
Other	19	10.6	10.6
Hospital			
Hospital (1)	15	8.3	8.3
Hospital (2)	4	2.2	2.2
Hospital (3)	12	6.7	6.7
Hospital (4)	10	5.6	5.6
Hospital (5)	11	6.1	6.1
Hospital (6)	0	0	0
Hospital (7)	15	8.3	8.3
Hospital (8)	36	20.0	20.0
Hospital (9)	15	8.3	8.3
Hospital (10)	24	13.3	13.3
Hospital (11)	12	6.7	6.7
Hospital (12)	8	4.4	4.4
Hospital (13)	7	3.9	3.9
Hospital (14)	11	6.1	6.1
Highest Level of Education			
Diploma	9	5.0	5.0
Associate Degree	45	25.0	25.0
Bachelor Degree	80	44.4	44.4
Masters Degree	33	18.3	18.3
PhD	0	0	0
MD	6	3.3	3.3
DNP	0	0	0
Unknown	7	3.9	3.9
Years of TeleICU Use			
0	130	72.2	72.2
1	7	3.9	3.9
2	11	6.1	6.1
3	2	1.1	1.1
4	6	3.3	3.3
5	15	8.3	8.3
6	7	3.9	3.9
7	2	1.1	1.1

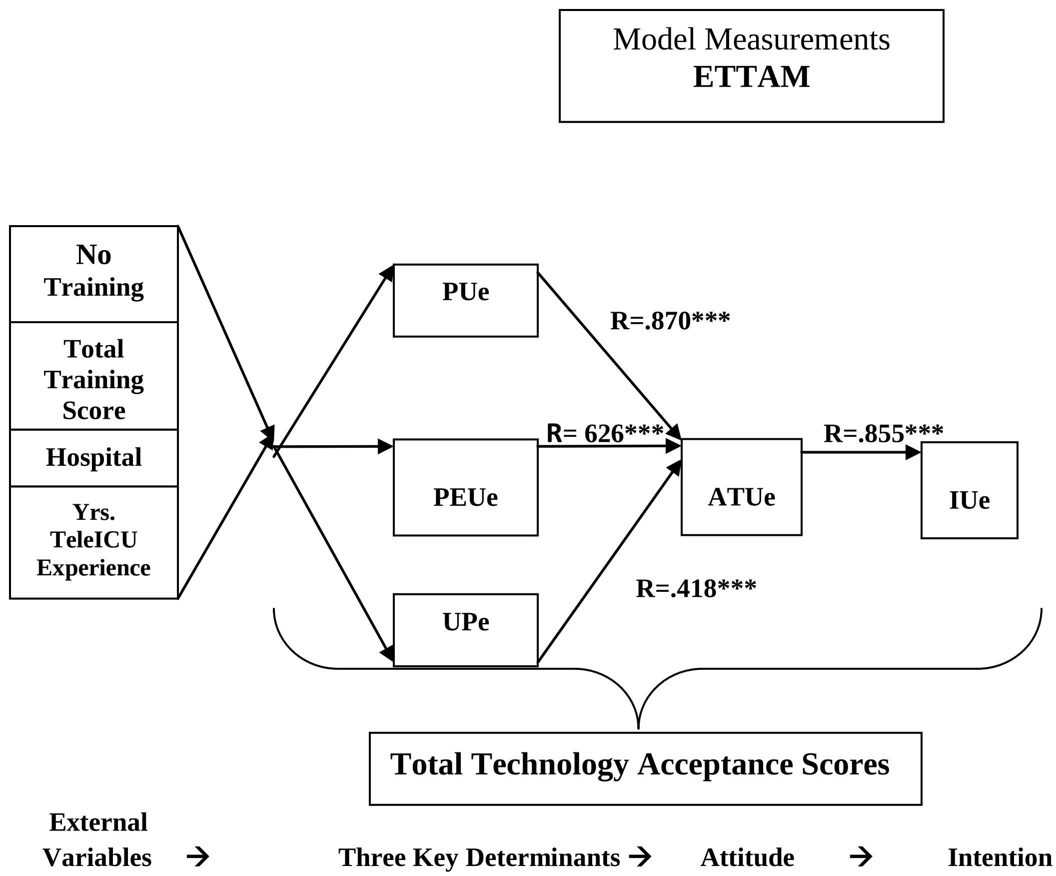
There were 10% (n = 18) men and 90% (n = 162) women in the respondents who received training. The mean age was 39.62. The majority of the respondents, 72.2% (n = 130) had no teleICU experience. The mean years of clinical experience were 13.34. Hospital 8 had the largest group of participants 20% (n = 36). The smallest group was hospital 2 with 2.2% (n = 4).The largest groups primary setting was in the emergency department 73.3% (n = 132). Those who responded other for primary setting worked in IT, or administration 3.3% (n = 6) The most common degree was the Bachelors Degree 44% (n = 80) and 76.1% (n = 137) were RNs. The mean years of ICU experience was 13.34. Tables 4.5 and 4.9

The constructs in the ETTAM were analyzed using nonparametric Spearman's Rank Correlation. The model constructs the three key determinants: Perceived ease of use, perceived usefulness, perceived understanding of process and attitude and intention were found to be highly positively correlated with the strongest relationship being between intention and attitude. Spearman's rho was used to evaluate the strength and direction of the relationship. Nonparametric correlations were used because the assumption of independent observations (survey responses) was not met. Trained observations and untrained observations were analyzed separately.

The results of observations corresponding to subjects who had not received training using Spearman Rank Correlation showed a statistically significant relationship between perceived usefulness and attitude towards using teleICU (r = 0.870; p = .000), so that 76 % of the variability in total attitude was explained by perceived usefulness.

There was a statistically significant relationship between perceived ease of use and attitude ($r = 0.626$; $p = .000$), so that 39 % of the variability in total attitude was explained by perceived ease of use. There was a statistically significant relationship between understanding of process and attitude ($r = 0.418$; $p = .000$), so that 17% of the variability in total attitude was explained by perceived understanding of process. There was a statistically significant relationship between attitude and intention to use ($r = 0.855$; $p = .000$), so that 73% of the variability in attitude was explained by intention to use. The relationship between total training scores and total technology scores ($r = 0.167$; $p = .044$), so that .03 percent of the variance in total training scores was explained in total technology scores. The relationship between champion and total technology scores ($r = -.026$; $p = .753$) was not statistically significant. Spearman's Rank Correlation measures the strength and direction of the relationship, all of the relationships are bidirectional and do not reflect causality.

Table 4.10



ETTAM= Emergency Telemedicine Technology Acceptance Model; PUe=Perceived Usefulness of eCareMobile; PEUe=Perceived Ease of Use of eCareMobile; UPe= Understanding of Process of eCareMobile; ATUe= Attitude toward Use of eCareMobile; IUe=Intention to Use eCareMobile; TTAS=Total Technology Acceptance Scores.

Figure 4.1 ETTAM Model Measurement Outcomes: No Training

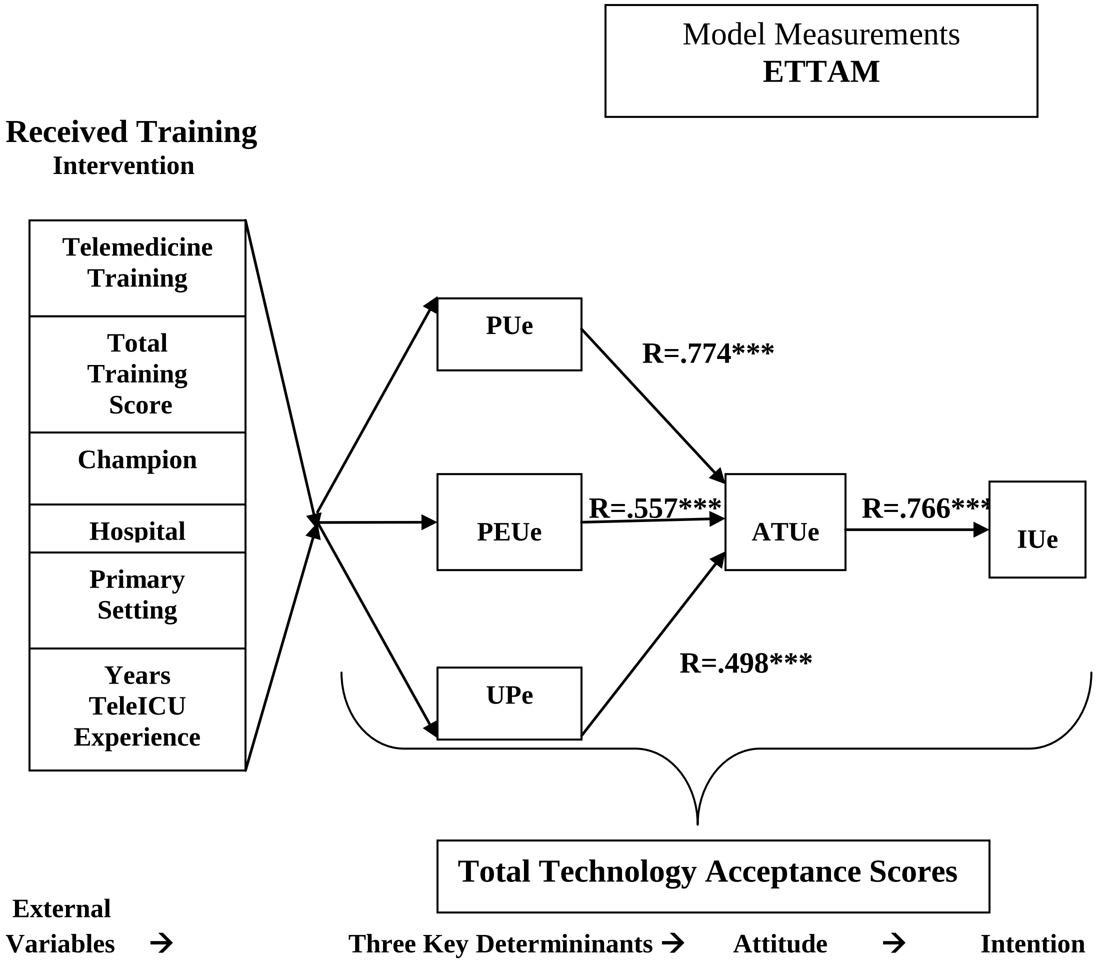
Table 4.10 Nonparametric Correlations Spearman's rho: No Training

Construct 1	Construct 2	R	R^2	P	n
Total Attitude	Perceived Usefulness	.870	.760	.000***	147
Total Attitude	Perceived Ease Use	.626	.390	.000***	147
Total Attitude	Understand Process	.418	.170	.000***	147
Total Attitude	Total Intention	.855	.730	.000***	147
Total Training	Total Technology Score	.167	.030	.044*	147
Champion	Total Technology Score	-.026	0.00	.753	147

*R=Correlation (Construct 1, Construct 2) *Correlation significant 0.05***Correlation significant 0.001

The Spearman rank correlation results in the trained respondents showed a statistically significant relationship between perceived usefulness and attitude towards using teleICU ($r = 0.774$; $p= .000$), so that 60 % of the variability in total attitude was explained by perceived usefulness. There was a statistically significant relationship between perceived ease of use and attitude ($r =0.557$; $p = .000$), so that 31 % of the variability in total attitude was explained by perceived ease of use. There was a statistically significant relationship between understanding of process and attitude ($r = 0.498$; $p = .000$), so that 25 % of the variability in total attitude was explained by perceived understanding of process and vice versa. There was a statistically significant relationship between attitude and intention to use ($r = 0.766$; $p = .000$), so that 59 % of the variability in attitude was explained by intention to use.

There was a statistically significant relationship between total training and total technology scores ($r = 0.208$; $p = .005$), so that .04 % of the variability in total training was explained by total technology scores and vice versa. There was a statistically significant relationship between champion and total technology scores ($r = .229$; $p = .002$), so that .05% of the variability in total technology scores was explained by the presence of a champion. Note slightly less strong but still significant nature of these two correlations compared to the correlations for the three key determinants and attitude and intention. All of these relationships are bidirectional and do not reflect causality. Table 4.10.



ETTAM= Emergency Telemedicine Technology Acceptance Model; PUe=Perceived Usefulness of eCareMobile; PEUe=Perceived Ease of Use of eCareMobile; UPe= Understanding of Process of eCareMobile; ATUe= Attitude toward Use of eCareMobile; IUe=Intention to Use eCareMobile; TTAS=Total Technology Acceptance Scores.

Figure 4.2 ETTAM Model Measurement Outcomes: Trained

Table 4.11 Nonparametric Correlations Spearman's rho: Trained

Construct 1	Construct 2	R	R^2	P	n
Total Attitude	Perceived Usefulness	.774	.60	.000***	180
Total Attitude	Perceived Ease Use	.557	.31	.000***	180
Total Attitude	Understand Process	.498	.25	.000***	180
Total Attitude	Total Intention	.766	.59	.000***	180
Total Training	Total Technology Score	.208	.04	.005**	180
Champion	Total Technology Score	.229	.05	.002**	180

*R=Correlation (Construct 1, Construct 2) **Correlation significant 0.01***Correlation significant 0.001

Table 4.12 Training Frequency

Training	Frequency # Surveys	Percent
Yes	180	55 %
No	147	45%
Total	327	100%

Due to the logistical challenges of the multisite study, not all of the individuals received a pretraining survey. This led to an uneven number of surveys in the trained and untrained observations. In many instances this may have occurred during the drill since the drill was activated at each of the 13 hospitals sites at the same time and the researcher could not be present at all of the sites at the same time. Also, some of the eliminated surveys due to missing data could have contributed to the variance. Table 4.12

Table 4.13 Total Training Score Frequency

Training	1 Type	2 Types	3 Types
180 Surveys	89 (49.4%)	66 (36.7%)	25(13.9%)

Of the respondents who were trained 89 (49.4%) had one type of training, 66 (36.7%) had two types of training and 25 (13.9%) had all three types of training. The training could have consisted of any of the three options, lecture, scenario practice and/or the full scale drill. Table 4.13

Table 4.14 Types of Training Frequency: Scenario

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	74	41.1	41.1	41.1
	Yes	106	58.9	58.9	100.0
	Total	180	100.0	100.0	

Among the respondents who were trained, 106(58.9%) received scenario practice and 74 (41%) of those who received training did not receive scenario practice. Scenario practices were held in the introductory class and one week later with a telemedicine interaction connecting the ED team in the hospital with the teleICU team at the telemedicine center outside of the hospital. The scenario practice allowed for a simulated case scenario, hands on experience with the mobile cart and virtual communication practice with the teleICU. Table 4.14

Table 4.15 Types of Training Frequency: Lecture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	49	27.2	27.2	27.2
	Yes	131	72.8	72.8	100.0
	Total	180	100.0	100.0	

Among the respondents who were trained, 131(72.8%) received the telemedicine lecture and 49 (27.2%) of those who received training did not receive the lecture. The lecture consisted of a 30 minute power point presentation describing the teledisaster model followed by an opportunity for questions and answers. Table 4.15

Table 4.16 Types of Training Frequency: Drill

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	121	67.2	67.2	67.2
	Yes	59	32.8	32.8	100.0
	Total	180	100.0	100.0	

Among the respondents who were trained 59(32.8%) participated in a full scale disaster drill and 121(67.2%) of those who received training did not participate in a full scale disaster drill. There were two full scale drills, one in 2009 and one in 2010. The drills allowed for both hands on experience and simulated application of the teledisaster model with moulaged patients and case scenarios.

Table 4.17 Descriptive Statistics: Mean survey scores ( ) = lowest or highest possible score

Training	Construct	Min Score	Max Score	M	Mode	SD	n
No	3KD	38(18)	90(90)	60.54	54	10.203	147
Yes	3KD	38(18)	90(90)	**69.95**	71	10.418	180
No	Intention	3(3)	15(15)	11.22	9	2.445	147
Yes	Intention	6(3)	15(15)	**12.71**	15	2.268	180
No	Attitude	13(9)	45(45)	34.86	27	6.919	147
Yes	Attitude	13(9)	45(45)	**39.10**	45	6.031	180
No	Useful	10(6)	30(30)	21.59	18	4.623	147
Yes	Useful	10(6)	30(30)	**24.31**	30	4.440	180
No	Ease Use	12(6)	30(30)	19.70	18	3.512	147
Yes	Ease Use	14(6)	30(30)	**22.77**	18	3.852	180
No	Process	10(6)	30(30)	19.26	18	3.302	147
Yes	Process	14(6)	30(30)	**22.88**	24	3.768	180
No	TTAS	58(30)	150(150)	106.62	90	18.191	147
Yes	TTAS	58(30)	150(150)	**121.76**	90	17.337	180

The mean score of the three key determinants for the untrained observations 60.54 (SD = 10.2030) ; trained observations 69.95 (SD = 10.418) mean difference (+9.41). The mean score of intention for untrained observations 11.22 (SD = 2.445); trained observations 12.71 (SD = 2.268); mean difference (+1.49). The mean score of attitude for the untrained observations was 34.86 (SD = 6.919); trained observations 39.10 (SD = 6.031); mean difference (+4.24). The mean score of perceived usefulness for the untrained observations 21.59 (SD = 4.623); trained observations 24.31 (SD = 4.440); mean difference (+2.72). The mean score of perceived ease of use for the untrained observations 19.70 (SD = 3.512); trained observations 22.77 (SD = 3.852); mean difference (+3.07). The mean score of understanding process for the untrained observations 19.26 (SD = 3.302); trained observations 22.88 (SD = 3.768); mean difference (+3.62). The mean Total Technology Acceptance score for the untrained observations 106.62 (SD = 18.191); the trained observations 121.76 (SD = 17.337); mean difference (+15.14).

Each mean score per category in the trained observation was higher than the mean score in the untrained observations. The mean score of the total three key determinants of the trained observation was 9.54 points higher than the mean score of the untrained observation. The total technology acceptance mean score of the trained observations was 15.42 points higher than the untrained observations. The overall mean scores of the trained observations reflected a higher level of technology acceptance. Table 4.17

Multiple Linear Regression (MLR) Modeling Using Stepwise Selection

Table 4.18 Model 1: MLR 3KD Scores: Untrained Observations n=147

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tol	VIF
3	(Constant)	58.441	.821		71.204	.000	56.819	60.063		
	7-Yrs of eICU tech	3.698	.629	.539	5.875	.000	2.454	4.943	.630	1.587
	Hospital2	11.781	3.110	.277	3.788	.000	5.634	17.929	.991	1.009
	Hospital8	-13.919	4.378	-.291	-3.179	.002	-22.573	-5.265	.634	1.578

The model selected via stepwise selection (entry significance level = 0.05; exit significance level = 0.1)

The overall expected mean in the three key determinant (3KD) scores among untrained observations was 58.441. For every additional year of experience using eICU technology, we expected a 3.69 increase in 3KD scores. For hospital 2, the 3KD mean was (58.441 + 11.78 = 70.22). For hospital 8, the mean 3KD was (58.441 – 13.919 =

44.52). Since none of the two-way interaction effects with X_1 (years of experience using eICU technology) were found to be statistically significant at the 10% significance level, the model selected via stepwise selection (above) was the final model. See Appendix D

Multiple Linear Regression (MLR) Modeling Using Stepwise Selection

Table 4.19 Model 2: MLR 3KD Scores: Trained Observations (n=180)

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tol	VIF
8	(Constant)	68.510	1.086		63.108	.000	66.367	70.653		
	Yrs of eICU	1.307	.363	.246	3.605	.000	.591	2.023	.881	1.135
	Hospital9	-7.310	2.550	-.194	-2.867	.005	-12.344	-2.276	.893	1.120
	Hospital10	-5.289	2.082	-.173	-2.540	.012	-9.398	-1.179	.886	1.129
	Hospital12	-5.962	3.327	-.118	-1.792	.075	-12.529	.605	.944	1.059
	Hospital1	7.537	2.488	.200	3.029	.003	2.625	12.448	.938	1.066
	Hospital4	8.367	3.004	.184	2.786	.006	2.438	14.296	.937	1.067
	Hospital5	7.217	2.905	.166	2.484	.014	1.483	12.952	.916	1.091
	Hospital2	10.490	4.598	.149	2.281	.024	1.413	19.567	.966	1.035

The model selected via stepwise selection (entry significance level = 0.05; exit significance level = 0.1)

The overall expected mean in the three key determinant (3KD) scores among trained observations was 68.51. For every additional year of experience using teleICU technology, we expected a 1.307 increase in 3KD. For hospital 9, the 3KD mean was (68.51 – 7.31 = 61.20). For hospital 10, the mean 3KD was (68.51-5.289 = 63.22). For hospital 12, the mean 3KD was (68.51 – 5.962 = 62.55). For hospital 1, the mean 3KD was (68.51 + 7.537 = 76.05). For hospital 4, the mean was (68.51 + 8.36 = 76.87). For hospital 5, the mean 3KD was (68.51 + 7.217 = 75.73). For hospital 2, the mean 3KD was (68.51 + 10.49=79.00). Since none of the two-way interaction effects with X_1 (years of experience using teleICU technology) were found to be statistically significant at the 10% significance level, the model selected via stepwise selection (above) was the final model. See Appendix E

Multiple Linear Regression (MLR) Modeling Using Stepwise Selection:

Table 4.20 Model 3: MLR TTAS Scores: Untrained Observations (n=147)

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tol	VIF
5	(Constant)	104.632	1.624		64.445	.000	101.422	107.841		
	7-Yrs of eICU	6.614	1.160	.519	5.702	.000	4.321	8.907	.627	1.594
	Hospital2	20.702	5.749	.262	3.601	.000	9.336	32.067	.980	1.020
	Hospital4	12.664	5.024	.183	2.521	.013	2.731	22.596	.984	1.016
	Hospital5	16.035	6.947	.168	2.308	.022	2.301	29.769	.986	1.015
	Hospital8	-17.009	8.060	-.191	-2.110	.037	-32.943	-1.075	.632	1.582

The model selected via stepwise selection (entry significance level = 0.05; exit significance level = 0.1)

The overall expected for the total technology acceptance scores (TTAS) in the untrained observations was 104.632. For every additional year of experience using teleICU we expected a 6.614 increase in TTAS. For hospital 2, the mean TTAS was (104.632 +20.702=125.334). For hospital 4, the mean TTAS was (104.632 +12.66=117.292). For hospital 5, the mean TTAS was (104.632 + 16.035=120.667). For hospital 8, the mean TTAS was (104.632 -17.009=87.623). Since none of the two-way interaction effects with X_1 (years of experience using eICU technology) were found to be statistically significant at the 10% significance level, the model selected via stepwise selection (above) was the final model. See Appendix F

Multiple Linear Regression (MLR) Modeling Using Stepwise Selection

Table 4.21 Model 4: MLR TTAS: Trained observations (n = 180)

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tol	VIF
8	(Constant)	133.701	2.210		60.508	.000	129.340	138.062		
	Hospital9	-14.808	4.226	-.227	-3.504	.001	-23.148	-6.468	.928	1.077
	Setting1	-14.093	2.666	-.345	-5.285	.000	-19.356	-8.830	.911	1.098
	Hospital1	15.901	4.130	.243	3.850	.000	7.749	24.052	.972	1.029
	Hospital4	17.792	5.045	.226	3.527	.001	7.834	27.750	.948	1.055
	Hospital5	15.747	4.795	.209	3.284	.001	6.283	25.212	.960	1.042
	Hospital2	19.392	7.722	.158	2.511	.013	4.150	34.634	.977	1.024

The model selected via stepwise selection (entry significance level = 0.05; exit significance level = 0.1)

The overall expected mean for the total technology acceptance scores (TTAS) in the trained observations was 133.701. For hospital 9, the mean TTAS was (133.701-14.808=118.893). For setting 1, the mean TTAS was (133.701 -14.093=119.608). For hospital 1 the mean TTAS was (133.701 + 15.901=149.602). For hospital 4, the mean TTAS was (133.701+17.792=151.493). For hospital 5, the mean TTAS was (133.701 + 15.747 = 149.448). For hospital 2 the mean TTAS was (133.701 + 19.392 = 153.093). Since none of the two-way interaction effects with X_1 (hospital 9) were found to be statistically significant at the 10% significance level, the model selected via stepwise selection (above) is the final model. A strength of each of the MLR models is that the VIF was close to one inferring low collinearity, this meant that each item in the model added a unique effect to the model. See Appendix G

CHAPTER V

Discussion of Findings

This chapter discusses the inferential findings of the study. The study sample is compared to the national sample. The strengths and limitations of the study are presented as well as future opportunities. The seven research questions are addressed and the implications of the study findings are included for inter-professional practice, educational opportunities, future research and limitations of the study.

Sample Population

There were 137(76.1%) RN's in the trained observations and there were 93(63.3%) RNs in the untrained observations. The sample population mean age was five years less than the nursing national average in 2012. The study population average age was 39; nationwide the average age of nurses was 44.5 in 2012. In the future it is expected that nurses in their 50's will become the largest segment of nursing; they will then make up between 1/4 and 1/3 of the nursing population. (Rosseter, 2012, HRSA, 2013)

In the sample population 80 (44%) of the trained subjects were Bachelor of Science in Nursing, 45 (25%) of the study population had an Associate degree in Nursing and 33 (18%) of the sample had their Master's degree in Nursing. 137 (76%) of the trained subjects were nurses, and nine (17%) of the subjects were managers. According to HRSA (2013) 55% of the RN workforce holds a Bachelors or higher degree. The Associate degree was often the first degree for many of these nurses. 28, 000 RN's were awarded bachelor degrees in nursing in 2011 and 26, 200 were awarded Masters or Doctoral degrees. In October 2010, the Institute of Medicine's report on the future of nursing called for increasing the number of nurses with a BSN to 80% and to double the number of nurses with Doctoral degrees (Rosseter, 2012). There were only nine physicians/physicians assistants in the study.

Inferential Results

The results of the Chronbach's Alpha analysis showed that the measurement tool was reliable for each of the construct categories in the group that received telemedicine training. The trained and untrained respondents were analyzed separately because this was a within-subjects design. Most of the individuals in the trained and untrained observations were the same individuals studied at different points in time with any combination of the three levels of training. Not all these subjects who were in the trained observations completed a survey prior to the training. The surveys were not matched individually; however they were matched to specific hospitals. Matching the tests individually in the trained and untrained groups would have been a more rigorous study design however, due to the two year span of the study; this would have presented logistical challenges.

The means scores in each category on the survey increased with training which leads the researcher to infer that the training was effective. One trainer was the researcher who was the director for the teleICU who implemented the teleICU program and the second trainer held a PhD in Biodefense. The curriculum was consistently applied throughout the training process. In three of the 13 hospitals training was delegated to different trainers because of the volume of training required. All the trainers used the same curriculum; however, at hospital ten the trainer was a student and requested to do the training as a school project. The hospital champion was present during this training and distributed the surveys prior to the training and the surveys after the training was completed. Hospital ten was in regression model 2 for the 3KD scores for trained observations. The mean score at this hospital was -5.289 lower than the overall mean. This result may be attributed to the level of experience and the lack of influence of the trainer on the students about this topic. However, the means of the trained scores were higher after this training than the untrained scores. This leads one to believe the training was effective but potentially not as effective as it would have been with an experienced trainer. It is interesting to note that hospital eight is the teleICU and that it had mean scores that were significantly lower in the untrained observations of -13.919 in the 3KD model and -17.009 in the TTAS model. Their scores increased after training and they did not appear in the training regression models. This reflects the idea that even with experience with this specific technology; these individuals had significantly lower technology acceptance scores than the mean prior to training.

The presence of a champion had a moderately significant effect in the training observations. The champion did not have a significant effect in the untrained observations. A future study that would focus on the role of leadership and champions and their influence on technology acceptance would be a valuable addition to evaluate their significance. Rogers (1976) believed that formal and informal leadership influenced individuals to accept a new innovation. The researcher observed that there was an increase in the number of participants, in the preparation for the class and in the employee awareness of the project when there was an engaged leader or champion present in the Emergency Department. It can be seen that these roles played an essential part in organizing and motivating the staff to participate in the training. That observation was not reflected strongly in the study because of the nature of the survey questions. There were no specific questions related to leadership involvement or the presence of a champion on the survey. The researcher suggests that future studies incorporate these questions.

The power analysis results showed that the sample size was adequate for both the trained and untrained observations; however, a larger sample population in each hospital would have strengthened the study findings. The four multiple linear regression models examined the effect of the external variables on the TTAS and the 3KD scores. Age, gender, clinical years of experience, education, clinical role, one or two way video and champions were eliminated from the regression model because the models showed that they have a lack of significance. Hospital, setting and teleICU experience had significant results and appeared in the regression models. Various hospitals were significant in each of the four models in both the untrained and trained observations. The years of teleICU experience increased the mean score for each year of teleICU experience in two of the untrained models and in one of the trained models. It is an interesting finding, that various hospitals were significant in the regression models. Each hospital was unique because each had a different leadership approach with varying levels of engagement or knowledge of the project. There were individual cultural differences between the hospitals. These results show the importance of further research on the characteristics of individual hospitals and their leadership style and its impact on technology acceptance.

The Research Questions

R1. What is the difference between the total key determinant scores of those who received telemedicine training compared with those who did not?

Descriptive statistics showed that those who received training had higher mean scores in total intention to use, total attitude, total perceived usefulness, total perceived ease of use, total understanding of process (total three key determinant scores) and total technology scores. The means of the scores varied across hospitals.

A Multi-linear stepwise regression for the three total key determinants (3KD) for the untrained observations showed multiple hospitals mean scores that were significantly different from the overall mean score. Years of teleICU experience showed a significant increase in mean scores with each added year of experience. Diffusion of Innovation theory uses the construct of knowledge as having an influence on accepting a new innovation (Rogers, 1976).

Trained observations had a larger number of hospitals in the model and the overall mean score was 10 points higher than the untrained observations.

R2. How much of the variability of attitude toward using telemedicine is explained by the three key determinants?

In the untrained observations, the results of the Spearman rank order showed a statistically significant relationship between attitude and each of the 3KDs. 76 % of the variability in total attitude was explained by perceived usefulness. 39 % of the variability in total attitude was explained by perceived ease of use. 17% of the variability in total attitude was explained by understanding of the process.

In the trained observations, the results of the Spearman rank order showed a statistically significant relationship between attitude and each of the 3KDs. 60 % of the variability in total attitude was explained by perceived usefulness. 31 % of the variability in total attitude was explained by perceived ease of use. Kowitlawakul (2008) found that perceived ease of use had a more significant effect on attitude than perceived usefulness. This researchers finding's match those of previous TAM studies done by Davis and Venkatesh (Davis, 1986), (Venkatesh, 2003). 25% of the variability in total attitude was explained by understanding of the process.

An interesting finding is that the relationship between attitude and perceived ease of use was decreased by 16% in the trained observations and the relationship between attitude and perceived usefulness decreased by 9% in the trained observations. The relationship between attitude and process increased by 8% in the trained observations. These findings showed a shift from usefulness and ease of use to process.

R3. How much of the variability of attitude is explained by intention to use telemedicine?

In the untrained observations, the results of the Spearman rank order showed a statistically significant relationship between attitude and intention to use, so that 73% of the variability in attitude was explained by the intention to use telemedicine. In the trained observations there was a statistically significant relationship between attitude and the intention to use so that 59% of the variability in attitude was explained by the intention to use. There is opportunity in future research to further explore the relationship between attitude and actual use. Studies of the relationship between attitude and intention have held the attention of researchers since the early 1930's (Fishbein, 1975). Karsh (2009) suggested that behaviors are influenced by beliefs. Research has consistently shown that behavioral intention to use technology was the strongest predictor of actual use. (Fishbein, 1975; Ajzen, 1980, Ajzen, 1991; Venkatesh, 2003). Kowitlawakul (2008) also found that the nurse's attitude was a significant factor toward intention to use TeleICU technology.

R4. How much of the variability in total technology acceptance scores is explained by the telemedicine training methods?

The results of the Spearman rank order in the untrained observations showed a moderately significant relationship between total training scores and total technology scores so that .03% of the variability in technology scores was explained by the total training scores.

In the trained group, there was a statistically significant relationship between total training and total technology scores so that .04 % of the variability in total training was explained by the total technology scores.

R5. What is the relationship between total technology scores and the external variables for the trained and untrained observations?

A Multi-linear stepwise regression for the Total Technology Acceptance Scores (TTAS) for the untrained observations showed multiple hospitals mean scores that were significantly different from the overall mean score. Years of teleICU experience showed a significant increase in mean scores with each added year of experience. A multi-linear regression was run for both the trained and untrained observations individually. The untrained observations had years of teleICU experience with a positive effect to the constant of 104.632 + 1.632 for each additional year of experience. Hospital two, four, and five all had scores higher than the constant by 12-20 points and hospital eight had a negative effect of -17.009. In the trained groups the overall mean score was 29.069 points higher than the untrained observations. Hospital nine and setting one had a negative correlation with the constant by greater than 14 points. Hospital one, two, four and five each had scores greater than the constant. Overall the education program lead to higher mean scores for each hospital, hospitals with negative correlations started out with baseline lower means.

R6. How much of the variability of total technology acceptance scores is explained by an onsite champion? Spearman rank order was used to analyze the relationship between total technology scores and champion. For the untrained observations, the relationship between champion and total technology scores was not statistically significant. For the trained observations, there was a statistically significant relationship between champion and total technology scores .05% of the variability in total technology scores was explained by the presence of a champion. Rogers (1976) describes leadership as an influencer in the acceptance of a new innovation. The leader can be formal or informal, the presence of a champion whether they were the manager or a unit educator impacted the team awareness and participation in the telemedicine training.

R7. Will the ETTAM reflect a positive relationship between the constructs that make up the Simulated Technology Acceptance Tool?

This question was the overall question for the study. The ETTAM reflected significant positive relationships in both the trained and untrained observations. The Spearman Rank Correlations showed significant relationships between each of the four constructs perceived ease of use, usefulness, process understanding, intention and attitude. This finding coincides with the findings of previous studies (Davis, 1976, Venkatesh, 2003 Kowitlawakul, 2008). The ETTAM models were changed after the study to reflect the external variables and independent variables that were significant in the study. Telemedicine training, total training score, champion, hospital, primary setting and years of teleICU experience all were significant in either the Spearman Rank Correlation or the regression models. The ETTAM model was very useful when adapting the measurement tool using the Davis (1976) measurement tool in which he combined the Theory of Planned Behavior and the Technology Acceptance Model. Rogers Diffusion of Innovation theory was added when the researcher began to observe the complexity of technology acceptance among individuals and realized there are many more elements that impact technology acceptance beyond the TAM model that need to be understood.

Implications

Interprofessional Practice

Nurses were vey engaged in the process of training and preparing for implementation of teleICU for disaster support. Physicians who were assisting in the teleICU were highly engaged throughout the process to include participating in the steering committee and writing guidelines for the program. In order to achieve ownership of a project, it is important to involve the stakeholders during the development phase of the project (Lee, 2005; Morris, 2005; Pare, 2006; Lee, 2007; Wakefield, 2007). There were challenges in the hospital to get physicians to participate in training that was offered to them. This impacted their participation during drills. Just in time training was delivered to them moments prior to a drill because they had not attended the recommended classes. There was a certain level of resistance just prior to the training but actual use changed to curiosity and possible acceptance. Even those physicians who were hesitant to use the technology eventually communicated effectively with the teleICU team. Pare (2006) describes technology adoption as an “evolution rather than a revolution”.

The clinical team plays a primary role during a disaster. They are often a member of the first responder team during an incident; we saw this occur in Boston during the bombing at the Boston Marathon on April 15, 2013. Many of the patients from the

Boston bombing presented themselves in emergency rooms with amputated limbs, burns and multiple traumatic injuries. When a surge of severely injured patients arrive in an emergency department it creates a chaotic situation which must be managed quickly in order to save lives. The findings of the study showed that different hospitals had varying levels of participation in disaster preparedness using teleICU and that there was a significant difference in total technology scores reflecting technology acceptance for use in disaster response. It is important to further understand what factors impacted their level of acceptance such as leadership influence, communication and engagement in new innovations.

Interprofessional Education

Clinical education is impacted by the study findings, the telemedicine training had a positive impact on each emergency department even in the cases were their initial scores were lower than the mean total technology acceptance scores. A comprehensive curriculum adds to the value of telemedicine training and laminated cards on the eCareMobile® cart act as a reminder of the process of using the cart for disaster. An organized approach to a new topic is very important to gain understanding and recall of the idea or new innovation. Consistency in presentation of the information is very important as well as the educator having prior experience and expertise regarding the subject matter. The researcher learned from the results in hospital ten that it is important to be consistent with the training procedures when studying acceptance levels and delivering new information during implementation of a new innovative model. The researcher also learned from the results in hospital eight that although a team has hands on experience with the technology, they may not immediately accept a new way to use the technology.

Disaster planning and management is a critical knowledge base that should be present in every physician and student nurse's curriculum. There should be core courses that address the magnitude of psychological, physiological and cultural needs of victims as well as those providing care to the victims.

Future Research

There is opportunity for further research regarding this important topic. Seeing the significant differences between the various hospitals leads one to believe it is very important to explore what elements played a role in those differences. Were the differences related to the individual hospital culture, leadership models, the presence of a champion, available resources and level of competency? Also a larger sample size from each hospital would allow for generalization of the findings. It is important to further explore the role leadership and the presence of a champion plays in technology acceptance. Roger's diffusion of innovation describes the complexity of the acceptance of new innovations and speaks of the influence a leader or role model may have (Rogers, 1976). There is also the opportunity to better understand the value of decision support using technology during a disaster. Culley (2011) stresses the need for further studies to explore the complexities of mass casualty incidents and the benefits of decision support using technology.

Health policy

One cause for concern often voiced by clinicians is the risk involved when responding to a mass casualty incident. This issue could play a role in technology acceptance. The health care provider liability protections House Bill 403/Senate Bill 657 was passed in the state of Virginia post 9/11. The language in the bill protects the provider from liability for injury or wrongful death when a state or local emergency is declared. It is important to have nationwide protection for both victims and care providers during a declared disaster because there is a different standard of care when conditions call for heroic measures to save lives and the resources are not available to provide routine medical care.

Limitations

The researcher recommends matching the untrained and trained observations of each individual. The ETTAM model was an appropriate model for measuring technology acceptance but it is important to realize the complexities of the healthcare environment. The simplicity of the TAM and the Theory of Planned Behavior are excellent for creating a measurement tool; however, the Diffusion of Innovation Theory added a complexity to the observations that better explained the progression of technology acceptance. A combined theory approach is recommended. Adding questions for leadership and champions in the questionnaire and to the model would assist with capturing the role of the leadership in technology acceptance. A larger sample size at each hospital would be recommended to strengthen the results of the findings between hospitals.

Dissemination

It is important to duplicate the efforts of the Northern Virginia Hospital Alliance and the Regional Hospital Coordinating Center. The NVHA has produced a professional video of the eCareMobile® teleICU project and it is available on public websites. There is opportunity to replicate the telemedicine educational program. The measurement tool could be used as is or adapted to various environments. Presentations on the use of teleICU for disaster response have been given at national conferences such as the American Association of Critical Care Nurses (AACN) and the American Telemedicine Association (ATA) and at International Conferences at Trinity University in Dublin, Ireland.

Conclusion

Leadership plays an important role in technology acceptance. Future studies should further explore this role and support leadership with this significant responsibility. The curriculum developed for telemedicine training had a positive effect on technology acceptance. Consistency in training processes throughout the study is a vital element. The ETTAM model and the measurement tool are resources for those who are developing a teledisaster model.

A plan for sustaining the program over time is also essential; the researcher has a procedure for checking the technology with the hospitals weekly and practicing scenarios with the ED team monthly to maintain their competency with the teledisaster program.

Lessons learned in this project will assist other sites to use teleICU technology to provide disaster support. This was a challenging learning experience for the Information Technology teams because it required unique teamwork to connect multiple hospital networks. Adding the IT teams to the telemedicine training is recommended. This project was an illustration of network capabilities and interoperability that is essential on a global scale to manage complex communication and situation awareness during a mass casualty incident.

APPENDIX A

STAT Simulated Telemedicine Acceptance Tool

Please answer all of the questions below.

1. The type of eCareMobile education I received was: (Circle All that Apply)

No eCareMobile Education	Lecture	Practice Scenarios	Drill

2. Primary Hospital affiliation: (Check one)

( ) Hospital 1	( ) Hospital 6	( ) Hospital 11
( ) Hospital 2	( ) Hospital 7	( ) Hospital 12
( ) Hospital 3	( ) Hospital 8	( ) Hospital 13
( ) Hospital 4	( ) Hospital 9	( ) Hospital 14
( ) Hospital 5	( ) Hospital 10	

3. Primary work setting is: (Circle all that apply)

Emergency Department	Intensive Care Unit	eICU	Other

4. Highest level of education: (Circle all that apply)

Diploma	AD	BS	MS	PhD	MD	DNP	Other

5. Clinical Role: (Circle all that apply)

RN	MD	PA	NP	Paramedic	Manager	Other

6. Years of clinical experience: ___________ (Write in # of years)
7. Years of eICU technology use in hospital or eICU: __________(Write in # years)
8. ____ Female ____ Male (Check one)
9. Age: _____Years (Write in age)

Purpose: To insure that the enVision eICU is providing a valuable resource to the hospital clinical teams during a mass casualty incident (MCI).

Directions: Please answer the questions below. ***Circle*** the choice on the right that best describes your response.

***A. Intention to Use eCareMobile during a Mass Casualty Incident (MCI)*:**

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
10. Assuming I have access to eCareMobile, I intend to use it during a MCI.	5	4	3	2	1
11. Given that I have access to eCareMobile during a MCI, I predict that I would use it.	5	4	3	2	1
12. During a MCI, I will be hesitant to use eCareMobile.	5	4	3	2	1

***B. Attitude toward using eCareMobile during a Mass Casualty Incident (MCI)*:**

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
13. Using eCareMobile during a MCI is an innovative idea.	5	4	3	2	1

14. Using eCareMobile during a MCI is a good idea.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
15. I do not like the idea of using eCareMobile during a MCI.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
16. Using eCareMobile during a MCI is positive.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
17. Having a virtual eICU intensivist available during a MCI is valuable.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
18. It is helpful to utilize the eICU intensivist for patient orders.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
19. Consulting with the eICU intensivist about patient issues during a MCI is valuable.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
20. Using eCareMobile during a MCI is a valuable clinical resource.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
21. Consulting with the eICU RN about patient issues during a MCI is beneficial.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1

C. Perceived Usefulness of eCareMobile during a Mass Casualty Incident (MCI):

22. Using eCareMobile will improve my performance on the job during a MCI.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
23. Using eCareMobile in my job will increase my productivity during a MCI.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
24. Using eCareMobile will enhance my effectiveness in my job during a MCI.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
25. I find eCareMobile will be useful in my job during a MCI.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
26. eCareMobile will not be useful during a medical emergency.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
27. eCareMobile will be useful during a MCI.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1

D. Perception of Ease of Use of eCareMobile during a Mass Casualty Incident (MCI):

28. My interactions with virtual clinicians utilizing eCare-Mobile will be clear and understandable.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
29. Interacting with virtual clinicians utilizing eCare-Mobile will not require a lot of my mental effort.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
30. I find eCareMobile will be easy to use.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
31. Interactions with a virtual eICU intensivist will be problematic to do.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
32. Interactions with virtual RNs will be uncomplicated.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1
33. I will find it difficult to get eCareMobile to do what I want it to do.	Strongly Agree 5	Agree 4	Uncertain 3	Disagree 2	Strongly Disagree 1

E. Understanding of the Process Development of eCare Mobile Activation and Sustainment:

34. The escalation process for activation of enVision eICU support during a MCI is clearly defined.	Strongly Agree Agree Uncertain Disagree Strongly Disagree 5 4 3 2 1
35. The contact for activating eCareMobile for eICU support is unclear.	Strongly Agree Agree Uncertain Disagree Strongly Disagree 5 4 3 2 1
36. The process of utilizing the eCareMobile equipment is straightforward.	Strongly Agree Agree Uncertain Disagree Strongly Disagree 5 4 3 2 1
37. The communication process during eCareMobile activation is clear.	Strongly Agree Agree Uncertain Disagree Strongly Disagree 5 4 3 2 1
38. The sustainment plan for eCareMobile is complicated.	Strongly Agree Agree Uncertain Disagree Strongly Disagree 5 4 3 2 1
39. The designated area for eCareMobile use is clearly identified.	Strongly Agree Agree Uncertain Disagree Strongly Disagree 5 4 3 2 1

MIS Quarterly 2003 User Acceptance of Information Technology Toward a Unified View/Engineering Management 2005 Gender and Age Differences in Employee Decision About new Technology: An Extension to the Theory of Planned Behavior. Permission granted by Viswanath Venkatesh & Fred Davis 10/30/07. Adapted to fit eCareMobile use during an MCI by Theresa M. Davis 8/27/09.

Please add any other comments that you would like to share with us

Comments:

Thank You for Taking the Time to Fill Out This Questionnaire

APPENDIX B

Adult Crisis Critical Care & Trauma Capacity (C4T) Project
Northern Virginia Hospital Alliance
enVision TeleICU Inova Health System
eCareMobile Support
Curriculum

1. Questionnaire: 39 Questions (15 minutes)

   - Intention to use eCareMobile
   - Attitude toward using eCareMobile
   - Perceived usefulness of eCareMobile
   - Perception of ease of use of eCareMobile
   - Understanding of eCareMobile processes

2. Power Point presentation (30 minutes)

   - enVision eICU structure
   - eICU clinical support
   - Mass casualty incident support
   - eCareMobile Technology
   - Activation Process
   - Communication Process
   - Sustainment Process

3. Scenario Based Learning (30 minutes)

   - Case scenario presentation
   - eCareMobile hands on experience
   - Virtual communication with eICU team
   - Dialogue about benefits and challenges of virtual communication

4. Question & Answer session (15 minutes)

APPENDIX C

Scenario Based Training and Simulation
Northern Virginia Hospital Alliance
enVision TeleICU Inova Health System
Critical Care Telemedicine During a Mass Casualty Incident

Introduction	The following are practice scenarios to assist with gaining experience utilizing eCareMobile®. The scenarios will enable all sites involved to both test the technology as well as become familiar with the use of eCareMobile®. The scenarios are simulation and may be role played by physicians or a nurse role playing as a physician. If the situations were real eICU RNs do not give orders from the eICU. eICU physicians will not give orders until all eCareMobile® activation policies are approved and finalized.
Simulated MCI	Following an explosion in a highly populated shopping center, there were 50 casualties; twenty patients will be coming to your hospital. You will receive 6 critically injured patients, 6 moderately injured and 8 walking wounded. Due to the volume of patients and limited resources for transport, you must prepare to manage the patients for 92 hours.
Practice Scenario #1	Approximately 50 yr old male. Identity unknown. Victim of bombing incident. Unresponsive, orally intubated in field. Bloody drainage from ears. 50% first degree burns upper extremities, and torso. Full circumference burn. HR 130, BP 70/30 RR 35. Unable to transfer to level 1 trauma center.
Practice Scenario # 2	Approximately 24 yr old female. Identity unknown. Nonresponsive, unable to intubate in field. Patient has oral airway, ambu bag. Victim of bombing incident. R leg amputation. Tourniquet applied. Shrapnel to R eye and face. Distended, firm bruised abdomen. HR 150, BP 60/ 30, RR 40. Unable to transfer to level 1 trauma center.

APPENDIX D

Multiple Linear Regression Modeling Using Stepwise Selection

Model 1: 3KD Scores for Untrained Observations (N=147)

Define the following for untrained observations $i = 1, 2, \ldots N = 147$:

$Y_i \equiv$ $3KD$ score for i^{th} untrained observation

$X_{1i} \equiv$ Years of experience the i^{th} untrained observation has using eICU tech

$X_{2i} \equiv$ Indicator variable for whether or not i^{th} untrained observation is from Hospital 2

$$= \begin{cases} 1, & \text{if } i^{th} \text{ untrained observation is from Hospital 2} \\ 0, & \text{otherwise} \end{cases}$$

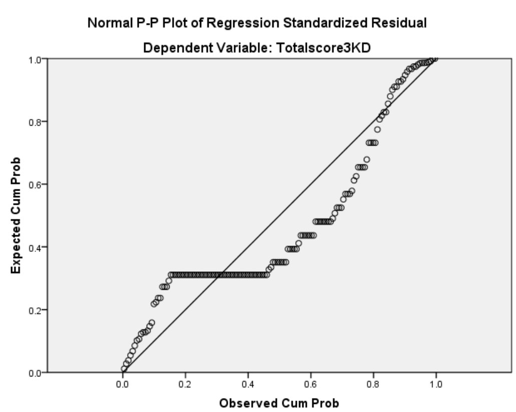
$X_{3i} \equiv$ Indicator variable for whether or not i^{th} untrained observation is from Hospital 8

$$= \begin{cases} 1, & \text{if } i^{th} \text{ untrained observation is from Hospital 8} \\ 0, & \text{otherwise} \end{cases}$$

The model selected via stepwise selection (entry significance level = 0.05; exit significance level = 0.1), is given by:

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_{1i} + \hat{\beta}_2 X_{2i} + \hat{\beta}_3 X_{3i} = 58.441 + 3.698X_{1i} + 11.781X_{2i} - 13.919X_{3i}$$

Since none of the two-way interaction effects with X_1 (years of experience using eICU technology) were found to be statistically significant at the 10% significance level, the model selected via stepwise selection (above) is the final model.



APPENDIX E

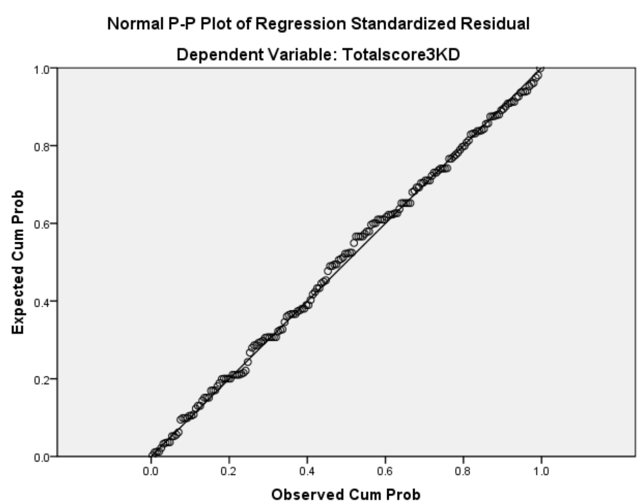
Multiple Linear Regression Modeling Using Stepwise Selection

Model 2: 3KD Scores for Trained Observations (n=180)

The model selected via stepwise selection (entry significance level = 0.05; exit significance level = 0.1), is given by:

$$Y = \text{Total 3KD Score (trained observations)}$$
$$= \beta_0 + \beta_1(\text{years of eICU use}) + \beta_2(\text{Hospital9}) + \beta_3(\text{Hospital10}) + \beta_4(\text{Hospital12}) + \beta_5(\text{Hospital1}) + \beta_6(\text{Hospital4}) + \beta_7(\text{Hospital5}) + \beta_8(\text{Hospital2}) + \varepsilon$$
$$= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon$$
$$= 68.51 + 1.307X_1 - 7.31X_2 - 5.289X_3 - 5.962X_4 + 7.537X_5 + 8.367X_6 + 7.217X_7 + 10.49X_8 + \varepsilon$$

Since none of the two-way interaction effects with X_1 (years of experience using eICU technology) were found to be statistically significant at the 10% significance level, the model selected via stepwise selection (above) is the final model.



APPENDIX F

Multiple Linear Regression Modeling Using Stepwise Selection

Model 3: TTAS Scores for Untrained Observations (N=147)

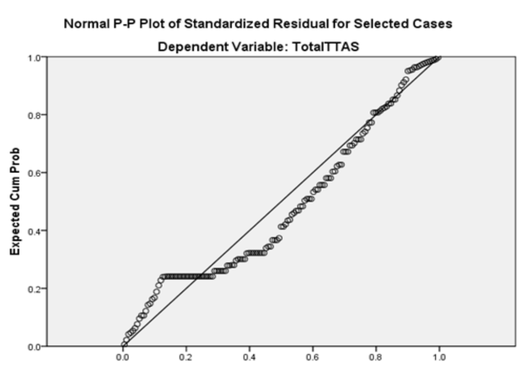
The model selected via stepwise selection (entry significance level = 0.05; exit significance level = 0.1), is given by:

Define:

$X_1 = 7 - \text{Yrs of eICU tech use}$
$X_2 = \text{Hospital2}$
$X_3 = \text{Hospital4}$
$X_4 = \text{Hospital5}$
$X_5 = \text{Hospital8}$
$Y = \text{TTAS}$

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$
$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \hat{\beta}_3 X_3 + \hat{\beta}_4 X_4 + \hat{\beta}_5 X_5$$
$$= 104.632 + 6.614X_1 + 20.702X_2 + 12.664X_3 + 16.035X_4 - 17.009X_5$$

Since none of the two-way interaction effects with X_1 (years of experience using eICU technology) were found to be statistically significant at the 10% significance level, the model selected via stepwise selection (above) is the final model.



APPENDIX G

Multiple Linear Regression Modeling Using Stepwise Selection

Model 4: Multiple Linear Regression: TTAS Scores for Trained Observations (N=180)

The model selected via stepwise selection (entry significance level = 0.05; exit significance level = 0.1), is given by:

Define:

$X_1 = \text{Hospital9}$

$X_2 = \text{Setting1}$

$X_3 = \text{Hospital1}$

$X_4 = \text{Hospital4}$

$X_5 = \text{Hospital5}$

$X_6 = \text{Hospital2}$

$Y = \text{TTAS}$

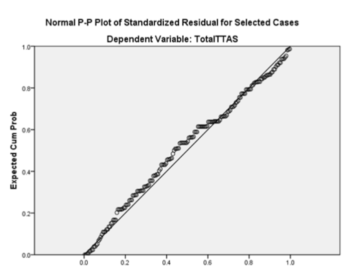
Linear model: is given by:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$$

$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \hat{\beta}_3 X_3 + \hat{\beta}_4 X_4 + \hat{\beta}_5 X_5 + \hat{\beta}_6 X_6$$

$$= 133.701 - 14.808X_1 - 14.093X_2 + 15.901X_3 + 17.792X_4 + 15.747X_5 + 19.392X_6$$

Since none of the two-way interaction effects with X_1 (hospital 9) were found to be statistically significant at the 10% significance level, the model selected via stepwise selection (above) is the final model.



APPENDIX H

INOVA HEALTH
SYSTEM

Inova Health System Institutional Review Board
Inova Fairfax Hospital
3300 Gallows Road,
Falls Church, Virginia 22042-3300
Tel 703-776-3167
*70.3_* --6_6678

Certificate of Exemption

The following was reviewed and has been found to meet the requirements under 45-CFR-46 as being exempt from the requirement of IRB review

Date: June 15, 2010

Investigator: Theresa M Davis, RN, MSN
Partnering Disaster Response and Mobile Telemedicine: Exploring the Impact of Training

Study Name: Techniques on the User's Attitude and Intention to Use eCareMobile During a Mass Casualty Incident
IRB Number: 10.079

Study Site(s): Inova Health System
45-CFR-46 101 (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:

Exemption (i) information obtained is recorded in such a manner that human subjects can be identified, directly

Category: or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Exemption is No personal identifiers are being collected.

granted subject to: All outcomes will be described in the aggregate.
Waiver of signed consent form granted per Section 46.117(c) Research presents no more than

Consent Waiver minimal risk of harm to subject and involves no procedures for which written consent is normally required outside of research context.

If you have questions, please contact the Inova IRB at 703-776-3167 or 703-776 - 3370
This is to certify that the information contained herein is true and correct as reflected in the records

of the Inova Institutional Review Board. I certify that the Inova IRB is in full compliance with all condition pursuant to the Inova Federal Wide Assurance (FWA)

*Laura Miller, **MSHA, IRB** Manager Date*

APPENDIX I

Title: Partnering Disaster Response and Mobile Telemedicine: Exploring the Impact of Training Techniques on the User's Attitude and Intention to Use eCareMobile during a Mass Casualty Incident

Principal Investigator: Theresa M. Davis, RN, MSN
Informed Consent for a Research Study

INTRODUCTION AND PURPOSE OF THE STUDY
You are eligible to participate in a research study. The purpose of the study is to explore the impact of a comprehensive mobile telemedicine curriculum on the user's attitude and intention to use eCareMobile during a mass casualty incident. The results of this survey will be used to: Evaluate and improve a curriculum for Mass Casualty Incident training utilizing eCareMobile Technology. Completion of the survey should take approximately 10 minutes.

What will happen if I take part in this research study?
If you agree to participate, please complete the attached survey. Place the completed survey in the return envelope and return to: Theresa M. Davis

What risks or benefits can I expect from being in the study?
The only foreseeable risk to you is possible loss of confidentiality. The potential benefit to you is a greater understanding of the use of Mobile Telemedicine during a Mass Casualty Incident.

Will my medical information be kept private?
Efforts have been made to protect your identity. No identifying code has been placed on the survey form and no one outside of the research team will have access to the individual completed surveys. Only group data will be reported and responses will not be person-identifiable. Once data analysis is complete and the research results are reported, the individual surveys will be shredded. You may request a copy of the research results by contacting Theresa M. Davis.

What other choices do I have if I do not take part in this study?

Taking part in this research study is voluntary. If you choose not to participate, there will be no penalty or loss of benefits to which you are otherwise entitled.

Who can answer my questions about the study?

If you have any questions regarding this research study, please contact: Theresa M. Davis at 703-289-8608. If you would like additional information about your rights as a participant in a research study, contact the Institutional Review Board Manager (committee that reviews research) at:

(703) 776-3167 Inova Institutional Review Board; Inova Fairfax Hospital; 300 Gallows Road; Falls Church, VA 22042

APPENDIX J

Informed Consent Template Language
Integrating Telemedicine for Disaster Response: Testing the Emergency Telemedicine Technology Acceptance Model (ETTAM)

INFORMED CONSENT FORM

RESEARCH PROCEDURES

This research is being conducted to test the Emergency Telemedicine Technology Acceptance Model using Telemedicine during a simulated Mass Casualty Incident. If you agree to participate, you will have the choice of participation in Telemedicine training. Prior to the training you will be asked to fill out a 39 question survey measuring technology acceptance. There will also be an opportunity to fill out the survey again after receiving various methods of telemedicine training. There are no experimental procedures. Completion of the survey should take approximately 15-20 minutes. There are no foreseeable risks for participating in this research.

BENEFITS

There are no direct benefits to participants.

CONFIDENTIALITY

The survey is anonymous. Names or other identifiers will not be placed on the surveys or in the data analysis. The data will be kept in a locked file cabinet in the investigators office, a code will be placed on the survey and other collected data but the code will not be linked to the identification of individuals

PARTICIPATION

Your participation is voluntary, and you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or loss of benefits to which you are otherwise entitled. There are no costs to you or any other party. There is no compensation for completing the study.

CONTACT

This research is being conducted by Theresa M. Davis at George Mason University. She may be reached at 703-289-8608 for questions or to report a research-related problem. You may also contact Dr. Jean Moore at George Mason University at 703-993-1923. You may contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research.This research has been reviewed according to George Mason University procedures governing your participation in this research. Current and proposed consent forms are attached.

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CURRICULUM VITAE

Theresa Davis received her Associates Degree in Nursing from Northern Virginia Community College in 1986. She received her Bachelor of Science in Nursing from George Mason University in 1998 and a Master of Nursing Administration from George Mason in 2002. Theresa holds a Certificate in Education since 2004. Her professional experiences have been in Trauma and Neurosurgical Critical Care. As the Clinical Operations Director, Theresa led the implementation and sustainment of the enVision eICU program at Inova Health System and is a telemedicine consult for disaster preparedness for the Northern Virginia Hospital Alliance. Theresa is a member of Sigma Theta Tau International Honor Society of Nursing, the American Association of Critical Care Nurses, the American Telemedicine Association and the Society of Critical Care Medicine. Theresa was past co-chair for the AACN tele-ICU workgroup and coauthored the *Guidelines for Tele-ICU Nursing Practice*. Theresa is the chair of the American Telemedicine Association TeleICU Special Interest Group and chair of the ATA TeleICU standards and guidelines workgroup.